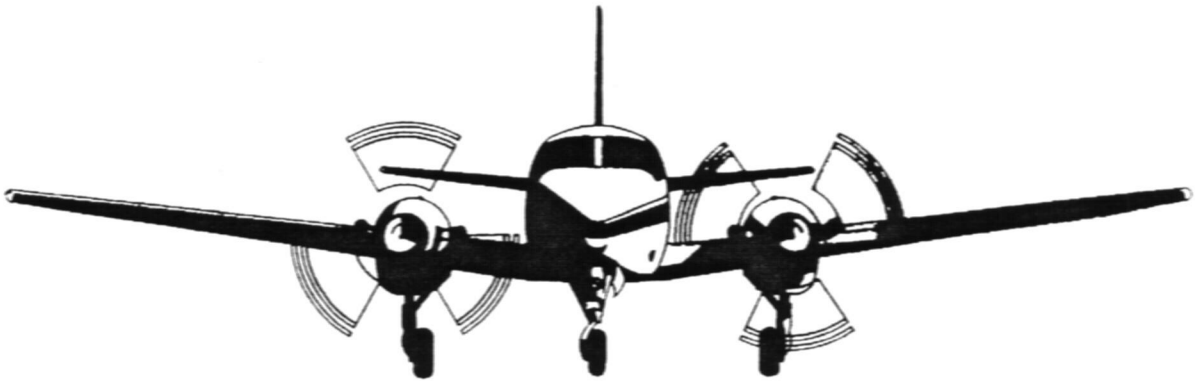
NAVIGATIONAL AIDS AND AVIATION SERVICES SPECIAL STUDY



ARIZONA DEPARTMENT OF TRANSPORTATION

AERONAUTICS DIVISION

November 1998

ACKNOWLEDGEMENTS

The preparation of the Navigational Aids and Aviation Services Special Study incorporated input from the aviation public and private sectors as members of a Project Advisory Committee and through the course of pilot information meetings. Those participating as member of the Committee are listed below. The insight they provided from their industry perspectives to the formulation of the Study recommendations is greatly appreciated.

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QED and ADOT Aeronautics also wish to recognize those pilots who attended the briefing meetings for their input. These combined outreach efforts served to enhance the Study and establish a basis from which future improvements to the Arizona system of airports can be implemented.

QED

Airport & Aviation Consultants

November 30, 1998

Mr. Gary Adams
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Dear Mr. Adams:

QED is pleased to submit the Navigational Aids and Aviation Services Special Study.

The Study represents many months of intensive evaluation, documentation, review and discussion among the participants in the effort. Special recognition should be given to the contributions of the members of the project advisory committee and the staff of the Aeronautics Division.

We trust that this document will serve as a working guideline for implementation of instrument approach procedures, visual landing aids, communications, weather facilities and aviation services to enhance flight safety in Arizona. The benefits of these facilities and services will be enjoyed by users of the airport and aviation system as well as potentially other segments of the Arizona public and private economies.

We are pleased to have had this opportunity to assist the Division in this progressive effort.

Sincerely,

Ronald F. Price

Ronald F. Price, P.E.
Principal

RFP/pss
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EXECUTIVE SUMMARY

Introduction

The Arizona Department of Transportation (ADOT), Aeronautics Division has prepared the Navigational Aids and Aviation Services Special Study to provide guidance in the development of the Arizona Primary and Secondary system of 95 airports with regard to instrument approaches, visual landing aids, communications, weather and aviation services. A project advisory committee representing pilot, airport management and aviation system users participated in the development of the Study findings, priorities and recommendations. Pilot information meetings were also conducted in Flagstaff, Phoenix and Tucson to present preliminary findings and obtain user input.

Study Basis

A primary objective of the Study is to identify improvements to the Arizona system of airports that have technical, practical and financial merit. This is accomplished by balancing facility improvements with the system's ability to accommodate them in an economically viable fashion. Use of operational and performance evaluation criteria and benefit/cost analyses, tempered with consideration of system objectives, allows for such assessments. For example, to address the need for improved instrument approach capability, application of global positioning system (GPS) technology is emphasized. GPS, in most instances, does not require the installation of ground facilities. However, the airport's physical layout with respect to compliance with applicable design standards may limit its ability to achieve a new or improved instrument approach in terms of lower minimums. The cost to meet standards versus the safety and operational benefits associated with the potential instrument approach minimums may not balance and thus suggest that the approach procedure is not economically justified. This same reasoning may apply to the installation of an approach lighting system to reduce the visibility minimum. The question to be addressed in this situation is whether the cost to install, operate and maintain the approach lighting system (its life cycle cost) is more or less than the incremental safety and operational benefits.

Application of this planning rationale was made to the other components of the Study such as the communications and aviation weather facilities. Visual landing aid improvements were based on establishing a standard level of service to pilots irrespective of airport activity levels.

Aviation service needs were determined primarily from the results of a random survey of pilots and airport managers/operators as well as input from public information meetings conducted during the Study. It was recognized that some of the needs identified by the "users" could not be provided or obtained through ADOT Aeronautics resources. Nevertheless, these needs were listed in the Study.

The Study provides an overview of existing capabilities, deficiencies and recommended improvements to be implemented over a 10-year period. Although economics has played a significant role in determining facility needs and the priorities for staging these improvements, operational factors such as system gaps, remoteness and emergency services may be more important under certain conditions. This situation is more pronounced in the northeast quadrant of Arizona (northern portions of Apache and Navajo counties). Some of the needs in this region of the State have been accommodated to meet system objectives with regard to low approach minimum capabilities and weather movement coverage. However, consideration of other operational factors may be appropriate when formulating the ADOT Aeronautics Five-Year Airport Development Program.

Guidelines/Criteria

The Planning Advisory Committee for the Study established the following criteria to be used in evaluating terminal navigational aid (NAVAID) facilities in Arizona:

1. A need for an adequate number of practice instrument approach facilities.

2. Access to emergency medical facilities and capability for night and/or adverse weather condition operations at airports in Arizona.

3. The use of Federal Aviation Administration Terminal Instrument Approach Procedures (TERPS) and airport design guidelines to determine the ability of airports to meet global positioning system (GPS) criteria.

4. All commercial service and reliever airports should be evaluated for the potential to provide a GPS precision instrument approach capability (Category I – 200-foot ceiling and ½-mile visibility).

5. All other paved runway, public-use airports in the State should be reviewed for the potential to provide GPS nonprecision instrument approaches (minimums of 300-foot ceiling and ¾-mile visibility or 400-foot ceiling and 1 mile visibility). All active Native American airports were to be included in the Study.

6. Visual landing guidance facilities will be planned for the primary end of the primary runway at each airport in Arizona.

Findings

Principal findings with respect to the key components of the Study are presented below.

GPS Approaches

Thirty-one (31) of the 95 system airports have an instrument approach procedure and, of these, 10 meet the evaluation criterion expressed as a desired or target level of capability in terms of approach minimums. Eleven (11) of the remaining 21 airports can achieve their target levels by development and publication of a new procedure as suggested in the Study. Of the final 10 airports in this category, 6 airports cannot qualify for an improved or new procedure due to an unacceptable cost/benefit ratio. Of the remaining four (4) airports, insufficient information was available concerning compliance with FAA design standards to make an objective determination concerning the GPS approach capability.

Many airports (64) do not have an existing instrument approach procedure. Evaluation of these airports indicated that 25 could expect to support an instrument approach capability consistent with their assigned minimums category. Also in this group were five (5) airports that could not qualify for an instrument procedure due to an unacceptable cost/benefit ratio. At another five (5) airports, it was determined that an instrument approach procedure was not possible due to an inability to obtain TERPS criteria. Information concerning compliance with FAA design standards was not available for 29 airports identified in this group and additional data will be necessary to justify an instrument approach procedure.

Visual Landing Aids

Visual landing aid facilities were required for the primary end of the primary runway at each airport to provide a consistent service level at airports in Arizona. A total of 44 airports meet these criteria at the present time while these facilities need to be installed at 51 airports in the system.

Communications

The ability of pilots to conveniently and efficiently communicate with air traffic control facilities immediately before and after flight is a valuable service for the more active airports. The Study revealed that 11 airports within the system should be provided with this capability. After installation of these facilities, the total number of airports in Arizona with this capability will increase from 35 to 46 airports.

Weather

Automated weather observing system (AWOS) and automated surface observing system (ASOS) units are operational at 25 airports in Arizona. Application of a series of evaluation criteria including cost/benefit analyses demonstrated a need for an additional 41 units (28 AWOS-3 and 13 AWOS-A).

The establishment of a weather network to acquire and disseminate aviation weather data on a real-time basis to pilots, airports, federal and state agencies, and other interest groups, including the general public is possible. The network can be established using existing and planned State telecommunications systems and the use of personal computers at airports. The network may be implemented under a public or a public/private partnership arrangement.

Aviation Services

The Study revealed that most pilots are satisfied that the essential services required at airports are available to them. Both pilots and airport operators/managers, however, see a need for more hangars, covered tiedowns, wash racks, rental/courtesy cars, restaurants/food service and flight planning rooms. High on the list of unmet needs was an Arizona aeronautical chart (previously published in 1992-93 but discontinued), expansion of aviation seminars and access to airport/aviation data and/or publications.

Implementation

The criteria for staging NAVAID facilities throughout the 10-year planning period was based upon scheduling those airports capable of realizing the most operational benefit in the least amount of time for the initial investment dollars. The number of airports and the dollars invested in the NAVAID facilities is illustrated below:

	Number of Airports				
	GPS	MALSR/ SSALS	AWOS	VISAIDS	GCO
Stage I (1-4 years)	25	1	23	19	11
Stage II (5-7 years)	13	8	6	19	0
Stage III (8-10 years)	30	3	12	18	0

	Capital Investment ($ x 1,000)				
	GPS	MALSR/ SSALS	AWOS	VISAIDS	GCO
Stage I (1-4 years)	0	150	1,140	821	132
Stage II (5-7 years)	0	2,000	385	821	0
Stage III (8-10 years)	0	750	2,305	821	0
Total	0	2,900	3,830	2,463	132

Note: If Category I ILS (or TLS) equipment is installed at four (4) airports that are qualified for the equipment, Stage I costs will increase by an additional $2,000,000.

System capital costs during the 10-year period could amount to approximately $11.5 million in 1998 dollars. Of that amount, federal funding could account for as much as $8.3 million but more likely those costs would be absorbed by the State. Operating costs would add an additional $728,000 to annual system costs (which includes approximately $451,000 in annual replacement costs).

Recommendations

The objective of the Study was to provide a comprehensive review of the existing navigational aids, aviation weather collection and dissemination systems and the aviation services provided to pilots and other users of aviation in the State. The NAVAIDS Study examined the existing terminal navigational facilities in the State, evaluated the capability of all public and Native American airports to support improved or new NAVAID facilities and quantified the costs associated with upgrading and improving the existing system during the next 10 years. Following the recommendations in this Study, the aviation system in the State of Arizona will be safer, more efficient and improve aviation service to pilots and other users of the system. The basic NAVAID facilities and aviation services recommendations made in the Study are:

1. Coordinate the design of GPS instrument approaches, both precision and nonprecision, with the FAA Western-Pacific Region. Follow the priority of GPS approach establishment determined in the Study for the most cost effective and operational benefit.

2. Procure and install visual landing aids required at system airports to improve service and safety throughout the system.

3. Equip eligible airports with ground communication outlets (GCO). The most efficient and economical method to install GCO equipment would be purchase the entire package and distribute the equipment to eligible airports through use agreements. Use agreements should provide for removal of the GCO in the event that the sponsor could not fulfill its operating obligation.

4. Equip airports with automated weather observing system (AWOS) utilizing a package procurement system similar to that recommended for GCO's. Use agreements should include FAA operating and maintenance procedures for standardization throughout the State aviation system.

5. Evaluate the necessity of reallocating priority for NAVAID installation in those areas of the State where there are deficient aviation services and facilities (Northeast and Southeast Arizona). Emergency service availability should be a major factor in determining priority.

6. Coordinate with the State agencies/divisions to design a weather network to serve multiple users and needs. Priority should be given to the northern half of the State. Examine the possibility of a public/private partnership to operate and maintain the network.

7. Periodically survey pilots, airports and fixed base operators to assess aviation needs and services. Produce the Arizona Aeronautical chart on a regular basis. Increase communication with the State's pilots and airport operators through newsletters, seminars and the Internet. Include the FAA in the communication/education process.

8. Analyze those airports/facilities for which insufficient information was available to determine their capacity to support NAVAID facilities and services. Determine their ability to comply with FAA airport design criteria and TERPS. Once determined, modify the results of this Study to include additional requirements in the NAVAIDS staging and prioritization schedules/programs.

Summary

The NAVAIDS and Aviation Services Special Study met the objectives of the Aeronautics Division in defining the adequacies of the State's existing navigational aids and aviation services. The Study analyzed the deficiencies and outlined a plan to reduce or eliminate the deficiency, improve the service to pilots and other users and provide facilities in remote areas to facilitate better access to emergency services. The Study will provide a basis for future development of the State's aviation system by improving aviation services throughout, increasing access to weather information for pilots and other users and increasing safety and security of flying within our borders. In addition, there is a potential to produce an intra-State weather network that could fulfill the needs of other State agencies and divisions.

The Study also assessed the costs to the State, the airport and the user. Three cost scenarios were studied to provide the State with funding requirements that might take place under a certain set of circumstances. At the time of the Study, the Aeronautics Division had lost a significant portion of its former aviation revenue. The FAA was seriously considering the reduction in procurement of additional NAVAID facilities for airports, a reduction in the number of FAA-maintained navigational aids and other programs, which would have a serious financial impact on major portions of this Study.

The major tenets of the Study remain intact. Prioritization of facilities were based primarily on economic factors (cost/benefit ratio) but provisions were made to recognize significant deficiencies in NAVAID coverage or availability of emergency services in specific instances. There is flexibility within the program and schedules to allow for adjustment in priorities should that be necessary. In conclusion, the Study has provided the State with a sound basis for improving NAVAIDS and services in the next 10 years as well as a foundation to conduct additional studies in the future. The Study is consistent with the goals and objectives of the Aeronautics Division and should serve the Division well throughout the planning period.

Chapter 1

INTRODUCTION

The State of Arizona acting through its Department of Transportation, Aeronautics Division has prepared the Navigational Aids and Aviation Services Special Study to support the mission of encouraging and advancing the safe and orderly development of aviation in the State. A project advisory committee representing pilot, airport management and aviation system users participated in the identification of study findings, recommendations and priorities as input to the planning process. User surveys and pilot information meetings were also conducted to obtain input. Key items to be addressed in the Study include instrument approaches, visual landing aids, communications, weather and aviation services.

The Study identifies the extent of existing federal and nonfederal resources available in the Arizona aviation system with respect to:

1. Terminal instrument approach capabilities.
2. Visual landing aids.
3. Air traffic and weather radar coverage.
4. Automated and manned weather observing facilities.
5. Radio and telecommunications networks.
6. Aviation services and facilities.

These existing facilities and capabilities are then compared to anticipated demands to identify future individual airport and aviation system needs. Care is exercised to ensure that State initiatives supplement and complement federal programs in order to maximize the investment of State and local resources. Underlying these study activities is an assessment of the implementation schedule of new programs and facilities and future technologies in areas related to navigation, communications and weather data reporting and networking.

The Study then addresses program options that are appropriate for State establishment and presents an implementation and prioritization plan. The latter considers funding requirements, staging and the potential for private sector participation in a form public/private partnerships for appropriate system needs.

The chapters that follow present a logical progression of analysis of each of the study elements and their implementation in the context of an overall program. Inasmuch as the topics addressed in this study are technical and specific to the air transportation sector, a glossary of acronyms and definitions is presented in Appendix A as an aid to the reader

Chapter 2

EXISTING SYSTEM FACILITIES

Introduction

The Arizona system of airports includes 95 facilities of varying scale and levels of activity. The system airports include three facilities that are currently closed in the northeast quadrant of the State and one facility in southeastern Arizona that is temporarily closed for construction. The northeastern closed airports are included because they may be reinstated at any time into operation and may contribute to meeting system objectives for that region. Additionally, three new airports are included in the Study.

NAVAIDS, VISAIDS and Communications

The deployment of terminal navigational aids, visual landing aids, aviation weather facilities and communications outlets throughout the Arizona system of public-use airports is presented in Table 2-1 and Table 2-2. Maintenance responsibility for these facilities may be assigned to the Federal Aviation Administration (FAA) or the local airport sponsor (owner) and is also denoted in the tables. The data was obtained from FAA records of equipment owned and maintained by the agency, information provided in the "Airport Facility Directory" publication and input from airport owners.

The topics addressed in this study are relatively technical in nature and involve the use of acronyms. As an aid to the reader, a glossary of terms is presented in Appendix A.

A review of the data presented in Table 2-1 and Table 2-2 indicates that:

1. With four exceptions, the installation and maintenance of terminal navigation aids (NAVAIDS) has been a FAA responsibility. The exceptions are the nondirectional radio beacon (NDB) facilities at the Avra Valley, Chandler Municipal, Glendale Municipal and Sedona airports. Each NDB was acquired through a combination of FAA, Arizona Department of Transportation (ADOT) and airport sponsor funding through the federal Airport Improvement Program (AIP). As a

consequence, maintenance responsibilities for these facilities are assigned to the airport sponsors.

2. Nearly all visual landing aids (VISAIDS) were acquired through grant programs administered by the FAA and ADOT or by the airport sponsor solely. Federal and ADOT grants do not usually allow for maintenance and thus most facilities are maintained by the airport sponsor. Those facilities which are maintained by the FAA are typically approach lighting systems which complement precision instrument landing systems also established and maintained by the FAA, and certain VISAIDS. All runway and taxiway edge lighting systems are maintained by the airport sponsor.

3. Automated surface observing system (ASOS) facilities operational at the airports are maintained by the National Weather Service (NWS) or, when installed at a military air base or facility, by the responsible Department of Defense agency. Automated weather observing systems (AWOS) facilities are the responsibility of the FAA when installed under their Facilities and Equipment Program (F&E); otherwise, AWOS facilities are maintained by the airport sponsor.

4. Radio communications facilities comprise a variety of types. Those used for communication from the airport and the airport environment to en route air traffic control facilities such as remote transmitter/receiver (RTR) and remote communication outlet (RCO) units are maintained by the FAA. The FAA also establishes and maintains remote radio communication systems (RRCS) which are used to activate those VISAIDS which are similarly assigned to the FAA. Airport sponsors may also install similar systems to activate VISAIDS under their responsibility. These are indicated by the pilot controlled lighting (PCL) acronym. Communication between the airport and aircraft where an air traffic control tower (ATCT) is not operational is conducted on radios operated and maintained by the airport sponsor or its designee in accordance with Federal Communications Commission (FCC) standards.

In summary, the data presented in Table 2-1 and Table 2-2 indicates that the FAA is responsible for a majority of the terminal NAVAIDS, federal AWOS and some VISAID facilities at those airports with scheduled airline service and/or significantly higher activity levels. The NWS has maintenance responsibility for ASOS units. Airport sponsors at all airports are responsible for runway and taxiway edge lighting systems and most VISAIDS and communications facilities.

In addition to NAVAIDS and communications facilities located on the airports, the FAA has established these facilities at strategic locations in Arizona. This equipment is used for en route navigation (VORTAC and NDB) and as transmission nodes on internal FAA communications linkages (RCO). Because a VORTAC operates on a line-of-sight basis, terrain in its vicinity can restrict the reception of its transmitted signals at different altitudes. The extent of such restriction is typically a factor for flights flown at relatively low altitudes. RCO facilities are commonly collocated with VORTAC units when used off-airport and in such instances are given the same identifier name. These facilities and relevant data are summarized in Table 2-3. All these facilities are maintained by the FAA.

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Table 2-1

EXISTING FACILITIES SUMMARY
TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
Ajo Municipal	None	--	LIRL (12-30)	Airport	
			VASI-2 (12)	Airport	
			VASI-2 (30)	Airport	
Ak-Chin Community	None	--	None	--	
Av Suquilla	None	--	MIRL (1-19)	Airport	
			PAPI-2 (1)	Airport	
			PAPI-2 (19)	Airport	
Avra Valley	NDB	Airport	MIRL (3-21)	Airport	NDB is VFR-only use.
			REIL (3)	Airport	
			REIL (12)	Airport	
			REIL (21)	Airport	
			REIL (30)	Airport	
			VASI-2 (3)	Airport	
			VASI-2 (21)	Airport	
Bagdad	None	--	LIRL	Airport	
Benson Municipal (New)	None	--	None	--	
Bisbee Douglas International	VORTAC	FAA	MIRL (8-26)	Airport	
			MIRL (17-35)	Airport	
			VASI-2 (17)	FAA	
			VASI-2 (35)	Airport	
Bisbee Municipal	None	--	MIRL (17-35)	Airport	
			PAPI-2 (17)	Airport	
			PAPI-2 (35)	Airport	
Bowie	None	--	None	--	

Table 2-1

EXISTING FACILITIES SUMMARY
TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
Buckeye Municipal	None	--	MIRL (17-35)	Airport	
			PAPI-4 (17)	Airport	
			PAPI-4 (35)	Airport	
Casa Grande Municipal	CAT I ILS (5)	FAA	MALSR (5)	FAA	
	DME (5)	FAA	MIRL (5-23)	Airport	
			VASI-2 (23)	Airport	
Chandler Municipal	NDB	Airport	MIRL (4L-22R)	FAA	
			MIRL (4R-22L)	FAA	
			PAPI-4 (4R)	FAA	
			PAPI-4 (22L)	FAA	
			REIL (4R)	FAA	
			REIL (22L)	FAA	
			VASI-2 (4L)	FAA	
			VASI-2 (22R)	FAA	
Chinle	None	--	None	--	
Cliff Dwellers Lodge	None	--	None	--	
Cochise College	None	--	LIRL (5-23)	Airport	
Cochise County	None	--	MIRL (3-21)	Airport	
Colorado City Municipal	NDB	FAA	MIRL (2-20)	Airport	
			MIRL (11-29)	Airport	
			PAPI-2 (11)	Airport	
			PAPI-2 (29)	Airport	
			REIL (11)	Airport	
			REIL (29)	Airport	

Table 2-1

EXISTING FACILITIES SUMMARY
TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
Coolidge Municipal	None	--	MIRL (5-23)	Airport	
			VASI-2 (5)	Airport	
			VASI-2 (23)	Airport	
Cordes Lake (New)	None	--	None	--	
Cottonwood Municipal	None	--	MIRL (14-32)	Airport	
			PAPI-2 (14)	Airport	
			PAPI-2 (32)	Airport	
			REIL (32)	Airport	
Douglas Municipal	None	--	MIRL (3-21)	Airport	
			PAPI-4 (3)	Airport	
			PAPI-4 (21)	Airport	
Duncan-O'Connor Field (Closed)	None	--	None	--	
Eloy Municipal	None	--	MIRL (2-20)	Airport	
			ODALS (20)	Airport	ODALS out of service
Ernest A. Love Field	CAT I ILS (21L)	FAA	MALSR (21L)	FAA	
	DME (21L)	FAA	MIRL (3L-21R)	Airport	
			MIRL (3R-21L)	Airport	
			MIRL (12-30)	Airport	
			PAPI-2 (3L)	Airport	
			PAPI-2 (12)	Airport	
			PAPI-2 (21R)	Airport	
			PAPI-2 (30)	Airport	
			PAPI-4 (3R)	Airport	
			PAPI-4 (21L)	Airport	
Estrella Sailport	None	--	None	--	

Table 2-1

EXISTING FACILITIES SUMMARY
TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
Flagstaff-Pulliam	CAT I ILS (21)	FAA	MALSR (21)	FAA	CAT I ILS includes GS and LOC only
	NDB	FAA	MIRL (3-21)	Airport	
	VOR/DME	FAA	VASI-4 (3)	FAA	
			VASI-4 (21)	FAA	
Flying J Ranch	None	--	None	--	
Ganado	None	--	None	--	
Gila Bend Municipal	VORTAC	FAA	LIRL (4-22)	Airport	
Glendale Municipal	NDB	Airport	MIRL (1-19)	Airport	
			PAPI-2 (1)	Airport	
			PAPI-2 (19)	Airport	
Globe-San Carlos Regional	NDB	FAA	MIRL (9-27)	Airport	NDB out of service
			VASI-2 (9)	Airport	
			VASI-2 (27)	Airport	
Grand Canyon Bar-Ten	None	--	None	--	
Grand Canyon Caverns	None	--	None	--	
Grand Canyon National Park	CAT I ILS (3)	FAA	MALSR (3)	FAA	CAT I ILS (3) MM unusable
	VOR/DME	FAA	MIRL (3-21)	Airport	
			REIL (21)	FAA	
			VASI-4 (21)	FAA	
Grand Canyon West	None	--	None	--	
Greasewood (Closed)	None	--	None	--	
Greenlee County	None	--	MIRL (7-25)	Airport	
H.A. Clark Memorial Field	None	--	MIRL (18-36)	Airport	

Table 2-1

EXISTING FACILITIES SUMMARY
TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
Holbrook Municipal	None	--	MIRL (3-21)	Airport	
			REIL (3)	Airport	
			REIL (21)	Airport	
			VASI-2 (3)	Airport	
			VASI-2 (21)	Airport	
Hualapai Tribal	None	--	None	--	
Kayenta	None	--	MIRL (5-23)	Airport	MIRL (5-23) out of service
			PVASI (23)	Airport	PVASI (23) out of service
Kearney	None	--	None	--	
Kingman	VOR/DME	FAA	MIRL (3-21)	Airport	
			MIRL (17-35)	Airport	
			PAPI-4 (17)	Airport	
			PAPI-4 (35)	Airport	
			VASI-2 (3)	Airport	
			VASI-2 (21)	Airport	
Lake Havasu City Municipal	None	--	MIRL (14-32)	Airport	
			PAPI-4 (14)	Airport	
			PAPI-4 (32)	Airport	
			REIL (14)	Airport	
			REIL (32)	Airport	
Laughlin/Bullhead International	None	--	MIRL (16-34)	Airport	
			PAPI-4 (16)	Airport	
			PAPI-4 (34)	Airport	
			REIL (16)	Airport	
			REIL (34)	Airport	

Table 2-1

EXISTING FACILITIES SUMMARY
TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
Libby AAF/Sierra Vista	CAT I ILS (26)	US Air Force	HIRL (8-26)	US Air Force	
			LIRL (2-20)	US Air Force	
			MIRL (11-29)	US Air Force	
			PAPI-4 (11)	US Air Force	
			PAPI-4 (29)	US Air Force	
			VASI-2 (8)	US Air Force	
			VASI-2 (26)	US Air Force	
			REIL (16)	Airport	
Low Mountain (Closed)	None	--	None	--	
Lukachukai	None	--	None	--	
Marble Canyon	None	--	None	--	
Memorial Airfield	None	--	None	--	
Mesa-Falcon Field	NDB	FAA	MIRL (4L-22R)	Airport	
			MIRL (4R-22L)	Airport	
			PAPI-2 (4L)	Airport	
			PAPI-2 (4R)	Airport	
			PAPI-2 (22L)	Airport	
			PAPI-2 (22R)	Airport	
Nogales International	NDB	FAA	MIRL (3-21)	Airport	
	VOR/DME	FAA	SAVASI-2 (3)	Airport	
			SAVASI-2 (21)	Airport	

Table 2-1

EXISTING FACILITIES SUMMARY
TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
Page Municipal	VOR/DME	FAA	MIRL (15-33)	Airport	
			REIL (15)	Airport	
			REIL (33)	Airport	
			VASI-4 (15)	FAA	
			VASI-4 (33)	FAA	
Payson	None	--	MIRL (6-24)	Airport	
			PAPI-2 (24)	Airport	
Pearce Ferry	None	--	None	--	
Phoenix-Deer Valley	None	--	MIRL (7L-25R)	Airport	
			MIRL (7R-25L)	Airport	
			PVASI (7L)	Airport	
			PVASI (25R)	Airport	
			REIL (7L)	Airport	
			REIL 7R)	Airport	
			REIL (25L)	Airport	
			REIL (25R)	Airport	
			VASI-2 (7R)	Airport	
			VASI-2 (25L)	Airport	
Phoenix-Goodyear	None	--	MIRL (3-21)	Airport	
			REIL (3)	Airport	
			REIL (21)	Airport	
			VASI-2 (3)	Airport	
			VASI-2 (21)	Airport	

Table 2-1

EXISTING FACILITIES SUMMARY
TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
Phoenix-Sky Harbor International	CAT I ILS/DME (8R)	FAA	HIRL (8L-26R)	Airport	
	CAT I ILS (26R)	FAA	HIRL (8R-26L)	Airport	CAT I ILS (26R) includes GS and LOC only
			MALSR (8R)	FAA	
			REIL (26L)	Airport	
			REIL (26R)	Airport	
			VASI-4 (8L)	FAA	
			VASI-6 (26L)	FAA	
			VASI-4 (26R)	FAA	
Pinal Airpark	None	--	MIRL (12-30)	Airport	
Pine Springs	None	--	None	--	
Pinon	None	--	None	--	
Pleasant Valley International	None	--	None	--	
Polaca	None	--	LIRL (4-22)	Airport	
Quartzsite (New)	None	--	None	--	
Rock Point	None	--	None	--	
Rocky Ridge	None	--	None		
Rolle Airfield	None	--	None		
Ryan Airfield	CAT I ILS (6R)	FAA	MIRL (6R-24L)	Airport	
	NDB	FAA	REIL (6R)	Airport	
			REIL (24L)	FAA	
Safford Regional	None	--	MIRL (8-26)	Airport	
			MIRL (12-30)	Airport	
			PAPI-2 (8)	Airport	
			PAPI-2 (26)	Airport	
			VASI-2 (12)	Airport	
			VASI-2 (30)	Airport	

Table 2-1

EXISTING FACILITIES SUMMARY
TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
San Carlos	None	--	LIRL (14-32)	Airport	
San Manuel	None	--	None	--	
Scottsdale	NDB	FAA	MIRL (3-21)	Airport	
			PAPI-2 (3)	Airport	
			PAPI-2 (21)	Airport	
			REIL (3)	Airport	
			REIL (21)	Airport	
Sedona	NDB	Airport	MIRL (3-21)	Airport	NDB out of service
			REIL (3)	FAA	
			VASI-2 (3)	Airport	
			VASI-2 (21)	Airport	
Seligman	None	--	None	--	
Sells	None	--	None	--	
Show Low Municipal	NDB	FAA	MIRL (6-24)	Airport	
			PAPI-2 (6)	Airport	
			PAPI-2 (24)	Airport	
			REIL (6)	Airport	
			REIL (24)	Airport	
Shonto	None	--	None	--	
Springerville Babbit Field	None	--	MIRL (3-21)	Airport	
			MIRL (11-29)	Airport	
			VASI-2 (3)	Airport	
			VASI-2 (11)	Airport	
			VASI-2 (21)	Airport	

Table 2-1

EXISTING FACILITIES SUMMARY
TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
St. Johns Industrial Airpark	None	--	MIRL (14-32)	Airport	
			PAPI-2 (14)	Airport	
			PAPI-2 (32)	Airport	
			REIL (32)	Airport	
Stellar Airpark	None	--	LIRL (17-35)	Airport	LIRL (17-35) is nonstandard
			VASI-4 (17)	Airport	
Sun Valley	None	--	LIRL (18-36)	Airport	LIRL (18-36) is nonstandard
Superior Municipal	None	--	None	--	
Taylor Municipal	None	--	MIRL (3-21)	Airport	
			PAPI-2 (3)	Airport	
			PAPI-2 (21)	Airport	
			REIL (3)	Airport	
			REIL (21)	Airport	
Temple Bar	None	--	None	--	
Tombstone Municipal	None	--	None	--	
Toyei School (Closed)	None	--	None	--	
Tuba City	None	--	MIRL (15-33)	Airport	MIRL (15-33) out of service
			PAPI-2 (15)	Airport	PAPI-2 (17) out of service
			PAPI-2 (33)	Airport	PAPI-2 (35) out of service

Table 2-1

EXISTING FACILITIES SUMMARY TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
Tucson International	CAT I ILS (11L)	FAA	HIRL (11L-29R)	Airport	
	DME	FAA	MALSR (11L)	FAA	
			MIRL (11R-29L)	Airport	
			MIRL (3-21)	Airport	
			PAPI-4 (11L)	FAA	
			REIL (11R)	Airport	
			REIL (21)	FAA	
			REIL (29L)	Airport	
			REIL (29R)	Airport	
			VASI-4 (21)	FAA	
			VASI-6 (29R)	FAA	
Tuweep	None	--	None	--	
Whiteriver	None	--	MIRL (1-19)	Airport	
Wickenburg Municipal	None	--	MIRL (5-23)	Airport	
			PAPI-4 (23)	Airport	
Williams Gateway	CAT I ILS (30C)	Airport	ALSF-1 (30C)	Airport	
	VORTAC	FAA	MIRL (12C-30C)	Airport	
			MIRL (12R-30L)	Airport	
			VASI-4 (12C)	Airport	
			VASI-4 (30C)	Airport	
Window Rock	None	--	MIRL (2-20)	Airport	
			PAPI-2 (2)	Airport	
			REIL (2)	Airport	

Table 2-1

EXISTING FACILITIES SUMMARY
TERMINAL NAVAIDS AND VISAIDS

Airport	Terminal NAVAID		VISAID		Comments
	Type (R/W)	Maintenance	Type (R/W)	Maintenance	
Winslow Municipal	None	--	MIRL (4-22)	Airport	
			MIRL (11-29)	Airport	
			REIL (11)	FAA	
			REIL (22)	FAA	
			VASI-4 (11)	FAA	
			VASI-4 (22)	FAA	
			VASI-4 (29)	FAA	
Yuma International	CAT I ILS (21R)	FAA	HIRL (3L-21R)	Airport	Yuma International Airport is a civil / military joint use facility
			HIRL (3R-21L)	Airport	
			HIRL (8-26)	Airport	
			HIRL (17-35)	Airport	
			MALSR (21R)	FAA	
			REIL (35)	FAA	
			VASI-4 (17)	FAA	

Note: See Appendix A for acronym definitions.
Sources: FAA records and Airport / Facility Directory, 1997.

Table 2-2

EXISTING FACILITIES SUMMARY
WEATHER FACILITIES AND COMMUNICATIONS OUTLETS

Airport	Weather Facility		Communications Outlet		Comments
	Type	Maintenance	Type	Maintenance	
Ajo Municipal	None	--	CTAF	Airport	
			PCL	Airport	
			RCO	FAA	
Ak-Chin Community	None	--	None	--	
Av Suquilla	None	--	CTAF/Unicom	Airport	
			PCL	Airport	
Avra Valley	AWOS-3	Airport	CTAF/Unicom	Airport	
			PCL	Airport	
Bagdad	None	--	CTAF	Airport	
			RCO	FAA	
Benson Municipal (New)	None	--	None	--	
Bisbee Douglas International	None	--	CTAF/Unicom	Airport	
			RCO	FAA	
			RRCS	FAA	RRCS activates MIRL (17-35)
Bisbee Municipal	None	--	CTAF/Unicom	Airport	
			RCO	FAA	
Bowie	None	--	CTAF	Airport	
Buckeye Municipal	None	--	CTAF/Unicom	Airport	
			RCO	FAA	
Casa Grande Municipal	AWOS-3	FAA	CTAF/Unicom	Airport	
			RRCS	FAA	RRCS activates MALSR (5)
Chandler Municipal	AWOS-3	Airport	ATCT	Airport	
			ATIS	Airport	
			CTAF/Unicom	Airport	
			PCL	Airport	

Table 2-2

EXISTING FACILITIES SUMMARY
WEATHER FACILITIES AND COMMUNICATIONS OUTLETS

Airport	Weather Facility		Communications Outlet		Comments
	Type	Maintenance	Type	Maintenance	
Chinle	None	--	None	--	
Cliff Dwellers Lodge	None	--	Unicom	Airport	
Cochise College	None	--	CTAF/Unicom	Airport	
Cochise County	None	--	CTAF/Unicom	Airport	
			RCO	FAA	
Colorado City Municipal	AWOS-3	Airport	CTAF/Unicom	Airport	
		FAA	PCL	Airport	
Coolidge Municipal	None	--	CTAF/Unicom	Airport	
			PCL	Airport	
Cordes Lake (New)	None	--	None	--	
Cottonwood Municipal	None	--	CTAF/Unicom	Airport	
			PCL	Airport	
Douglas Municipal	None	--	CTAF/Unicom	Airport	
			PCL	Airport	
			RCO	FAA	
Duncan-O'Connor Field (Closed)	None	--	None	--	
Eloy Municipal	None	--	CTAF/Unicom	Airport	
Ernest A. Love Field	ASOS-C	NWS	ATCT	FAA	
			ATIS	FAA	
			CTAF	Airport	
			FSS	FAA	
			PCL	Airport	
			RTR	FAA	
			Unicom	Airport	
Estrella Sailport	None	--	CTAF	Airport	

Table 2-2

EXISTING FACILITIES SUMMARY
WEATHER FACILITIES AND COMMUNICATIONS OUTLETS

Airport	Weather Facility		Communications Outlet		Comments
	Type	Maintenance	Type	Maintenance	
Flagstaff-Pulliam	ASOS-C	NWS	ATCT	FAA	
			ATIS	FAA	
			CTAF	Airport	
			RCO	FAA	
			RRCS	FAA	RRCS activates MALSR (21) and MIRL (3-21)
Flying J Ranch	None	--	CTAF	Airport	
Ganado	None	--	CTAF	Airport	
Gila Bend Municipal	None	--	CTAF/Unicom	Airport	
			PCL	Airport	
			RCO	FAA	
Glendale Municipal			ATCT	FAA	
			CTAF	Airport	
			PCL	Airport	
			RCO	FAA	
			Unicom	Airport	
Globe-San Carlos Regional	None	--	CTAF/Unicom	Airport	
			PCL	Airport	
			RCO	FAA	
Grand Canyon Bar-Ten	None	--	CTAF	Airport	
Grand Canyon Caverns	None	--	CTAF/Unicom	Airport	

Table 2-2

EXISTING FACILITIES SUMMARY
WEATHER FACILITIES AND COMMUNICATIONS OUTLETS

Airport	Weather Facility		Communications Outlet		Comments
	Type	Maintenance	Type	Maintenance	
Grand Canyon National Park	ASOS-B	NWS	ATCT	FAA	
			ATIS	FAA	
			CTAF	Airport	
			RCO	FAA	
			RRCS	FAA	RRCS activates MALSR (3) and MIRL (3-21)
			RTR	FAA	
			Unicom	Airport	
Grand Canyon West	None	--	None	--	
Greasewood (Closed)	None	--	CTAF	Airport	
Greenlee County	None	--	CTAF	Airport	
			PCL	Airport	
H.A. Clark Memorial Field	None	--	CTAF	Airport	
Holbrook Municipal	None	--	CTAF	Airport	
			PCL	Airport	
			RCO	FAA	
Hualapai Tribal	None	--	None	--	
Kayenta	None	--	CTAF	Airport	
Kearney	None	--	CTAF	Airport	
Kingman	ASOS-D	NWS	CTAF/Unicom	Airport	
			RCO	FAA	
Lake Havasu City Municipal	AWOS-3	Airport	CTAF/Unicom	Airport	
			PCL	Airport	

Table 2-2

EXISTING FACILITIES SUMMARY
WEATHER FACILITIES AND COMMUNICATIONS OUTLETS

Airport	Weather Facility		Communications Outlet		Comments
	Type	Maintenance	Type	Maintenance	
Laughlin/Bullhead International	None	--	ATCT	FAA	
			CTAF	Airport	
			PCL	Airport	
			Unicom	Airport	
Libby AAF/Sierra Vista	AWOS-3	US Air Force	ATCT	US Air Force	
			ATIS	US Air Force	
			CTAF	US Air Force	
			PCL	US Air Force	
			Unicom	US Air Force	
Low Mountain (Closed)	None	--	None	--	
Lukachukai	None	--	None	--	
Marble Canyon	None	--	CTAF	Airport	
Memorial Airfield	None	--	Unicom	Airport	
Mesa-Falcon Field	LAWRS	FAA	ATCT	FAA	
			ATIS	FAA	
			CTAF	Airport	
			RTR	FAA	
			Unicom	Airport	
Nogales International	ASOS-D	NWS	CTAF/Unicom	Airport	
			PCL	Airport	
			RCO	FAA	
Page Municipal	ASOS-D	NWS	CTAF/Unicom	Airport	
			PCL	Airport	
			RCO	FAA	
Payson	None	--	CTAF/Unicom	Airport	

Table 2-2

EXISTING FACILITIES SUMMARY
WEATHER FACILITIES AND COMMUNICATIONS OUTLETS

Airport	Weather Facility		Communictions Outlet		Comments
	Type	Maintenance	Type	Maintenance	
Pearce Ferry	None	--	CTAF	Airport	
Phoenix-Deer Valley	ASOS-C	NWS	ATCT	FAA	
			ATIS	FAA	
			CTAF	Airport	
			RCO	FAA	
			RTR	FAA	
			Unicom	Airport	
Phoenix-Goodyear	LAWRS	FAA	ATCT	FAA	
			ATIS	FAA	
			CTAF	Airport	
			RCO	FAA	
			RTR	FAA	
			Unicom	Airport	
Phoenix-Sky Harbor International	ASOS-A	NWS	ATCT	FAA	
	LLWAS	FAA	ATIS	FAA	
			RCO	FAA	
			RTR	FAA	
			Unicom	Airport	
Pinal Airpark	None	--	CTAF/Unicom	Airport	
Pine Springs	None	--	None	--	
Pinon	None	--	None	--	
Pleasant Valley International	None	--	None	--	
Polacca	None	--	None	--	
Quartzsite (New)	None	--	None	--	
Rock Point	None	--	None	--	

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EXISTING FACILITIES SUMMARY
WEATHER FACILITIES AND COMMUNICATIONS OUTLETS

Airport	Weather Facility		Communications Outlet		Comments
	Type	Maintenance	Type	Maintenance	
Rocky Ridge	None	--	None		
Rolle Airfield	None	--	CTAF	Airport	
Ryan Airfield	AWOS-3	FAA	ATCT	FAA	
			CTAF	Airport	
			RCO	FAA	
Safford Regional	ASOS-D	NWS	CTAF/Unicom	Airport	
			RCO	FAA	
San Carlos	None	--	None	--	
San Manuel	None	--	CTAF	Airport	
Scottsdale	ASOS-C	NWS	ATCT	FAA	
	LAWRS	FAA	ATIS	FAA	
			CTAF	Airport	
			PCL	Airport	
			RCO	Airport	
			RTR	Airport	
			Unicom	Airport	
Sedona	AWOS-3	Airport	CTAF/Unicom	Airport	
			PCL	Airport	
			RCO	FAA	
			RRCS	FAA	RRCS activates REIL (3)
Seligman	None	--	CTAF	Airport	
Sells	None	--	CTAF	Airport	
			Unicom	Airport	
Show Low Municipal	None	--	CTAF/Unicom	Airport	
			PCL	Airport	

Table 2-2

EXISTING FACILITIES SUMMARY
WEATHER FACILITIES AND COMMUNICATIONS OUTLETS

Airport	Weather Facility		Communications Outlet		Comments
	Type	Maintenance	Type	Maintenance	
Shonto	None	--	None	--	
Springerville Babbit Field	None	--	CTAF/Unicom	Airport	
			PCL	Airport	
St. Johns Industrial Airpark	ASOS-D	NWS	CTAF/Unicom	Airport	
			RCO	FAA	
Stellar Airpark	None	--	CTAF/Unicom	Airport	
Sun Valley	None	--	CTAF/Unicom	Airport	
			PCL	Airport	
Superior Municipal	None	--	CTAF	Airport	
Taylor Municipal	AWOS-3	Airport	CTAF/Unicom	Airport	
			PCL	Airport	
Temple Bar	None	--	CTAF/Unicom	Airport	
Tombstone Municipal	None	--	CTAF	Airport	
Toyei School (Closed)	None	--	CTAF/Unicom	Airport	
Tuba City	None	--	CTAF	Airport	MIRL (15-33) out of service
			RCO	FAA	
Tucson International	ASOS-B	NWS	ATCT	FAA	
	LLWAS	FAA	ATIS	FAA	
			RCO	FAA	
			RTR	FAA	
			Unicom	Airport	
Tuweep	None	--	CTAF	Airport	
Whiteriver	None	--	CTAF/Unicom	Airport	
Wickenburg Municipal	None	--	CTAF/Unicom	Airport	
			PCL	Airport	

Table 2-2

EXISTING FACILITIES SUMMARY
WEATHER FACILITIES AND COMMUNICATIONS OUTLETS

Airport	Weather Facility		Communications Outlet		Comments
	Type	Maintenance	Type	Maintenance	
Williams Gateway	None	--	ATCT	FAA	
			ATIS	FAA	
			CTAF	Airport	
Window Rock	ASOS-D	NWS	CTAF/Unicom	Airport	
			PCL	Airport	
			RCO	FAA	
Winslow Municipal	ASOS-D	NWS	CTAF/Unicom	Airport	
			RCO	FAA	
			RRCS	FAA	
Yuma International	ASOS-A	US Navy	ATCT	USMC	Yuma International Airport is a civil / military joint use facility
			ATIS	USMC	
			CTAF	USMC	
			PCL	USMC	
			RCO	FAA	
			Unicom	USMC	

Note: See Appendix A for acronym definitions.
Sources: FAA records and Airport / Facility Directory, 1997.

Table 2-3

EXISTING OFF-AIRPORT NAVAIDS AND COMMUNICATIONS FACILITIES

Facility Name / Location	Type	Agency	Comments
Bard / Yuma	VORTAC	FAA	VORTAC unusable: 280° - 300° beyond 27 nm below 3,600' MSL
Bard / Yuma	RCO	FAA	--
Buckeye / Buckeye	VORTAC	FAA	VOR portion unusable: 060° - 075° beyond 28 nm below 4,000' MSL 230° - 260° beyond 35 nm below 5,000' MSL 280° - 320° beyond 35 nm below 7,000' MSL 320° - 020° beyond 37 nm below 6,000' MSL DME unusable 020° - 072° beyond 28 nm below 8,000' MSL
Dragoo / Libby-Sierra Vista	NDB	FAA	--
Drake / Prescott	VORTAC	FAA	VOR unusable: 055° - 080° beyond 29 nm below 9,300' MSL 125° - 140° beyond 35 nm below 8,500' MSL 140° - 160° beyond 30 nm below 9,500' MSL 160° - 175° beyond 35 nm below 9,500' MSL 175° - 185° beyond 30 nm below 9,500' MSL 185° - 195° beyond 23 nm below 9,100' MSL 195° - 220° beyond 13 nm below 9,100' MSL 220° - 235° beyond 25 nm below 9,100' MSL 265° - 275° beyond 30 nm below 8,800' MSL
Flagstaff / Flagstaff	NDB	FAA	--
Mingus Mountain / Jerome	RCO	FAA	--

Table 2-3

EXISTING OFF-AIRPORT NAVAIDS AND COMMUNICATIONS FACILITIES

Facility Name / Location	Type	Agency	Comments
Mount Lemon / Tucson	RCO	FAA	--
Needles / Topock	VORTAC	FAA	HIWAS broadcast
			VOR unusable:
			100° - 130° beyond 27 nm below 6,600' MSL
			170° - 220° beyond 20 nm below 5,800' MSL
			220° - 280° beyond 35 nm below 6,800' MSL
Peach Springs / Peach Springs	VORTAC	FAA	--
Peach Springs / Peach Springs	RCO	FAA	--
Phoenix / Tempe	VORTAC	FAA	HIWAS broadcast
			090° - 100° beyond 15 nm below 8,000' MSL
			185° - 190° beyond 30 nm below 8,000' MSL
			185° - 190° beyond 35 nm below 9,000' MSL
			190° - 235° beyond 20 nm below 10,000' MSL
			345° - 034° beyond 10 nm below 6,000' MSL
			345° - 034° beyond 20 nm below 8,000' MSL
			345° - 015° beyond 33 nm below 11,000' MSL
			015° - 034° beyond 33 nm below 10,000' MSL
Robles	NDB	FAA	--

Table 2-3

EXISTING OFF-AIRPORT NAVAIDS AND COMMUNICATIONS FACILITIES

Facility Name / Location	Type	Agency	Comments
San Simon	VORTAC	FAA	VORTAC unusable: 020° - 050° beyond 30 nm below 8,000' MSL 150° - 190° beyond 28 nm below 11,300' MSL 190° - 220° beyond 30 nm below 9,000' MSL 235° - 250° beyond 30 nm below 9,900' MSL 350° - 360° beyond 30 nm below 8,000' MSL
St. Johns / St. Johns	VORTAC	FAA	--
Stanfield / Stanfield	VORTAC	FAA	--
Stanfield / Stanfield	RCO	FAA	--
Tuba City / Tuba City	VORTAC	FAA	--
Tucson / Tucson	VORTAC	FAA	HIWAS broadcast VORTAC unusable: 350° - 005° beyond 30 nm below 11,20' MSL 350° - 020° beyond 30 nm below 13,000' MSL
Willie / Chandler	VORTAC	FAA	VORTAC unusable: 150° - 195° beyond 20 nm below 7,500' MSL
Winslow / Winslow	VORTAC	FAA	HIWAS broadcast
Zuni / Zuni	VORTAC	FAA	HIWAS broadcast

Note: See Appendix A for acronym definitions.

Source: Airport / Facility Directory, 1997.

Air Traffic Control Radar Coverage

Radar coverage for air traffic control throughout Arizona is provided by airport surveillance radars (ASR) and air route surveillance radars (ARSR). ASR facilities are used primarily for terminal air traffic control and normally cover an area within a 55-nautical mile to 60-nautical mile radius of the radar site. ASR-9 units are installed in the Phoenix and Tucson areas and ASR-8 facilities at the Williams Gateway and Yuma International airports.

Radar facility coverage is characterized by line-of-sight and thus high terrain within the coverage radius of the ASR could block aircraft target identification at lower altitudes. This restriction occurs in portions of areas north, east and west of the Phoenix ASR beginning at elevations ranging between 1,500 feet above mean sea level (MSL) and 3,000 feet MSL.

Coverage of Arizona en route airspace is provided by ARSR-4 units located at Humboldt Mountain, and strategic sites near Seligman and Yuma in Arizona, and Angel Peak in Nevada. The ARSR normally provides a 200-nautical mile radius of coverage and those used for air traffic control purposes in Arizona airspace have clear areas of coverage at elevations of 11,000 feet MSL and above. Radar coverage below this altitude is spotty. This deficiency and alternate means to enhance radar coverage at low altitudes should be explored by ADOT Aeronautics with the FAA.

Required improvements or enhancements to the available radar coverage are a federal responsibility. In the future, satellite-based radar coverage technology will be implemented and this will overcome shortfalls associated with traditional ground-based radar systems as noted above.

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Aviation Weather

The NWS and FAA currently take or contract out manned aviation surface observations which on June 1, 1996 were renamed as meteorological aerodrome reports (METAR) at several locations within Arizona. The NWS may use its own staff at a weather forecast office (WFO) or weather service office (WSO) to take surface observations, or contract this activity at a weather service contract meteorological office (WSCMO). NWS observations are taken hourly or when needed as significant changes in weather occur.

The NWS has also established a supplemental aviation weather observation program where the federal government cannot provide aviation weather observations and has no requirement for such activity, except possibly to provide a forecast service for a particular location. These supplementary aviation weather reporting stations (SAWRS) are established and staffed by the local operators at their own expense and under NWS supervision and certification. However, SAWRS reports are not normally entered into the national weather data collection system because they are intended to serve certain aircraft operations at a particular airport. The SAWRS observations may be taken on an hourly or more frequent basis, or at irregular intervals, and are restricted to aircraft operated by the entity serving as the SAWRS observer.

The FAA takes hourly, or when required, special weather observations at airports under the limited aviation weather reporting program. These limited aviation weather reporting station (LAWRS) observations are taken by air traffic control tower (ATCT), automated flight service station (AFSS), flight service station (FSS) or contract personnel. The latter are termed federal contract weather observing sites (FCWOS).

The NWS and FAA are in the process of automating surface aviation weather observations although the NWS continues to operate 1960's technology automatic meteorological observing stations (AMOS) at some airports and nonairport locations. The NWS, as an element of its modernization plan, has initiated the establishment of ASOS units at selected airports across the country. The FAA F&E program provides for the establishment of Level 3 AWOS units. Airports not designated to receive an ASOS or F&E AWOS-3 may obtain an AWOS (Level A, 1, 2 or 3) through the FAA's administration of the AIP, or acquire the unit directly with its own funds or with state aviation agency funding participation. Many airports across the country have taken such action, including several airports in Arizona.

Table 2-2 also presents a summary of the existing installed or precommissioned deployment of ASOS and AWOS units at the public-use system airports in Arizona. An AWOS-3 is also operational at Bedard Field, a private-use system airport located approximately 17 nautical miles south-southwest of Kayenta, and is maintained by the airport sponsor.

Table 2-4 summarizes the location of existing NWS, FAA and local airport weather reporting locations in Arizona, and these are illustrated in Figure 2-1. Some are collocated with ASOS or AWOS units in order to afford opportunity for augmented reports by observers. In response to industry and pilot requests, the NWS and FAA have defined four levels of ASOS for which full, some or no augmentation is required. Table 2-5 summarizes the ASOS service standard levels, which are noted for the applicable sites presented in Table 2-1. The weather reporting parameters associated with AWOS facilities are shown in Table 2-6.

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Table 2-4

MANNED WEATHER OBSERVATION SITES

Airport	Type Service	Comments
Bisbee Douglas International	LAWRS[1]	24 hours; FAA contractor
Chandler Municipal	LAWRS	0600 - 2100; FAA ATCT observer
Ernest A. Love Field	LAWRS	24 hours; FSS observer and contractor
Libby AAF-Sierra Vista	LAWRS	0600 - 2100; US Army observer
Gila Bend Municipal	LAWRS	0700 - 2200; US Air Force observer
Mesa-Falcon Field	LAWRS	0600 - 2100
Payson (non-airport site)	SAWRS[2]	Every 3 hours between 0800 - 1700
Phoenix-Deer Valley	LAWRS	0600 - 2100; FAA ATCT observer
Phoenix-Goodyear	LAWRS	0600 - 2100; FAA contractor
Phoenix-Sky Harbor International	LAWRS	24 hours; FAA contractor
Safford Regional	AMOS[3]	24 hours; possible observer augmentation
Scottsdale	LAWRS	0600- 2100
Williams Gateway	SAWRS	0600 -2100

Notes : Hours where indicated are local time.

See Appendix A for acronym definitions.

Source: National Weather Service records, 1997.

1. LAWRS - Limited Aviation Weather Reporting Station.
2. SAWRS - Supplemental Aviation Weather Reporting Station.
3. AMOS - Automatic Meteorological Observing System.

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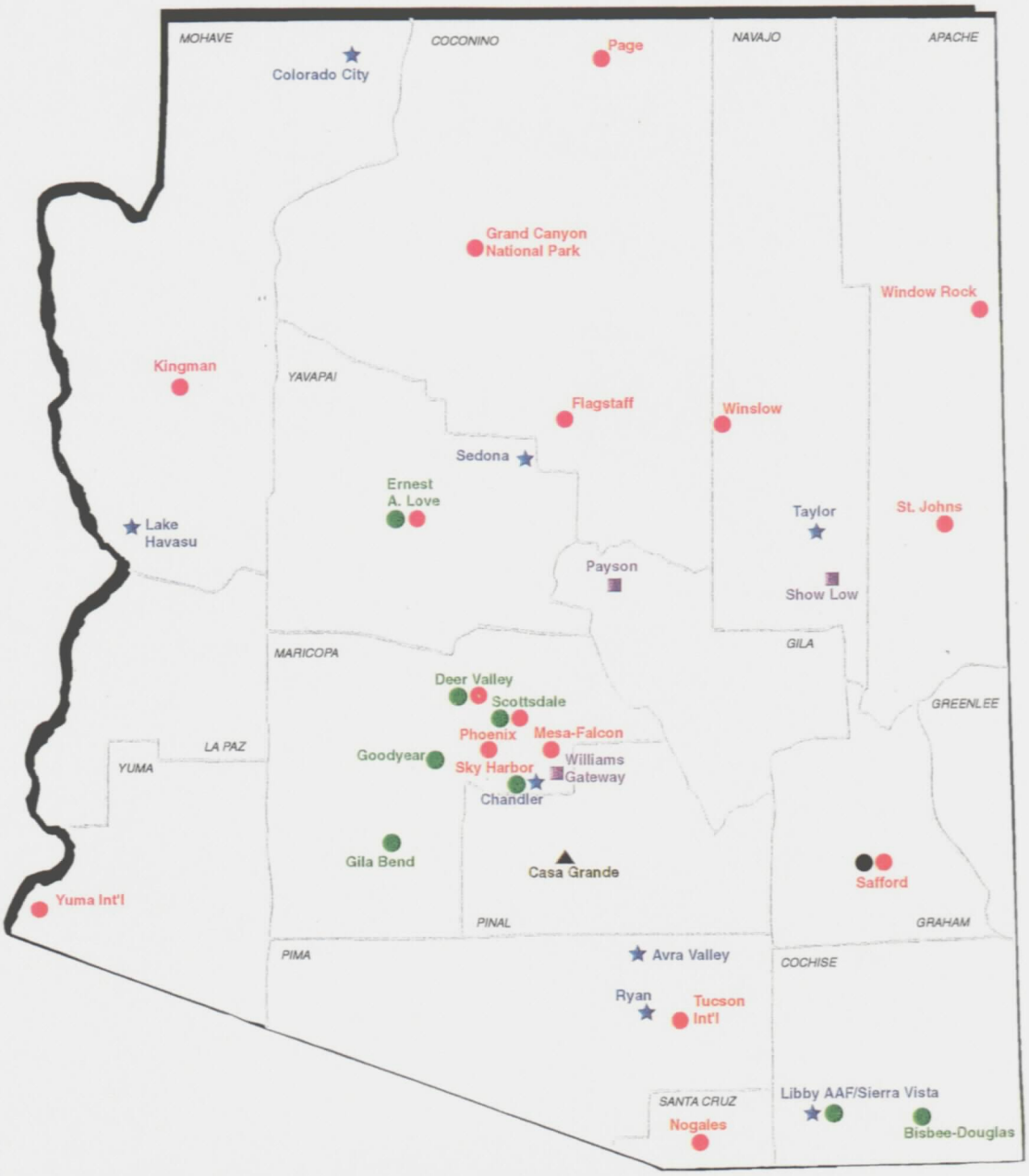
Figure 2-1

EXISTING WEATHER OBSERVATION SITES



LEGEND

●	AMOS	Automatic Meteorological Observing System
●	ASOS	Automated Surface Observing System
★	AWOS	Automated Weather Observing System
▲	AWOS-F	AWOS-3 - FAA Facilities and Equipment Program Unit
●	LAWRS	Limited Aviation Weather Reporting Station
■	SAWRS	Supplemental Aviation Weather Reporting Station

N

1 inch = 50 n.m. (approximate)

SOURCE: National Weather Service and Federal Aviation Administration records, 1997

Table 2-5

ASOS SERVICE STANDARD LEVELS (C and D)

ASOS SERVICE LEVEL D (No Augmentation)	
Wind Speed and Direction	Temperature and Dew Point
Visibility	Altimeter
Precipitation and Obstruction to Vision	Freezing Rain
Cloud Height and Sky Cover	Lightning Reporting*

ASOS AUGMENTATION SERVICE LEVEL C
Thunderstorms
Tornadoes
Hail
Virga
Volcanic Ash
Tower Visibility

* In operational testing

Notes:

Augmentation consists of adding the weather elements shown for the designated ASOS Service Level at the site, if observed.

Back-up consists of inserting the correct value if the system malfunctions or is unrepresentative.

Air traffic control specialists are allowed the option of adding operationally significant remarks.

During hours that the observing facility is closed, the site reverts to Level Service D.

Service Level D consists of an ASOS continually measuring the atmosphere at a point near the runway.

Table 2-5

ASOS SERVICE STANDARD LEVELS (A and B)

ASOS AUGMENTATION SERVICE LEVEL B

All Level Service C and:

- Longline Runway Visual Range at precedented sites*
- Freezing Drizzle versus Freezing Rain
- Ice Pellets
- Snow Depth and Snow Increasing Rapidly remarks
- Thunderstorms and Lightning Location remarks
- Observed Significant Weather not at the Station remarks

* In operational testing

ASOS AUGMENTATION SERVICE LEVEL A

All Level Service B, C and:

- 10-Minute Longline Runway Visual Range at precedented sites or Additional Visibility Increments of 1/8, 1/16 and 0*
- Sector Visibility
- Variable Sky Conditions
- Cloud Layers Above 12,000 feet and Cloud Types
- Widespread Dust, Sand and Other Obscurations
- Volcanic Eruptions

Notes: Augmentation consists of adding the weather elements shown for the designated ASOS Service Level at the site, if observed.

Back-up consists of inserting the correct value if the system malfunctions or is unrepresentative.

Air traffic control specialists are allowed the option of adding operationally significant remarks.

During hours that the observing facility is closed, the site reverts to Level Service D.

Service Level D consists of an ASOS continually measuring the atmosphere at a point near the runway.

Source: FAA document, 1997.

Table 2-6

AWOS LEVELS AND REPORTS

AWOS SPECIFICATIONS BY LEVEL

Sensor	Specification	AWOS Level A	1	2	3
Atmospheric Pressure	16.9" Hg to 31/5" Hg	X	X	X	X
Wind Direction	Accuracy to +/- 5°		X	X	X
Wind Speed	0 knots to 125 knots		X	X	X
Temperature	-60°F to +130°F		X	X	X
Dew Point	-30°F to +86°F		X	X	X
Visibility	To and including 10 miles			X	X
Cloud Height	20 feet to 10,000 feet				X

AWOS REPORT DETAIL

Text of Report	Report Detail
Airport Identifcation	Airport name and location
Type of Report	States that the report is AWOS-generated
Time of Day	Greenwich Mean Time (GMT)
Sky Condition	Cloud height and sky coverage in 100-foot increments
Visibility	Visibility near runway
Temperature	Air temperature near runway
Dew Point	Condensation temperature near runway
Wind Direction	Speed to nearest knot if greater than 5 knots; calm if below 5 knots
Wind Gust	Reported to the nearest knot
Altimeter Setting	Pressure at surface to nearest 0.01" Hg

Source: FAA Advisory Circular, 150/5220-16B.

METAR Dissemination

Although the availability of a METAR is important to support aviation activity at the location where the observation is taken, the data is also of value to users in other locations for flight planning and weather forecasting purposes. Therefore, a system of networks exists to facilitate the collection and dissemination of weather data. Presently, NWS offices use the automation of field operations and services (AFOS) computer network to transmit this data to other NWS offices. Concurrently, the data is transmitted to the NWS Systems Operations Center (SOC) in Suitland, Maryland for distribution to various public agency and private subscriber users. The SOC gateway system transfers the data and other weather products (terminal forecasts, center weather advisories, (etc.) to the FAA national aviation weather processor (NAWP) in Salt Lake City, Utah that handles the western portion of the country including Arizona. A second NAWP is located in Atlanta, Georgia to serve the eastern half of the country. Each NAWP then forwards the data to each other and their associated regional FAA air route traffic control center (ARTCC), AFSS and FSS computers via the national airspace data interchange network (NADIN). FAA observations are transmitted to the NWS SOC via NADIN. There, the NWS uses AFOS to disseminate the FAA data to other NWS offices. NAWP serves as the primary FAA gateway to the NWS telecommunications gateway (NWSTG) which is the source of NWS products for the FAA and the national airspace system.

NADIN is a multi-node, distributor-processor network through which information pertaining to air traffic is exchanged between FAA facilities and the U.S. military, domestic air carriers, commercial data communication providers and the international aviation community. NADIN concentrators located at each ARTCC are connected to the NAWP. NADIN is being upgraded to a packet switching network referred to as NADIN-II that will permit high data flow capacity and efficiency to the network users.

NWS AMOS and ASOS and FAA F&E AWOS-3 reports are also collected and disseminated on their respective networks. The FAA is presently finalizing plans to establish the AWOS/ASOS data acquisition system (ADAS). ADAS will use landline communications to access AWOS- and ASOS-generated reports on a scheduled basis or when certain parameter levels are reached that trigger the release of a special report. This information is routed to ADAS concentrators located at the nearest ARTCC for distribution via the NAWP to serve other FAA facilities and via NADIN to NWS locations. Although ADAS is intended to serve FAA F&E AWOS-3 and FAA-required ASOS sites, data from airport sponsor-installed AWOS-3 units may be integrated into the FAA network under certain procedures and protocols.

ASOS and AWOS units located at nontowered airports broadcast their observations on a continuous basis via a discrete frequency transmitter or in conjunction with other very high frequency (VHF) radio transmission outlets. ASOS units located at airports with an ATCT and/or automatic terminal information system (ATIS) do not broadcast continuously when the ATCT or ATIS is operational. In these instances, the ASOS report is given by the air traffic controller or included in the ATIS broadcast.

Weather Radar

The NWS and FAA have instituted new weather radar programs that employ Doppler technology to monitor severe weather. The NWS program, commonly referred to as next generation radar (NEXRAD) will provide information on precipitation, wind velocity and turbulence at an advanced level of detection and is intended for advisories within en route airspace. NEXRAD provides weather products related to frontal activity, hail, hurricane, icing conditions, tornadoes, turbulence, winds and wind shear. NEXRAD also provides useful reflectivity and storm detection out to a radius of about 250 nautical miles. The Doppler products of NEXRAD are confined to a range of 125-nautical miles. NWS NEXRAD imagery will be conveyed via the advanced weather interactive processing system (AWIPS) for agency-wide distribution. The latest version of the NEXRAD program radar is the WSR-88D model.

The FAA has installed terminal Doppler weather radars (TDWR) at airports to provide improved short-range coverage. The TDWR identifies wind shear and other weather events by measuring wind fields within a 50-nautical mile radius of the terminal area. A TDWR is located approximately 10 miles west of the Phoenix Sky Harbor International Airport.

Table 2-7 identifies the NEXRAD and TDWR locations that provide coverage within Arizona. Nearly the entire State is covered by the NEXRAD sites, with many areas of overlap, as illustrated in Figure 2-2.

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Table 2-7

EXISTING WEATHER RADAR FACILITIES

Radar Location	Type Radar	Agency
Albuquerque, New Mexico	WSR-88D[1]	NWS
Cedar City, Utah	WSR-88D	NWS
El Paso, Texas	WSR-88D	NWS
Flagstaff, Arizona	WSR-88D	NWS
Las Vegas, Nevada	WSR-88D	NWS
Phoenix, Arizona	WSR-88D	NWS
Phoenix, Arizona	TDWR[2]	FAA
Tucson, Arizona	WSR-88D	NWS
Yuma, Arizona	WSR-88D	NWS

See Appendix A for acronym definitions.

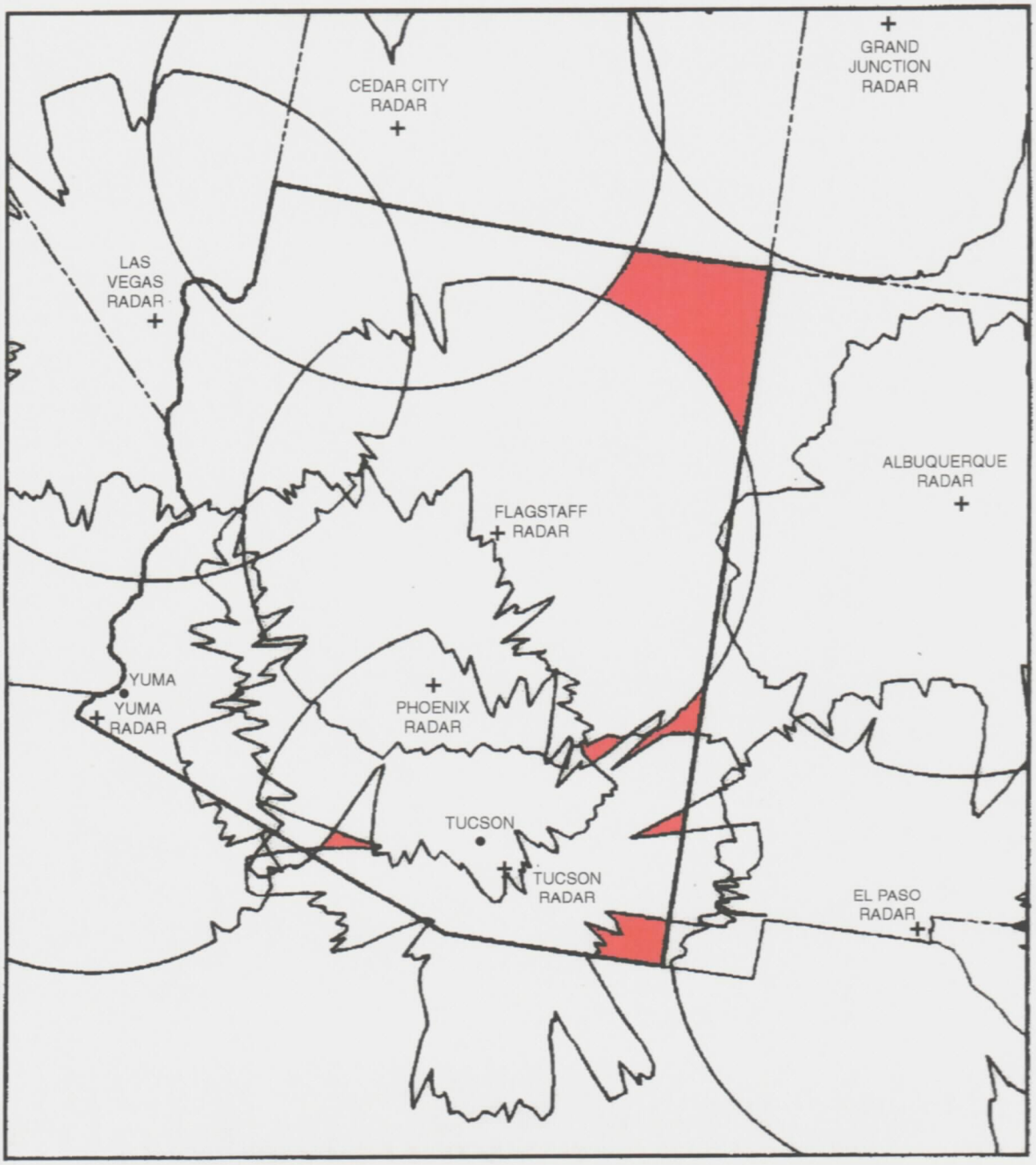
Notes: 1. Weather Service Doppler Radar, 1988 model.

2. Terminal Doppler Weather Radar.

Sources: National Weather Service and FAA records, 1997.

Figure 2-2

EXISTING NEXRAD WEATHER RADAR COVERAGE



LEGEND

Area not covered below 10,000 feet above site level

NEXRAD site

Limit of coverage

N

1 inch = 80 n.m. (approximate)

SOURCE: National Weather Service, 1997

AFSS/FSS Services

FAA AFSS and FSS facilities are a primary source of flight and weather information available to pilots. Within Arizona, there is a single AFSS located at the Ernest A. Love Field, Prescott. The AFSS provides pilots on the ground with pre-flight briefings and serve pilots in the air with similar information and services. One service provided by the AFSS is the dissemination of hazardous inflight weather advisory service (HIWAS) via the VHF omnidirectional radio (VOR, VORTAC) facilities that provide navigational information to pilots. HIWAS data are transmitted over these VOR/VORTAC facilities on an as required basis. The broadcast is essentially line-of-sight and dependent on the altitude of the aircraft and its avionics. The AFSS also receives pilot weather reports for dissemination to other pilots, ARTCC, NWS and other AFSS/FSS facilities.

The AFSS is supplemented by the FAA's direct user access terminal system (DUATS). DUATS permits FAA-certified pilots with personal computers to access weather briefing services (surface observations, winds aloft, temperatures aloft, terminal forecasts, pilot reports, and other nongraphic weather products) and to file flight plans via FAA-selected vendors. By redirecting the responsibility of these services to private contractors, the FAA expects to satisfy the increasing demand for such services while maintaining staffing levels. There is no charge to the pilot for the data and telephone call is toll free. The vendors are compensated by the FAA based on the number of calls received. Other on-line services to DUATS users include flight planning prior to filing, graphic weather information, and airport facilities information. These services are available for a fee. Pilots can also obtain weather data by dialing 1-800-WXBRIEF. This is a free service and telephone calls are routed to the AFSS nearest to the caller. A menu select feature allows the caller to listen to a pre-recorded weather summary via the telephone information briefing services (TIBS) or speak to a weather briefer at the AFSS.

Commercial Vendor Services

There are several vendors of surface weather condition information, weather radar imagery, flight planning assistance and filing services that are available to the aviation industry. Fixed base operators, corporate flight departments, aviation training schools and individual pilots can subscribe to such services, many of which are offered on a menu-style basis. A variety of such services is provided at some airports in Arizona.

Communications Facilities

All State of Arizona agencies use voice and data communications in the conduct of their activities. Voice transmission is managed by the Department of Administration that leases telephone lines from one of several companies operating in the State for use by State agencies with two exceptions. These are the Department of Revenue and Department of Economic Security, which operate on independent voice networks. Data communications are decentralized with each State agency using separately leased or owned facilities to support their operations. For the most part, these agency networks are not interconnected and may be characterized as multiple parallel networks. For example, two or more agencies in Phoenix may be contacting two or more branch offices in Flagstaff and using separate data communications linkages rather than a single data line which can then be switched to the desired branch office. Most of these stand-alone networks use a star topology and the most sophisticated of these is operated by the Arizona Department of Transportation. Named TRANSNET, this wide area frame relay network relies on leased T1 (1.544 mb/s) lines from AT&T and US West to link principal offices in Phoenix, Prescott, Tucson and Flagstaff to each other. These principal locations then are linked to their associated local area network offices via other leased lines for the transmission of data.

The Department of Administration has recognized the inefficiency of the existing statewide voice and data communications system. In response, the State is currently soliciting proposals from vendors to implement Project EAGLE for Statewide communication services. The intent of Project EAGLE is to cause a consolidation of these networks, reduce operating costs and encourage economic development. The project does not envision that the State would own and operate a communications system but rather serve as an anchor tenant between a single communications services provider and the EAGLE alliance. The initial EAGLE alliance participants are the three branches of Arizona State government (executive, legislative and judicial), community colleges, universities and libraries within 155 Arizona communities. Communication services to be provided include:

- Dedicated voice circuits
- Dedicated data services
- Packet-based services
- ISDN and xDSL services
- Cell-based services
- Voice value-added services
- Video value-added services

- Messaging services
- Internetworking related services
- Management and monitoring services
- Billing services
- Reporting services

Eventually Project EAGLE will be expanded to include other political subdivisions such as cities, counties and elementary/middle/high school districts.

When operational, Project EAGLE will enable a level of interconnectivity among units of government that presently cannot be achieved. Further, the resulting statewide communications services can support services that the Arizona Department of Transportation and Aeronautics Division may seek to provide to the aviation community.

Chapter 3

FORECASTS OF AVIATION ACTIVITY

Introduction

This chapter examines the forecasts of aviation-related activity from two aviation system plans and assesses the need to prepare new forecasts for use in this study. The forecasts include registered pilots, registered aircraft and aircraft operations. As part of this evaluation process, those factors that served as input to and influenced the development of the earlier aviation projections were reviewed. These include statewide socioeconomic characteristics, and local and national trends in the aviation industry. The forecasts of annual activity were then used to derive projections of peak-hour aircraft operations under instrument flight rule (IFR) procedures to assess demand versus capacity relationships.

Socioeconomic Characteristics

The forecasts of aviation activity presented in the 1995 State Aviation Needs Study (SANS) and 1996 Maricopa Association of Governments Regional Aviation System Plan were reviewed for their continued validity. These forecasts address registered pilots, based aircraft and general aviation activity. The projections were predicated on population, employment and per capita income measures as well as anticipated trends in the aviation industry. Significant changes in the values of these independent socioeconomic variables and/or industry trends could result in a requirement for new projections.

A review of the socioeconomic data as forecast for 1995 and compared to actual results led to the following conclusions:

1. The actual population of Arizona in 1995 was 4,307,150 as compared to the value of 4,134,925 used in the earlier aviation plans. The population distribution among the 15 counties varied as well with some higher and lower than that projected. Counties in the northeast portion of the State actually experienced lower populations than those in the southwest, northwest and Valley (Maricopa County) regions when compared to the levels used in the earlier studies.

2. Rates of growth in population as presented in current State population projections compared to those used previously indicate generally comparable levels in most counties. Differences in growth rates occur in the southeastern counties where growth rates are greater than earlier projected. However, in terms of the number of persons, the differences are slight. The Valley region had a higher population in 1995 than that projected earlier, a difference of five percent. The higher growth rate now anticipated for the Valley increases this difference by the year 2020 to about nine percent. The Valley accounted for about 59 percent of the State population in 1995; by 2020, this share will increase slightly to some 61 percent. These percentage shares are essentially the same as those used as input to the previous aviation system planning studies.

3. Employment levels in Arizona have been expanding at growth rates above that of the nation and this trend is expected to continue in the future as represented by the Arizona Department of Economic Security. This scenario was similarly anticipated when the earlier projections of aviation activity were prepared.

4. Historical and forecast per capita income levels used in the previous studies were presented in current 1994 values, but the basis for the adjustment was not articulated. This results in an inability to directly compare actual versus historical values, and projections then considered and those now available. Nonetheless, current per capita income projections indicate a continued increasing trend in dollar amounts, but at values about 12 percent less than those anticipated for the United States.

In sum, the variances in the socioeconomic factors between the time the 1995 SANS and regional aviation system plan were developed and the present are not significant to warrant a revision to the earlier forecasts presented. However, as described below, there may be other factors that may indicate a need to present new projections.

Registered Pilots

The 1995 SANS projections of registered pilots in Arizona for 1995 were nearly 20 percent less than the actual count as provided in FAA records –13,072 versus 15,662. Within the groupings of general aviation, commercial and airline transport pilots, some 60 percent of the difference can be attributed to the latter sector. A revised projection of registered pilots by county was developed to account for this variance using the most current FAA data available (end of calendar year 1997). The analysis considered historical trends in aviation activity in Arizona and nationally, and an assessment of future potential directions.

Since 1990, all categories of registered pilots in Arizona have shown increases in counts versus declines nationwide with the exception of the national number of airline transport pilots which also grew in size. The 1995 SANS and FAA projections during this period continued their respective trends. More recently, the potential for growth in the general aviation sector has improved due to industry promotions and the slightly delayed effect of product liability reform legislation in 1994. This is reflected in the fiscal year 1998 FAA projections that indicate growth in each of the pilot groupings through their forecast horizon to fiscal year 2009. These projections show growth rates ranging from 0.6 percent to 2.7 percent annually on average, with the higher growth applied to the general aviation pilot category.

Historical growth patterns in Arizona aviation activity have been more positive than those nationwide. The is due in large part to increasing general population levels and the climate that is conducive to flight activity, particularly in the southern half of the State. It was determined that each of the three pilot sectors would continue to show gains in numbers. Average annual growth rates of 2.5 percent, 1.5 percent and 1.5 percent were applied to the general aviation, commercial and airline transport groupings, respectively. These projections indicate that the general aviation pilot sector will remain as the largest in terms of number of pilots and account for a slightly increasing percentage of the total registered pilot population over time, from 56 percent in 1997 to 61 percent by the year 2015. The resulting forecasts are shown in Tables 3-1 through 3-4.

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Table 3-1

REGISTERED GENERAL AVIATION PILOTS

	Actual	Forecast			
County	1997	2000	2005	2010	2015
Apache	23	25	28	32	36
Cochise	284	306	346	391	443
Coconino	251	270	306	346	391
Gila	70	75	85	96	109
Graham	22	24	27	30	34
Greenlee	9	10	11	12	14
La Paz	38	41	46	52	59
Maricopa	5,888	6,341	7,174	8,117	9,183
Mohave	334	360	407	460	521
Navajo	76	82	93	105	119
Pima	1,498	1,613	1,825	2,065	2,336
Pinal	155	167	189	214	242
Santa Cruz	40	43	49	55	62
Yavapai	576	620	702	794	898
Yuma	153	165	186	211	239
Unknown	9	10	11	12	14
Total	9,426	10,512	11,485	12,292	14,700

Sources: U.S. Civil Airmen Statistics, FAA, December 31, 1997.
QED for forecast years.

Table 3-2

REGISTERED COMMERCIAL PILOTS

County	Actual 1997	Forecast 2000	2005	2010	2015
Apache	6	6	7	7	8
Cochise	96	100	108	117	126
Coconino	108	113	122	131	141
Gila	27	28	30	33	35
Graham	11	12	12	13	14
Greenlee	5	5	6	6	7
La Paz	16	17	18	19	21
Maricopa	1,891	1,977	2,130	2,295	2,472
Mohave	93	97	105	113	122
Navajo	29	30	33	35	38
Pima	584	611	658	709	763
Pinal	64	67	72	78	84
Santa Cruz	13	14	15	16	17
Yavapai	271	283	305	329	354
Yuma	96	100	108	117	126
Unknown	1	1	1	1	1
Total	3,311	3,461	3,730	4,019	4,329

Sources: U.S. Civil Airmen Statistics, FAA, December 31, 1997.
QED for forecast years.

Table 3-3

REGISTERED AIRLINE TRANSPORT PILOTS

County	Actual 1997	Forecast 2000	2005	2010	2015
Apache	5	5	6	6	7
Cochise	49	51	55	59	64
Coconino	76	79	86	92	99
Gila	18	19	20	22	24
Graham	-	0	0	0	0
Greenlee	-	0	0	0	0
La Paz	4	4	5	5	5
Maricopa	2,931	3,065	3,302	3,557	3,832
Mohave	48	50	54	58	63
Navajo	17	18	19	21	22
Pima	554	579	624	672	724
Pinal	32	33	36	39	42
Santa Cruz	9	9	10	11	12
Yavapai	176	184	198	214	230
Yuma	70	73	79	85	92
Unknown	3	3	3	4	4
Total	3,992	4,172	4,497	4,845	5,220

Sources: U.S. Civil Airmen Statistics, FAA, December 31, 1997.
QED for forecast years.

Table 3-4

TOTAL REGISTERED PILOTS

	Actual	Forecast			
County	1997	2000	2005	2010	2015
Apache	34	36	41	45	51
Cochise	429	457	509	567	633
Coconino	435	462	514	569	631
Gila	115	122	135	151	168
Graham	33	36	39	43	48
Greenlee	14	15	17	18	39
La Paz	58	62	69	76	85
Maricopa	10,710	11,383	12,606	13,969	15,487
Mohave	475	507	566	631	706
Navajo	122	130	145	161	179
Pima	2,636	2,803	3,107	3,446	3,823
Pinal	251	267	297	331	368
Santa Cruz	62	66	74	82	91
Yavapai	1,023	1,087	1,205	1,337	1,482
Yuma	319	338	373	413	232
Unknown	13	14	15	17	19
Total	16,729	17,785	19,712	21,856	24,042

Sources: U.S. Civil Airmen Statistics, FAA, December 31, 1997
QED for forecast years.

Registered Aircraft

The 1995 SANS projected a 1995 estimate of 6,105 registered aircraft in Arizona. Records available from the ADOT Aeronautics indicate that the actual count was 5,076. The difference is due in large part to a change in aircraft registration regulations and fees in Arizona, which served to distinguish between airworthy aircraft and those no longer in use. The latter aircraft are not included in the 5,076 count.

Although most pilots indicated a base location for their aircraft when registering, thus enabling a listing of aircraft by county, some were without such designation. These aircraft, representing about five percent of the total, were proportionately allocated to each county. Future levels of Arizona active registered aircraft were determined based on average annual growth rates and percentage allocations utilized in preparing the 1995 SANS. The resulting projections are presented in Table 3-5.

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Table 3-5

TOTAL REGISTERED AIRCRAFT

County	Actual 1995	Forecast 2000	2005	2010	2015
Apache	27	30	32	35	38
Cochise	128	138	148	158	167
Coconino	149	165	181	196	210
Gila	54	57	59	62	64
Graham	35	39	43	45	47
Greenlee	2	2	2	2	2
La Paz	43	44	47	51	54
Maricopa	2,796	2,951	3,165	3,398	3,650
Mohave	208	238	269	301	331
Navajo	82	88	94	100	107
Pima	748	893	1,021	1,078	1,171
Pinal	245	266	287	307	326
Santa Cruz	17	19	21	23	25
Yavapai	398	451	511	574	636
Yuma	144	161	177	193	210
Total	5,076	5,542	6,057	6,523	7,038

Source: 1995 State Aviation Needs Study.

General Aviation Activity

In the early and mid-1990's, growth in general aviation activity was viewed with guarded optimism. This was due primarily to the cost of flying which increased more rapidly than the cost of living, and to issues related to tort liability for aircraft manufacturers. The forecasts presented in the 1995 SANS indicate a slightly increasing growth rate, about 1.8 percent annually statewide over a 20-year period. Relatively higher growth rates were projected for the northwestern counties (2.8 percent) with those in the southeastern counties reflecting an average annual growth rate of 1.1 percent. The Valley region was expected to realize growth at a rate of 1.7 percent annually on average. Comparatively, the average annual growth rate projected in 1995 by the FAA for general aviation activity in the country was some 0.9 percent for an 11-year period. Current national projections of general aviation activity by the FAA indicate an average annual growth rate of 0.7 percent. Although these projections reflect a more positive outlook for general aviation than in years past, they place a higher emphasis on business corporate flight activity and the use of more sophisticated multi-engine aircraft including jets.

The process by which the 1995 SANS forecasts of general aviation activity were derived reflects an industry-accepted methodology employing the use of regression analysis. The measures of population, employment and income used continue to be valid with comparable growth rates and characteristics Statewide and by county and region. Aircraft operations growth rate levels used in the earlier projections were higher than those applied to generate nationwide forecasts both in 1995 and those currently in use, thus reflecting the higher propensity to fly in good weather climates. Overall, it appears that the projections shown in the 1995 SANS and 1996 regional aviation study remain valid for continued application. These forecasts are presented in Table 3-6.

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Table 3-6

GENERAL AVIATION AIRCRAFT OPERATIONS

County	Airport	Actual 1995	Forecast 2000	2005	2010	2015
Apache	Chinle	2,703	2,703	2,703	8,109	8,109
	Ganado	108	108	108	108	108
	Greasewood (Closed)	108	108	108	108	108
	Lukachukai	108	108	108	108	108
	Pine Springs	65	65	65	65	65
	Rock Point	324	324	324	324	324
	Springerville Babbit Field	6,486	7,027	7,567	7,567	8,108
	St. Johns Industrial Park	4,108	4,108	4,108	4,519	4,930
	Toyei School (Closed)	22	22	22	22	22
	Window Rock	5,045	7,567	7,567	7,567	10,089
Cochise	Benson Municipal (New)	-	800	1,200	1,600	1,800
	Bisbee Douglas International	1,946	1,946	2,141	2,335	2,530
	Bisbee Municipal	7,610	8,245	8,879	9,513	10,147
	Bowie	600	800	800	1,000	1,000
	Cochise College	59,455	59,455	59,455	59,455	59,455
	Cochise County	7,243	7,800	8,357	8,636	8,914
	Douglas Municipal	7,459	7,459	7,832	7,832	8,205
	Libby AAF / Sierra Vista	21,131	23,112	23,773	27,075	29,056
	Tombstone Municipal	216	216	216	216	216

Table 3-6

GENERAL AVIATION AIRCRAFT OPERATIONS

County	Airport	Actual 1995	Forecast 2000	2005	2010	2015
Coconino	Cliff Dwellers Lodge	200	200	200	200	200
	Flagstaff-Pulliam	48,020	52,946	59,102	64,643	69,568
	Grand Canyon National Park	2,162	2,378	2,594	2,702	3,027
	H.A. Clark Memorial	216	216	216	216	216
	Marble Canyon	2,270	2,838	3,405	3,405	3,405
	Page Municipal	14,127	15,742	17,358	18,971	20,585
	Tuba City	6,486	6,486	6,486	6,486	6,486
Gila	Globe-San Carlos Regional	5,264	5,528	5,791	5,791	6,054
	Payson	21,776	22,723	23,670	25,563	26,510
	Pleasant Valley International	200	200	200	200	200
	San Carlos	2,000	2,500	3,000	4,000	5,000
Graham	Safford Regional	16,564	17,632	19,235	20,304	21,907
Greenlee	Duncan-O'Connor Field (Closed)	-	1,300	1,700	2,000	2,500
	Greenlee County	3,784	3,784	3,784	3,784	3,784
La Paz	Avi Suquilla	25,404	25,404	26,381	27,358	28,335
	Quartzsite (New)	-	1,000	1,400	2,000	2,400

Table 3-6

GENERAL AVIATION AIRCRAFT OPERATIONS

County	Airport	Actual 1995	Forecast 2000	2005	2010	2015
Maricopa	Buckeye Municipal	47,000	62,500	81,800	107,200	140,600
	Chandler Municipal	189,000	200,600	212,900	226,000	242,000
	Gila Bend Municipal	12,800	13,600	14,500	15,400	16,300
	Glendale Municipal	167,500	185,800	206,200	228,700	253,300
	Memorial Airfield[1]	2,300	4,100	7,600	13,800	25,100
	Mesa-Falcon Field	202,300	213,700	255,700	238,300	252,200
	Phoenix-Deer Valley	296,400	316,100	337,200	359,700	386,100
	Phoenix- Goodyear	222,000	242,700	265,400	290,100	313,700
	Phoenix Sky Harbor Int'l	92,066	85,358	78,500	73,000	68,000
	Scottsdale	271,300	278,200	285,200	292,400	300,000
	Stellar Airpark	52,200	53,800	55,400	57,100	58,100
	Wickenburg Municipal	17,800	19,400	21,100	23,000	25,000
	Williams Gateway	37,600	75,800	95,300	128,500	159,500
Mohave	Colorado City	865	865	1,298	1,298	1,514
	Grand Canyon Bar-Ten	200	200	200	200	200
	Grand Canyon Caverns	200	200	200	200	200
	Grand Canyon West	200	200	200	200	400
	Hualapai Tribal	200	200	400	1,000	2,000
	Kingman	28,961	31,374	33,184	34,391	35,598
	Lake Havasu City Municipal	34,364	39,651	43,805	48,336	51,735
	Laughlin / Bullhead City	93,370	118,420	138,916	163,967	179,908
	Pearce Ferry	200	200	200	200	400
	Sun Valley	200	200	200	200	200
	Temple Bar	3,026	3,026	3,026	3,026	4,539
	Tuweep	200	200	200	200	200

Note: 1. Airport was closed to aircraft in 1997 and forecast operations may not reach these levels. Airport continues to be used for practice approaches.

Table 3-6

GENERAL AVIATION AIRCRAFT OPERATIONS

County	Airport	Actual 1995	Forecast 2000	2005	2010	2015
Navajo	Holbrook Municipal	973	1,022	1,070	1,070	1,119
	Kayenta	4,000	4,000	4,000	4,000	4,000
	Low Mountain (Closed)	200	200	200	200	200
	Pinon	200	200	200	200	200
	Polacca	200	200	200	200	200
	Rocky Ridge	200	200	200	200	200
	Shonto	200	200	200	200	200
	Show Low Municipal	13,837	15,374	16,912	19,218	20,756
	Taylor Municipal	3,784	4,099	4,730	5,045	5,045
	Whiteriver	1,730	1,730	1,730	1,730	1,730
	Winslow Municipal	20,539	20,539	20,539	22,119	22,119
Pima	Ajo Municipal	1,600	1,800	2,000	2,200	2,400
	Avra Valley	30,200	34,200	36,800	39,200	41,800
	Flying J Ranch	200	200	200	200	200
	Ryan Airfield	41,000	46,200	49,800	53,200	56,800
	Sells	200	200	200	200	400
	Tucson International	71,000	80,200	86,400	92,200	98,400

Table 3-6

GENERAL AVIATION AIRCRAFT OPERATIONS

County	Airport	Actual 1995	Forecast 2000	2005	2010	2015
Pinal	Ak Chin Community	400	400	600	600	800
	Casa Grande Municipal	86,974	92,904	100,811	106,741	108,718
	Coolidge Municipal	8,513	9,459	10,405	11,351	12,296
	Eloy Municipal	24,623	26,424	28,226	30,028	31,229
	Estrella Sailport	72,968	78,373	83,778	88,282	92,786
	Kearny	5,318	5,318	7,091	8,864	10,637
	Pinal Airpark	8,980	9,653	10,214	10,888	11,449
	San Manuel	1,390	1,544	1,699	1,853	2,008
	Superior	216	648	648	864	1,080
Santa Cruz	Nogales International	3,695	4,223	4,751	5,279	5,807
Yavapai	Bagdad	18,626	23,283	29,104	37,253	44,238
	Cordes lake (New)	-	2,000	3,000	4,700	6,000
	Cottonwood Municipal	18,354	20,489	23,903	27,318	30,306
	Ernest A. Love Field	293,082	330,903	370,142	411,831	450,993
	Sedona	16,677	18,786	21,278	23,578	26,262
	Seligman	200	400	600	800	1,000
Yuma	Rolle Field	200	200	200	200	200
	Yuma International	89,862	99,540	109,908	119,586	129,263

Sources: 1995 State Aviation Needs Study.
1996 Maricopa Association of Governments Regional Aviation System Plan.

IFR Peak-Hour Aircraft Operations

Forecasts of IFR peak-hour aircraft operations were generated from the projections of total activity as presented in Table 3-6. The forecast process derives estimates of instrument operations based on a methodology developed for the FAA in the report, "An Improved Forecast Model for Annual Instrument Approaches". The translation of annual aircraft operations into annual instrument operations takes into consideration the extent of itinerant aircraft activity at the airport as identified in airport- or aviation-specific studies and the use of IFR flight plans. The latter was anticipated to increase over time as more pilots become IFR-rated. Adjustments to the data presented in Table 3-6 were made to account for airports with scheduled aircraft service.

IFR peak-hour aircraft operations were based on a planning factor that activity during the peak-hour is 3 times the average hourly activity measured during a 16-hour day. This factor was based on the experience and judgement of QED. The resultant values, as presented in Table 3-7, were determined to be reasonable and appropriate for use in this study. In many cases, a nominal value of one IFR peak-hour aircraft operation was assigned. This accounts for those airports, with or without an instrument approach procedure, that can serve as a point of departure for access to the IFR operating environment.

IFR Peak-Hour Capacity

IFR peak-hour capacities for each system airport are also presented in Table 3-7 for convenience of comparison. The capacities reflect existing airport situations whereas the forecasts shown are for the year 2015, reflecting a conservative view. The capacities were based on the extent and type of instrument approaches at each airport, the availability of an approach

Table 3-7

IFR PEAK-HOUR DEMAND / CAPACITY

County	Airport	IFR Peak-Hour Demand	IFR Peak-Hour Capacity
Apache	Chinle	1	3
	Ganado	1	3
	Greasewood (Closed)	1	3
	Lukachukai	1	3
	Pine Springs	1	3
	Rock Point	1	3
	Springerville Babbit Field	1	10
	St. Johns Industrial Park	1	5
	Toyei School (Closed)	1	3
	Window Rock	1	10
Cochise	Benson Municipal (New)	1	5
	Bisbee Douglas International	1	10
	Bisbee Municipal	1	3
	Bowie	1	3
	Cochise College	3	3
	Cochise County	1	10
	Douglas Municipal	1	3
	Libby AAF / Sierra Vista	1	30
	Tombstone Municipal	1	3

County	Airport	IFR Peak-Hour Demand	IFR Peak-Hour Capacity
Coconino	Cliff Dwellers Lodge	1	3
	Flagstaff-Pulliam	10	25
	Grand Canyon National Park	1	25
	H.A. Clark Memorial	1	3
	Marble Canyon	1	3
	Page Municipal	2	10
	Tuba City	1	3
Gila	Globe-San Carlos Regional	1	3
	Payson	1	3
	Pleasant Valley International	1	3
	San Carlos	1	3
Graham	Safford Regional	1	3
Greenlee	Duncan-O'Connor Field (Closed)	1	3
	Greenlee County	1	3

Table 3-7

IFR PEAK-HOUR DEMAND / CAPACITY

County	Airport	IFR Peak-Hour Demand	IFR Peak-Hour Capacity
La Paz	Avi Suquilla	2	5
	Quartzsite (New)	1	10
Maricopa	Buckeye Municipal	8	3
	Chandler Municipal	10	10
	Gila Bend Municipal	1	3
	Glendale Municipal	9	3
	Memorial Airfield	2	3
	Mesa-Falcon Field	10	15
	Phoenix-Deer Valley	14	15
	Phoenix- Goodyear	14	3
	Phoenix Sky Harbor Int'l	72	90
	Scottsdale	17	20
	Stellar Airpark	3	3
	Wickenburg Municipal	1	3
	Williams Gateway	9	40

County	Airport	IFR Peak-Hour Demand	IFR Peak-Hour Capacity
Mohave	Colorado City	1	5
	Grand Canyon Bar-Ten	1	3
	Grand Canyon Caverns	1	3
	Grand Canyon West	1	3
	Hualapai Tribal	1	10
	Kingman	2	10
	Lake Havasu City Municipal	3	15
	Laughlin / Bullhead City	13	10
	Pearce Ferry	1	3
	Sun Valley	1	3
	Temple Bar	1	3
	Tuweep	1	3
Navajo	Holbrook Municipal	1	3
	Kayenta	1	3
	Low Mountain (Closed)	1	3
	Pinon	1	3
	Polacca	1	3
	Rocky Ridge	1	3
	Shonto	1	3
	Show Low Municipal	1	3
	Taylor Municipal	1	3
	Whiteriver	1	3
	Winslow Municipal	1	10

Table 3-7

IFR PEAK-HOUR DEMAND / CAPACITY

County	Airport	IFR Peak-Hour Demand	IFR Peak-Hour Capacity
Pima	Ajo Municipal	1	3
	Avra Valley	2	3
	Flying J Ranch	1	3
	Ryan Airfield	2	20
	Sells	1	3
	Tucson International	18	50
Pinal	Ak Chin Community	1	3
	Casa Grande Municipal	2	20
	Coolidge Municipal	1	10
	Eloy Municipal	2	3
	Estrella Sailport	1	1
	Kearny	1	1
	Pinal Airpark	1	3
	San Manuel	1	3
	Superior Municipal	1	1

County	Airport	IFR Peak-Hour Demand	IFR Peak-Hour Capacity
Santa Cruz	Nogales International	1	5
Yavapai	Bagdad	3	3
	Cordes Lake (New)	1	10
	Cottonwood Municipal	1	3
	Ernest A. Love Field	12	50
	Sedona	2	5
	Seligman	1	3
Yuma	Rolle Field	1	3
	Yuma International	8	50

Source: QED.

Chapter 4

TECHNOLOGICAL ASSESSMENT

Introduction

The Federal Aviation Administration (FAA) is responsible for providing the infrastructure to operate, maintain and improve the air traffic control system and otherwise manage the airspace system within the United States. Although these responsibilities represent just one area of the FAA's charge, they are the primary focus of those issues related to this study. The FAA is presently examining its mission and means to best provide for continued management of the airspace infrastructure. Terms such as communications/navigation/surveillance (CNS) and air traffic management (ATM) are mentioned with increasing regularity within the aviation industry. These elements have an impact on future actions in which a state aviation agency may elect to participate. The following sections are intended to highlight principal issues with respect to CNS/ATM and aviation support services to provide a basis for establishing and maintaining future navigational aids and services in Arizona.

Navigation

1. The introduction of global positioning system (GPS) technology for civilian aviation use in February 1994 ushered in a new mind set with respect to air navigation. Although the United States Department of Defense forces have used GPS since 1973, it was not until early 1994 that the technology was made available for civilian aviation applications. Three major driving forces supported this transition:

    1. A need to maximize the existing air navigation facilities system.

    2. Demands to reduce the cost of operating and maintaining the existing navigation system.

    3. Desires to further enhance aviation safety and capacity.

GPS is the United States' response to the International Civil Aviation Organization (ICAO) challenge of developing a primary stand-alone navigation capability through a global navigation satellite system (GNSS). GNSS builds on the United States GPS, Russian global orbiting navigation satellite system (GLONASS) and other satellite systems, as they become available. Other such systems include, for example, the European geostationary navigation overlay system (EGNOS) which is the European counterpart to WAAS (see below).

Essentially, GPS, GLONASS and other such systems use earth-orbiting satellites positioned in different orbital planes, which radiate precisely timed signals of code and navigation data. The signals are received by airborne aircraft to calculate a three-dimensional position (latitude, longitude and altitude). The GPS receiver in the aircraft typically acquires positioning data from between four and eight satellites and selects at least those four which best enable a computation of the aircraft's position. As one satellite moves from view of the aircraft receiver, a new satellite should become visible so that the receiver continues to monitor and compute its position. Ground reference stations also receive GPS satellite positioning data and because the location of these stations is precisely known, can detect errors in the satellite positioning data stream. Corrections are then uplinked to geostationary satellites that transmit the corrections to the aircraft GPS receivers.

Due to the evolutionary impact GPS has on aviation, the FAA has embarked on a deliberate program to introduce the available and planned technology in a measured fashion. An initial step was the establishment of TSO-C129, "Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)" which enabled civilian use of GPS in instrument flight rule (IFR) procedures for en route, terminal and nonprecision approaches. Depending upon the classification of the TSO-C129 GPS equipment installed in the aircraft and whether it transmits data to an integrated navigation system such as flight management system which provides enhanced guidance to an autopilot or flight director in order to reduce flight technical errors, pilots can utilize GPS for oceanic, en route, terminal and nonprecision approaches except those based on procedures using localizer (LOC), localizer-type directional aid (LDA), or simplified directional facility (SDF) equipment. A basic requirement is that the GPS equipment provide the receiver autonomous integrity monitoring (RAIM) for the procedure intended. RAIM involves the use of redundant measurements to test the validity of the received signals. RAIM obtains positioning data from at least four satellites visible to the aircraft in order to select those most appropriate for calculating the position of the aircraft. RAIM provides an integrity capability, but reduces the availability because the system is available only when redundant satellites are in view in an acceptable geometry. Should one or more satellites

be malfunctioning, RAIM could not provide the reliability for navigation. When RAIM is not provided, the aircraft must fly the ground-based navigational aids (NAVAIDS) which are used to establish the procedures. This applies to flights to the destination airport. Any required alternate airport must have an approved instrument procedure and the aircraft must be able to navigate to that alternate using means other than those provided by GPS or long range navigation-C system (LORAN-C). These same regulations apply to stand-alone nonprecision GPS approach procedures.

International standards associated with civilian aviation navigation are developed by ICAO of which the FAA is an active participant. Additionally, the RTCA, Inc., an association of aeronautical organizations of the United States government and industry provides technical assistance in defining these standards. A principal output of this collaborative effort is the required navigation performance (RNP) for all phases of flight. RNP defines the navigation performance accuracy necessary for operation within a defined airspace. Measures of RNP include accuracy, integrity, availability and continuity. Accuracy is the degree of conformance of an aircraft's measured position with its true position. Integrity is the ability to provide timely warnings when part or all of the system is providing erroneous information and thus should not be used for navigation. Availability is the probability that at any time the system will meet the accuracy and integrity requirements for a specific phase of flight. Continuity is the probability that a service will continue to be available for a specified period of time and is of concern primarily in the approach phase of flight.

Because GPS with RAIM or an integrated navigation system to provide RAIM-equivalent capability cannot meet the RNP for precision approaches, the FAA is implementing a wide area augmentation system (WAAS) to permit Category I approaches (ceiling as low as 200 feet and visibility as low as ½-mile). Standards for a local area augmentation system (LAAS) are being readied to provide Category II/III approach capabilities. WAAS is intended to operate in the following sequence of events, which requires about six seconds of time:

1. The GPS satellite data is received at one of the 24 (initial) to 36 (future) wide area ground reference stations precisely located throughout the United States.

2. This data is transmitted over landlines to one or two wide area master stations that determine the integrity, differential corrections, residual error and ionospheric information for each monitored satellite.

3. The wide area corrections computed at the master station are then sent via landlines to a ground earth station which uplinks the message to one of several geostationary communications satellites.

4. The geostationary satellite then downloads this data to the WAAS receiver on the aircraft.

5. The WAAS receiver processes the integrity data to ensure that the satellites being used are providing in-tolerance data; applies the differential correction and ionoshperic information data to improve the accuracy of the aircraft's position solution; and processes the ranging data from one or more of the geostationary satellites for position determination.

WAAS meets the RNP for Category I precision approaches. However, a finer level of augmentation is necessary to comply with Category II/II RNP standards. LAAS is being designed to achieve this capability. Whereas WAAS can be considered a centralized approach in which data from the reference station is sent to a central location for processing and corrections are broadcast through communications satellites, LAAS is a distributed approach with ground stations close to the airport to which the approach is being conducted. These locations provide positioning corrections that are specific to the point of use at the airport and reduce the time for data link transmissions to the receiver in the aircraft which is coupled to the aircraft's flight management system, thereby providing greater accuracy on approach.

Interestingly, WAAS corrections are applicable at grid points and must be interpolated by aircraft software to produce the requisite positioning accuracies. The interpolation algorithms needed to compute location-specific corrections result in high complexity for airborne and ground software with attendant development and certification risks. This large software development effort also has attendant schedule risk. LAAS is a simpler technology and eliminates the need for external processing or satellite communications links. LAAS has moved more quickly into production development with several manufacturers providing the equipment. However, the FAA has yet to establish the final performance standards for LAAS and, thus, those systems being marketed will also serve as test centers for the FAA in their standard-setting process. The primary debate on standards is related to the choice of data link from the ground station to the aircraft receiver. In practice today, these pre-LAAS systems are actually established as differential GPS Special Category I Systems (SCAT-I). SCAT-I is normally developed as a private-use facility, but to not less than Category I minimums. Minimum aviation system performance standards (MASPS) have

been defined by FAA and RTCA for SCAT-I application. SCAT-I systems are certified in accordance with Federal Aviation Regulations Part 171, Non-Federal Navigation Facilities. This requires that special authorization, equipment and/or training be approved before any operator is approved to conduct SCAT-I approaches. Also, these regulations require that the owner of a SCAT-I facility comply with requirements related to the operation and maintenance of the system. While intended as private-use systems, any user that can satisfy the same requirements for equipage (avionics), aircraft and crew performance can be authorized to use the SCAT-I procedure.

Due to the evolutionary process in transitioning to a totally satellite-based system with wide area and local area augmentation, it is not anticipated that SCAT-I receivers will be compatible with WAAS or LAAS equipment. Further, avionics meeting TSO-C129 standards are considered supplemental means of navigation and will not meet the standards for WAAS for en route, nonprecision or precision (Category I) navigation.

GPS Transition Planning

The transition to GPS is but one part of the FAA's overall activities involving evolutionary changes in the nation's CNS/ATM systems. Usually, long transition periods are needed when aircraft equipage changes are involved. These factors influence the introduction and staging of systems to serve the aviation community. FAA plans, while emphasizing commercial air transportation, also need to consider the large and valuable general aviation and corporate business fleet and the airports they use. To address these and related concerns, the FAA has undertaken a major effort to develop an "affordable" national airspace system architecture which is to be the roadmap of its plans and programs to the future. Present plans and schedules suggest the following scenario:

Omega System	Ends 2000
Loran System	Ends 2000
NDB Phase-out	Begins 2000; completed by 2005
VOR/NDB Phase-out	Begins 2005; completed by 2010
ILS Phase-out	Begins 2005; completed by 2010
GPS WAAS	Phase-in begins 1998; completed by 2001
GPS LAAS	Phase-in begins 2001; completed by 2006

Observations

Notwithstanding the plans and programs of the FAA, which reflect technical considerations, history has shown that technology has not been the limitation to

implementation. Rather, non-technical factors have driven events. The timing of evolutionary changes in CNS is heavily dependent on federal funding, but also on the pace of decision making in the aviation community and in Congress, and the ability of the FAA to follow through on its aims and plans.

Economic factors have a major influence in the transition from a ground-based navigation system to one that relies on satellite positioning and augmentation. Although the transition in aircraft equipage can be expected to relatively progress more quickly in those aircraft used in scheduled airline and commercial service, the greater impact will be on the general aviation community. Because the nation's navigation system must accommodate all levels of users, any transition schedule must allow sufficient time for all users to participate in an economically acceptable basis. The FAA intends to provide about 10 years of dual operations until the ground-based systems are decommissioned. Inherent in this dual operations mode is the underlying fact that there be a period of time to ensure that the WAAS operates as designed. The FAA estimates that 100 percent of the general aviation executive and business fleet will be equipped with GPS WAAS receivers by 2004, about 2 years after the scheduled and air taxi fleets reach this capability level. Nearly two-thirds of the balance of the general aviation fleet will transition to this capability by 2011, by which time the demand for GPS/WAAS receivers will be sufficiently high as to become more affordable for general aviation users.

The requirement for back-up systems to a satellite-based navigation program appears to be a valid argument inasmuch as the system could be vulnerable to incidental, unintentional or intentional interference. This situation is currently under evaluation with an aim to avoid or minimize ground-based solutions. One area of investigation involves the use of the ATM and surveillance capabilities to provide flight direction information in the event of the loss of GPS service. Another means provides for the retention of a base network of VOR/VORTAC facilities or the Loran-C network.

The implications of the preceding information are that the FAA is progressing toward a primary means of navigation that will be satellite-based. The aging of the present ground-based systems and funding constraints to maintain and operate this equipment dictate that new technologies be employed to meet the demands of increasing air traffic activity. The transition period is necessarily influenced by the ability of the users to modify their aircraft equipage, including complementary components such as communications and data link features. The pace of this transition will likely be longer than outlined above because the FAA has not yet finalized all components of the architecture of a future CNS/ATM and the views of the aviation public are continuing to be expressed. It

is expected that a dual operations mode will exist for the planning horizon of this study and there will be steady progress in the development of nonprecision stand-alone GPS approaches based on the WAAS. WAAS will also support Precision Category I approaches, but the implementation of this capability will require extensive field evaluations. However, in the interim, the FAA is not promoting the installation of conventional ILS facilities with grant funding. Airports justifying a precision instrument approach capability have the option of pursuing FAA funding for a conventional ILS, waiting for the confirmed implementation of WAAS, or purchasing and maintaining commercial off-the-shelf Category I ILS equipment and supporting approach lighting systems.

Transponder Landing System

The transponder landing system (TLS) has been under development and testing for several years and in May 1998 received type certification from the FAA to support Special Category I precision approach operations by aircraft equipped with standard ILS receivers and a Mode A secondary surveillance radar transponder. Operational approval is currently limited to a single aircraft on approach. The type certification is in accordance with FAR Part 171. This currently places the TLS in the same status as the SCAT-I facilities that are associated with the LAAS concept for navigation. Thus, the TLS is limited to those aircraft operators requesting authorization to conduct precision (lateral and vertical guidance) approaches to a particular airport. Similar to the GPS-derived SCAT-I procedures, the TLS can serve multiple runway ends, but at only one airport. The TLS is also subject to airport owner compliance with defined operation and maintenance procedures for the facility. The TLS thus offers another option to certain aircraft operators and airport owners desiring to have a precision approach capability.

The advantage that the TLS enjoys over a SCAT-I/LAAS solution is that the aircraft operator can utilize avionics that are relied upon to conduct traditional Category I ILS approach procedures. No new aircraft equipment is needed. The TLS operates by interrogating the aircraft on final approach through the on-board transponder. The transponder replies and is sensed by multiple ground receivers near the runway. A processor computes the position of the aircraft relative to the database approach path and flight path guidance signals are transmitted to the aircraft on localizer and glide slope frequencies. These signals are displayed on the aircraft's existing ILS indicators. The pilot or autopilot equipment can then control the aircraft position through the approach and landing.

Siting requirements for the TLS ground sensors are less demanding than those for the conventional Category I ILS facilities. This is similar to the SCAT-I/LAAS installation. Establishment costs for the TLS are comparable to those of conventional Category I ILS and SCAT-I facilities.

In summary, the TLS offers an option to airports with challenging siting conditions where a conventional Category I ILS facility may not properly function, and/or where there is a lack of suitably equipped aircraft to utilize a GPS-based SCAT-I facility. It is also better suited for low activity airports because the TLS approach is limited to one aircraft at a time.

Communications

The FAA is addressing communications requirements as part of its airspace architecture analysis and evaluation, however, many of the items of concern relate to internal FAA communications. Therefore, in the context of this study, communications issues center on air-to-ground capabilities.

Currently, air-to ground communications are for analog voice transmission only without data capability. Transmissions for civilian aviation use rely on the very high frequency (VHF) spectrum, which is presently reaching a saturation of available frequencies. The FAA created more frequencies when it deployed 25 kHz spacing for air-to-ground communications in the mid-1980's. Yet the need for additional frequency spectrum is increasing, especially in high traffic density areas. The decommissioning of ground-based NAVAIDS would allow for their associated frequencies to be reassigned, however, the operational gain might sustain operations for a few years. Consideration has been given to implementing a spacing of 8.33 kHz, but again this is expected to extend operational capability for some 10 to 12 years.

1. Coupled with this situation is the explosion in telecommunications capabilities with strong movement toward digital transmission of voice and data. Private communications systems in use by major air carriers, regional airlines and high-end general aviation/corporate aircraft are communicating with data uplink/downlink systems. Other segments of the general aviation community have expressed an interest in such systems to receive flight information services, weather updates and advisories and other in-flight information to enhance safety. Accordingly, there are a variety of alternative communications vehicles that the FAA is exploring. Among these are:

1. Continuing the current analog system while providing a separate VHF digital uplink capability.

2. Implementing a next generation communications system (NEXCOM) which would have both a digital voice and data capability and emulate the existing analog system.

3. Using 8.33 kHz voice radios together with VHF digital radios.

4. Employing low and medium earth orbit satellites.

5. Integrating voice and data over time division multiple access (TDMA) radios.

6. Using only data-only TDMA radios.

7. Using carrier sense multiple access (CSMA) radios.

As in the case of a future navigation system, the transition to a new air-to-ground communications system will be based on user acceptance of the proposed equipment and ability to absorb the establishment costs. The FAA's ability to implement and fund the intended program to meet its operational needs is another factor contributing to any schedule. It is likely that a new digital communications system will eventually be necessary if the full benefits of a future CNS/ATM program are to be achieved.

Surveillance

The need to enhance air traffic control capabilities with updated surveillance facilities is a role relegated to the FAA and not necessarily that of state governments. It is clear that the FAA will be advancing its use of current and anticipated technologies for surveillance purposes. A number of individual programs are being investigated, each with an aim to contributing to flight safety and minimizing operating costs.

Of those technologies being investigated is automatic dependent surveillance broadcast (ADS-B). The ADS-B is a transponder that provides periodic broadcast of the aircraft position, altitude, identification and other information to other similarly equipped aircraft as well as to air traffic control centers. It is a satellite-dependent system, which for air-to-air communications, can be implemented within the next three years. Data transmission to the air route traffic control centers will necessitate the establishment of ADS-B ground

stations. These are expected to be phased into operation in the 2008 to 2012 timeframe. A benefit of ADS-B is its use in areas not covered by conventional radar systems, as occurs in certain areas of Arizona at low altitudes, and in oceanic airspace.

Flight Services

The FAA provides flight services through its system of automated and auxiliary flight service stations (AFSS/FSS). The AFSS/FSS provides preflight briefings with regard to navigation, airport details, and weather; opens and closes flight plans; and offers inflight weather and other support services. Pre-flight information is available by walk-up if the pilot is at the AFSS/FSS location or by telephone. The FAA also offers pre-flight services through its direct user access terminal service (DUATS) as described in Chapter 2.

The future of these services lies in their automation so that pilots may self-brief using advanced computer software capabilities including graphics. Access to a briefer will continue to be available, however, their duties will be directed more toward assisting pilots in flight. The proposed architecture for the automation enhancement program is named the operational and supportability implementation system (OASIS). One of the planned features of OASIS is to provide more, different and improved weather products and interfaces with the National Weather Service. Also included in the future is the deployment of terminals and self-service kiosks at airport locations to enhance the access and delivery of these data and products.

Federal funding limitations may lead to the continued deployment of some services by the private sector, a practice already in effect for several years with good results. DUATS is an example of a public-private partnership in the delivery of pre-flight services. However, this federally subsidized, vendor-provided service will likely be phased out as the capabilities of OASIS are implemented. There are also opportunities that state aviation agencies can explore to complement FAA initiatives and programs related to pre-flight services to the aviation community. Such options will be considered in a subsequent part of this study.

Chapter 5

INSTRUMENT APPROACH PROCEDURES ANALYSIS

Introduction

This chapter presents an inventory of existing instrument approaches at the Arizona system airports and the bases for establishing new approaches utilizing global positioning system (GPS) technology. It concludes with a defined instrument approach capability for each airport consistent, to the extent possible, with the objectives of the analysis and an emphasis on presenting a viable and practical solution.

The material is presented in text and tabular format. The tables are organized in a fashion that allows the reader to follow the situational status of a particular airport as its instrument approach capability requirement is identified and evaluated in sequence. The report text provides informational support to complement the material presented in the tables.

Existing Instrument Approach Procedures

Table 5-1 presents a listing of each published instrument approach procedure (IAP) to the system of airports as of November 6, 1997 and associated minimums and restrictions. Inasmuch as this study focuses primarily on the needs of general aviation users, the minimums presented are those applicable to aircraft approach category B as defined in "The United States Standard for Terminal Instrument Procedures (TERPS)". This category includes those aircraft with approach speeds of between 91 knots and 121 knots, a range that includes all general aviation, small commuter and some business jets.

For the benefit of the reader, a translation of terms and acronyms used in this report and others as may be useful is presented in Appendix A and illustrated in the following example: NDB or GPS 17, 500-1 – the NDB or GPS 17 specifies that an NDB facility or GPS waypoints are used to establish an instrument approach to Runway 17. The term 500-1 designates that the ceiling minimum is 500 feet above the touchdown elevation and the visibility minimum is 1 statute

mile. When the reported visibility is equal to or greater than 1 statute mile, as in this example, the pilot may descend to a 500-foot height above the touchdown (HAT) elevation and continue the approach below 500 feet HAT if the aircraft is in a position from which a normal approach can be made, and the approach threshold of the intended runway, or associated approach lights or other markings are clearly visible.

The majority of existing instrument approach procedures are established on a ground-based terminal navigational aid (NAVAID), many of which carry a global positioning system (GPS) overlay designation. There are 12 stand-alone GPS procedures, some to the same runway ends also served by a ground-based NAVAID but with different approach minimums, and 2 stand-alone GPS circling procedures. A stand-alone GPS approach is a procedure designed solely on the use of waypoints, or positions in space used to navigate to a specific runway end or the airport in general as part of a circling approach.

TERPS prescribes standardized methods for use in designing instrument flight procedures. These methods provide for the definition of approach and missed approach surfaces whose shapes, dimensions and slopes vary dependent upon the type of instrument approach under consideration. Obstacles which penetrate the applicable surfaces, or for which there is insufficient clearance between the obstacle and the surface require increases to the lowest authorized minimums of the approach procedure. Approach lighting systems may provide a ¼-mile reduction in visibility minimums; however, this is dependent on meeting certain criteria with respect to obstacles and approach surfaces.

TERPS also defines increases or penalties to the ceiling component of an approach minimum (which, in turn, can modify the visibility minimum) to account for the unavailability of a local altimeter setting source or the use of a remote airport altimeter setting, and the presence of precipitous terrain. Penalties assigned due to the latter are of a subjective nature reflecting the skill and judgement of the Federal Aviation Administration (FAA) flight procedures specialist designing the procedure, whereas penalties associated with the first two conditions can be calculated. In some cases, the lack of a local altimeter setting results in non-authorization of the approach procedure. Instances where the approach minimums are subject to increase due to the unavailability of a local altimeter setting source and the extent of such penalties, including non-authorization of the procedures, are noted in Table 5-1. The provision of an automated weather observing system will be considered in a subsequent chapter of this report to enhance the potential utilization of the instrument approach procedure.

Table 5-1
EXISTING INSTRUMENT APPROACH PROCEDURES

Airport	Existing IAPs (Type) (HAA/HAT-VIS) (Notes)		
Ajo Municipal	None		
Ak-Chin Community	None		
Avi Suquilla	VOR/DME or GPS-A 1300'-1½ Note 1; 200'		
Avra Valley	None		
Bagdad	None		
Benson Municipal (New)	None		
Bisbee Douglas International	VOR/DME or GPS 17 317-1		
Bisbee Municipal	None		
Bowie	None		
Buckeye Municipal	None		
Casa Grande Municipal	ILS/DME 5 285-½ Note 1; 140'	VOR 5 484-½ Note 1; 140'	GPS 5 424-½
Chandler Municipal	VOR or GPS 4L 446-1 Note 1; 40'	NDB 4R 541-1	VOR or GPS-A 465-1 Note 2
Chinle	None		
Cliff Dwellers Lodge	None		
Cochise College	None		
Cochise County	GPS 21 354-1 Note 3	GPS-A 454-1 Note 3	

Table 5-1

EXISTING INSTRUMENT APPROACH PROCEDURES

Airport	Existing IAPs (Type) (HAA/HAT-VIS) (Notes)			
Colorado City Municipal	NDB-A 829-1¼ Note 3			
Coolidge Municipal	VOR/DME 5 452-1¼ Note 4	GPS 23 486-1 Note 4		
Cordes Lake (New)	None			
Cottonwood Municipal	None			
Douglas Municipal	None			
Duncan-O'Connor Field (Closed)	None			
Eloy Municipal	None			
Ernest A. Love Field	ILS/DME 21L 200-½ GPS 21L 443-½	VOR/DME RNAV 21L 443-½	VOR 12 519-1	GPS12 419-1
Estrella Sailport	None			
Flagstaff-Pulliam	ILS/DME 21 250-½ GPS 21 420-1	VOR/DME 21 400-1	VOR or GPS-A 688-1	NDB/DME 21 760-1¼
Flying J Ranch	None			
Ganado	None			
Gila Bend Municipal	None			

Table 5-1

EXISTING INSTRUMENT APPROACH PROCEDURES

Airport	Existing IAPs (Type) (HAA/HAT-VIS) (Notes)	
Glendale Municipal	None	
Globe-San Carlos Regional	None	
Grand Canyon Bar-Ten	None	
Grand Canyon Caverns	None	
Grand Canyon National Park	ILS/DME 3 200-½ Note 5	VOR 3 546-½ Note 5
Grand Canyon West	None	
Greasewood (Closed)	None	
Greenlee County	None	
H.A. Clark Memorial Field	None	
Holbrook Municipal	None	
Hualapai Tribal	None	
Kayenta	None	
Kearny	None	
Kingman	VOR/DME or GPS 21 359-1 Note 3	
Lake Havasu City Municipal	VOR/DME or GPS-A 939-1¼ Note 3	
Laughlin/Bullhead International	VOR/DME 34 1708-1½ Note 6	GPS 34 1208-1½ Note 6

Table 5-1

EXISTING INSTRUMENT APPROACH PROCEDURES

Airport	Existing IAPs (Type) (HAA/HAT-VIS) (Notes)			
Libby AAF/Sierra Vista	ILS 26 200-¾ Note 7	VOR or GPS 26 434-1 Note 7	NDB 26 494-1 Note 7	
Low Mountain (Closed)	None			
Lukachukai	None			
Marble Canyon	None			
Memorial Airfield	None			
Mesa-Falcon Field	NDB or GPS-A 468-1 Note 1; 60'	GPS 4R 419-1 Note 1; 60'		
Nogales International	VOR/DME or GPS-B 1268-1½ Note 8	VOR or GPS-A 1568-1½ Note 8	NDB or GPS-C 2648-1½ Note 8	
Page Municipal	VOR or GPS-A 690-1	GPS 15 435-1		
Payson	None			
Pearce Ferry	None			
Phoenix-Deer Valley	NDB or GPS 25L 1107-1½ Note 1; 80'	GPS 7R 562-1 Note 1; 80'	GPS-A 924-1¼ Note 1; 80'	
Phoenix-Goodyear	None			
Phoenix-Sky Harbor International	ILS 8R 200-½ VOR/DME or GPS 26L 610-2	ILS 26R 250-¾ GPS 8L 945-1¼	LOC BC 26L w/DME 510-1 VOR/DME or GPS 8R 427-½	GPS 26R 667-1

Table 5-1

EXISTING INSTRUMENT APPROACH PROCEDURES

Airport	Existing IAPs (Type) (HAA/HAT-VIS) (Notes)		
Pinal Airpark	None		
Pine Springs	None		
Pinon	None		
Pleasant Valley International	None		
Polacca	None		
Quartzsite (New)	None		
Rock Point	None		
Rocky Ridge	None		
Rolle Airfield	None	419-1	
Ryan Airfield	ILS 6R 200-¾ Note 1;40'	NDB/DME or GPS 6R 900-1¼ Note 1; 40'	NDB or GPS-D 785-1¼ Note 1; 40'
Safford Regional	None		
San Carlos	None		
San Manuel	None		
Scottsdale	VOR or GPS-A 1032-2½ Note 1; 80'	VOR or GPS-C 892-2½ Note 1; 80'	NDB or GPS-B 652-1 Note 1; 80'
Sedona	NDB or GPS-A 1213-1½ Note 3		
Seligman	None		
Sells	None		
Shonto	None		

Table 5-1

EXISTING INSTRUMENT APPROACH PROCEDURES

Airport	Existing IAPs (Type) (HAA/HAT-VIS) (Notes)		
Show Low Municipal	NDB or GPS-A 509-1 Note 3		
Springerville Babbit Field	GPS 21 321-1 Note 3		
St. Johns Industrial Airpark	VOR/DME or GPS-A 507-1 Note 3		
Stellar Airpark	VOR or GPS-A 465-1 Note 2		
Sun Valley	None		
Superior Municipal	None		
Taylor Municipal	None		
Temple Bar	None		
Tombstone Municipal	None		
Toyei School (Closed)	None		
Tuba City	None		
Tucson International	ILS 11L 200-½	LOC/DME BC 29R 479-1	VOR or TACAN or GPS 11L 264-½
	VOR/DME or TACAN or GPS 29R 479-1		
Tuweep	None		

Table 5-1

EXISTING INSTRUMENT APPROACH PROCEDURES

Airport	Existing IAPs (Type) (HAA/HAT-VIS) (Notes)		
Whiteriver	None		
Wickenburg Municipal	None		
Williams Gateway	ILS 30C	VOR or TACAN or GPS 30C	
	200-¾	502-1	
	Note 1; 80', ¼	Note 1; 80', ¼	
Window Rock	VOR/DME or GPS-A	RNAV or GPS 2	
	983-1½	786-1¼	
	Note 4	Note 1; 60'	
Winslow Municipal	VOR or GPS 11		
	423-1		
	Note 3		
Yuma International	ILS 21R	VOR/DME or GPS 17	VOR 17
	200-½	404-1	404-1
	RNAV or GPS 21R		
	427-½		

Table 5-1

EXISTING INSTRUMENT APPROACH PROCEDURES

Airport	Existing IAPs (Type) (HAA/HAT-VIS) (Notes)
Note 1	Obtain local altimeter setting on CTAF; when not received, use specified airport altimeter setting and increase MDA/DH and VIS as indicated.
Note 2	Use specified airport altimeter setting. Procedure not authorized at night.
Note 3	Obtain local altimeter on CTAF; when not available, procedure not authorized.
Note 4	Use specified airport altimeter setting.
Note 5	When control zone not in effect, except for operators with an approved weather reporting service, procedure not authorized.
Note 6	Obtain local altimeter setting on CTAF; when not received, except for operators with approved weather reporting service, procedure not authorized.
Note 7	Procedure not authorized when control tower closed, except for operators with approved weather reporting service.
Note 8	Use specified airport altimeter setting; when not received, procedure not authorized.

See Appendix A for acronym definitions.

Source: U.S. Terminal Procedures, June 1998.

Desired Instrument Approach Capability

Traditionally, establishing a desired instrument approach capability at an airport would consider such factors as the role of the airport, activity levels, its contribution to the overall economic stability of its service area, and the life-cycle cost of establishing, maintaining and operating a ground-based NAVAID. Incremental gains in airport and runway operational capability achieved as a result of lowering approach minimums would also be incorporated into the analysis. In this manner, a matrix of airport role/activity levels/desired instrument approach capabilities could be defined. The next step in the process would be to evaluate means to achieve the desired instrument approach capability if it was not currently met.

The introduction of GPS technology to civil aviation use necessitates a re-examination of this traditional approach. This is because the GPS signal is satellite-generated, thereby eliminating the relatively high cost of establishing and maintaining a ground-based NAVAID. Further, new standards associated with the airport landing surface and runway facility design to support new instrument approach procedures have been issued by the FAA. Although these standards have been in effect to evaluate other physical and facilities needs at the airport, their recent tie to achievable ceiling and visibility minimums serves to strengthen their importance with respect to the establishment of instrument approach procedures.

QED considers that the ability of an airport to meet applicable landing surface and facility design standards will be used by the FAA to establish priorities in publishing stand-alone GPS procedures, if at all, depending on the circumstances at the airport under consideration. A key factor in this evaluation is the ability of the airport to meet those standards associated with ceilings equal to or less than 400 feet HAT and visibilities less than ¾-statute mile inasmuch as these standards are more rigorous than those for approaches with higher ceiling and visibility minimums.

Table 5-2 summarizes a review of the landing surface standards associated with key approach minima classifications. The premise to this review reflects the rationale that airports be developed or be reasonably capable of meeting standards which are related to the safety of aircraft operations conducted during periods of low ceilings and visibilities. From the point of view of the pilot, there should be an expectation that the physical characteristics of the airport are compatible with the instrument approach and allows for the potential to land safely within a margin of pilot/aircraft proficiency. The FAA has implicitly established airport and landing surface standards by applying similar reasoning.

A desired or target visibility minimum was selected and presented in Table 5-2 based on the results of this standards review with input from the ADOT Aeronautics staff. A target ceiling minimum was not identified because airport design standards are influenced by the aircraft approach category and visibility minimum. Certain airports were targeted to achieve ½-mile visibility minimums irrespective of their ability to meet the standards due to their system role and/or relatively high activity level. The review was conducted from available mapping and data for each airport. These materials were unavailable for several airports and therefore an assessment could not be made.

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Table 5-2
DESIRED / TARGET INSTRUMENT APPROACH CAPABILITY

Airport	Present Best IAP[1]	Ability to Meet Standards for Approach Minimums and *Comments*[2]			Desired/Target Visibility (sm)[2]
		200-½	300-¾	400-1	
Ajo Municipal	None	No *No Comments*	No	Yes	1
Ak-Chin Community	None	-- *ALP not available.*	--	--	1
Avi Suquilla	VOR/DME or GPS-A 1271-1½	No *Land available for SSALS on R/W 19.*	Yes	Yes	1
Avra Valley	None	No *Requires land acquisition for MALSR to achieve 1/2 mile visibility.*	No	Yes	½
Bagdad	None	No *No Comments.*	No	Yes	1
Benson Municipal (New)	None	No *Airport to be designed to meet applicable standards.*	No	Yes	1
Bisbee Douglas Int'l	VOR/DME or GPS 17 317-1	Yes *Land available for SSALS or MALSR on R/W 17.*	Yes	Yes	1
Bisbee Municipal	None	No *No Comments.*	No	Yes	1
Bowie	None	No *Does not meet applicable primary surface, ROFA or RSA standards.*	No	No	1
Buckeye Municipal	None	No *Does not meet aplicable ROFA or RSA standards.*	No	No	1
Casa Grande Municipal	ILS/DME 5 285-½	Yes *No Comments.*	Yes	Yes	½

Table 5-2
DESIRED / TARGET INSTRUMENT APPROACH CAPABILITY

Airport	Present Best IAP[1]	Ability to Meet Standards for Approach Minimums and Comments[2]			Desired/Target Visibility (sm)[2]
		200-½	300-¾	400-1	
Chandler Municipal	VOR or GPS 4L 446-1	No *Primary surface standard met on R/W 4R-22L.* *Requires land acquisition for MALSR on R/W 4R.*	No	Yes	½
Chinle	None	-- *ALP not available.*	--	--	1
Cliff Dwellers Lodge	None	-- *ALP not available.*	--	--	1
Cochise College	None	No *Does not meet applicable ROFA or RSA standards.*	No	No	1
Cochise County	GPS 21 354-1	No *Land available for SSALS on R/W 3.*	Yes	Yes	1
Colorado City Municipal	NDB-A 829-1¼	No *No Comments.*	No	Yes	1
Coolidge Municipal	GPS 23 486-1	No *Land available for SSALS on R/W 23.*	Yes	Yes	1
Cordes Lake (New)	None	No *Airport to be designed to meet applicable standards.*	No	Yes	1
Cottonwood Municipal	None	No *Land available for SSALS on R/W 14.*	Yes	Yes	1
Douglas Municipal	None	No *Land available for SSALS on R/W 21.*	Yes	Yes	1
Duncan-O'Connor Field (Closed)	None	No *Does not meet applicable standards for primary surface, ROFA or RSA.*	No	No	1
Eloy Municipal	None	No *No Comments.*	No	Yes	1

Table 5-2
DESIRED / TARGET INSTRUMENT APPROACH CAPABILITY

Airport	Present Best IAP[1]	Ability to Meet Standards for Approach Minimums and *Comments*[2]			Desired/Target Visibility (sm)[2]
		200-½	300-¾	400-1	
Ernest A. Love Field	ILS/DME 3 200-½	Yes *No Comments.*	Yes	Yes	½
Estrella Sailport	None	-- *Airport not intended for IFR use.*	--	--	--
Flagstaff-Pulliam	ILS/DME 21 250-½	Yes *No Comments.*	Yes	Yes	½
Flying J Ranch	None	-- *ALP not available.*	--	--	1
Ganado	None	-- *ALP not available.*	--	--	1
Gila Bend Municipal	None	No *Does not meet applicable ROFA or RSA standards.*	No	No	1
Glendale Municipal	None	No *Does not meet applicable standards for primary surface, ROFA or RSA. Land available for MALSR on R/W 1.*	Yes	Yes	½
Globe-San Carlos Regional	None	No *No Comments.*	No	Yes	1
Grand Canyon Bar-Ten	None	-- *ALP not available.*	--	--	1
Grand Canyon Caverns	None	-- *ALP not available.*	--	--	1
Grand Canyon Nat'l Park	ILS/DME 3 200-½	Yes *No Comments.*	Yes	Yes	½
Grand Canyon West	None	No *No Comments.*	No	Yes	1

Table 5-2
DESIRED / TARGET INSTRUMENT APPROACH CAPABILITY

Airport	Present Best IAP[1]	Ability to Meet Standards for Approach Minimums and Comments[2]			Desired/Target Visibility (sm)[2]
		200-½	300-¾	400-1	
Greasewood (Closed)	None	--	--	--	1
		ALP not available.			
Greenlee County	None	No	No	Yes	1
		No Comments.			
H.A. Clark Memorial Field	None	No	No	No	1
		Does not meet applicable ROFA or RSA standards.			
Holbrook Municipal	None	No	No	Yes	1
		No Comments.			
Hualapai Tribal	None	--	--	--	1
		ALP not available.			
Kayenta	None	--	--	--	1
		ALP not available.			
Kearny	None	No	No	No	1
		Does not meet applicable standards for primary surface, ROFA or RSA.			
Kingman	VOR/DME or GPS 21 359-1	No	No	Yes	½
		Does not meet applicable standards for primary surface. Inner OFZ standard met on R/W 21. Land available for MALSR on R/W 3 and R/W 21.			
Lake Havasu City Municipal	VOR/DME or GPS-A 939-1¼	Yes	Yes	Yes	½
		Applicable standards for Inner OFZ and TERPS 332 not met on R/W 14. Land for MALSR available on R/W 14.			

Table 5-2

DESIRED / TARGET INSTRUMENT APPROACH CAPABILITY

Airport	Present Best IAP[1]	Ability to Meet Standards for Approach Minimums and Comments[2]			Desired/Target Visibility (sm)[2]
		200-½	300-¾	400-1	
Laughlin / Bullhead International	GPS 34 1208-1½	No	Yes	Yes	½
		Applicable standards for Inner OFZ and TERPS 332 met on R/W 16. Requires land acquisition for MALSR to achieve ½-mile visibility.			
Libby AAF/Sierra Vista	ILS 26 200-¾	Yes	Yes	Yes	½
		Land available for MALSR on R/W 26.			
Low Mountain (Closed)	None	--	--	--	1
		ALP not available.			
Lukachukai	None	--	--	--	1
		ALP not available.			
Marble Canyon	None	--	--	--	1
		ALP not available.			
Memorial Airfield	None	--	--	--	1
		ALP not available.			
Mesa-Falcon Field	GPS 4R 419-1	No	No	Yes	½
		Applicable standard for Inner OFZ not met on R/W 4R. Land available for MALSR on R/W 4R, but requires road crossing.			
Nogales International	VOR/DME or GPS-B 1268-1½	No	No	Yes	1
		No Comments.			
Page Municipal	GPS 15 435-1	No	Yes	Yes	½
		Land available for SSALS on R/W 33. Land acquisition required for MALSR on on R/W 15 and R/W 33.			

Table 5-2
DESIRED / TARGET INSTRUMENT APPROACH CAPABILITY

Airport	Present Best IAP[1]	Ability to Meet Standards for Approach Minimums and Comments[2]			Desired/Target Visibility (sm)[2]
		200-½	300-¾	400-1	
Payson	None	No	No	Yes	1
		No comments.			
Pearce Ferry	None	--	--	--	1
		ALP not available.			
Phoenix-Deer Valley	GPS 7R 562-1	No	No	Yes	½
		Applicable standard for Inner OFZ not met on R/W 7R. Requires land acquistion for R/W 7R MALSR. Land available for SSALS on R/W 7R.			
Phoenix-Goodyear	None	No	Yes	Yes	½
		Applicable standard for Inner OFZ met on R/W 3. Requires land acquisition for MALSR on R/W 3.			
Phoenix-Sky Harbor International	ILS 8R 200-½	Yes	Yes	Yes	½
		No comments.			
Pinal Airpark	None	No	Yes	Yes	1
		Land available for SSALS on R/W 12.			
Pine Springs	None	--	--	--	1
		ALP not available.			
Pinon	None	--	--	--	1
		ALP not available.			
Pleasant Valley International	None	--	--	--	1
		ALP not available.			
Polacca	None	--	--	--	1
		ALP not available.			
Quartzsite (New)	None	No	No	Yes	1
		Airport to be designed to applicable standards.			

Table 5-2
DESIRED / TARGET INSTRUMENT APPROACH CAPABILITY

Airport	Present Best IAP[1]	Ability to Meet Standards for Approach Minimums and *Comments*[2]			Desired/Target Visibility (sm)[2]
		200-½	300-¾	400-1	
Rock Point	None	--	--	--	1
		ALP not available.			
Rocky Ridge	None	--	--	--	1
		ALP not available.			
Rolle Airfield	None	No	No	Yes	1
		No comments.			
Ryan Airfield	ILS 6R 200-¾	No	Yes	Yes	½
		Requires land acquisition for MALSR on R/W 6R.			
Safford Regional	None	No	No	Yes	1
		No comments.			
San Carlos	None	--	--	--	1
		ALP not available.			
San Manuel	None	--	--	--	1
		ALP not available.			
Scottsdale	NDB or GPS-B 652-1	No	No	Yes	½
		Does not meet applicable stanards for primary surface and ROFA. Requires land acquisition for MALSR on R/W 3.			
Sedona	NDB or GPS-A 1213-1½	No	No	No	1
		Does not meet applicable standard for ROFA.			
Seligman	None	No	No	No	1
		Does not meet applicable standards for primary surface and ROFA.			
Sells	None	--	--	--	1
		ALP not available.			

Table 5-2

DESIRED / TARGET INSTRUMENT APPROACH CAPABILITY

Airport	Present Best IAP[1]	Ability to Meet Standards for Approach Minimums and Comments[2]			Desired/Target Visibility (sm)[2]
		200-½	300-¾	400-1	
Shonto	None	--	--	--	1
		ALP not available.			
Show Low Municipal	NDB or GPS-A 509-1	No	No	Yes	½
		Requires land acquisition for MALSR.			
Springerville Babbit Field	GPS 21 321-1	No	No	Yes	1
		No Comments.			
St. Johns Industrial Airpark	VOR/DME or GPS-A 507-1	No	No	No	1
		Does not meet applicable standards for primary surface and ROFA.			
Stellar Airpark	VOR or GPS-A 465-1	--	--	--	1
		ALP not available.			
Sun Valley	None	--	--	--	1
		ALP not available.			
Superior Municipal	None	--	--	--	1
		ALP not available.			
Taylor Municipal	None	No	No	No	1
		No Comments.			
Temple Bar	None	--	--	--	1
		ALP not available.			
Tombstone Municipal	None	No	No	Yes	1
		No Comments.			
Toyei School (Closed)	None	--	--	--	1
		ALP not available.			
Tuba City	None	--	--	--	1
		ALP not available.			

Table 5-2
DESIRED / TARGET INSTRUMENT APPROACH CAPABILITY

Airport	Present Best IAP[1]	Ability to Meet Standards for Approach Minimums and *Comments*[2]			Desired/Target Visibility (sm)[2]
		200-½	300-¾	400-1	
Tucson International	ILS 11L 200-½	Yes *No comments.*	Yes	Yes	½
Tuweep	None	-- *ALP not available.*	--	--	1
Whiteriver	None	-- *ALP not available.*	--	--	1
Wickenburg Municipal	None	No *No comments.*	No	Yes	1
Williams Gateway	ILS 30C 200-¾	Yes *No comments.*	Yes	Yes	½
Window Rock	RNAV or GPS 2 786-1¼	No *No comments.*	No	Yes	1
Winslow Municipal	VOR or GPS 11 423-1	No *No comments.*	No	Yes	1
Yuma International	ILS 21R 200-½	Yes *No comments.*	Yes	Yes	½

Note: See Appendix A for acronym definitions.
Sources: 1. Table 5.1.
2. QED.

GPS Analysis

The GPS analysis was based on the procedures outlined in TERPS and, more specifically, those FAA Orders that provide the criteria in the use of GPS for navigation. The latter include:

1. FAA Order 8260.38A, "Civil Utilization of Global Positioning System (GPS)". This order applies to instrument procedures based on GPS airborne equipment meeting en route, terminal and "nonprecision" requirements of technical standard order (TSO) C-129, "Airborne Supplemental Navigation Equipment Using the GPS".

2. FAA Order 8260.36A, "Civil Utilization of Microwave Landing System (MLS)". Although developed for MLS procedures, the criteria contained in this order applies to the use of GPS "precision" procedures.

For the purposes of this study, the architecture for the wide area augmentation system (WAAS) is expected to meet the required navigation performance (RNP) standards for "nonprecision" and Category I "precision" approaches.

<u>"Precision " and "Nonprecision" Vernacular</u>

It is appropriate at this juncture to introduce the reader to a likely change in terminology related to instrument approaches. Currently, instrument approaches are categorized as "precision" or "nonprecision". The difference is linked to the availability of vertical guidance during the approach procedure. When lateral and vertical guidance is communicated to the pilot/aircraft, the approach is termed a "precision" approach. A "nonprecision" approach is one for which only lateral guidance is available. The ceiling minimum in a "precision" approach is termed a decision height (DH); for "nonprecision" approaches, the term minimum descent altitude (MDA) is used. For many users, the term "precision" also implies minimums of 200-foot ceiling and ½-mile visibility, also referred to as Category I.

The above terminology may change when the use of GPS becomes more widespread and standards for use are finalized. Because GPS provides both lateral and vertical guidance information, all GPS approaches may be considered "precision with variable decision heights". Approach minimums for GPS procedures will range from the Category I standard (200'-½) to higher values. Yet, each will be considered "precision". Consequently, this report seeks to adopt a new vernacular when describing GPS approaches. Terms "precision" and "nonprecision" are not used and the reader should refer to the minimums associated with the procedure. These minimums correlate with airport landing surface and design standards to which airport facilities should be developed.

GPS Analysis Findings

The use of GPS technology to meet the desired visibility component of the approach minimums as outlined in Table 5-2 is dependent not only on the height and location of obstacles in the approach and missed approach surfaces, but the availability of an appropriate approach lighting system and a final approach fix. Generally, the ceiling minimum, which is determined based on a review of obstacles underlying the applicable approach surface, also establishes a floor level for the visibility minimum and this relationship varies based on the type of approach and category of aircraft. In most instances, for example, when evaluating an approach procedure which results in a relatively high ceiling minimum (between 741 feet and 950 feet HAT for category B aircraft), the corresponding visibility minimum is 1¼ miles assuming that a final approach fix is available. An appropriate approach lighting system (ALS) could lower the visibility by ¼-mile under most circumstances. It should be noted that due to the complexity of TERPS guidelines and the variety of situations which can arise, the examples presented above and elsewhere in this report are intended to be illustrative and general in nature of the evaluation procedure and not all inclusive. Further, the analysis assumed that each airport would be capable of providing a local altimeter setting source so that the approach procedure would be available at all times or the minimums would not be increased with a remote altimetry penalty.

The simplified short approach lighting system (SSALS) is the least sophisticated facility in terms of size and features which can be installed to gain a ¼-mile visibility credit. The medium intensity approach lighting system with runway alignment indicator lights (MALSR) is the standard facility for Category I approaches.

With the foregoing as a basis, Table 5-3 succinctly summarizes the results of the GPS analysis for each airport. The table is organized by airport, desired or target visibility minimum, present best instrument approach and minimums, an initial potential instrument approach to best match the desired or target level and the resultant minimums, and any comments or factors which influenced that determination. The "Comments" section of Table 5-3 provides a summarization of the key findings in each airport evaluation. The term OCS refers to the obstacle clearance surface defined for GPS approaches intended to have ½-mile visibility minimums. The OCS has three sets of sloping surfaces (W, X and Y) which make obstacles further distant from the runway threshold or offset from the approach alignment less of an influencing factor in the approach minimums determination.

Table 5-3 summarizes the results for each system airport. These are initial findings inasmuch as airport system and other aviation needs associated with enhanced IAP capabilities have not yet been addressed and may affect a final determination.

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Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Ajo Municipal	1	None	GPS 30 402-1
	Controlling obstacle is terrain at 1600' MSL 26,800' SE. Requires 20° right turn missed approach procedure to avoid high terrain at 1800' MSL 15,000' NW.		
Ak-Chin Community	1	None	GPS 17 250-1
	Final approach and missed approach segments clear. Survey airport to determine compliance with applicable facility design standards.		
Avi Suquilla	1	VOR/DME or GPS-A 1271-1½	GPS 1 271-1
	Controlling obstacle is terrain at 460' MSL 3,000' SE. GPS 19 yields 651-1 due to terrain at 840' MSL 27,000' N.		
Avra Valley	½	None	GPS 12 200-1/2
	OCS clear. Final approach course could overfly Pinal Air Park. Requires left turn missed approach procedure to avoid Panther Peak at 3453' MSL 22,700' SE in missed approach segment. Rillito Point at 2503' MSL not a factor. Airspace interaction with Tucson International minimized due to similar course alignment. Requires land acquisition to install MALSR. Procedure dependent on establishment of WAAS by FAA. "Nonprecision" GPS 12 yields 250-¾ with SSALS.		
Bagdad	1	None	GPS 5 1057-1½
	Controlling obstacle is terrain in Blue Mountains at 5560' MSL 23,000' NE in missed approach segment.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Benson Municipal (New)	1	None	GPS 28 250-1
	Final approach and missed approach segments clear.		
Bisbee Douglas International	1	VOR/DME or GPS 17 317-1	Same
	Meets target IAP capability. Minimums can be lowered to 317-¾ with installation of SSALS if considered justified; land available.		
Bisbee Municipal	1	None	GPS-A 1120-1½
	Mexican border to south requires approach to R/W 17 and a turning misssed approach to maintain procedures in US airspace. High terrain including Mt. Martin at 7160' MSL yields unacceptably high minimums (2400-2). Offset alignment (15° N) provides minimal relief. A circling approach originating W of the airport and straight missed approach segment is viable.		
Bowie	1	None	GPS 26 250-1
	Final approach and missed approach segments clear. Airport requires improvements to meet applicable primary surface, ROFA and RSA standards.		
Buckeye Municipal	1	None	GPS 25 250-1
	Final approach and missed approach segments clear. Airport requires improvements to meet applicable ROFA and RSA standards.		
Casa Grande Municipal	½	ILS/DME 5 285-½	GPS 5 200-½
	Existing approach minimums based on flight check value associated with glide slope reception (glide slope unusable below 1665' MSL). Procedure dependent on establishment of WAAS by FAA.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Chandler Municipal	½	VOR or GPS 4L 446-1	GPS 4R 200-½
	Airspace environment suggests procedure to NE. Airport layout and compliance with applicable design standards favor R/W 4R. Requires land acquisition to install MALSR. Procedure dependent on establishment of WAAS by FAA. "Nonprecision" GPS 4R yields 250-1; and 250-¾ with SSALS.		
Chinle	1	None	GPS 17 365-1
	Controlling obstacle is powerline at 5615' MSL 1,800' S.		
Cliff Dwellers Lodge	1	None	GPS 22 663-1
	Controlling obstacle is terain at 4617' MSL 3,000' NE. Requires left turn missed approach to avoid high terrain at Walts Bench (4400' MSL 9,500' S). Survey airport to determine compliance with applicable design standards.		
Cochise College	1	None	GPS 23 250-1
	Proximity of Mexican border requires approach from the NE. Requires turn for missed approach to maintain procedure within US airspace. Airport requires improvements to meet applicable ROFA and RSA standards.		
Cochise County	1	GPS 21 354-1	Same
	Meets target IAP capability.		
Colorado City Municipal	1	NDB-A 829-1¼	GPS 29 489-1
	Controlling obstacle is terrain at 5098' MSL 30,000' E.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Coolidge Municipal	1	GPS 23 486-1	Same
	Meets target IAP capability. Minimums can be lowered to 486-¾ with installation of SSALS if considered justified; land available.		
Cordes Lake (New)	1	None	GPS 19 745-1
	Controlling obstacle is terrain at 4232' MSL 30,000' N. GPS 1 yields 885-1 based on terrain at 4372' 29,500' S.		
Cottonwood Municipal	1	None	GPS 32 1310-1½
	Controlling obstacle is terrain at 4600' MSL 39,000' NW in missed approach segment. GPS 14 yields 1570-1½ due to terrain at 4338' MSL 10,000' E in missed approach segment. SSALS not warranted with relatively high ceiling minimum.		
Douglas Municipal	1	None	GPS 21 427-1
	Proximity of Mexican border requires approach from the NE. Contolling obstacle is terrain at 4348' MSL 24000' NE. Requires turning missed approach to remain in US airspace. Minimums can be lowered to 427-¾ with installation of SSALS if considered justifiable; land available.		
Duncan-O'Connor Field (Closed)	1	None	GPS 21 533-1
	Controlling obstacle is terrain at 4327' MSL 17,000' SE in missed approach segment. Requires 180° right turn missed approach to avoid higher terrain. Airport requires improvements to meet applicable primary surface, ROFA and RSA standards.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Eloy Municipal	1	None	GPS 20 250-1
	Final approach and missed approach segments clear.		
Ernest A. Love Field	½	ILS/DME 21L 200-½	Same
	Meets target IAP capability.		
Estrella Sailport	N/A	None	Same
	Airport restricted to VFR sailplane activity.		
Flagstaff-Pulliam	½	ILS/DME 21 250-½	GPS 21 200-½
	Existing CAT I ILS/DME utilizes offset localizer which establishes the lowest achievable minimums at 250-½. Establishment of WAAS by FAA should eliminate 50' ceiling penalty.		
Flying J Ranch	1	None	GPS 19 550-1
	Controlling obstacle is Coyote Knoll at 3900' MSL 20,000' S in missed approach segment. Survey airport to determine compliance with applicable facility design standards.		
Ganado	1	None	GPS 18 398-1
	Controlling obstacle is terrain at 6797' MSL 23,000' SW. Airport requires survey to determine compliance with applicable facility design standards.		
Gila Bend Municipal	1	None	GPS 4 302-1
	Controlling obstacle is terrain at 813' MSL 23,000' SW. Airport requires improvements to meet applicable ROFA and RSA standards.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Glendale Municipal	½	None	GPS 19 250-¾
	Airspace interaction with Luke AFB requires 15° E offset alignment. Airport requires installation of SSALS.		
Globe-San Carlos	1	None	GPS 27 565-1
	Requires 13° N offset alignment to avoid impact of Bucket Mountain. Requires right turn missed approach to avoid higher terrain. Controlling obstacle is terrain at 3600' MSL 13,000' NW in missed approach segment.		
Grand Canyon Bar-Ten	1	None	Same
	Surrounding terrain in all quadrants precludes practical straight-in, offset or circling IAP capability.		
Grand Canyon Caverns	1	None	GPS 23 394-1
	Controlling obstacle is terrain at 5845' MSL 16,000' W in missed approach segment. Survey airport to determine compliance with applicable facility design standards.		
Grand Canyon National Park	½	ILS/DME 3 200-½	Same
	Meets target IAP capability.		
Grand Canyon West	1	None	GPS 35 305-1
	Controlling obstacle is terrain at 4816' MSL 5,000' S.		
Greasewood (Closed)	1	None	GPS 4 300-1
	Controlling obstacle is terrain at 6290' MSL 10,000' NE in missed approach segment. Survey airport to determine compliance with applicable facility design standards.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Greenlee County	1	None	GPS 7 949-1¼
	Requires 15° N offset alignment to avoid Guthrie Mountain. Requires 180° turn to right in missed approach to avoid highest terrain. Controlling obstacle is terrain at 3846' MSL 17,000' SE.		
H.A. Clark Memorial Field	1	None	GPS 18 1300-1½
	Controlling obstacle is Sister Peak at 7644' MSL 18,000' S in missed approach segment. Airport requires improvements to meet ROFA and RSA standards.		
Holbrook Municipal	1	None	GPS 21 323-1
	Controlling obstacle is terrain at 5229' MSL 29,000' NE.		
Hualapai Tribal	1	None	GPS 7 483-1
	Controlling obstacle is terrain at 5829' MSL 19,000' NE in missed approach segment. Survey airport to determine compliance with applicable facility design standards.		
Kayenta	1	None	GPS 23 510-1
	Controlling obstacle is terrain at 6543' MSL 20,500' SW in missed approach segment. Airport requires improvements to meet applicable primary surface, ROFA and RSA standards.		
Kearny	1	None	Same
	Surrounding terrain in all quadrants precludes practical straight-in, offset or acircling IAP capability.		
Kingman	½	VOR/DME or GPS 21 359-1	GPS 21 200-½
	OCS and missed approach segment clear. Procedure dependent on establishment of WAAS by FAA.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Lake Havasu City Municipal	½	VOR/DME or GPS-A 939-1¼	GPS 32 200-½
	Noise abatement procedures designate R/W 32 as the calm wind R/W with straight-in and straight-out operations prohibited to avoid overflight of residential areas to the S and SW. OCS and missed approach segment clear. Procedure dependent on establishment of WAAS by FAA. Airport requires improvements to meet applicable primary surface standard and land acquisition for MALSR.		
Laughlin / Bullhead international	½	GPS 34 1208-1½	GPS 34 314-½
	Controlling obstacle is Buttshead Point at 1575' MSL 15,000' N in missed approach segment. Turning missed approach procedure does not avoid obstacle. Adjustment to DH required to provide clear misssed approach segment. Approach to R/W 16 not viable due to high terrain in final approach segment. Procedure dependent on establishment of WAAS by FAA. Airport requires improvements to meet applicable standards for Inner OFZ, TERPS 332 and land acquisition for MALSR.		
Libby AAF/Sierra Vista	½	ILS 26 200-¾	ILS 26 200-½
	Requires installation of MALSR to achieve ½ mile visibility.		
Low Mountain (Closed)	1	None	GPS 30 1180-1½
	Controlling obstacle is terrain at 6600' MSL 4,000' NW in missed approach segment. Survey airport to determine compliance with applicable facility design standards.		
Lukachukai	1	None	GPS 12 313-1
	Controlling obstacle is powerline at 6483' MSL 1,000' NW. Survey airport to determine compliance with applicable facility design standards.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Marble Canyon	1	None	GPS 3 1517-1½
	Controlling obstacle is terrain at 4061' MSL 4,500' NE in missed approach segment. Survey airport to determine compliance with applicable facility design standards.		
Memorial Airfield	1	None	GPS 12 455-1
	Controlling obstacle is terrain at 1383' MSL 29,000' NW in final approach segment. Survey airport to determine compliance with applicable facility design standards.		
Mesa-Falcon Field	½	GPS 4R 419-1	GPS 4R 200-½
	OCS clear. Requires 180° right turn missed approach procedure to avoid potential penetrations of surface. Procedure dependent on establishment of WAAS by FAA. Airport requires improvements to meet Inner OFZ standards and MALSR installation.		
Nogales International	1	VOR/DME or GPS-B 1268-1½	Same
	Proximity of Mexican border precludes final approach segment to R/W 3 within US airspace. GPS 21 yields 1488-1½ due to impact of Patagonia Mountains at 5160' MSL 30,000' NE.		
Page Municipal	½	GPS 15 435-1	GPS 15 200-½
	OCS and missed approach segment clear. Final approach overflies Glen Canyon National Recreation Area. Procedure dependent on establishment of WAAS by FAA. Requires land acquisition for MALSR.		
Payson	1	None	GPS 6 383-1
	Controlling obstacle is Murphy Point at 5277' MSL 9,000' SW.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Pearce Ferry	1	None	GPS 19 250-1
	Final approach and missed approach segments clear. Survey airport to determine compliance with applicable facility design standards.		
Phoenix-Deer Valley	½	GPS 7R 562-1	GPS 7R 200-½
	OCS and missed approach segment clear. Procedure dependent on establishment of WAAS by FAA. Airport requires improvements to meet Inner OFZ standard and land acquisition to install MALSR.		
Phoenix-Goodyear	½	None	GPS 3 200-½
	OCS and missed approach segment clear. Missed approach requires left turn to avoid overflight of residential areas to NE in accordance with noise abatement practices. Procedure dependent on establishment of WAAS by FAA. Requires land acquisition for MALSR.		
Phoenix Sky Harbor International	½	ILS 8R 200-½	Same
	Meets target IAP capability.		
Pinal Airpark	1	None	GPS 12 250-1
	Final approach and missed approach segments clear. Minimums can be lowered to 250-¾ with installation of SSALS if considered justified; land available.		
Pine Springs	1	None	GPS 5 390-1
	Controlling obstacle is terrain at 6955' MSL 500' S. Survey airport to determine compliance with applicable facility design standards.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Pinon	1	None	GPS 1 345-1
	Controlling obstacle is terrain at 6380' MSL 13,000' S. Survey airport to determine compliance with applicable facility design standards.		
Pleasant Valley International	1	None	GPS 5 640-1
	Requires 5° S offset alignment to avoid impact of Twin Buttes. Controlling obstacle is terrain at 2000' MSL 18,000' SW. Survey airport to determine compliance with applicable design standards.		
Polacca	1	None	GPS 4 250-1
	Final approach and missed approach segments clear. Survey airport to determine compliance with applicable facility design standards.		
Quartzsite (New)	1	None	GPS 17 250-1
	Final approach and missed approach segments clear.		
Rock Point	1	None	GPS 19 250-1
	Final approach and missed approach segments clear. Survey airport to determine compliance with applicable facility design standards.		
Rocky Ridge	1	None	GPS 21 250-1
	Final approach and missed approach segments clear. Survey airport to determine compliance with applicable facility design standards.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Rolle Airfield	1	None	GPS 17 250-1
	Final approach segment clear. Missed approach procedure requires 180° left turn to maintain flight within US airspace.		
Ryan Airfield	½	ILS 6R 200-¾	ILS 6R 200-½
	Final approach segment clear. Requires land acquisition to install MALSR and achieve ½-mile visibility.		
Safford Regional	1	None	GPS 30 250-1
	Final approach and missed approach segments clear.		
San Carlos	1	None	Same
	Surrounding terrain in all quadrants precludes practical straight-in, offset or circling IAP capability.		
San Manuel	1	None	GPS 29 305-1
	Controlling obstacle is terrain at 3322' MSL 13,000' SE. Survey airport to determine compliance with applicable facility design standards.		
Scottsdale	½	NDB or GPS-B 652-1	GPS 3 200-½
	R/W 3 is preferred R/W for noise abatement. Requires increase of TCH to 60' to avoid penetration of OCS W surface by terrain in Phoenix Mountains Preserve at 2429' MSL 31,000' SW. Requires 180° left turn missed approach procedure to avoid high terrain to N and NE. Procedure dependent on establishment of WAAS by FAA. Requires airport improvements to meet applicable primary surface and RSA standards. Requires land acquisition to install MALSR.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Sedona	1	NDB or GPS-A 1213-1½	GPS 3 1623-1½
	Controlling obstacle is terrain at 6748' MSL 22,000' NE in missed approach segment. Turns in in missed approach encompass similarly high terrain. Airport requires improvements to meet applicable ROFA standard. GPS 3 yields higher minimums than existing NDB or GPS-A approach but provides a straight-in procedure.		
Seligman	1	None	GPS 4 303-1
	Requires 7° W offset alignment to avoid high terrain to S. Controlling obstacle is railroad at 5277' MSL 1,000' SW. Airport requires improvements to meet applicable primary surface and ROFA standards.		
Sells	1	None	GPS 4 250-1
	Final approach and missed approach segments clear. Survey airport to determine compliance with applicable facility design standards.		
Shonto	1	None	GPS 19 250-1
	Final approach and missed approach segments clear. Survey airport to determine compliance with applicable facility design standards.		
Show Low Municipal	½	NDB or GPS-A 509-1	GPS 24 200-½
	OCS and missed approach segment clear. Procedure dependent on establishment of WAAS by FAA. Requires land acquisition to install MALSR.		
Springerville Babbit Field	1	GPS 21 321-1	Same
	Meets target IAP capability.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
St. Johns Industrial Airpark	1	VOR/DME or GPS-A 507-1	GPS 14 250-1
	Requires 8° N offset alignment to avoid high terrain to NW. Controlling obstacle is terrain at 5800' MSL 6,500' NW. Airport requires improvements to meet applicable standards for primary surface and ROFA.		
Stellar Airpark	1	VOR or GPS-A 465-1	GPS 35 315-1
	GPS provides straight-in approach capability. Controlling obstacle is powerline at 1220' MSL 760'S; missed approach segment clear. Final approach overflies Memorial Airpark 17,000' S. Requires 90° right turn missed approach procedure to avoid overflight of Tempe. GPS 17 yields 305-1 with overflights of Tempe 19,000' N and 90° right turn missed approach procedure to avoid overflight of Memorial Airpark to S and Chandler Municipal Airport 32,000' SE. Survey airport to determine compliance with facility design standards.		
Sun Valley	1	None	GPS 36 250-1
	Final approach and missed approach segments clear. Survey airport to determine compliance with applicable facility design standards.		
Superior Municipal	1	None	Same
	Surrounding terrain in all quadrants precludes practical straight-in, offset or circling IAP capability.		
Taylor Municipal	1	None	GPS 3 250-1
	Final approach and missed approach segments clear.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Temple Bar	1	None	GPS 18 376-1
	Controlling obstacle is terrain at 2490' MSL 27,000' S in missed approach segment. Final approach overflies Lake Mead Recreation Area. Survey airport for compliance with applicable facility design standards.		
Tombstone Municipal	1	None	GPS 6 777-1¼
	Controlling obstacle is terrain at 5145' MSL 15,500' NE in missed approach segment. Turning missed approach does not reduce minimums.		
Toyei School (Closed)	1	None	GPS 21 250-1
	Final approach and missed approach segments clear. Survey airport to determine compliance with applicable facility design standards.		
Tuba City	1	None	GPS 33 447-1
	Controlling obstacle is terrain at 4699' MSL 8,000' SE. Survey airport for compliance with applicable facility design standards.		
Tucson International	½	ILS 11L 200-½	Same
	Meets target IAP capability.		
Tuweep	1	None	Same
	Surrounding terrain in all quadrants precludes practical straight-in, offset or circling IAP capabillity.		

Table 5-3
INITIAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Initial Potential IAP (Type, HAA/HAT-VIS)[3]
Whiteriver	1	None	GPS 1 1648-1½
	Controlling obstacle is Big A Mountain at 6050' MSL 8,000' NE in missed approach segment. Approach overflies City of Whiteriver. Survey airport for compliance with applicable facility design standards.		
Wickenburg Municipal	1	None	GPS 5 894-1¼
	Controlling obstacle is Black Mountain at 3108' MSL 14,000' SW.		
Williams Gateway	½	ILS 30C 200-¾	ILS 30R 200-½
	CAT I ILS facilities to be relocated to R/W 30R and MALSR to be installed in near future.		
Window Rock	1	RNAV or GPS 2 786-1¼	Same
	Best achievable minimums due to surrounding terrain and obstructions.		
Winslow Municipal	1	VOR or GPS 11 423-1	Same
	Meets target IAP capability.		
Yuma International	½	ILS 21R 200-½	Same
	Meets target IAP capability.		

Note: See Appendix A for acronym definitions.
Sources: 1. Table 5-2.
2. Table 5-1.
3. QED.

To place the initial GPS analysis findings in another perspective, they have been segregated by overall capability into sets as presented in Table 5-4. A total of 11 sets are defined as follows:

Set 1 -- Airports with an existing instrument approach procedure (IAP) that meets the target IAP capability. There are 12 airports in this set.

Set 2 -- Airports with or without an existing IAP that does not meet the target IAP capability. However, there is the potential to establish an IAP capability that will meet the target IAP capability for the airport. These airports also meet the applicable landing surface and facility design standards associated with the potential IAP. There are 16 airports in this set.

Set 3 -- Airports without an existing IAP that does not meet the target IAP capability, but for which there is the potential that an instrument approach can be established. However, the new IAP does not meet the target capability for the airport. These airports meet applicable landing surface and facility design standards. There are 7 airports in this set.

Set 4 -- Airports without and existing IAP and whose geographical setting and surrounding terrain and/or other obstructions are such that an IAP is not viable. There are 5 airports in this set.

Set 5 -- Airports with an existing IAP that does not meet the target IAP capability. However, a new IAP procedure cannot improve upon the existing situation due to surrounding terrain/obstructions that would provide lower approach minimums. There are 2 airports in this set.

Set 6 -- Airports with an existing IAP that does not meet the target IAP capability. However, the establishment of the WAAS by the FAA will enable the airport to have the potential to achieve the target IAP. These airports also meet the applicable landing surface and facility design standards. There are 2 airports in this set.

Set 7 -- Airports with and without an existing IAP that does not meet the target IAP capability. There is the potential to establish an IAP that will meet the target capability. However, the ability of these airports to meet applicable landing surface and facility design standards is not known due to the unavailability of airport layouts and mapping. There are 25 airports in this set.

Set 8 -- Airports without an existing IAP, but an IAP can be established. However, the resulting IAP does not meet the target capability. Also, the ability of these airports to meet applicable landing surface and facility design standards is not known due to the unavailability of airport layouts and mapping. There are 3 airports in this set.

Set 9 -- Airports with and without an existing IAP, but an IAP can be established. However, the resulting IAP does not meet the target capability and the airports do not meet the applicable landing surface and facility design standards. There are 3 airports in this set.

Set 10 – Airports with and without an existing IAP that does not meet the target IAP capability. An IAP can be established to meet the target, however, these airports do not meet applicable landing surface and facility design standards. There are 10 airports in this set.

Set 11 – Airports with and without an existing IAP that does not meet the target IAP capability. The establishment of WAAS by the FAA will enable these airports to achieve the target IAP capability. However, these airports do not meet the applicable landing surface and facility design standards. There are 11 airports in this set.

These results suggest the following:

1. No improvements in IAP capability are warranted for the 12 airports in Set 1.

2. Certain airports can progress toward establishment of the target IAP capability with a high level of assurance of achieving the intended objective. This would apply to the 16 airports in Set 2.

3. GPS approaches for the 7 airports in Set 3 are also viable candidates even though their IAP capability does not meet the intended target level.

4. The 7 airports in Sets 4 and 5 maintain their existing status as no improvement in their IAP capability can be realized.

5. The 2 airports in Set 6 are viable candidates as soon as the FAA commissions the WAAS for Category I approaches.

6. There are a total of 28 airports in Groups 7 and 8 whose ability to meet standards is not known. Of these airports, 10 do not have a paved runway.

7. The appropriateness of improving the remaining 23 airports accounted in Sets 9, 10 and 11 to comply with the applicable standards consistent with the type of IAP is dependent on two principal factors. These are the cost to achieve standards compliance and the operational benefit afforded by the improved IAP capability. These are reviewed in further detail in the section describing the benefit/cost assessment following Table 5-4.

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Table 5-4

INITIAL GPS ANALYSIS GROUPING

Set 1 Existing IAP Capability Meets Target IAP Capability (12 airports)

Bisbee Dougals International[1]	Estrella Sailport	Tucson International
Cochise County	Grand Canyon National Park	Williams Gateway
Coolidge Municipal[1]	Phoenix-Sky Harbor Int'l	Winslow Municipal
Ernest A. Love Field	Springerville-Babbit Field	Yuma International

Set 2 Potential IAP Capability Meets Target IAP And Airport Meets Applicable Facility Design Standards (16 airports)

Ajo Municipal	Eloy Municipal	Quartzsite (New)
Avi Suquilla	Globe-San Carlos Regional	Rolle Airfield
Benson Municipal (New)	Grand Canyon West	Safford Regional
Colorado City Municipal	Holbrook Municipal	Taylor Municipal
Cordes Lake (New)	Payson	
Douglas Municipal[1]	Pinal Airpark[1]	

Set 3 Potential IAP Capability Does Not Meet Target IAP But Airport Meets Applicable Facility Design Standards (7 airports)

Bagdad	Glendale Municipal	Tombstone Municipal
Bisbee Municipal	Greenlee County	Wickenburg Municipal
Cottonwood Municipal		

Table 5-4

INITIAL GPS ANALYSIS GROUPING

Set 4 Potential IAP Not Capable Due To Obstructions In Airport Setting (5 airports)

Grand Canyon Bar-Ten	San Carlos	Tuweep
Kearny	Superior Municipal	

Set 5 Existing IAP Is Best Achievable But Does Not Meet Target IAP Capability (2 airports)

Nogales International	Window Rock

Set 6 Potential IAP Capability Dependent On Establishment Of WAAS By FAA And Airport Meets Applicable Facility Design Standards (2 airports)

Casa Grande Municipal	Flagstaff-Pulliam

Set 7 Potential IAP Capability Meets Target IAP But Compliance With Applicable Facility Design Standards Is Not Known (25 airports)

Ak-Chin Community	Lukachukai	Rocky Ridge	Tuba City
Chinle	Memorial Airfield	San Manuel	
Cliff Dwellers Lodge	Pearce Ferry	Sells	
Flying J Ranch	Pine Springs	Shonto	
Ganado	Pinon	Stellar Airpark	
Grand Canyon Caverns	Pleasant Valley International	Sun Valley	
Greasewood (Closed)	Polacca	Temple Bar	
Hualapai Tribal	Rock Point	Toyei School (Closed)	

Table 5-4

INITIAL GPS ANALYSIS GROUPING

Set 8 Potential IAP Capability Does Not Meet Target IAP And Compliance With Applicable Facility Design Standards Is Not Known (3 airports)

Low Mountain (Closed)	Marble Canyon	Whiteriver

Set 9 Potential IAP Capability Does Not Meet Target IAP And Airport Does Not Meet Applicable Facility Design Standards (2 airports)

H.A. Clark Memorial	Sedona

Set 10 Potential IAP Capability Meets Target IAP But Airport Does Not Meet Applicable Facility Design Standards (10 airports)

Bowie	Gila Bend Municipal	Seligman
Buckeye Municipal	Kayenta	St. Johns Industrial Airpark
Cochise County	Libby AAF / Sierra Vista	
Duncan-O'Connor Field (Closed)	Ryan Airfield	

Set 11 Potential IAP Capability Dependent On Establishment Of WAAS By FAA But Airport Does Not Meet Applicable Facility Design Standards (11 airports)

Avra Valley	Laughlin / Bullhead Int'l	Phoenix-Goodyear
Chandler Municipal	Mesa-Falcon Field	Scottsdale
Kingman	Page Municipal	Show Low Municipal
Lake Havasu City Municipal	Phoenix-Deer Valley	

Note: 1. On-airport land available to install SSALS and achieve a ¼-mile reduction in visibility minimum.

Benefit / Cost Assessment

Airports that require improvements to meet landing area and design standards in order to achieve their desired IAP capability should be evaluated with regard with regard to the appropriateness of such investment. An industry-accepted practice employs the use of benefit/cost evaluations to make such assessments. Ratios that are equal to or greater than 1.0 imply that the benefits realized exceed the investment cost. The higher the ratio, the greater the return from the investment. Therefore, benefit/cost assessments were conducted for the 23 airports included in Sets 9, 10 and 11 as identified in the section above.

Each of these 23 airports can achieve their desired or an improved IAP capability but do not meet the applicable landing surface and design standards. The benefit/cost assessment of these airports takes into account the following factors and are described more fully below.

1. The increase in runway end utilization afforded by the potential reduction in approach minimums.

2. The demand for annual instrument approach activity.

3. The operational benefit in dollar terms associated with the potential IAP capability.

4. The cost to achieve standards compliance and install, operate and maintain the appropriate approach lighting system.

Guidelines and data presented in the FAA document, "Establishment and Discontinuance Criteria for Precision Landing System", were used to determine the increased runway utilization due to lowered instrument approach minimums and the operational benefit associated with an instrument approach.

Projections of general aviation aircraft operations (Table 3-6), adjusted to account for itinerant activity based on available individual airport studies, were utilized to derive unconstrained demand forecasts of annual instrument approaches. An instrument approach is an approach made to an airport by an aircraft on an IFR flight plan, when the visibility is less than three statute miles or the ceiling is at or below the minimum initial approach altitude. Studies conducted for the FAA have shown that the counting of instrument approaches is understated, particularly at nontowered airports. Consequently, the methodology utilized in forecasting annual instrument approaches was premised on an unconstrained basis. Unconstrained in the sense that given the potential for an airport to generate a total annual activity level, a certain portion of that activity

represents a demand which could be expected during IFR conditions. This demand level is not constrained by the extent of terminal navigational aids and/or published instrument approaches, but rather is attributable to the type of airport user, trip purpose, type of aircraft and avionics installed.

The methodology utilized in the forecasting process was based on an approach developed for the FAA in the report, "An Improved Forecast Model for Annual Instrument Approaches", prepared by Native American Consultants, Inc. This procedure yields forecasts of annual instrument approaches which take into consideration the propensity to travel in marginal weather and differences in weather characteristics between northern and southern Arizona. The latter addresses a key factor in defining an instrument approach -- that it be conducted in IFR weather conditions. Adjustments to the methodology were applied to reflect an increased propensity to file IFR flight plans through the forecast horizon. These adjustments were based on growth rates anticipated in general aviation instrument operations in the report, "FAA Aviation Forecasts, Fiscal Years 1997- 2008.

The operational benefit for general aviation users of an instrument approach takes into consideration two factors. The first factor is reduced levels of flight disruptions such as delays, diversions and overflights. The second factor is improved safety attributable to the enhanced accuracy of an approach. These operational benefits were estimated by the FAA and adjusted for inflation rates since the initial benefit value determination. The resultant current dollar operational benefit value approximates $290 per general aviation approach.

The costs to implement a GPS approach are comprised of two factors – compliance with landing surface and design standards, and installation and operation of an approach lighting system where required. Table 5-5 indicates those airports where such improvements are required to achieve the desired or target IAP capability. Because of the variability in costs to meet applicable landing surface standards (primary surface, runway object free area, runway safety area and obstacle free zone) at each airport, these costs have not been quantified. Nor have costs been established to acquire land for the required installation of an approach lighting system. The SSALS facility requires a land area of 1,600 feet in length and 400 feet in width beginning at the runway threshold. Land area requirements for the MALSR have the same width, however, the length is increased to 2,600 feet. Notwithstanding these limitations, the 20-year cost associated with installing, operating and maintaining a SSALS is $258,000 in current dollars. The value increases for a MALSR to $430,000. Whether these approach lighting systems are installed, maintained and operated by federal, state or airport sponsor agencies is moot. The decision to implement the facility needs to weigh benefits and costs.

Alternatively, the operational benefit over a 20-year period in current dollars associated with the potential improved IAP capability has been determined. This value for each airport can be compared to establishment and continuing operations and maintenance costs where applicable, as they may be determined at a later date in airport-specific studies. Benefit/cost ratios can be calculated and those which are equal to or greater than 1.0 imply an economically justified improvement. The higher the value of the resulting benefit/cost ratio, the greater the justification for the improvement. These results are summarized in Table 5-5 and include a Comments section which reflects on the potential ability to achieve a benefit/cost ratio of at least 1.0. Certain values presented in Table 5-5 intuitively suggest a likely determination. These results were then used as input to define the GPS approach recommendation presented in a later section of this report.

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Table 5-5

BENEFIT / COST ASSESSMENT FOR SELECTED AIRPORTS

Airport	Initial Potential IAP (Type, HAA/HAT-VIS)[1]	Total 20-Year Operational Benefit ($)[2]	Comments
Set 9			
H.A. Clark Memorial	GPS 18 1300-1½	1,700	Land acquisition costs for ROFA and RSA are likely to exceed $1,700.
Sedona	GPS 3 1623-1	0	GPS 3 has higher approach minimums than existing NDB or GPS-A. Costs to achieve ROFA standard are likely to exceed operational benefit value.
Set 10			
Bowie	GPS 26 250-1	25,500	Costs to meet primary surface, ROFA and RSA standards are likely to exceed operational benefit value.
Buckeye	GPS 25 250-1	3,630,300	Investment in required improvements to meet ROFA and RSA standards is likely to be economically justified.
Cochise College	GPS 23 250-1	1,693,900	Investment in required improvements to meet ROFA and RSA standards is likely to be economically justified.
Duncan-O'Connor Field (Closed)	GPS 21 533-1	19,500	Costs to meet primary surface, ROFA and RSA standards are likely to exceed operational benefit value.

Table 5-5

BENEFIT / COST ASSESSMENT FOR SELECTED AIRPORTS

Airport	Initial Potential IAP (Type, HAA/HAT-VIS)[1]	Total 20-Year Operational Benefit ($)[2]	Comments
Set 10 (cont.)			
Gila Bend Municipal	GPS 4 302-1	588,400	Investment in required improvements to meet ROFA and RSA standards is likely to be economically justified.
Kayenta	GPS 23 510-1	340,700	Investment in required improvements to meet primary surface, ROFA and RSA standards is likely to be economically justified.
Libby AAF/Sierra Vista	ILS 26 200-½	7,500	Operational benefit does not exceed cost to establish, operate and maintain MALSR.
Ryan Airfield	ILS 6R 200-½	12,600	Operational benefit does not exceed cost to establish, operate and maintain MALSR.
Seligman	GPS 4 303-1	42,200	Costs to meet primary surface and ROFA standards are likely to exceed operational benefit value.
St. Johns Industrial Airpark	GPS 14 250-1	7,700	Costs to meet primary surface and ROFA standards, especially those associated with adjacent Apache Fairgrounds facilities, are likely to exceed operational benefit value.

Table 5-5

BENEFIT / COST ASSESSMENT FOR SELECTED AIRPORTS

Airport	Initial Potential IAP (Type, HAA/HAT-VIS)[1]	Total 20-Year Operational Benefit ($)[2]	Comments
Set 11			
Avra Valley	GPS 12 200-½	908,900	Investment to acquire land and install, operate and maintain MALSR is economically justified.
Chandler Municipal	GPS 4R 200-½	413,300	Costs to acquire land and install, operate and maintain MALSR may be economically justified. Operational benefit of an approach with 250-¾ minimums based on SSALS is $297,300, a value which may also be economically justified.
Kingman	GPS 21 200-½	156,700	Excluding costs to meet primary surface standard, costs to install, operate and maintain MALSR are not likely to be economically justified. Operational benefit of an approach with 250-¾ minimums based on SSALS is $96,700 and also not likely to be economically justified.
Lake Havasu City Municipal	GPS 32 200-½	1,184,200	Costs to meet primary surface standard and acquire land to install, operate and maintain MALSR are likely not to be economically justified.
Laughlin / Bullhead International	GPS 34 314-½	16,846,900	Costs to meet Inner OFZ and TERPS 332 standards and acquire land to install, operate and install, operate and maintain MALSR are likely to be economically justified.

Table 5-5

BENEFIT / COST ASSESSMENT FOR SELECTED AIRPORTS

Airport	Initial Potential IAP (Type, HAA/HAT-VIS)[1]	Total 20-Year Operational Benefit ($)[2]	Comments
Set 11 (cont.)			
Mesa-Falcon Field	GPS 4R 200-½	408,400	Costs to meet Inner OFZ standard and install, operate and maintain MALSR may be economically justified. GPS 4R with SSALS yields minimums of 250-¾ and operational benefit value of $281,800 may also be economically justified.
Page Municipal	GPS 15 200-½	179,400	Costs to acquire land and install, operate and maintain MALSR are not economically justified. GPS 15 with SSALS yields 250-¾ and an operational benefit value of $127,100 and is also not economically justified.
Phoenix-Deer Valley	GPS 7R 200-½	908,100	Investment to install, operate and maintain MALSR is economically justified.
Phoenix-Goodyear	GPS 3 200-½	9,575,500	Investment to acquire land and install, operate and maintain MALSR is economically justified.
Scottsdale	GPS 3 200-½	1,580,800	Costs to meet primary surface and ROFA standards and acquire land to install, operate and maintain MALSR may be economically justified.
Show Low Municipal	GPS 12 200-½	57,700	Costs to acquire land and install, operate and maintain MALSR are not economically justified. GPS 24 with SSALS yields 250-¾ and an operational benefit value of $44,500 and is also not economically justified.

See Apendix A for acronym definitions.
Sources: 1. Table 5-3. 2. QED.

Airport System Services

The development of a plan for GPS approaches should also reflect airport system objectives. These may affect a final determination of required individual airport approach capabilities and do not include reliance on airports in bordering states. The primary system objective related to the determination of airports with ½-mile visibility approach capability. It was considered desirable for each system airport to be within a 100-n.m. range of such airports. This provides a viable alternate airport for filing IFR flight plans or for other in-flight needs.

Figure 5-1 illustrates the area coverage afforded by the existing system of airports with visibility approach minimums of ½-mile. Most of Arizona is provided with the desired coverage with some gaps and several areas of overlap. At a minimum, the ability to provide ½-mile visibility minimums at the following airports could provide the coverage required to meet this system service objective:

1. Lake Havasu City and either Laughlin/Bullhead or Kingman for areas in northwest Arizona.

2. Page, Show Low and Libby AAF/Sierra Vista for areas along the eastern boundary of Arizona.

The initial potential IAP evaluation summarized in Table 5-2 indicates that each of the above airports can achieve the target ½-mile visibility minimum. However, each will require some improvements to meet applicable landing surface and design standards, and all but Libby AAF/Sierra Vista are dependent on the establishment of WAAS by the FAA. The applicable costs to achieve this IAP capability may or may not be economically justified.

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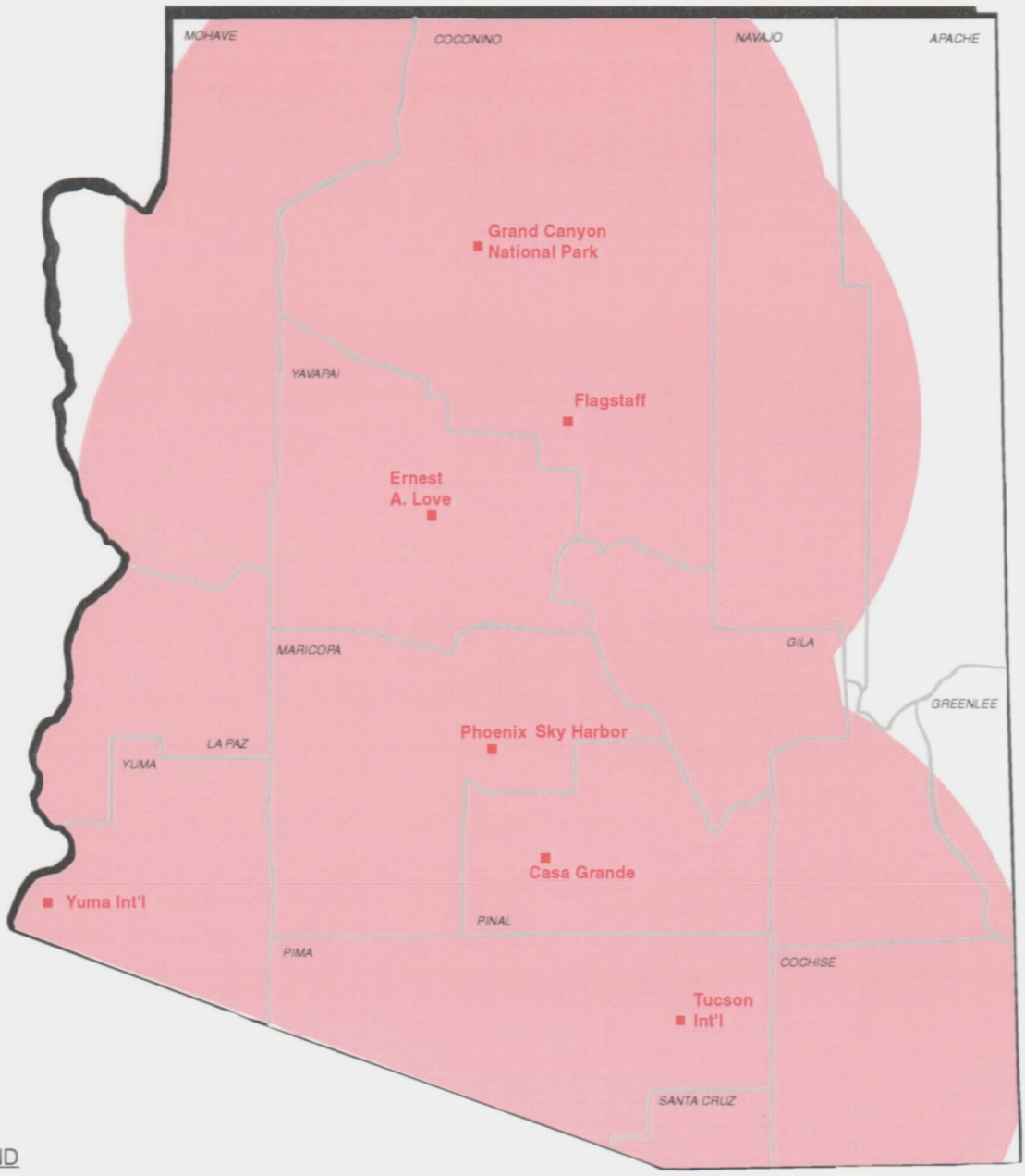
Figure 5-1

EXISTING SYSTEM AREA COVERAGE

(1/2-MILE VISIBILITY MINIMUM)



LEGEND

Existing

Limit of coverage

N

1 inch = 50 n.m. (approximate)

GPS Approach Recommendations

The final recommendations for the most appropriate GPS approach for each system airport are presented in Table 5-6. These recommendations take into account the following factors:

1. Ability to achieve the target IAP capability from the application of TERPS guidelines and criteria.

2. Operational benefit values versus costs to meet applicable standards and install, operate and maintain an approach lighting system.

3. Airport system objectives with regard to area coverage.

4. Lack of airport mapping information.

Notwithstanding the landing surface and facility design standards defined by the FAA, it was assumed for the purposes of this study that airports intended to be provided with an instrument approach also be served with an all-weather landing surface. Therefore, if an unpaved runway is not programmed for such improvement, pursuit of an IAP is not recommended. Conversely, if an IAP is necessary, then the runway should be paved.

The initial potential IAP analysis (Table 5-3 and Table 5-4 Sets 1 and 2) identified four airports which meet applicable standards to achieve lower than the target visibility. These airports (Bisbee Douglas International, Coolidge Municipal, Douglas Municipal and Pinal Airpark) also have the land resources available to install an SSALS to achieve the lower (¾-mile) visibility minimum. Therefore, the benefit/cost of installing, operating and maintaining the SSALS was evaluated. However, in each case, these airports have insufficient activity levels during the course of the next 20 years to economically justify the installation, operation and maintenance of the SSALS. Consequently, these airports are not recommended for such improvements.

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Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Ajo Municipal	1	None	GPS 30 402-1
	No comments.		
Ak-Chin Community	1	None	GPS 17 250-1
	Procedure subject to standards compliance survey. Associated improvement costs should not exceed $17,200 to be economically justified.		
Avi Suquilla	1	VOR/DME or GPS-A 1271-1½	GPS 1 271-1
	No comments.		
Avra Valley	½	None	GPS 12 200-½
	Procedure dependent on establishment of WAAS by FAA. Acquire land and install MALSR.		
Bagdad	1	None	GPS 5 1057-1½
	No comments.		
Benson Municipal (New)	1	None	GPS 28 250-1
	Airport to be designed to meet all applicable standards.		
Bisbee Douglas International	1	VOR/DME or GPS 17 317-1	Same
	Operational benefit value of GPS 17 with SSALS yielding 317-¾ is $900. SSALS is not economically justified.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Bisbee Municipal	1	None	GPS-A 1120-1½
	No comments.		
Bowie	1	None	Same
	Initial potential IAP is not economically justified.		
Buckeye Municipal	1	None	GPS 25 250-1
	Improve airport to meet applicable ROFA and RSA standards.		
Casa Grande Municipal	½	ILS/DME 5 285-½	GPS 5 200-½
	Procedure dependent on establishment of WAAS by FAA.		
Chandler Municipal	½	VOR or GPS 4L 446-1	GPS 4R 200-½
	Procedure economically justified if total costs to acquire land and install, operate and maintain MALSR do not exceed $413,300. Procedure dependent on establishment of WAAS by FAA. Consider establishing GPS 4R yielding 250-¾ if costs to acquire land and install SSALS do not exceed $297,300. Otherwise, opt for GPS 4R yielding 250-1.		
Chinle	1	None	GPS 17 365-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $585,200 to be economically justified.		
Cliff Dwellers Lodge	1	None	GPS 22 663-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $14,100 to be economically justified.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Cochise College	1	None	GPS 23 250-1
	Improve airport to meet applicable ROFA and RSA standards.		
Cochise County	1	GPS 21 354-1	Same
	No comments.		
Colorado City Municipal	1	NDB-A 829-1¼	GPS 29 489-1
	No comments.		
Coolidge Municipal	1	GPS 23 486-1	Same
	Operational benefit value of GPS 23 with SSALS yielding 486-3/4 is $3,200. SSALS is not economically justified.		
Cordes Lake (New)	1	None	GPS 19 745-1
	Airport to be designed to meet all applicable standards.		
Cottonwood Municipal	1	None	GPS 32 1310-1½
	No comments.		
Douglas Municipal	1	None	GPS 21 427-1
	Opertional benefit of GPS 21 with SSALS yielding 427-3/4 is $202,300. SSALS is not economically justified.		
Duncan-O'Connor Field (Closed)	1	None	Same
	Initial potential IAP is not economically justified.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Eloy Municipal	1	None	GPS 20 250-1
	No comments.		
Ernest A. Love Field	½	ILS/DME 21L 200-½	Same
	No comments.		
Estrella Sailport	N/A	None	Same
	No comments.		
Flagstaff-Pulliam	½	ILS/DME 21 250-½	GPS 21 200-½
	Procedure dependent on establishment of WAAS by FAA.		
Flying J Ranch	1	None	GPS 19 550-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $4,600 to be economically justified.		
Ganado	1	None	GPS 18 398-1
	Procedure dependent on providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $7,700 to be economically justified.		
Gila Bend Municipal	1	None	GPS 4 302-1
	Procedure economically justified if costs to provide ROFA and RSA do not exceed $588,400.		
Glendale Municipal	½	None	GPS 1 250-¾
	Operational benefit of GPS 19 with SSALS yielding 250-¾ is $5,782,500. SSALS is economically justified.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Globe-San Carlos	1	None	GPS 27 565-1
	No comments.		
Grand Canyon Bar-Ten	1	None	Same
	No comments.		
Grand Canyon Caverns	1	None	GPS 23 394-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $18,900 to be economically justified.		
Grand Canyon National Park	½	ILS/DME 3 200-½	Same
	No comments.		
Grand Canyon West	1	None	GPS 35 305-1
	No comments.		
Greasewood (Closed)	1	None	GPS 4 300-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $9,500 to be economically justified.		
Greenlee County	1	None	GPS 7 949-1¼
	No comments.		
H.A. Clark Memorial Field	1	None	Same
	Initial potential IAP is not economically justified.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Holbrook Municipal	1	None	GPS 21 323-1
	No comments.		
Hualapai Tribal	1	None	GPS 7 483-1
	Procedure subject to standards compliance survey. Associated improvement costs should not exceed $17,500 to be economically justified.		
Kayenta	1	None	GPS 23 510-1
	Procedure economically justified if total costs to improve ROFA and RSA do not exceed $340,700.		
Kearny	1	None	Same
	No comments.		
Kingman	½	VOR/DME or GPS 21 359-1	Same
	Target ½ mile visibility minimum is not economically justified. Area coverage to meet system objective is better served by Laughlin/Bullhead International.		
Lake Havasu City Municipal	½	VOR/DME or GPS-A 939-1¼	GPS 32 200-½
	Improve airport to meet applicable primary surface standard and acquire land to install MALSR. Procedure dependent on establishment of WAAS by FAA.		
Laughlin / Bullhead International	½	GPS 34 1208-1½	GPS 34 314-½
	Improve airport to meet applicable standards for Inner OFZ and TERPS 332, and acquire land and install MALSR. Procedure dependent on establishment of WAAS by FAA.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Libby AAF / Sierra Vista	½	ILS 26 200-¾	ILS 26 200-½
	Installation of MALSR to achieve ½-mile visibility is not economically justified. However, it is warranted to meet system area coverage in eastern Cochise and southern Greenlee counties.		
Low Mountain (Closed)	1	None	GPS 30 1180-1½
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $2,900 to be economically justified.		
Lukachukai	1	None	GPS 12 313-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $10,900 to be economically justified.		
Marble Canyon	1	None	GPS 3 1517-1½
	Procedure subject to standards compliance survey. Associated improvement costs should not exceed $6,900 to be economically justified.		
Memorial Airfield	1	None	GPS 12 455-1
	Procedure subject to standards compliance survey. Associated improvement costs should not exceed $605,600 to be economically justified.		
Mesa-Falcon Field	½	GPS 4R 419-1	GPS 4R 200-½
	Procedure economically justified if total cost to meet standards for Inner OFZ and installation, operation and maintenance of MALSR do not exceed $408,400. Procedure dependent on establishment of WAAS by FAA.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Nogales International	1	VOR/DME or GPS-B 1268-1½	Same
	No comments.		
Page Municipal	½	GPS 15 435-1	GPS 15 200-½
	Initial potential IAP is not economically justified. However, it is warranted to meet system area coverage in northern Navajo and Apache counties.		
Payson	1	None	GPS 6 383-1
	No comments.		
Pearce Ferry	1	None	GPS 19 250-1
	Procedure subject to providing an all-weather runway surface and standards compliance survey. Associated improvement costs should not exceed $16,600 to be economically justified.		
Phoenix-Deer Valley	½	GPS 7R 562-1	GPS 7R 200-½
	Improve airport to meet applicable standards for Inner OFZ and acquire land to install MALSR. Procedure dependent on establishment of WAAS by FAA.		
Phoenix-Goodyear	½	None	GPS 3 200-½
	Improve airport to acquire land and install MALSR. Procedure dependent on establishment of WAAS by FAA.		
Phoenix Sky Harbor International	½	ILS 8R 200-½	Same
	No comments.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Pinal Airpark	1	None	GPS 12 250-1
	Operational benefit value of GPS 12 with SSALS yielding 250-¾ is $4,900. SSALS is not economically justified.		
Pine Springs	1	None	GPS 5 390-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $6,300 to be economically justified.		
Pinon	1	None	GPS 1 345-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $19,500 to be economically justified.		
Pleasant Valley International	1	None	GPS 5 640-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $4,000 to be economically justified.		
Polacca	1	None	GPS 4 250-1
	Procedure subject to standards compliance survey. Associated improvement costs should not exceed $20,400 to be economically justified.		
Quartzsite (New)	1	None	GPS 17 250-1
	Airport to be designed to meet all applicable standards.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Rock Point	1	None	GPS 19 250-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $33,000 to be economically justified.		
Rocky Ridge	1	None	GPS 21 250-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $20,400 to be economically justified.		
Rolle Airfield	1	None	GPS 17 250-1
	No comments.		
Ryan Airfield	½	ILS 6R 200-¾	Same
	No comments.		
Safford Regional	1	None	GPS 30 250-1
	No comments.		
San Carlos	1	None	Same
	No comments.		
San Manuel	1	None	GPS 29 305-1
	Procedure subject to standards compliance survey. Associated improvement costs should not exceed $50,500 to be economically justified.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Scottsdale	½	NDB or GPS-A 652-1	GPS 3 200-½
	Procedure is economically justified if total cost to meet standards for primary surface and RSA, and to acquire land to install, operate and maintain MALSR do not exceed $1,580,800. Procedure dependent on establishment of WAAS by FAA.		
Sedona	1	NDB or GPS-A 1213-1½	Same
	No comments.		
Seligman	1	None	Same
	No comments.		
Sells	1	None	GPS 4 250-1
	Procedure subject to compliance standards survey. Associated improvement costs should not exceed $7,200 to be economically justified.		
Shonto	1	None	GPS 19 250-1
	Procedure subject to providing an all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $20,400 to be economically justified.		
Show Low Municipal	½	NDB or GPS-A 509-1	GPS 24 200-½
	Land acquisition and installation of MALSR to achieve 200-½ is not economically justified. However, it is warranted to meet system area coverage in northern Greenlee and southern Apache counties. Procedure dependent on establishment of WAAS by FAA.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Springerville Babbit Field	1	GPS 21 321-1	Same
	No comments.		
St. Johns Industrial Airpark	1	VOR/DME or GPS-A 507-1	Same
	No comments.		
Stellar Airpark	1	VOR or GPS-A 465-1	GPS 35 250-1
	Procedure subject to compliance standards survey. Associated improvement costs should not exceed $6,600 to be economically justified.		
Sun Valley	1	None	GPS 36 250-1
	Procedure subject to compliance standards survey. Associated improvement costs should not exceed $20,400 to be economically justified.		
Superior Municipal	1	None	Same
	No comments.		
Taylor Municipal	1	None	GPS 3 250-1
	No comments.		
Temple Bar	1	None	GPS 18 376-1
	Procedure subject to compliance standards survey. Associated improvement costs should not exceed $325,200 to be economically justified.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Tombstone Municipal	1	None	GPS 6 777-1¼
	No comments.		
Toyei School (Closed)	1	None	GPS 21 250-1
	Procedure subject to compliance standards survey. Associated improvement costs should not exceed $600 to be economically justified.		
Tuba City	1	None	GPS 33 447-1
	Procedure subject to compliance standards survey. Associated improvement costs should not exceed $585,500 to be economically justified.		
Tucson International	½	ILS 11L 200-½	Same
	No comments.		
Tuweep	1	None	Same
	No comments.		
Whiteriver	1	None	GPS 1 1648-1½
	Procedure subject to providing and all-weather runway surface and a standards compliance survey. Associated improvement costs should not exceed $1,100 to be economically justified.		
Wickenburg Municipal	1	None	GPS 5 894-1¼
	No comments.		

Table 5-6
FINAL GPS ANALYSIS

Airport	Target Visibility (sm)[1]	Present Best IAP (Type, HAA/HAT-VIS)[2]	Recommended IAP (Type, HAA/HAT-VIS)[3]
Williams Gateway	½	ILS 30C 200-¾	ILS 30R 200-½
	No comments.		
Window Rock	1	RNAV or GPS 2 786-1¼	Same
	No comments.		
Winslow Municipal	1	VOR or GPS 11 423-1	Same
	No comments.		
Yuma International	½	ILS 21R 200-½	Same
	No comments.		

Note: See Appendix A for acronym definitions.
Sources: 1. Table 5-2.
2. Table 5-1.
3. QED.

Table 5-7 provides a convenient summary of the approach capability by type and situation. Airports are grouped by those with and without an existing IAP capability and then by a mix of nine potential outcomes. Some noteworthy outputs of this classification process are:

Airports Without An Existing IAP

Group 1 -- A total of 25 airports are expected to have a GPS approach capability which meets the desired level and can be economically justified, that is, have benefit/cost ratios equal to or greater than 1.0.

Group 2 -- There are 29 airports which have the potential to achieve a GPS approach provided the costs to improve the airport to applicable standards is at least equal to the anticipated 20-year stream of operational benefits.

Group 3 -- Site conditions at 5 airports preclude the introduction of a GPS approach.

Group 4 -- There are 5 airports which have activity levels that do not economically justify a GPS approach. One of these airports is limited by function (sailplanes) to VFR-only status.

Airports With An Existing IAP

Group 5 -- There are 11 airports that can realize an improved IAP capability and which are justified either economically (8) or for area coverage system objectives (3). Of these, 7 airports are dependent on the establishment of WAAS by the FAA.

Group 6 -- A total of 10 airports meet their desired or target IAP capability.

Group 7 -- There are 4 airports that can be improved to meet their target IAP capabilities provided the costs do not exceed the 20-year stream of operational benefits. Three of these airports are dependent on the establishment of WAAS by the FAA.

Group 8 -- There are 3 airports that have the best achievable minimums and cannot meet the desired or target IAP capability.

Group 9 -- There are 3 airports that have activity levels insufficient to economically justify an improvement to their IAP capability.

Table 5-7

FINAL GPS ANALYSIS GROUPING

Group 1 Airports Without An Existing IAP And An IAP Is Justified (25 airports)

Ajo Municipal
Avra Valley[1]
Bagdad
Benson Municipal (New)
Bisbee Municipal
Buckeye Municipal
Cochise College
Cordes Lake (New)
Cottonwood Municipal
Douglas Municipal[2]
Eloy Municipal
Glendale Municipal
Globe-San Carlos Regional
Grand Canyon West
Greenlee County
Holbrook Municipal
Payson
Phoenix-Goodyear[1]
Pinal Airpark
Quartzite (New)
Rolle Airfield
Safford Regional
Taylor Municipal
Tombstone Municipal
Wickenburg Municipal

Group 2 Airports Without An Existing IAP And AIP May be Justified Subject To Cost Limitations (29 airports)

Ak-Chin Community
Chinle
Cliff Dwellers Lodge
Flying J Ranch
Ganado
Gila Bend Municipal
Grand Canyon Caverns
Greasewood (Closed)
Hualapai Tribal
Kayenta
Low Mountain (Closed)
Lukachukai
Marble Canyon
Memorial Airfield
Pearce Ferry
Pine Springs
Pinon
Pleasant Valley International
Polacca
Rock Point
Rocky Ridge
San Manuel
Sells
Shonto
Sun Valley
Temple Bar
Toyei School (Closed)
Tuba City
Whiteriver

Table 5-7

FINAL GPS ANALYSIS GROUPING

Group 3 Airports Without An Existing IAP And None Is Viable (5 airports)

Grand Canyon Bar-Ten	San Carlos	Tuweep
Kearny	Superior Municipal	

Group 4 Airports Without An Existing IAP And An IAP Is Not Justified (5 airports)

Bowie	Estrella Sailport[3]	Seligman
Duncan-O'Connor Field (Closed)	H.A. Clark Memorial	

Group 5 Airports With An Existing IAP That Can Be Improved and Is Justified (11 airports)

Avi Suquilla	Lake Havasu City Municipal[1]	Phoenix-Deer Valley[1]
Casa Grande Municipal[1]	Laughlin / Bullhead Int'l[1]	Show Low Municipal[1,4]
Colorado City Municipal	Libby / Sierra Vista[4]	Williams Gateway
Flagstaff-Pulliam[1]	Page[1,4]	

Group 6 Airports With An Existing IAP That Meet Target IAP Capability (10 airports)

Bisbee Douglas International[2]	Grand Canyon National Park	Winslow Municipal
Cochise County	Phoenix Sky Harbor Int'l	Yuma International
Collidge Municipal[2]	Springerville-Babbit Field	
Ernest A. Love Field	Tucson International	

Table 5-7

FINAL GPS ANALYSIS GROUPING

Group 7 Airports With An Existing IAP That Can Be Improved Subject To Cost Limitations (4 airports)

Chandler Municipal[1]	Scottsdale[1]
Mesa-Falcon Field[1]	Stellar Airpark

Group 8 Airports With An Existing IAP But Cannot Meet The Target IAP Capability (3 airports)

Nogales International	Sedona	Window Rock

Group 9 Airports With An Existing IAP Whose Improvement Cannot Be Justified (3 airports)

Kingman	Ryan Airfield	St. Johns Industrial Airpark

Notes:
1. Dependent on WAAS.
2. SSALS not economically justified to achieve ½-mile visibility minimum.
3. VFR-only airport.
4. IAP not economically justified but warranted for area coverage system objective.

Source: Table 5-6.

Figure 5-2 illustrates the contribution afforded by Libby AAF/Sierra Vista, Page Municipal and Show Low Municipal airports to achieve the ½-mile/100n.m. system service objective. Additionally, airports located in adjacent states also contribute to meeting this system objective. These include those airports serving Las Vegas, Nevada; Durango, Colorado; and Cedar City, Utah. Further, in the event of emergencies, military bases with aviation missions are available to serve civilian aircraft.

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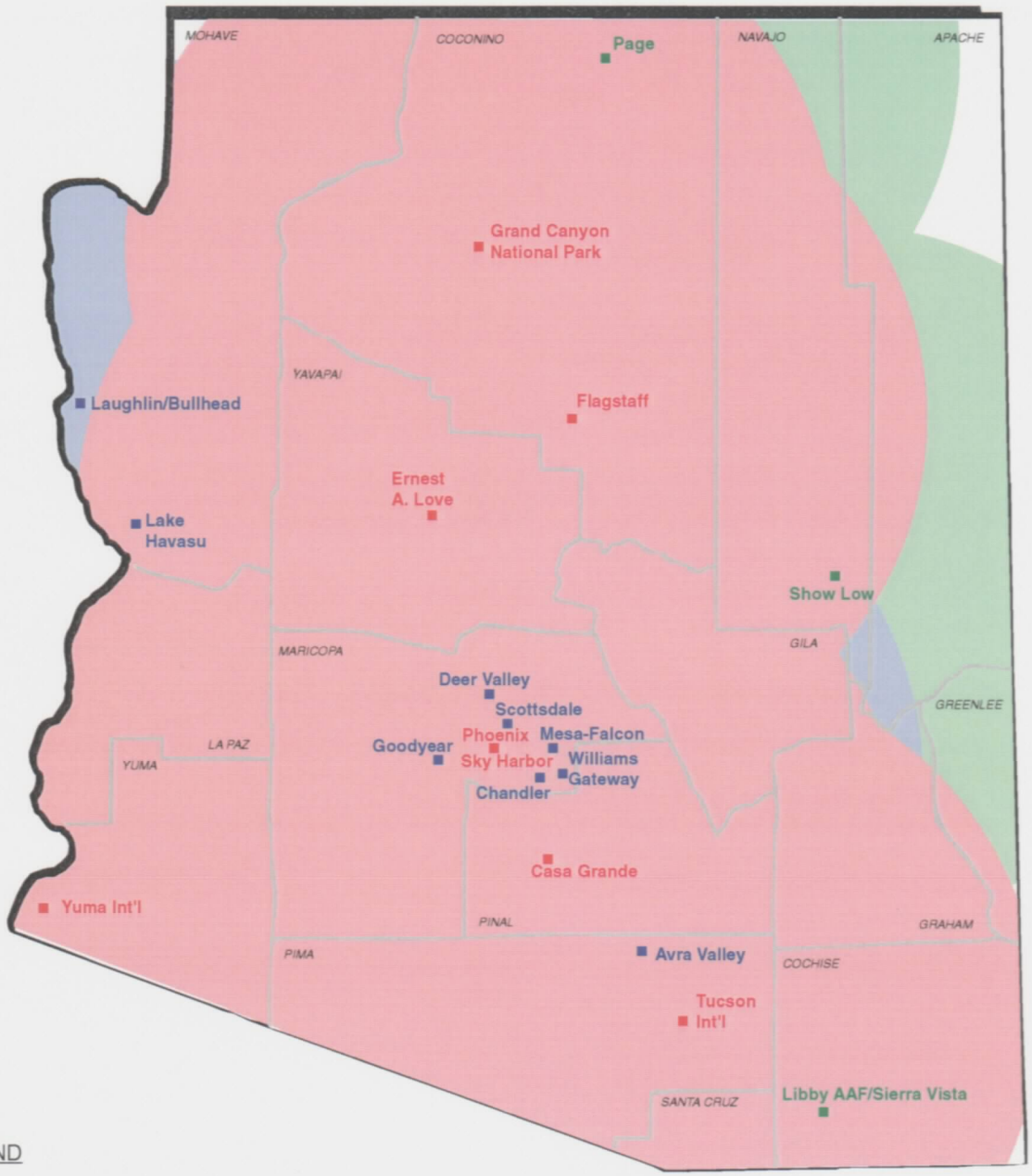
Figure 5-2

FINAL SYSTEM AREA COVERAGE

(1/2-MILE VISIBILITY MINIMUM)



LEGEND

- Existing
- Future and justified
- Required for coverage
- Limit of coverage

N

1 inch = 50 n.m. (approximate)

Differential GPS

Chapter 4 provided an assessment of existing and future technologies for navigation. One concept, the pre-LAAS or differential GPS, is available for implementation as SCAT-I systems. A benefit of this technology is that the differential GPS signal may serve all runway ends at airports within a 20-mile to 30-mile range of its transmission.

This capability is presently being considered at the Phoenix Sky Harbor International Airport. When implemented, it could serve as a means of providing appropriately designed airports in the Phoenix Valley region with a Category I RNP capability prior to the establishment of WAAS by the FAA. This capability would apply to the Chandler Municipal, Glendale Municipal, Mesa-Falcon, Phoenix-Deer Valley, Phoenix-Goodyear and Scottsdale airports. These airports should invest in the necessary improvements to meet the landing surface and runway design standards applicable to their target approach capability as presented in previous sections of this chapter.

Although individual airports have received SCAT-I installations, the Phoenix proposal would represent the industry's first test of differential GPS to serve more than one runway end as well as other airports. Because of the need for Category I RNP capability in the currently high air traffic activity Valley region, this proposal should be given careful consideration by potential public and private parties.

The cost to establish a SCAT-I system is approximately $500,000 including an allowance of $100,000 for installation. These costs are based on an operating requirement of 3 ground stations (receivers) and 1 transmitter. In addition, there is the requirement to acquire and install a MALSR which represents an additional $250,000 investment. Operating costs for the SCAT-I system are minimal – power and emergency back-up systems. The MALSR will require an annual operating and maintenance budget of about $9,000.

Instrument Approach Training

The availability of more GPS approaches at Arizona system airports also provides an operational benefit to instrument approach flight training activities. Flight training in areas of northeastern Arizona will be a prime beneficiary inasmuch as there is a current lack of airports which can support such activity in this geographic area. This deficiency has created the need to fly relatively long distances to conduct instrument approach training flights. Additionally, new GPS approaches at more airports serves to redistribute the demand for such training activity at the relatively more busy airports in the system.

Chapter 6

VISAID FACILITY REQUIREMENTS

In addition to identifying instrument approach procedure requirements at system airports, visual landing aids are an important element of this overall planning effort. Minimum suggested guidelines for visual landing aids (VISAIDS) were developed for commercial service/reliever and general aviation airports and whether the airport operates in IFR and/or VFR conditions. In this manner, the VISAID facilities complement the operational capability of the airport.

These guidelines are associated solely with the primary runway at the airport. Secondary or crosswind runways were determined not to require stated minimum suggested guidelines. The installation of VISAIDS on these runways is best left to the discretion of the airport sponsor who may establish VISAIDS in addition to those identified in accordance with acceptable practices.

The guidelines presented in Table 6-1 were compared to the facilities available at each airport. Deficiencies in meeting the minimum recommended guidelines are summarized in Table 6-2; individual airport data related to taxiway lighting was not available. Runway edge lighting should comply with applicable standards (low versus medium or high intensity) consistent with the type of instrument approach procedure established for the runway. Some discretion should be given to when applying the VISAID guidelines. For example, runways served with exits directly to the apron areas and short distances taxiways may be better equipped with taxiway reflectors or just reflectors in the area of the runway/taxiway intersection.

With three exceptions, each of the commercial service and reliever airports meet the minimum VISAID requirements. These exceptions are Kingman, Ryan Airfield and Williams Gateway, each of which require the installation of pilot controlled lighting systems. Of the 12 general aviation airports operating under VFR conditions, all but two (Bisbee Municipal and St. Johns Industrial) require certain improvements. The majority of general aviation airports operating in IFR conditions also are deficient in one or more minimum VISAID facilities.

Table 6-1
MINIMUM GUIDELINES FOR VISUAL LANDING AIDS
PRIMARY RUNWAY

VISAID Facility	Commercial Service and Reliever Airports Operating Condition		General Aviation Airport Operating Condition	
	VFR	IFR	VFR	IFR
Wind indicator / cone and Segmented circle	X[1]	X[1]	X[1]	X[1]
Rotating beacon	X	X	--	X
Runway edge lighting	X	X	--	X
Runway reflectors	--	--	X	--
Taxiway edge lighting	X	X	--	X[2]
Taxiway reflectors	--	--	X	--
Visual approach guidance (primary runway end)	X	X	X	X
Pilot controlled lighting (when airport not attended)	X	X	--	X

See Appendix A for acronym definitions.

Notes: 1. Lighted if airport is open after dusk.
2. Taxiway reflectors for stub taxiways.

Source: QED.

Table 6-2

VISAID FACILITY REQUIREMENTS - PRIMARY RUNWAY

Airport	Operating Condition	Wind Indicator / Segmented Circle	Rotating Beacon	R / W Edge Lighting	VAGI	PCL
Commercial Service and Reliever Airports						
Avra Valley	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Chandler Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Ernest A. Love Field	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Flagstaff-Pulliam	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Glendale Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Grand Canyon National Park	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Kingman	IFR / VFR	Yes / Yes	Yes	Yes	Yes	No
Lake Havasu City Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Laughlin/Bullhead International	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Mesa-Falcon Field	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Page Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Phoenix-Deer Valley	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Phoenix-Goodyear	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Phoenix Sky Harbor International	IFR / VFR	Yes / Not Apl	Yes	Yes	Yes	Not Apl
Ryan Airfield	IFR / VFR	Yes / Yes	Yes	Yes	Yes	No

Table 6-2

VISAID FACILITY REQUIREMENTS - PRIMARY RUNWAY

Airport	Operating Condition	Wind Indicator / Segmented Circle	Rotating Beacon	R / W Edge Lighting	VAGI	PCL
Commercial Service and Reliever Airports (cont.)						
Scottsdale	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Show Low Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Tucson International	IFR / VFR	Yes / Not Apl	Yes	Yes	Yes	Not Apl
Williams Gateway	IFR / VFR	Yes / No	Yes	Yes	Yes	No
Yuma International	IFR / VFR	Yes / Not Apl	Yes	Yes	Yes	Yes
General Aviation Airports						
Ajo Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Ak-Chin Community	IFR / VFR	Yes / No	No	No	No	No
Avi Suquilla	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Bagdad	IFR / VFR	Yes / No	Yes	Yes	No	No
Benson Municipal (New)	IFR / VFR	Airport to be designed to meet these standards				
Bisbee Douglas International	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes

Table 6-2

VISAID FACILITY REQUIREMENTS - PRIMARY RUNWAY

Airport	Operating Condition	Wind Indicator / Segmented Circle	Rotating Beacon	R / W Edge Lighting	VAGI	PCL
Bisbee Municipal	VFR (Circling)	Yes / Yes	Not Apl	Yes	Yes	Not Apl
Bowie	VFR	Yes / No	Not Apl	No	No	Not Apl
Buckeye Municipal	IFR / VFR	Yes / No	Yes	Yes	Yes	No
Casa Grande Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	No
Chinle	IFR / VFR	Yes / No	No	No	No	No
Cliff Dwellers Lodge	IFR / VFR	Yes / Yes	No	No	No	No
Cochise College	IFR / VFR	Yes / Yes	Yes	Yes	Yes	No
Cochise County	IFR / VFR	Yes / Yes	Yes	Yes	Yes	No
Colorado City Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Coolidge Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Cordes Lake (New)	IFR / VFR	Airport to be designed to meet these requirements				
Cottonwood Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Douglas Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Duncan-O'Connor Field (Closed)	VFR	No / No	Not Apl	No	No	Not Apl
Eloy Municipal	IFR / VFR	Yes / Yes	Yes	Yes	No	No
Estrella Sailport	VFR	Yes / Yes	Not Apl	No	Yes	Not Apl
Flying J Ranch	IFR / VFR	No / No	No	No	No	No
Ganado	IFR / VFR	Yes / No	No	No	No	No

Table 6-2

VISAID FACILITY REQUIREMENTS - PRIMARY RUNWAY

Airport	Operating Condition	Wind Indicator / Segmented Circle	Rotating Beacon	R / W Edge Lighting	VAGI	PCL
Gila Bend Municipal	IFR / VFR	Yes / Yes	Yes	Yes	No	Yes
Globe-San Carlos	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Grand Canyon Bar-Ten	VFR	No / No	Not Apl	No	No	Not Apl
Grand Canyon Caverns	IFR / VFR	Yes / No	No	No	No	No
Grand Canyon West	IFR / VFR	No / No	No	No	No	No
Greasewood (Closed)	IFR / VFR	No / No	No	No	No	No
Greenlee County	IFR / VFR	Yes / No	Yes	Yes	No	Yes
H.A. Clark Memorial Field	VFR	Yes / Yes	Not Apl	Yes	No	Not Apl
Holbrook Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Hualapai Tribal	IFR / VFR	No / No	No	No	No	No
Kayenta	IFR / VFR	Yes / Yes	Yes	Yes	No	No
Kearny	VFR	Yes / Yes	Not Apl	No	No	Not Apl
Libby AAF / Sierra Vista	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Low Mountain (Closed)	IFR / VFR	No / No	No	No	No	No
Lukachukai	IFR / VFR	No / No	No	No	No	No
Marble Canyon	IFR / VFR	Yes / Yes	No	No	No	No
Memorial Airfield	IFR / VFR	Yes / Yes	No	No	No	No
Nogales International	IFR / VFR	Yes / Yes	No	No	No	No

Table 6-2

VISAID FACILITY REQUIREMENTS - PRIMARY RUNWAY

Airport	Operating Condition	Wind Indicator / Segmented Circle	Rotating Beacon	R / W Edge Lighting	VAGI	PCL
Payson	IFR / VFR	Yes / Yes	Yes	Yes	No	No
Pearce Ferry	IFR / VFR	Yes / Yes	No	No	No	No
Pinal Airpark	IFR / VFR	Yes / Yes	Yes	Yes	No	No
Pine Springs	IFR / VFR	Yes / No	No	No	No	No
Pinon	IFR / VFR	No / No	No	No	No	No
Pleasant Valley International	IFR / VFR	Yes / Yes	No	No	No	No
Polacca	IFR / VFR	Yes / No	No	Yes	No	No
Quartzsite (New)	IFR / VFR	Airport to be designed to meet these standards				
Rock Point	IFR / VFR	No / No	No	No	No	No
Rocky Ridge	IFR / VFR	Yes / No	No	No	No	No
Rolle Airfield	IFR / VFR	Yes / Yes	No	No	No	No
Safford Regional	IFR / VFR	Yes / Yes	Yes	Yes	Yes	No
San Carlos	VFR	Yes / No	Not Apl	No	No	Not Apl
San Manuel	IFR / VFR	Yes / Yes	No	No	No	No
Sedona	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Seligman	VFR	Yes / No	Not Apl	No	No	Not Apl
Sells	IFR / VFR	Yes / No	No	No	No	No
Shonto	IFR / VFR	No / No	No	No	No	No

Table 6-2

VISAID FACILITY REQUIREMENTS - PRIMARY RUNWAY

Airport	Operating Condition	Wind Indicator / Segmented Circle	Rotating Beacon	R / W Edge Lighting	VAGI	PCL
Springerville Babbit Field	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
St. Johns Industrial Airpark	VFR	Yes / Yes	Not Apl	Yes	Yes	Not Apl
Stellar Airpark	IFR / VFR	Yes / No	Yes	No	Yes	No
Sun Valley	IFR / VFR	Yes / Yes	No	No	No	Yes
Superior Municipal	VFR	Yes / No	Not Apl	No	No	Not Apl
Taylor Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Temple Bar	IFR / VFR	Yes / Yes	No	No	No	No
Tombstone Municipal	IFR / VFR	Yes / No	No	No	No	No
Toyei School (Closed)	IFR / VFR	No / No	No	No	No	No
Tuba City	IFR / VFR	Yes / Yes	Yes	Yes	Yes	No
Tuweep	VFR	Yes / No	Not Apl	No	No	Not Apl
Whiteriver	VFR	Yes / Yes	No	Yes	No	No
Wickenburg Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Window Rock	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes
Winslow Municipal	IFR / VFR	Yes / Yes	Yes	Yes	Yes	Yes

See Appendix A for acronym definitions.

Sources: Airport / Facility Directory, 1997.
Airport Master Record.

Chapter 7

WEATHER FACILITY REQUIREMENTS

Introduction

This chapter addresses requirements for facilities that provide aviation weather data and a conceptual means to acquire and disseminate such information on a real-time basis to pilots and other users. The former objective is accomplished through the strategic placement of automated weather observing system (AWOS) units and the latter seeks to define a network capability which can utilize existing and planned State data and telecommunications systems. Appendices B, C, D and E provide the results of aviation and State agency surveys that addressed the need and use of weather data. Appendix F provides background information on automated weather facilities.

AWOS Requirements

For aviation purposes, the AWOS serves to provide real-time weather data at an airport to support the utilization of instrument approach procedures, eliminate the incorporation of remote altimetry penalties. Depending on the nature of the flight activity (commercial or pleasure), the AWOS permits the legal operation of the aircraft. For example, the AWOS-2 provides the capability (visibility) of determining whether a specific airport is actually above or below the minimums established for the specified approach for aircraft operating under Federal Aviation Regulation (FAR) Parts 121 or 135. The use of an AWOS-2 as a sole weather observation source by FAR Part 121 or 135 certificate holders is approved on a case-by-case basis. The determination is made by the AFAA and is dependent on how the operator's procedures for a particular airport incorporate the use of the AWOS-2 data. The FAA may approve operational limitations dependent on the circumstances of each case. The AWOS-3 provides further data in terms of ceiling height which information is required if the airport is identified as an alternate in the pilot's IFR flight plan. An AWOS-3 is approved for FAR Part 121 and 135 flight operations without restriction.

The installation of AWOS units at airports across a large geographical area provides an additional benefit beyond the terminal environment in that pilots are able to receive real-time weather data information along their route of flight. Safety is the primary advantage and the secondary benefits relate to enhanced utilization of the airport system and increased operating capacity. Knowledge of weather conditions on a real-time basis can help pilots determine:

1. If flights can be made safely before leaving the ground.

2. If continued flight toward the intended destination is advisable.

3. If diversion to the alternate airport should be initiated.

A distribution of AWOS units, complementing a planned deployment of federally-installed and operated facilities, also serves to provide real-time weather information to users outside of aviation.

Given the large number of airports in the Arizona system, development of a means to identify the most appropriate automated weather observing capability in promoting and establishing a real-time aviation weather data information network was necessary. The methodology employed is built upon the following factors as described in the sections below.

AWOS Level Determination

When AWOS technology was re-introduced to the aviation community in the early 1980's for application at those airports not anticipated to receive a federal installation, the cost differential between each level of AWOS was significant. An AWOS-1 could be installed for about $65,000 while and AWOS-3 was nearly double that amount. Consequently, care was exercised in selecting the most appropriate level AWOS for an airport. Since then and as a result of increased competition in the AWOS market, the installed cost of an AWOS-3 is about $75,000 in comparison to a $40,000 cost for an AWOS-1. The reduction in the cost between the AWOS-1 and AWOS-3 has narrowed considerably; an installed AWOS-2 is estimated at $50,000. Most vendors have established the AWOS-3 as their primary unit of sale and economized in its manufacturing process. Therefore, the need to focus on which level of AWOS capability is required has now become less of an issue. The estimated annual maintenance and operating costs of an AWOS-1 and AWOS-3 is about $3,000 and $4,000, respectively. Thus, the continuing financial operating obligation of either unit is within a narrow range. Consequently, the AWOS-3 has become the standard level at nearly all airports today.

The industry's "standardization" of the AWOS-3 is also substantiated by consideration of the following factors:

1. The AWOS-3 is approved for FAR Parts 121 and 135 flight operations without restriction. Because these flight operations are not airport-specific, the availability of the AWOS-3 at an airport does not present an operational impediment.

2. Industry trends are such that the AWOS data has been increasingly transmitted to the federal weather data networks. The primary point of data entry for AWOS reports is through NADIN and the FAA and NWS will only accept AWOS-3 data.

3. Technological advances in AWOS equipment are expected in the future. FAA-certified vendors have provided the option to add three sensors to its version of the AWOS-3 configuration. These sensors include a thunderstorm detector to provide advanced warning of such activity within 30 miles of the AWOS site; a present weather sensor to provide precipitation identification including rain, snow, fog and smoke; and a freezing rain sensor. These additional sensors have been approved for use by the FAA and nearly constitute its definition of an AWOS-4. The addition of a runway surface sensor would complete the FAA-defined components constituting an AWOS-4. This sensor would identify whether the runway surface is wet or the potential for icing conditions exist.

The sections below present the basis for identifying AWOS-3 requirements at the system airports throughout Arizona.

Each system airport within Arizona was evaluated with respect to its need for an AWOS-3 based on the following criteria:

1. The airport, whether existing or planned, is included in the Arizona system of public-use facilities.

2. Those airports with an existing or planned federal ASOS or AWOS-3 are expected to maintain or receive the designated facilities. ASOS units have been installed in lots as authorized by the NWS in concert with the FAA. Budget constraints and other factors have influenced the staged implementation program and those ASOS units assigned to Lots 7a and 7b are not anticipated to be purchased by the NWS/FAA. The resulting federal deployment of ASOS and AWOS-3 units, together with those non-federal AWOS-3 facilities presently in operation, may be collectively referred to as the existing or backbone system.

3. Each system airport served with an existing or future instrument approach should be equipped with an AWOS-3 provided it meets the benefit/cost criterion described below.

4. Activity levels projected at each AWOS-3 candidate system airport should be sufficient to yield a benefit/cost ratio of 1.0 or greater, thus justifying the installation and continued maintenance of the unit. In other words, the value of the benefits exceed those associated with the costs to provide the facility. The higher the resulting benefit/cost ratio, the greater the justification for the unit.

   The benefits to users of an AWOS facility center on issues related to safety and operational efficiency. The latter concerns the potential reduction in flight disruptions; safety benefits consider the accident potential associated with a particular weather phenomenon such as wind, temperature, dew point, ceiling and visibility. Benefit values determined by the FAA in its "Establishment and Discontinuance Criteria for Automated Weather Observing Systems (AWOS)" and the associated evaluation methodology were used as guidelines in determining the benefit of each potential AWOS-3 unit. The total benefit value varies dependent on the number of general aviation local and itinerant aircraft operations. The FAA benefit values were adjusted for inflation rates since they were first determined. The resultant current dollar benefit for each local aircraft operation is about $0.25 and $2.25 per itinerant aircraft operation. The benefit values are conservative in that they exclude those benefits to nonaviation users.

   Because the AWOS-3 is assigned a 10-year useful life, airports should be evaluated for their benefit/cost in each of the two, 10-year periods covered in this study. In this fashion, airports that do not qualify based on their activity level forecasts for years 1 through 10 may yield a justifiable ratio as a result of their expected aviation activity between years 11 and 20 of the forecast horizon.

5. The resulting statewide distribution of AWOS and ASOS units should be within a 25-nautical mile radial coverage from any system airport with an instrument approach procedure. This will permit pilots to file an AWOS-3 airport as an IFR alternate to their intended destination. The 25-nautical mile radius is representative of the typical broadcast range of an ASOS and AWOS-3 unit and the AWOS report is for conditions at the airport proper.

6. The resulting statewide distribution of AWOS and ASOS units should be also capable of monitoring the movement of weather, particularly along common frontal passage routes. Coverage requirements were based on a 30-knot frontal passage speed and a 90-minute travel time between these units, thus representing a distance of 45 nautical miles.

Table 7-1 presents a listing of those airports comprising the AWOS/ASOS Backbone System. There are a total of 25 airports. Figure 7-1 illustrates the area coverage afforded by the Backbone System.

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Table 7-1

AWOS / ASOS BACKBONE SYSTEM

Airport	Type Unit
Avra Valley	AWOS-3
Bisbee Douglas International	ASOS
Casa Grande Municipal	AWOS-3[1]
Chandler Municipal	AWOS-3
Colorado City Municipal	AWOS-3
Ernest A. Love Field	ASOS
Flagstaff - Pulliam	ASOS
Grand Canyon National Park	ASOS
Kingman	ASOS
Lake Havasu City Municipal	AWOS-3
Libby AAF / Sierra Vista	AWOS-3
Nogales International	ASOS
Page Municipal	ASOS
Phoenix - Deer Valley	ASOS
Phoenix - Sky Harbor International	ASOS
Ryan Airfield	AWOS-3
Safford Regional	ASOS
Scottsdale	ASOS
Sedona	AWOS-3
St. Johns Industrial Airpark	ASOS
Taylor Municipal	AWOS-3
Tucson International	ASOS
Window Rock	ASOS
Winslow Municipal	ASOS
Yuma International	ASOS

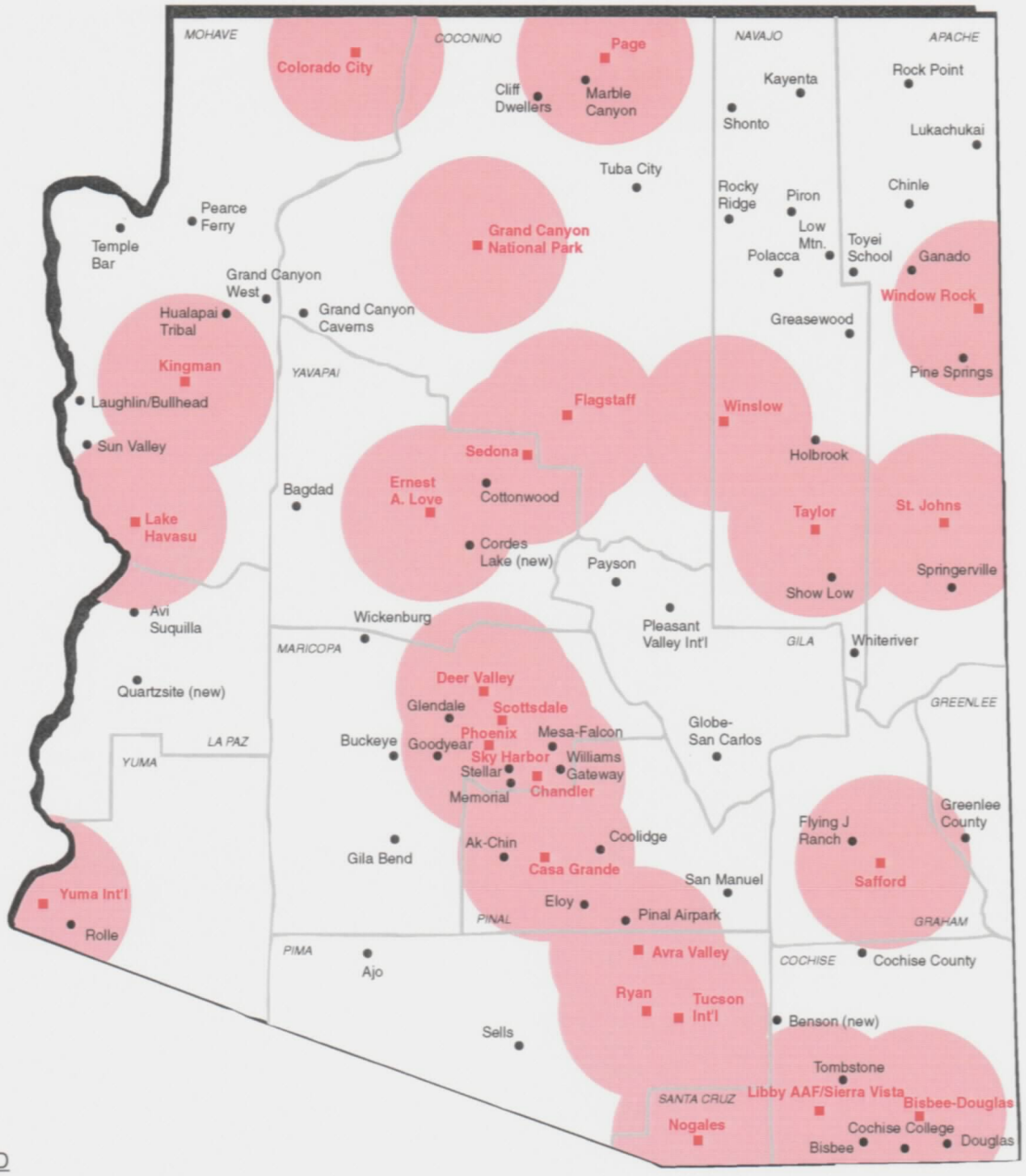
See Appendix A for acronym definitions.

Note: 1. FAA Facilities and Equipment Program unit.

Sources: Airport / Facility Directory, 1997.
FAA records, 1997.

Figure 7-1

AWOS / ASOS BACKBONE SYSTEM



LEGEND

- Airport with an existing or planned IAP
- Existing AWOS-3 or ASOS locations
- Limit of coverage

1 inch = 50 n.m. (approximate)

N

Table 7-2 was generated to list those airports that satisfy Criterion 3 (existing or planned instrument approach) and Criterion 4 (benefit/cost ratio equal to greater than 1.0) and that are not included in Table 7-1. There are 20 such airports and their contribution to area coverage is presented in Figure 7-2 representing AWOS Scenario 1.

Examination of Figure 7-2 indicates that there are gaps in area coverage to satisfy Criterion 5. This criterion suggests that all airports with an instrument approach procedure be located within a 25-n.m. range of an AWOS-3 or ASOS unit. These deficiencies can be partially eliminated through the strategic positioning of AWOS-3 units at the 10 airports listed below. The contribution to area coverage afforded by these 10 additional units is illustrated in Figure 7-3 as AWOS Scenario 2.

Ajo Municipal	Kayenta
Chinle	Polacca
Cochise County	Sells
Globe-San Carlos Regional	Temple Bar
Grand Canyon Caverns	Tuba City

As a result of adding these 10 AWOS-3 units, 7 airports continue to lie beyond the 25-nautical mile radius of airports located in their general regions with an ASOS or AWOS-3. These include:

Benson Municipal (New)	Lukachukai
Greasewood (Closed)	Rock Point
Greenlee County	San Manuel
Holbrook Municipal	

However, there are ASOS and AWOS-3 sites located within 30 to 35 nautical miles of these airports. This is considered to yield an acceptable satisfaction of Criterion 5.

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Table 7-2
AWOS SCENARIO 1

Airport[1]	Benefit / Cost Ratio for Years[2] 1 - 11	12 - 20
AWOS / ASOS Backbone System And:		
Avi Suquilla	3.14	3.57
Bagdad	4.23	6.58
Buckeye Municipal	5.34	11.33
Cochise College	6.48	6.48
Coolidge Municipal	1.08	1.29
Cottonwood Municipal	1.60	3.04
Eloy Municipal	2.98	3.34
Gila Bend Municipal	2.02	2.28
Glendale Municipal	16.56	26.69
Laughlin / Bullhead International	6.67	7.73
Memorial Airfield	1.10	3.65
Mesa - Falcon Field	25.99	27.16
Payson	2.53	2.84
Phoenix - Goodyear	29.46	35.01
Pinal Airpark	0.84	1.73
Show Low Municipal	2.50	2.53
Springerville - Babbit Field	1.18	1.20
Stellar Airpark	6.52	6.68
Wickenburg Municipal	2.21	3.62
Williams Gateway	6.48	12.16

See Appendix A for acronym definitions.

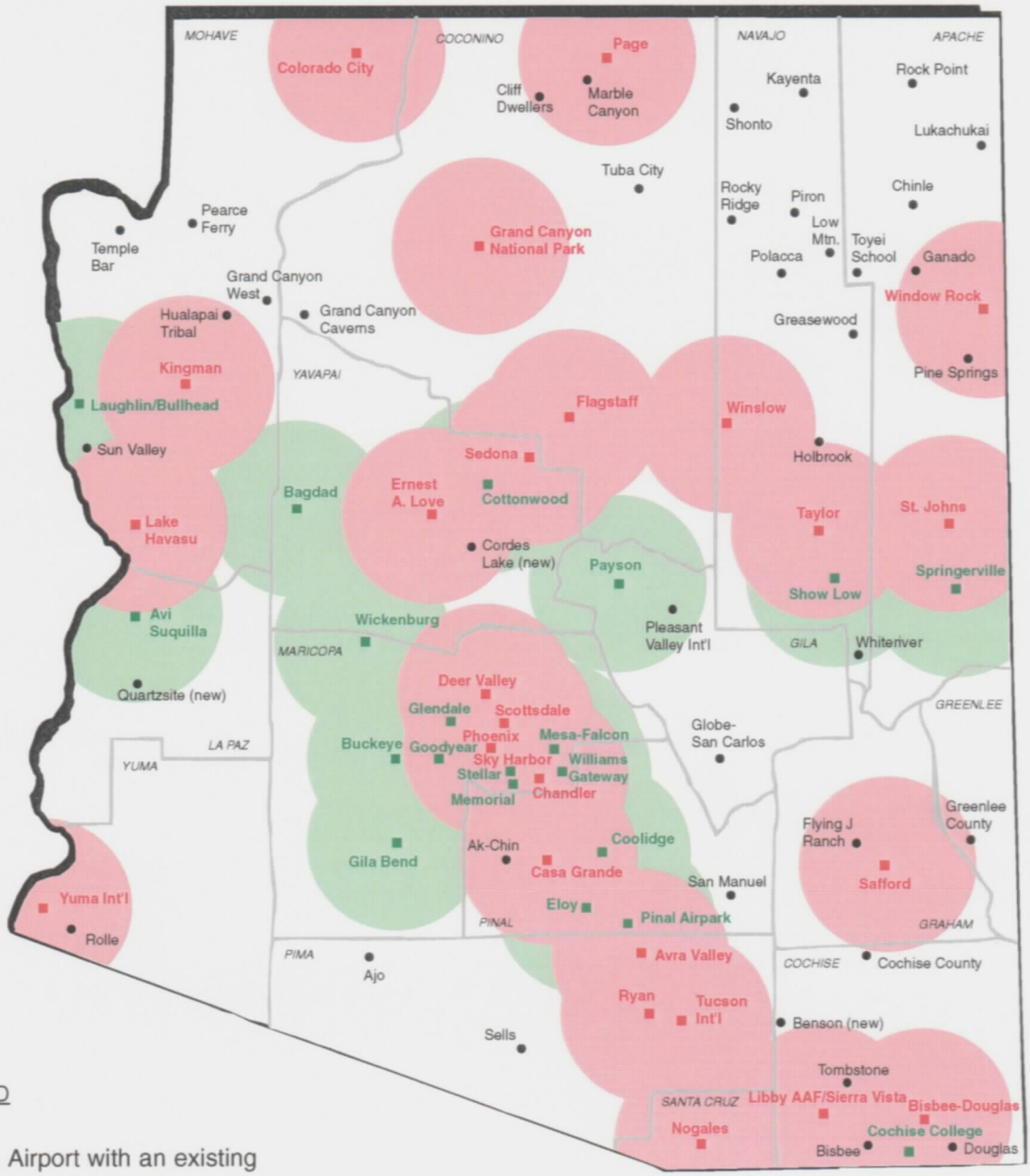
Notes: 1. Each airport listed has or is planned to have an IAP capability.

2. Benefit / cost ratio greater than or equal to 1.00 indicates an AWOS is justified based on values of benefit and cost.
Benefit / cost ratio less than 1.00 indicates an AWOS is not justified.

Figure 7-2

AWOS SCENARIO 1

(BACKBONE AND AWOS-3'S WITH BENEFIT / COST ≥ 1.0)



LEGEND

- Airport with an existing or planned IAP
- AWOS / ASOS Backbone locations
- Additional AWOS-3 locations justified on basis of benefit / cost
- Limit of coverage

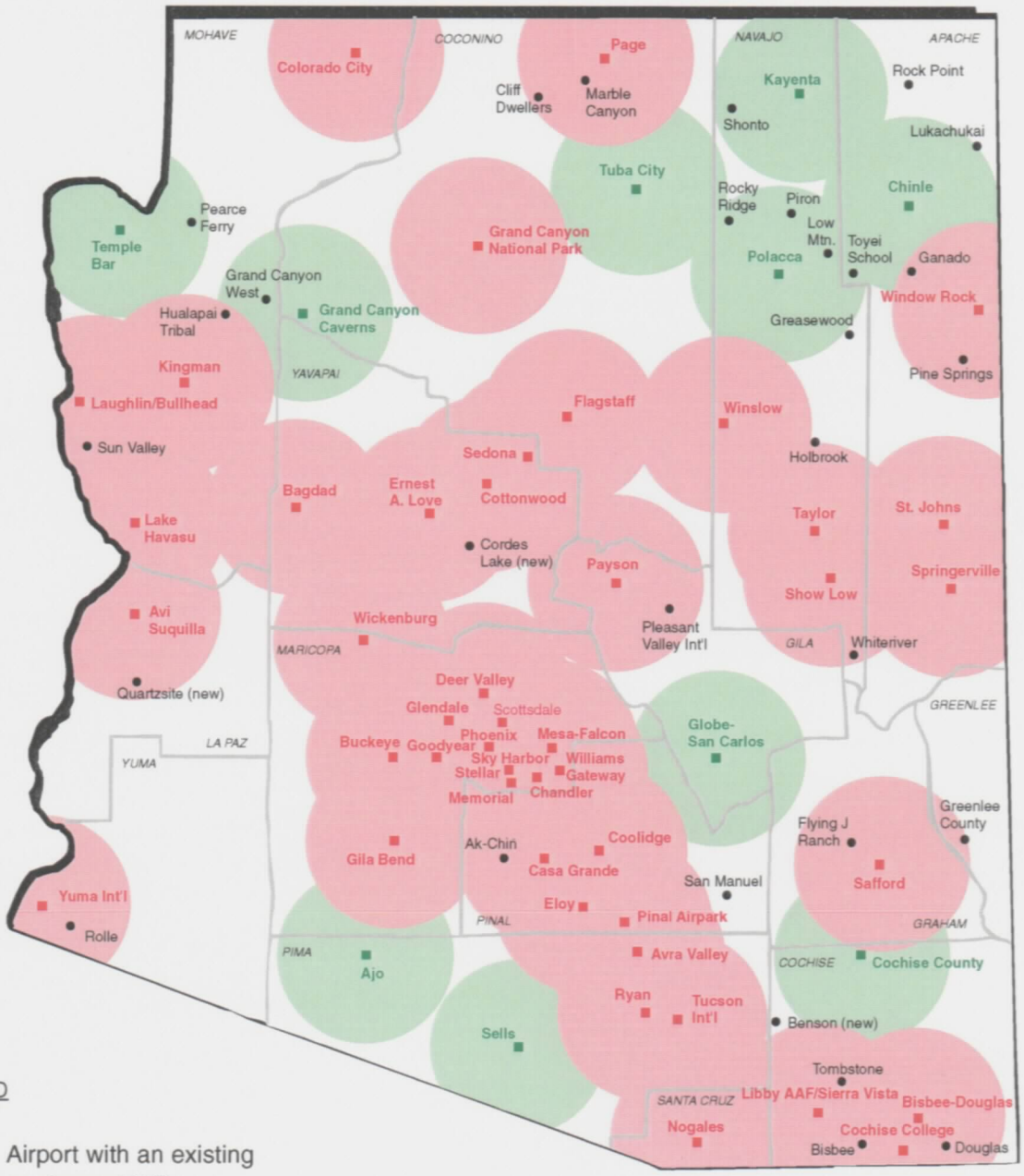
N

1 inch = 50 n.m. (approximate)

Figure 7-3

AWOS SCENARIO 2

(AWOS SCENARIO 1 AND STRATEGIC AWOS-3 LOCATIONS AT IAP AIRPORTS)



LEGEND

- Airport with an existing or planned IAP
- AWOS / ASOS Scenario 1 locations
- Additional AWOS-3 locations to serve all IAP-capable airports
- Limit of coverage

N

1 inch = 50 n.m. (approximate)

The resulting distribution of the 55 ASOS/AWOS-3 sites was evaluated with respect to Criterion 6 – coverage of weather frontal movement. In order to meet this objective, a total of three additional AWOS-3 units are required as follows:

- Dateland, a closed airport midway between Gila Bend Municipal and Yuma International and within the unrestricted airspace corridor between these airports.
- H.A. Clark Memorial Field
- Tuweep

The addition of the above three AWOS units to those preceding form AWOS Scenario 3 which is illustrated as Figure 7-4. Some areas of non-coverage of weather movement remain, however, there are no suitable sites to fill in these gaps. The maximum distance between aviation weather facility sites is about 100 nautical miles.

AWOS Scenario 3 was then evaluated to determine if AWOS-3 sites in proximity to one another substantially benefit the system. For example, there is extensive overlap of coverage in the Phoenix region where abrupt changes in topography is not a factor and near homogeneous weather conditions exist. Other regions of overlap include the corridor from Casa Grande southeast to Douglas, and in southern Apache and Navajo counties. Where appropriate, the installation of an AWOS-A unit would satisfy an aviation requirement and avoid an assessment of a remote altimetry penalty. Weather reports from adjacent ASOS and AWOS-3 units would satisfy the aviation weather needs. Exceptions to this rationale extend to those airports expected to have an instrument approach capability of ½-mile visibility. On this basis, AWOS-A units would provide a satisfactory operational capability at the following five airports:

Coolidge Municipal
Glendale Municipal
Memorial Airfield
Pinal Airpark
Stellar Airpark

Intervening terrain in southern Apache and Navajo counties precludes the ability to substitute an AWOS-A for AWOS-3 facilities.

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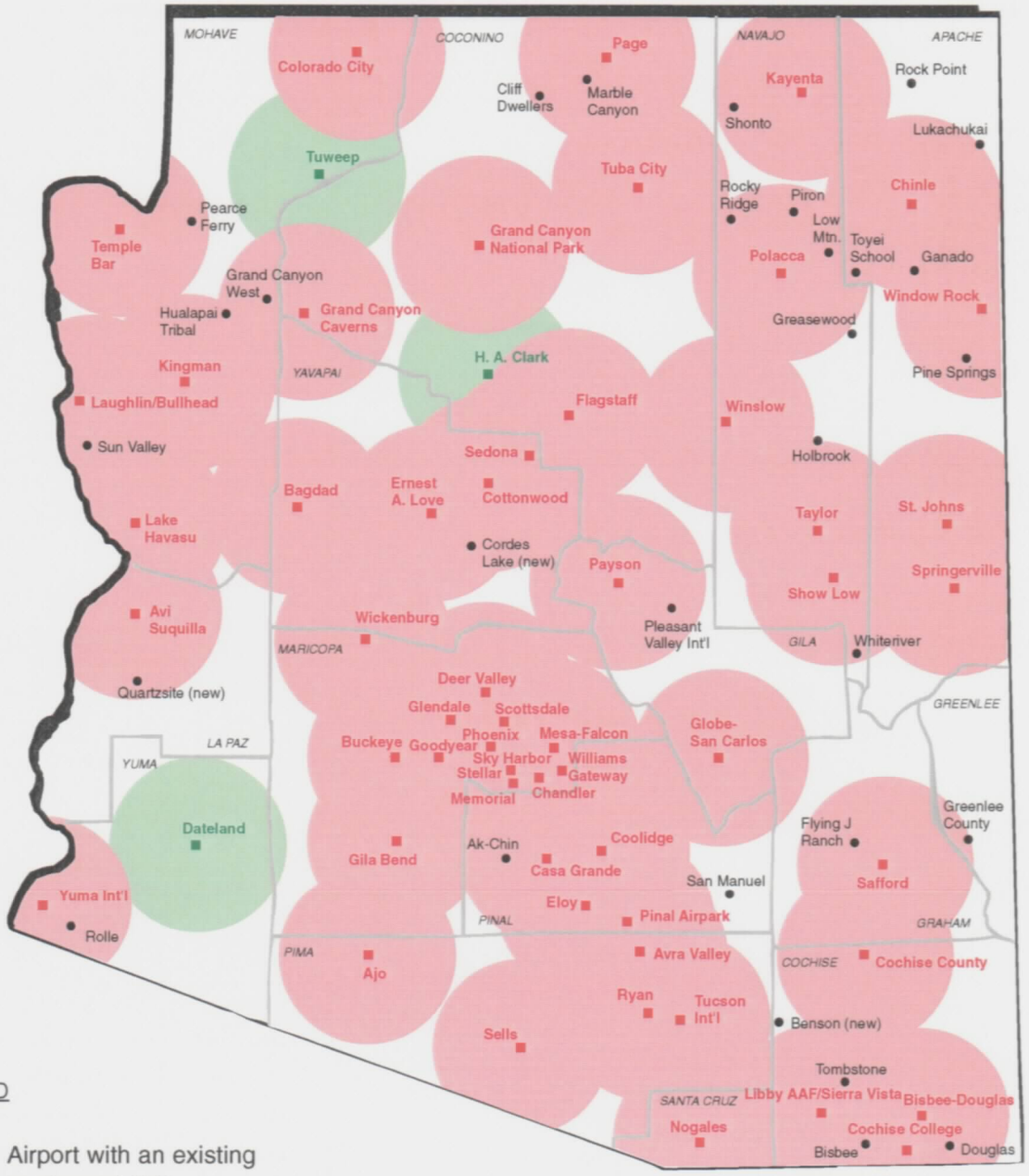
Figure 7-4

AWOS SCENARIO 3

(AWOS SCENARIO 2 AND AWOS-3'S FOR INCREASED COVERAGE)



The AWOS Scenario 3 distribution was further evaluated with respect to a requirement for an AWOS-A at those airports with a recommended GPS approach but not otherwise selected to receive an AWOS-3 or AWOS-A unit. The purpose of the AWOS-A at these airports is to eliminate the assessment of a remote altimetry penalty for the potential approach. There are 30 airports that fall under this situation. It was considered appropriate that an investment in an AWOS-A should be made at those airports with annual activity levels, at any year of the forecast horizon, that could economically justify the annual maintenance cost of the facility. This threshold value is 2,000 annual aircraft operations. Consequently, there are eight airports that qualify to receive an AWOS-A. These include:

Bisbee Municipal	Greenlee County
Cordes Lake (New)	Marble Canyon
Douglas Municipal	Quartzsite (New)
Grand Canyon West	San Manuel

The resulting Final AWOS Requirements for the Arizona system of airports and aviation requirements is summarized in Table 7-3 and illustrated in Figure 7-5. At total of 66 ASOS/AWOS units are required representing a need for 41 new facilities (28 AWOS-3 and 13 AWOS-A), as follows. Of these, a total of 25 exist as the Backbone System.

Existing Facilities	**Number of Units**
Backbone AWOS/ASOS units	25
Future Facilities	
AWOS-3 units for airports with an IAP and an AWOS-3 benefit/cost ratio of 1.0 or greater and all airports with ½-mile visibility minimum	15
AWOS-3 units to meet 25-nautical mile radius coverage for alternate airport filing and en route diversion purposes	10
AWOS-3 units for weather movement coverage	3
AWOS-A units to avoid assessment of remote altimetry penalties	13
Total	66

Table 7-3
FINAL AWOS REQUIREMENTS

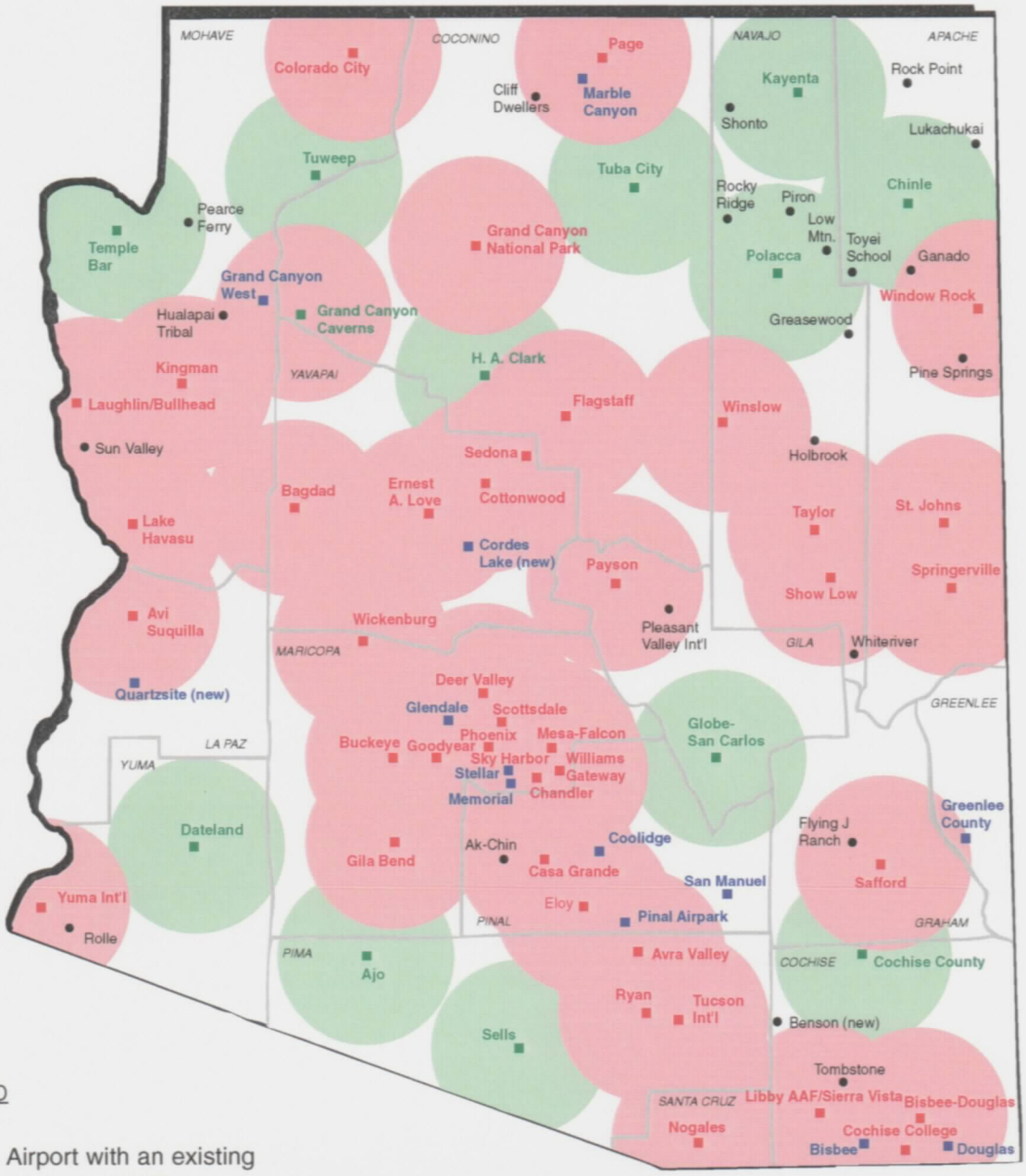
Airport	Type Unit	Airport	Type Unit
AWOS / ASOS Backbone System And:			
Ajo Municipal	AWOS-3	Laughlin / Bullhead International	AWOS-3
Avi Suquilla	AWOS-3	Marble Canyon	AWOS-A
Bagdad	AWOS-3	Memorial Airfield	AWOS-A
Bisbee Municipal	AWOS-A	Mesa - Falcon Field	AWOS-3
Buckeye Municipal	AWOS-3	Payson	AWOS-3
Chinle	AWOS-3	Phoenix - Goodyear	AWOS-3
Cochise College	AWOS-3	Pinal Airpark	AWOS-A
Cochise County	AWOS-3	Polacca	AWOS-3
Coolidge Municipal	AWOS-A	Quartzsite (New)	AWOS-A
Cordes Lake (New)	AWOS-A	San Manuel	AWOS-A
Cottonwood Municipal	AWOS-3	Sells	AWOS-3
Douglas Municipal	AWOS-A	Show Low Municipal	AWOS-3
Eloy Municipal	AWOS-3	Springerville - Babbit Field	AWOS-3
Gila Bend Municipal	AWOS-3	Stellar Airpark	AWOS-A
Glendale Municipal	AWOS-A	Temple Bar	AWOS-3
Globe - San Carlos Regional	AWOS-3	Tuba City	AWOS-3
Grand Canyon Caverns	AWOS-3	Tuweep	AWOS-3
Grand Canyon West	AWOS-A	Wickenburg Municipal	AWOS-3
Greenlee County	AWOS-A	Williams Gateway	AWOS-3
H.A. Clark Memorial Field	AWOS-3	Dateland (non - airport location)	AWOS-3
Kayenta	AWOS-3		

See Appendix A for acronym definitions.

Source: QED.

Figure 7-5

FINAL AWOS REQUIREMENTS



LEGEND

- Airport with an existing or planned IAP
- AWOS / ASOS Backbone locations
- Additional AWOS-3 locations
- Additional AWOS-A locations
- Limit of coverage

1 inch = 50 n.m. (approximate)

N

Broadcast

An evaluation was made of the most appropriate means to broadcast the AWOS-generated report to pilots en route. Factors that entered into the analysis included the availability of navigational aids (NAVAID) on the airport with voice capability to broadcast the weather observation. A VHF discrete frequency transmitter (DFT) would be required in those instances where a suitable NAVAID was unavailable. The use of a localizer to broadcast the AWOS report is not recommended because the localizer signal is highly directional and would only benefit aircraft within its propagation characteristics. Another broadcast option involves the use of Unicom radio frequency. When the radio is unattended, the pilot can use a microphone keying sequence to acquire a synthesized voice broadcast of the weather observation. As an alternative, consideration could be given to permit the Unicom to broadcast the AWOS report at pre-selected time intervals using present dial-up technology.

The FAA is moving toward the eventual replacement of most ground-based NAVAIDS as they reach the end of their useful lives or otherwise become too expensive to maintain. The application of GPS technology is on-going and by the year 2005 - 2010 timeframe is envisioned to be a primary source for flight navigation. Consequently, it would be prudent to establish the broadcast means for the AWOS facilities utilizing DFT equipment.

The bandwidth assigned for aeronautical purposes, as managed by the FAA in coordination with the Federal Communications Commission (FCC), is limited and in certain geographical areas restricted. In those instances where the suggested ground-to-air broadcast means is not available, the alternatives listed below should be considered:

1. Joint use of a single frequency. For example, up to three AWOS reports can be broadcast sequentially via a single frequency. This will necessitate the use of a communications network to link the reporting facilities.

2. Dissemination via a communications network to the nearest AFSS/FSS that will provide the report to the pilot on an as-needed basis. However, this is a proliferation of the current procedure and not necessarily an appropriate solution.

3. Use of data-over-voice (DOV) or voice-in-data (VID) emission modes for batch weather products transmission to the aircraft.

Federal ASOS and AWOS installations may utilize an available automatic terminal information service (ATIS) frequency, voice capable NAVAID or VHF discrete frequency when the installation is at an airport with an air traffic control tower (ATCT). Controllers will relay the ASOS/AWOS report to the pilot as part of their normal air traffic control procedures. When the ATCT is unmanned, the ASOS/AWOS broadcast will be the official weather observation.

AWOS-3 Upgrades

An area of interest with respect to weather coverage and addressed earlier in this chapter concerns the upgrade of AWOS-3 units to an AWOS-4 capability. The AWOS-4 can provide additional real-time weather condition information to support the tracking of weather frontal movement. Coverage requirements can be based on a 30-knot frontal passage speed and a 90-minute travel time between AWOS-4 units, representing a distance of 45 nautical miles. Because the ability to enhance the tracking of weather movement is intended to support State objectives, the preferred course is to identify those non-federal AWOS-3 units that should be upgraded to an AWOS-4 capability. This isolates the AWOS-4 program from federal decisions and policies concerning the types of sensors in a federally-owned and operated ASOS/AWOS configuration or the means by which the data from these units may be obtained. The primary criterion to monitor weather movement is the strategic location of these units with the objective of providing effective statewide coverage.

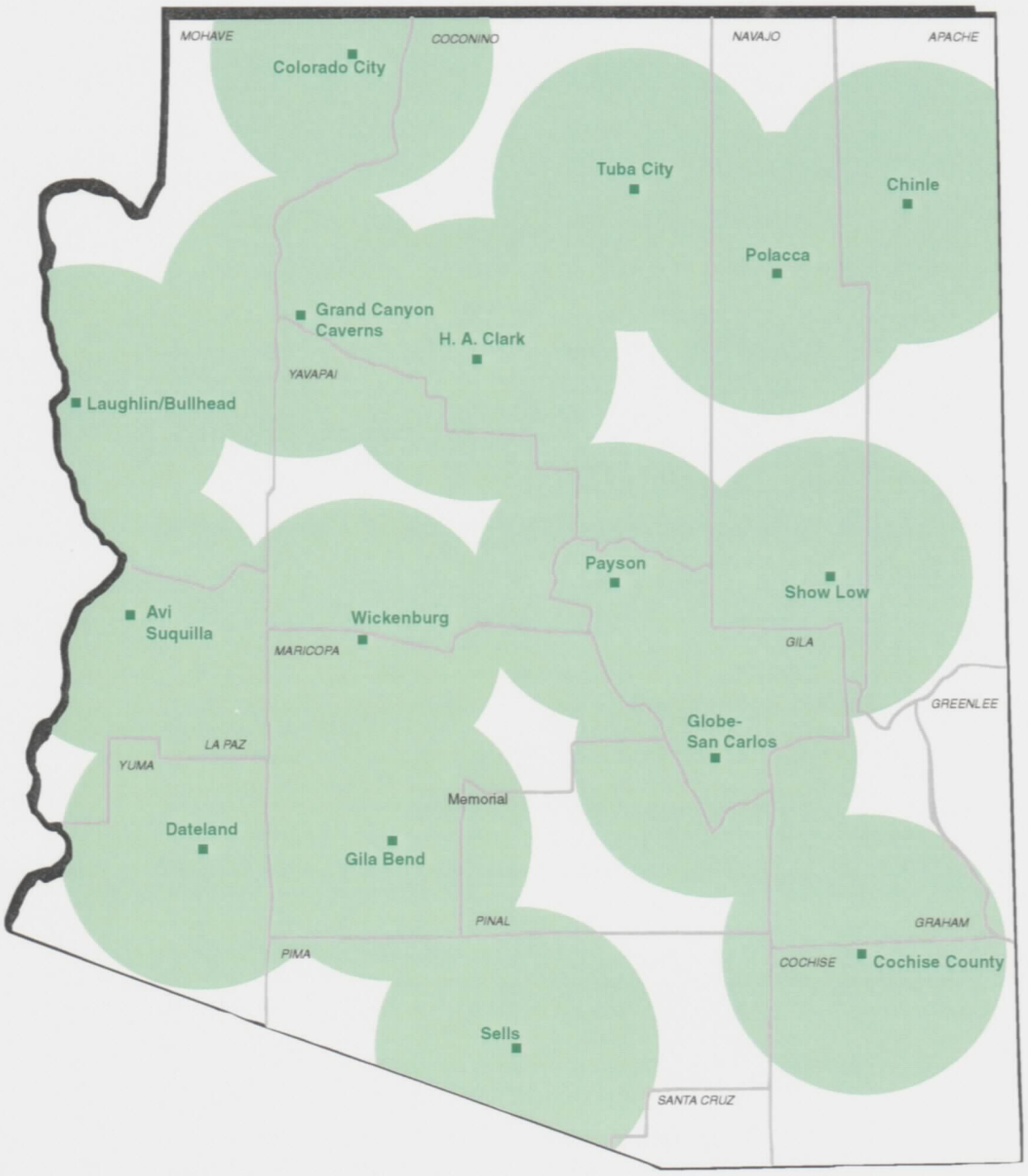
On this basis, 16 of the AWOS-3 sites recommended in the preceding section should be upgraded to an AWOS-4 capability at such time as this AWOS type is certified by the FAA. The AWOS sites selected for upgrade are presented in Figure 7-6 and include:

- Avi Suquilla
- Chinle
- Cochise County
- Colorado City Municipal
- Dateland (non-airport)
- Gila Bend Municipal
- Globe-San Carlos Regional
- Grand Canyon Caverns
- H.A. Clark Memorial
- Laughlin/Bullhead International
- Payson
- Polacca
- Sells
- Show Low Municipal
- Tuba City
- Wickenburg Municipal

Figure 7-6

AWOS-4 LOCATIONS

(POTENTIAL UPGRADE)



LEGEND

- AWOS-3 unit to be upgraded to AWOS-4 capability
- Limit of coverage

N

1 inch = 50 n.m. (approximate)

Chapter 8

REMOTE COMMUNICATIONS OUTLET REQUIREMENTS

The provision of remote communications outlet (RCO) ties has in the past been the responsibility of the FAA. These facilities have been established to meet the regional requirements for terminal and en route air traffic control and flight services. Existing RCO facilities within Arizona are reviewed in Chapter 2.

A precedent for the establishment of remote radio access by private industry began in the early 1980's. The first remote radio access system was developed by ARINC, a company owned by the commercial air carriers to respond to internal airline operations communications. The remote radio access system was used as an alternative to dedicated voice networks.

The technology applied to the needs of commercial airlines was first tested at two general aviation airports, one each in Maryland and Virginia, for the issuance of IFR clearances. Results indicated that this technology could meet the needs of the general aviation community and the air traffic control facility at a lesser cost than conventional federally-installed RCO facilities. The FAA has accepted the concept, certified the equipment and additional facilities have been installed at airports across the country. The facility, referred to generically as a ground communications outlet (GCO) addresses the needs at low activity airports for clearance delivery and closure of flight plans. The GCO is intended for use on-airport and in the airport terminal airspace area.

The GCO functions as follows:

1. A microphone key click signal from the cockpit triggers a dial-up, pre-programmed telephone call to the appropriate air traffic control facility using an interface device between the VHF radio and the public telephone network.

2. The pilot then receives the necessary air traffic control instructions without needing to leave the aircraft.

3. When approaching the airport to land, the pilot need not cancel his/her flight plan in the air, but can use the GCO when on the ground and before shutting down the aircraft.

4. The communication remains connected until the air traffic control facility terminates the call.

The GCO also allows air traffic control to enhance the safety of aircraft movement by increasing the efficiency of the use of airspace surrounding outlying airports.

Airports within Arizona to be equipped with a GCO were selected on the following basis:

1. The airport should have or plan to have an instrument approach procedure.

2. There should be a sufficient number of instrument operations to payback the establishment of the GCO within one year. The costs for the telephone line and calls are borne by the local airport, but not included as part of the payback calculation.

3. Airports currently provided with a federal RCO or RTR were excluded from the analysis.

Based on an estimated establishment cost of $12,000 and the value of time involved to place telephone calls to the air traffic control facility before and after each instrument takeoff and landing ($25 per hour and a time savings of one-half hour), it was determined that the airport should have an activity level of approximately 2,000 annual instrument operations during the 20-year planning horizon. Those 11 airports meeting this GCO establishment criterion are noted below. It is recommended in Chapter 11 that all GCO units be acquired in a block purchase to take advantage of a lower unit cost and installed in the initial stage of facilities improvements. Further, existing and future activity levels at these and other system airports should be reviewed to assure that they meet the above threshold values prior to funding the GCO units.

Avi Suquilla
Avra Valley
Casa Grande Municipal
Chandler Municipal
Cochise College
Cottonwood Municipal
Eloy Municipal
Lake Havasu City Municipal
Laughlin/Bullhead International
Memorial Airfield
Stellar Airpark

Chapter 9

AVIATION SERVICES ASSESSMENT

Introduction

A focus of this study concerns the requirement for aviation services as expressed by pilots (users) and airport owners/sponsors and fixed base operators/tenants (providers). These service needs may be inferred from the results of surveys presented in Appendices B, C and D. The term "aviation services" can include a number of items, many of which are highlighted in the survey questionnaires and responses. Those that are especially important as evidenced by the number of responses may be classified as services being met or not being met and are discussed below. The results suggest areas in which ADOT Aeronautics can supplement or otherwise support the provision of unmet needs.

Service Needs That Are Being Met

Aviation Fuel

The availability of fuel at airports is a key service requirement. VFR-only rated pilots expressed a need for low-lead avgas while IFR-rated pilots indicated requirements for both low-lead avgas and Jet-A fuel. These results are directly related to the types of aircraft typically flown by pilots with such ratings. The ability to meet fuel requirements is evidenced by the lack of negative comments expressed by users and confirmation from the providers that this is a service need that is being met.

Maintenance

Although about one-third of all pilots surveyed do not own the aircraft they fly, the need for maintenance of the aircraft was cited as a strong requirement at airports. Few pilots reported a lack of maintenance capabilities at the airports they frequent, and the providers did not indicate that maintenance service was an unmet need.

Aircraft Tiedown

Pilots expressed a requirement for aircraft tiedown space, a need that is being met by the providers based on the lack of comments to the contrary.

Lounge/Waiting Area

Most pilots utilize a lounge/waiting area at the airports they visit and the providers of the airport terminal facility suggest that this need is being met.

Telephone

Access to a public telephone is an essential need at airports and this capability appears to be well accommodated.

Service Needs That Are Not Being Met

Wash Racks

A sufficient number of users and providers expressed a need for wash racks in order to clean aircraft exteriors, thus confirming this as an unmet service need. Although no reasons were mentioned as to the cause for this situation, ADOT Aeronautics may want to investigate potential environmental rules and procedures that can inhibit the provision of this service at reasonable costs. The evaluation should also include an assessment of the ability of airports to properly manage the wastewater runoff generated from plane washing activities. It may be viable to prepare a generic design standard for such facilities that can be site-adapted in compliance with typical environmental safeguards and permitting regulations.

Hangar/Sun Shade Storage

The need for conventional hangar and/or sun shade protection for aircraft storage was mentioned as an unmet service need by the providers. These comments likely reflect needs expressed by pilots and aircraft owners who are on waiting lists for such facilities. The relatively high cost associated with these capital improvements and the inability to earn an appropriate return on investment are the likely causes for the lack of these facilities. Privately-owned, public-use airports are especially pressed for such funds because their capital costs are higher and financing is more difficult to obtain from traditional lenders.

ADOT Aeronautics presently offers an innovative low interest rate funding program for these and other types of facilities. The program offers the

opportunity to finance such facilities on the best financial terms available so that airport sponsors can provide higher levels of service to their users. This program has the potential to bring required rental fees in line with the resulting debt service requirement. The program may need some form of additional and/or new promotion to ensure that airport sponsors are aware of the State service that is available to them.

Rental Cars/Courtesy Vehicles

About 29 percent of all pilots expressed a need for rental cars but did not suggest that this service feature was being unmet. Airport service providers cited an opposite opinion. QED believes that these service amenities are a function of the provider of services at the airport and that ADOT Aeronautics cannot play a role in facilitating the delivery of such services.

Restaurants/Food

Similar to the situation with regard to rental and courtesy vehicles, few pilots expressed a need for eating facilities at the airport while the provider responses suggested this to be an unmet need. These results may be due to the survey questionnaire design, yet it is unlikely that ADOT Aeronautics could effect a program to improve upon these perceived needs.

Flight Planning Room

Pilots require an area that can be equipped to enable flight planning activities, and the responses from the users support this need. Provider responses suggest that this need is not being met. Whether this unmet need is a factor of available space or equipment to meet an operational activity function is not clear. Nonetheless, providers have the impression that flight planning room requirements represent an unmet need. This service amenity is tied in part to that of weather data and computer access described below; however, provision of the necessary floor area for flight planning activities is a responsibility of the airport owner and/or operator.

Weather and Computer Access

The increasing availability of weather data and products has stimulated a demand for such information by pilots. About one-half of all pilots consider access to weather data as a primary service need and they use a wide range of data sources to acquire the information. Responses from the providers recognize that demand and indicate that this need is not presently well served. Capital costs to improve this service would involve personal computers and

printers (preferably color). This unmet service need could be improved upon by a program administered by ADOT Aeronautics to acquire such equipment in multiple quantities to take advantage of lower unit costs. The providers would be responsible for telephone access or other suitable communications links to acquire the desired weather data products. This initiative could be integrated into an overall statewide program that addresses the real-time acquisition and dissemination of weather data and conditions, forecasts and related products.

Arizona Aeronautical Chart

Most pilots (62 percent) expressed a desire to have the Arizona Aeronautical Chart made available once again by ADOT Aeronautics. The chart is quite convenient because it combines information from several federal aviation sectional maps into one product. Pilots recognize that the chart would be authorized for only reference and informational purposes. ADOT Aeronautics should consider re-establishing this service.

Educational Seminars/Publications

The majority of responding pilots indicated an interest in education-related services that could be administered by ADOT Aeronautics. A published guide to airports in Arizona was also cited as a strong need. The FAA currently conducts flight safety seminars and it is possible that ADOT Aeronautics could develop a partnering activity. Additionally, publication of an ADOT Aeronautics newsletter and safety briefs would be well received by the pilot community.

Potential ADOT Aeronautics Initiatives

Publications

State aviation agencies have historically taken a proactive role in enhancing the use of the aviation facilities in which they have invested public funds. These activities also include pilot educational efforts to enhance flight safety.

Many state aviation agencies publish a monthly or other periodic newsletter that is used to communicate items of interest to registered pilots and others in the airport and aviation industry. Often, these newsletters include flying techniques which are especially relevant to conditions encountered within the state – high density altitude operations, mountainous terrain and icing are some examples. One state, Idaho, has produced videos on flying in mountainous terrain and within their Wilderness Area. These newsletters also serve as a means of communicating state policies and programs with regard to aviation.

Several state aviation agencies publish aeronautical sectional maps, authorized for information purposes only, as a service to pilots. These maps are updated annually and usually include features not found on federal charts such as airport runway layout diagrams and safe flying hints.

ADOT Aeronautics has published items of interest to the aviation public. These include:

1. The Annual Progress Report – reviews the activities of ADOT Aeronautics.

2. Helicopter Facts – an educational pamphlet which provides basic information on helicopters and how they fly.

3. Bald Eagle Nesting Sites – a brochure designed to provide pilots with the most specific and current information available on sensitive bald eagle nest areas.

4. Desert Survival Guide – a pamphlet outlining various desert survival principles, including specific techniques in survival situations.

5. Arizona Aviation Facts – a reference on general aviation data and facilities in Arizona.

6. Five Year Airport Development Program - a listing of projects anticipated to be funded at eligible airports over a five-year period.

These items may need to be updated periodically to maintain their usefulness.

Items of interest to the pilot community can also released through cooperative efforts with private sector companies and organizations. For example, the publication, "Arizona Flyways," is an excellent means of disseminating information to pilots within Arizona as well as to those who subscribe to the publication from other states. Information can also be released in conjunction with mailings of the Arizona Pilots Association and Arizona Airports Association.

School Outreach Programs

Some state aviation agencies have organized formal programs that seek to introduce aviation as a recreation and career opportunity through the public school system. Illinois, for example, has been recognized by its peers in aviation for these types of programs which reach students at all grade levels. These activities differ from the occasional classroom visit to the local airport in that they

are supported with literature, videos and other communication means to deliver the intended message.

ADOT Aeronautics has participated in the State's Aviation Education Week, art contests and aviation expositions. A more formalized year-round program may be desirable.

Weather Data Dissemination

The preceding sections have highlighted state aviation agency activities that for many years have been traditional areas of engagement and in which ADOT Aeronautics has been also been involved to varying levels or degrees.

1. Since the mid-1908's, state aviation agencies have begun initiatives that broaden their reach into operational issues. Changes in federal funding programs that permit the states to acquire facilities and equipment in block purchases on behalf of several airport sponsors and thereby reduce administrative and unit acquisition costs have contributed to this involvement. Revised or new tax programs have generated significantly higher funding levels than in the past for some states. Some state aviation agencies, excluding ADOT Aeronautics, receive a portion of automobile fuel tax collections to fund aviation programs as part of an increasing trend to multimodal initiatives. In addition to enabling states to fund projects that were ineligible for federal funding participation (hangars, for example), some states have made major investments in enhancing the acquisition and dissemination of aviation weather data. Notable examples include:

    1. Minnesota – Installed computer terminals at 43 airports to provide direct links to federal weather data networks. Later, the program expanded to 57 computer terminals at 48 airports as well as transmitting live color weather radar through the public broadcast television system. The State then initiated a program to install automated weather observing system (AWOS) facilities at 37 airports, each of which is linked to input the weather report to the FAA national aviation data interchange network (NADIN). These AWOS units will be supplemented with precipitation sensors in the near future. A corollary program that involves other State agencies serves as a means for pilots to access weather data maintained in federal networks.

    2. Iowa – Purchased and installed a total of 32 AWOS units each linked to a single host computer which then transmitted the AWOS reports on a 20-minute update cycle to NADIN. The Iowa Aviation Weather

System (IAWS) is the first and only host-based system in operation in the country. The IAWS also provides for the acquisition of weather data contained within the federal circuits and the capability to file flight plans.

3. Illinois, Pennsylvania, Tennessee and Virginia – Have provided funding assistance to individual airports to acquire AWOS units but without a networking feature as implemented by Iowa. Illinois recently acquired several AWOS units in a single purchase. Virginia also provided computer terminals to access federal weather data networks, as did Pennsylvania.

4. Missouri – Is evaluating the integration of AWOS and roadway weather information system (RWIS) data into a host-based network. Outputs of the system include site-specific observations as well as the potential to generate value-added products and services to industry, state agencies, federal agencies and the general public. Arizona DOT is in the process of enhancing its deployment of RWIS units and this could lead to a coordination of activities with ADOT Aeronautics.

5. Maryland, Michigan and Virginia – Are installing ground communications outlets that allow pilots to contact the controlling FAA center for clearance deliveries and to close flight plans. These actions would be directly from the cockpit at airports not equipped with FAA remote transmitter receivers.

Helicopter System Planning

There are many heliport/landing areas used by emergency and private concerns located throughout Arizona. There is an ever present need for ADOT Aeronautics to assist local jurisdictions in the permitting of the installation of these aviation facilities and in means to prevent instances that jeopardize their continued utilization and services. Guidelines for compatible land use, siting, and physical layout and safety standards can be prepared for the benefit of local planning and zoning boards. The FAA has established special standards for the establishment of GPS approaches at heliport facilities and these may be applied to define potential procedures to enhance the use of heliports during poor weather conditions, especially for those facilities fulfilling an emergency services mission. A heliport system study addressing these and other related needs, and facilitating interaction among heliport users, operators and local government officials is recommended, especially in the relatively more populated metropolitan areas of Arizona.

Chapter

10

WEATHER DATA NETWORK

Introduction

Individual AWOS reports broadcast to pilots en route or accessed by direct dial-up (synthesized voice message or computer modem) are one of the primary benefits of this weather observing system. Its utilization can be increased multifold if the data can be acquired and disseminated by other means to a wide range of potential users. These users represent other transportation modes, emergency response operations, State agencies including tourism centers, federal and other state agencies, and the general public. The need for reliable, near real-time data is evident throughout societal functions and has a value that varies depending on the user's specific needs (refer to related responses in Appendices B, C, D and E). This chapter seeks to identify a potential conceptual network for the acquisition and dissemination of the AWOS data.

Conceptual Network

The operating and performance specifications of federally-certified AWOS units provide for the potential to acquire the weather data on an automatic basis. The FAA is currently finalizing its networking of AWOS-3 units installed under the Facilities and Equipment Program. The network is the AWOS data acquisition system (ADAS) and relies on the use of leased telephone lines to connect each federally-installed and maintained AWOS with its associated air route traffic control center (ARTCC). The center has the gateway to transfer this information to the national data interchange network (NADIN) where it is routed throughout the FAA and NWS data systems and worldwide. There is the potential for non-federal AWOS units to be linked to ADAS, however, the existing capacity of the system cannot accommodate large numbers of such connections. Further, the owner of each connecting AWOS would be responsible for the telephone communications cost and 24-hour monitoring and control to ensure the correct functioning of the connection including resolution of transmission anomalies.

Alternative means to acquire and disseminate AWOS data are available and in application today. One network concept available from two commercial vendors essentially involves the uplink of the weather report to a satellite for downlink to a central location and direct input to NADIN. The installation of other facilities at the AWOS site, or terminal building, enables the receipt of data within NADIN as well as value-added products and services offered by the vendor. Such products include weather satellite imagery (as received from linkages to federal weather satellite networks), weather condition mapping and flight plan filing services. This alternative represents a decentralized solution at the state level.

A second primary means to network the AWOS data relies on the use of available telecommunications facilities owned/leased by the State to establish a link to NADIN for the two-way flow of weather data from a central location. This approach is presently in application today in Iowa and is referred to as the Iowa Aviation Weather System. Within Arizona, the implementation of Project EAGLE in conjunction with TRANSNET (refer to Chapter 2, Communications Facilities), would provide the backbone for an AWOS data network. Each AWOS can be linked to the nearest node on the TRANSNET or as provided through Project EAGLE. The connection is by local telephone line or a radio data link capability where viable. The latter eliminates monthly telephone line access charges. The AWOS data would then be routed to a central host computer for storage and further dissemination including a linkage to NADIN. Weather data and products available on NADIN would flow to the host computer and then be disseminated through the TRANSNET and Project EAGLE facilities to the end user.

Recommended AWOS Network Topology

The basic options to network the weather data described above represent a decentralized versus centralized approach. Inasmuch as the State is able to provide a high capacity backbone telecommunications network through Project EAGLE and TRANSNET, there will not be a need to rely on third-party services to collect the AWOS data in a decentralized fashion. Because the amount of data transmitted from the AWOS is relatively small (on the order of 2,000 bytes) its demand on the telecommunications network is minimal. The AWOS units to be networked are the 30 AWOS-3 units recommended in Chapter 7. AWOS-A facilities are not required to be networked and their limited data is not eligible for transmission to NADIN.

Under the centralized weather data network concept, each AWOS-3 installed under a State/local program would be linked to TRANSNET or Project EAGLE facilities and routed to a stand-alone, multi-user multi-tasking application server. This server (computer) could be sited at any location on the TRANSNET, but preferably one which is equipped and staffed to manage the TRANSNET. For

purposes of this study, this location is referred to as the Weather Center. Weather data received would be stored in an appropriate database and be available to all users over the TRANSNET frame relay network. This database could be maintained on the server itself or could operate as a separate application running on another stand-alone personal computer (PC). This network approach confirms the appropriateness of the Arizona DOT's earlier long-range communications plan which yielded TRANSNET and the State's implementation of Project EAGLE.

The Weather Center could be equipped and staffed to create value-added products and services from the AWOS data collected and other weather data sources to a wide range of users including aviation interests. The extent of such commitment is dependent on the desire or need to consolidate weather data collection efforts undertaken by multiple State agencies into a single operating/service center.

Facilities at the Weather Center would be accessed to transmit the latest received AWOS report to NADIN. Presently, the allowable frequency of update is every 20 minutes unless a weather condition of certain magnitude triggers the identification of a special weather report. There are basically two options to accomplish the linkage to NADIN. The first envisions that the State would develop the interface and take responsibility for the connection in conformance with federal standards and requirements. The second option would have this responsibility assigned to a third-party. The latter is the preferred option inasmuch as weather data vendors have developed this capability and can provide the service, including the monitoring of the data content and its transmission, and assume the responsibility for such activity.

Access to weather data contained on NADIN circuits can be facilitated at the Weather Center for dissemination to airports. This will require the installation of a PC at each airport location and, where more than one fixed base operator provides services to pilots, potentially multiple PCs. Users of these PCs could be linked to TRANSNET via a local telephone line and thereby gain access to the Weather Center. Alternatively, these PCs could be linked to DUATS or its replacement service as part of the FAA OASIS program to acquire NADIN data and the value-added services offered by the DUATS/OASIS providers.

Because private industry access to TRANSNET is not a likely option for security and other reasons, the PC to DUATS/OASIS linkage is recommended. This linkage will enable access to federal ASOS and AWOS-3 data which otherwise could not be obtained through linkages to TRANSNET. The provision of the PCs at the airports could be a State responsibility or that of each participating fixed base operator. The latter is preferred inasmuch as it limits the State's

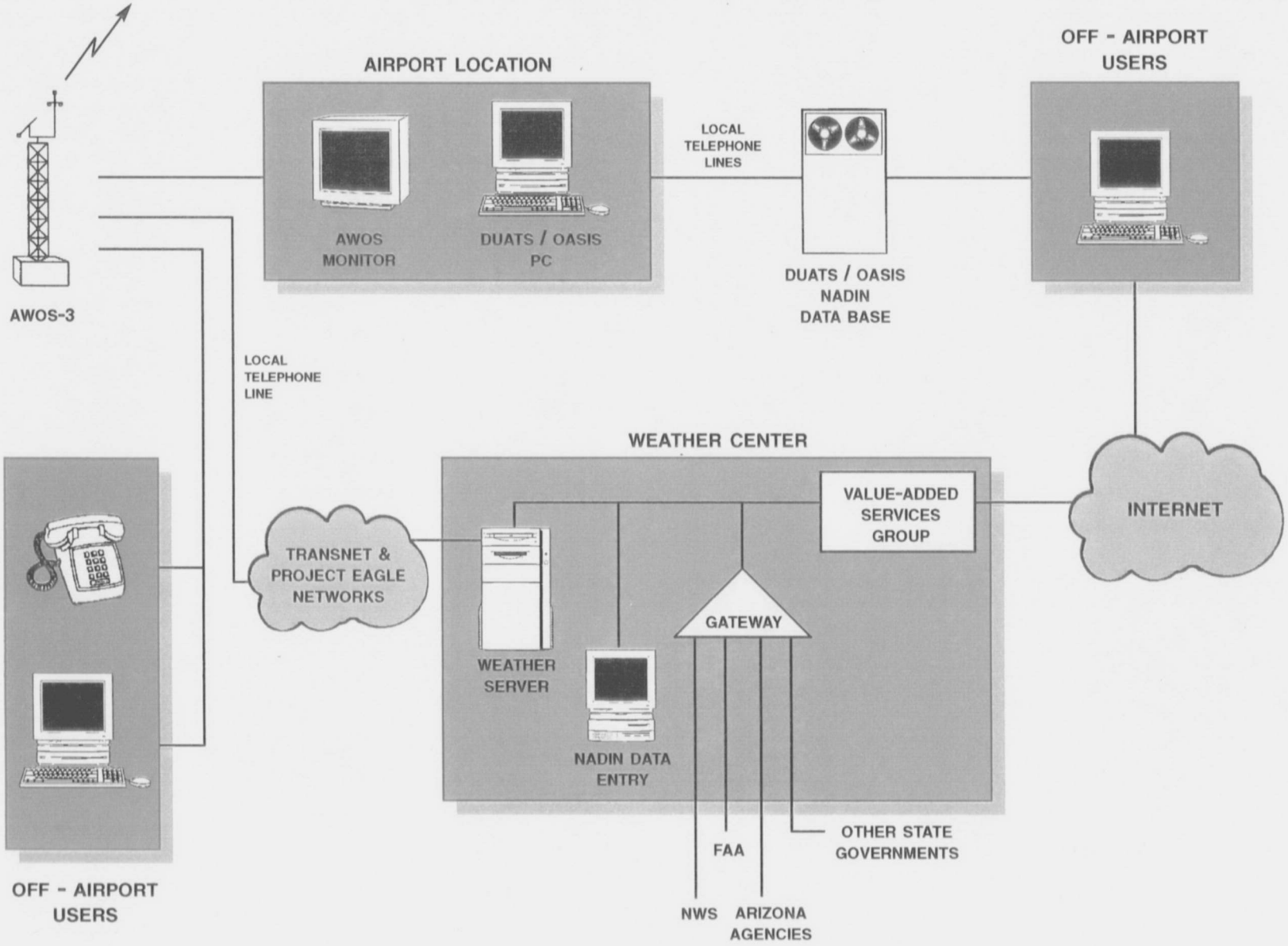
involvement and encourages private investment and an element of competition. The State should specify minimum operating and performance standards for the PCs and can explore the potential of acquiring the units in bulk purchase to take advantage of lower unit costs and seek reimbursement from the operators.

The Weather Center also serves as the gateway to disseminate raw and value-added weather products and services. One increasingly popular means would be through the Internet and the Arizona home page. Conversely, linkages to weather data sources such as the FAA, NWS and other state aviation/transportation departments should be concentrated at the Weather Center. This data inflow will aid in the preparation of value-added weather products and services should the State elect to pursue such activity.

The recommended topology for the AWOS Weather Network is illustrated in Figure 10-1. This network is presented in a conceptual format that reflects the use of currently available technology and programmed telecommunications system improvements within Arizona. It serves as a springboard from which further study and detailed design of system integration can be initiated.

Figure 10-1

AWOS WEATHER NETWORK CONCEPT



Chapter 11

IMPLEMENTATION PROGRAM

Introduction

This chapter presents the staged development and associated costs of the GPS approach, VISAID, weather facilities and GCO improvements recommended in previous chapters. The staging has been divided into three periods to spread the cost, implement the available technology within a reasonable time frame, and provide for the conduct of necessary field surveys and economic justification assessments where applicable. While staging periods cover a 10-year time frame, the benefit/cost analyses considered a 20-year cycle. This has the effect of accelerating the establishment of facilities.

It is recommended that where possible, the facility improvements be installed as part of package procurements. This takes advantage of provisions in the FAA Airport Improvement Program (AIP) which permit state sponsorship of multiple equipment purchases in the interest of reducing overall establishment cost. Facilities that lend themselves to this process are the VISAIDS, AWOS and GCO.

FAA programs that may provide for federal installation and maintenance of some of the facility improvements recommended in this Study should be reviewed. This will ensure compatibility between federal and ADOT Aeronautics programs and maximize the investment potential of each effort. The primary federal initiative that is applicable to the improvements addressed in this Study is the FAA Facilities and Equipment (F&E) program, particularly with regard to communications equipment and possible certain visual landing aids. The F&E program is submitted annually for Congressional review and appropriation and is subject to frequent modification. Therefore, ADOT Aeronautics actions to fund improvements that may be included in the F&E program at any given time should be coordinated with the FAA prior to initiating the procurement process.

GPS Approach Procedures

The implementation of GPS procedures is influenced by four principal factors:

1. Whether the procedure is "nonprecision" or dependent on the establishment of the WAAS by the FAA to provide a "precision" approach.

2. The ability of the airport to meet applicable landing surface and design standards.

3. The ability to meet economic justification criteria for those airports requiring improvements to achieve standards.

4. The conduct of compliance standards surveys for airports having limited on-file data.

These factors have been assessed for each airport with a recommended GPS approach procedure. The results lend themselves to a logical grouping in a staged implementation program. A total of seven categories have been defined. Each airport within a category was ranked in priority based on activity levels. This serves to highlight those airports with the relatively greater operational benefits.

The seven categories for GPS approach establishment are defined as follows:

1. Category 1 -- Those airports without an existing IAP and meet the applicable facility design standards for the potential GPS procedure.

2. Category 2 -- Airports without an existing IAP and improvements to meet the facility design standards for the potential GPS procedure are economically justified by achieving a benefit/cost ratio equal to or greater than 1.0. an existing IAP that can be improved with reduced approach minimums and meet the applicable facility design standards.

3. Category 3 -- Airports with an existing IAP that can be improved with reduced approach minimums and meet the applicable facility design standards.

4. Category 4 -- Those airports with an existing IAP that can be improved with reduced approach minimums and improvements to meet the applicable facility design standards are economically justified (benefit/cost ratio equal to or greater than 1.0).

5. Category 5 -- Airports whose potential GPS procedure capability is dependent on improvements to meet applicable facility design standards such that the cost to achieve compliance does not exceed the defined operational benefit value in order to achieve a benefit/cost ratio equal to or greater than 1.0.

6. Category 6 -- Those airports whose GPS procedure is required to provide area coverage.

7. Category 7 -- Airports subject to a standards compliance survey to determine if the costs to meet facility design standards applicable to the potential GPS procedure are economically justified and achieve a benefit/cost ratio equal to or greater than 1.0.

Tables 11-1 through 11-3 present the staged GPS establishment program that takes into consideration the various GPS approach establishment categories. Priority is assigned to those airports which do not require improvements to meet applicable landing surface requirements and facility design standards. This applies first to airports without an instrument approach capability (Category 1) and then to those airports presently served with an instrument approach procedure (Category 2). These airports are included in the Initial Stage.

The Initial Stage also includes the conduct of a number of planning and design activities intended to both improve successively staged airports to meet applicable facility standards. Further, provision is made in the Initial Stage to assess the benefit/cost for airports where the required data is currently unavailable to make such findings. For example, certain airports (Categories 5 and 7) require an assessment of facility development costs in order to test their economic justification by conduct of benefit/cost assessments. Three of the Category 5 airports, none of which are classified as commercial service, could potentially have the need for National Ocean Survey attention due to their reliance on the WAAS. As these airports are surveyed and assessments made regarding their benefit/cost values and economic justification of the approach procedure, ADOTY Aeronautics can sequence each airport in the most appropriate category based on activity levels.

The Intermediate Stage addresses those airports that require facility improvements to support the potential GPS approach procedure. Those airports without an existing instrument approach (Category 3) should precede those that have an instrument approach capability (Category 4).

Airports requiring an instrument approach procedure to support the system objective of area coverage (Category 6) are included in the Final Stage, especially as two of these three airports are dependent on the establishment of the WAAS.

Those airports relying on the establishment of the WAAS for their GPS approach procedure will need to await its availability. In the interim, these airports should undergo the detailed field surveys that identify required latitude, longitude and elevation data points which influence the design of the approach procedure. Requests for such surveys can be made to the National Ocean Survey through the FAA Western-Pacific Region which has been coordinating such surveys in the recent past. If warranted, these airports should then be reassigned to the appropriate implementation/staging category. As an option, ADOT Aeronautics may elect to establish a ground-based, conventional Category I ILS or TLS at the commercial service airports lacking this capability. This option applies to four airports – Kingman, Lake Havasu City Municipal, Laughlin/Bullhead International and Show Low Municipal.

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Table 11-1

GPS APPROACHES STAGING PROGRAM
INITIAL STAGE (YEARS 1 - 4)

Category 1 Airports Without An IAP And Meet Applicable Facility Design Standards	Category 2 Airports With An IAP That Can Be Improved And Meet Applicable Facility Design Standards	Pre - GPS Approach Planning and Design Activities
Glendale Municipal	Casa Grande Municipal[1]	Initiate and complete improvements to Category 3 and Category 4 airports.
Eloy Municipal	Flagstaff-Pulliam[1]	
Payson	Williams Gateway	
Bagdad	Avi Suquilla	
Cottonwood Municipal	Colorado City Municipal	Conduct field surveys to support WAAS "precision" approaches at airports indicated with * in all groups.
Wickenburg Municipal		
Safford Regional		
Pinal Airpark		
Bisbee Municipal		
Douglas Municipal		Assess benefit/cost for Category 5 airports.
Globe-San Carlos Regional		
Taylor Municipal		
Greenlee County		Conduct standards compliance surveys and assess benefit/cost for Category 7 airports.
Cordes Lake (New)		
Ajo Municipal		
Quartzsite (New)		
Holbrook Municipal		Establish Category I ILS or TLS at 4 commercial service airports (optional).
Tombstone Municipal		
Grand Canyon West		
Rolle Airfield		

See Appendix A for acronym definitions.

Notes: All airports ranked by activity level per category.

1. GPS approach dependent on establishment of WAAS by FAA.

Source: Table 5-7.

Table 11-2

GPS APPROACHES STAGING PROGRAM
INTERMEDIATE STAGE (YEARS 5 - 7)

Category 3 Airports Without An IAP And Improvements To Meet Applicable Design Standards Are Justified	Category 4 Airports With An IAP That Can Be Improved And Improvements To Meet Applicable Facility Design Standards Are Justified	Category 5 Airports Whose IAP Capability Is Dependent On Not Exceeding A Cost Limitation
Phoenix - Goodyear[1]	Phoenix - Deer Valley[1]	Scottsdale[1]
Cochise College[1]	Laughlin / Bullhead International[1]	Mesa-Falcon Field[1]
Buckeye Municipal	Lake Havasu City Municipal[1]	Chandler Municipal[1]
Avra Valley[1]		Stellar Airpark
		Gila Bend Municipal
		Kayenta

See Appendix A for acronym definitions.

Notes: All airports ranked by activity level per category.

1. GPS approach dependent on establishment of WAAS by FAA.

Source: Table 5-7.

Table 11-3

GPS APPROACHES STAGING PROGRAM
FINAL STAGE (YEARS 8 - 10)

Category 6	Group 7	
Airports Whose IAP Is Required To Provide Area Coverage	Airports Whose Compliance With Applicable Facility Design Standards Are Not Known And Compliance Surveys Are Required	
Libby AAF/Sierra Vista	Memorial Airfield	Flying J Ranch
Page Municipal[1]	Tuba City	Grand Canyon Caverns
Show Low Municipal[1]	Temple Bar	Low Mountain (Closed)
	Chinle	Pinon
	Marble Canyon	Pleasant Valley International
	Whiteriver	Polacca
	San Manuel	Rocky Ridge
	Ak-Chin Community	Shonto
	Rock Point	Sun Valley
	Hualapai Tribal	Ganado
	Pearce Ferry	Greasewood (Closed)
	Sells	Lukachukai
	Cliff Dwellers Lodge	Pine Springs
		Toyei School (Closed)

See Appendix A for acronym definitions.

Notes: All airports ranked by activity level per category.

1. GPS approach dependent on establishment of WAAS by FAA.

Source: Table 5-7.

AWOS Facilities

The staged deployment of AWOS facilities is linked to the establishment of GPS approach procedures and presented in Tables 11-4 and 11-5. This rationale serves to maximize the benefit of the instrument procedure and eliminates any potential for the assessment of a remote altimetry penalty. While these GPS approach procedures are in development, it would be advisable to install the recommended AWOS level at those airports which currently are assessed remote altimetry penalties, or whose existing IAP is not authorized when a local altimeter setting is not available. These airports constitute the first set of AWOS units to be deployed in the initial stage. The initial stage also provides for those activities intended to establish the Weather Center. AWOS-3 units required for weather movement coverage (three facilities) are suggested to be installed during the last staging period.

AWOS-3 to AWOS-4 upgrades for the 16 airports recommended in Chapter 7 should be initiated at such time as the private sector produces and receives FAA certification of an AWOS-4. The upgrades can be phased or made concurrently at all 16 airports. In the event of a staged implementation, the sequence might typically follow usual weather movements which are primarily from the west to the east in the northern half of Arizona, and from the south and southwest to the north and northeast in the southern half of the State.

Weather Center

Should the State elect to pursue the establishment of a Weather Center to serve as a focal point for the collection and dissemination of weather data, products and services, its development will need to be integrated consistent with the deployment of AWOS units and on-airport PC equipment. The linkages to TRANSNET and Project EAGLE communications facilities also impact the stage development of the Weather Center. Included in the early stages is the development of the software to access the data collection unit of the AWOS and its transmission to the Weather Center and selected gateways.

VISAIDS

The staging of VISAIDS should typically occur concurrent with other capital improvements programmed for the airport. In general, priority should be given to project items involving basic facilities such as the wind indicator/cone, runway edge lighting/reflectors and visual approach guidance indicators.

Table 11-4

AWOS FACILITIES STAGING PROGRAM
INITIAL STAGE (YEARS 1 - 4)

AWOS Units At Airports With Existing Remote Altimetry Penalties Or Nonauthorized IAP When Local Altimeter Setting Is Not Available	AWOS Units To Complement GPS Approach Categories 1 And 2 Airports (Table 11-1)	Weather Center Activities
Avi Suquilla	Glendale Municipal	Install weather server
Cochise County	Eloy Municipal	
Coolidge Municipal	Payson	Coordinate telecommunications requirements with TRANSNET and Project EAGLE agencies
Laughlin / Bullhead International	Bagdad	
Mesa - Falcon Field	Cottonwood Municipal	
Show Low Municipal	Wickenburg Municipal	
Springerville Babbit Field	Pinal Airpark	Write software for Weather Center
Williams Gateway	Bisbee Municipal	
	Douglas Municipal	Install PCs at AWOS-3 airports
	Globe - San Carlos Regional	
	Greenlee County	Install telephone lines and modems to access Weather Center and DUATS / OASIS
	Cordes Lake (New)	
	Ajo Municipal	
	Quartzsite (New)	
	Grand Canyon West	

See Appendix A for acronym definitions.

Sources: Table 5-2 and Table 11-1.

Table 11-5

AWOS FACILITIES STAGING PROGRAM INTERMEDIATE STAGE (YEARS 5 - 7) AND FINAL STAGE (YEARS 8 - 10)

Intermediate Stage (Years 5 - 7)	Final Stage (Years 8 - 10)	
AWOS Units To Complement GPS Approach Category 3, 4 and 5 Airports (Table 11-2)	AWOS Units To Complement GPS Approach Category 6 And 7 Airports (Table 11-3) And For Weather Movement Coverage	Upgrade AWOS-3 Units To AWOS-4 Capability
Phoenix - Goodyear	Memorial Airfield	Lauglin / Bullhead International
Cochise College	Tuba City	Avi Suquilla
Buckeye Municipal	Temple Bar	Payson
Stellar Airpark	Chinle	Wickenburg Municipal
Gila Bend Municipal	Marble Canyon	Show Low Municipal
Kayenta	San Manuel	Gila Bend Municipal
	Sells	Cochise County
	Grand Canyon Caverns	Chinle
	Polacca	Tuba City
	Dateland (non - airport location)	Globe - San Carlos Regional
	Tuweep	Colorado City Municipal
	H.A. Clark Memorial	Sells
		Grand Canyon Caverns
		H.A. Clark Memorial
		Polacca
		Dateland (non- airport location)

See Appendix A for acronym definitions.

Sources: Table 11-2 and Table 11-3.

GCO Facilities

The provision of a GCO at the relatively more active airports that are not presently served with a federal facility can result in early and positive benefits. The technology is readily available for establishment and the cost manageable as a block purchase. Consequently, the establishment of GCO facilities at all eligible airports is recommended in the initial staging period.

Establishment and Operating Costs

Table 11-6 presents a summary of the unit establishment costs for each principal development improvement. These costs can then be summed to derive the total costs for each staging period as presented in Table 11-7 which also includes allowances for maintenance and facility replacement costs as discussed in the sections below. For the purposes of this evaluation, it was considered that the WAAS is established by the FAA during the intermediate staging period and that the VISAIDS would be installed throughout the course of the staging periods in nearly equal budget allocations. Table 11-8 allocates the total costs by airport.

Maintenance Costs

Maintenance costs center on those capital improvements associated with the approach lighting system and weather facilities. GPS instrument approaches do not require maintenance by the State or local airport with the exception of normal operating costs associated with the runway and its edge lighting. VISAID and GCO facilities are also not subject to significant maintenance costs.

Unit maintenance costs for an AWOS-3 are $4,000 per year; an AWOS-A will require an average annual outlay of $700. The AWOS-4 annual maintenance cost should approximate $5,000. Annual maintenance costs for a MALSR are about $9,000 and for a SSALS approximately $5,400. Maintenance costs were assigned to the required 28 new AWOS-3, 13 AWOS-A units 16 AWOS-3 units to be upgraded to an AWOS-4 capability. Maintenance responsibilities for the existing 8 AWOS-3 units continue with the local airport sponsor unless the unit is recommended for upgrade. This situation arises only for the AWSO-3 currently installed at Colorado City Municipal.

Replacement Costs

The State/local responsibility for the improvements presented in this study extends beyond establishment and maintenance functions. As new technological applications arise and equipment ages, a fund should be established (sinking fund) to replace previously installed facilities. The sinking fund is best suited to those improvements with a life span of about 10 years. This would include the AWOS, GCO, Weather Center hardware and software, and airport PC facilities.

Replacement costs can be based on an amortization schedule of 10 years at an interest rate of 7 percent. These funds are set aside by the State/local airport sponsor and do not provide for federal funding participation in eligible items. This is a conservative approach to facility resource funding management because the future availability of federal funds in terms of an aid to airports program is questionable, or the priority of these projects may be insufficiently low to preclude such participation. On this basis, the annual funding requirement for the 28 AWOS-3 units, 8 existing non-federal AWOS-3 units, 13 AWOS-A units, 12 GCO facilities, the Weather Center hardware/software and 36 airport PCs are as previously presented in Table 11-7.

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Table 11-6

UNIT ESTABLISHMENT AND ANNUAL MAINTENANCE COSTS

Facility Improvement	Costs ($) Establishment	Annual Maintenance
GPS - Related Facilities		
MALSR	250,000	9,000
SSALS	150,000	5,400
Weather Facilites		
AWOS-A	10,000	700
AWOS-3	75,000	4,000
AWOS-3 to AWOS-4 Upgrade	100,000	5,000
Airport PC to DUATS / OASIS	1,500	NIL
Weather Server	50,000	NIL
Weather Center Software	100,000	NIL
VISAIDS		
Wind Indicator	2,000	NIL
Segmented Circle	5,000	NIL
Medium Intensity Rotating Beacon	10,000	NIL
Runway Reflectors (per 1,000 feet)	1,000	NIL
Visual Guidance Indicator	20,000	NIL
Pilot Controlled Lighting	3,000	NIL
Medium Intensity Runway Edge Lighting (per 1,000 feet)	6,000 + 10,000 for regulator	NIL
Communications		
GCO	12,000	NIL

See Appendix A for acronym definitions.
Source: QED.

Table 11-7

STAGED ESTABLISHMENT AND ANNUAL COSTS

Expense Category		Establishment Cost ($)		
Establishment Cost for Facilities	Total	Initial Stage	Intermediate Stage	Final Stage
MALSR	2,750,000	0	2,000,000	750,000
SSALS	150,000	150,000	0	0
AWOS-A	130,000	90,000	10,000	30,000
AWOS-3	2,100,000	1,050,000	375,000	675,000
AWOS-3 to AWOS-4 Upgrade	1,600,000	0	0	1,600,000
Weather Center	204,000 [1]	204,000	0	0
VISAIDS	2,463,000	821,000	821,000	821,000
GCO	132,000	132,000	0	0
Total	9,529,000	2,447,000	3,206,000	3,876,000
Category I ILS or TLS (Optional)	2,000,000	2,000,000	0	0
Annual Maintenance[2]				
MALSR	99,000	0	72,000	99,000
SSALS	5,400	5,400	5,400	5,400
AWOS-A	9,100	6,300	7,000	9,100
AWOS-3	112,000 / 48,000[3]	56,000	76,000	48,000
AWOS-4	0 / 80,000	0	0	80,000
Total	225,500 / 241,500	67,700	160,400	241,500
Annual Operating				
NADIN Data Entry	10,000	10,000	10,000	10,000
Telecommunications	25,900	15,800	19,500	25,900
Total	35,900	25,800	29,500	35,900
Annual Replacement Fund				
AWOS	402,900	402,900	402,900	402,900
Weather Center (Public or Private)	29,100	29,100	29,100	29,100
GCO	18,800	18,800	18,800	18,800
Total	450,800	450,800	450,800	450,800
Total Establishment Cost Without Optional Facilities	9,529,000	2,447,000	3,206,000	3,876,000
Total Establishment Cost With Optional Facilities	11,529,000	4,447,000	3,206,000	3,876,000
Total Annual Cost	712,200 / 728,200	544,300	640,700	728,200

See Appendix A for acronym definitions.

Notes: 1. Reflects either public or private sector development cost.
2. Intermediate and final stages reflect cumulative annual maintenance costs.
3. Reduction in total expenses due to the upgrade of 16 AWOS-3 units to AWOS-4 capability.

Sources: Table 11-1, Table 11-2, Table 11-3, Table 11-4, Table 11-5 and Table 11-6.

Table 11-8

SYSTEM AIRPORT FACILITY ESTABLISHMENT COSTS

Airport	Airport Roles	Establishment Cost ($) MALSR / SSALS[1]	AWOS[2]	AWOS-3 Upgrade[3]	VISAIDS[4]	GCO[5]	Total
Ajo Municipal	GA - P	0	75,000	0	0	0	75,000
Ak-Chin Community	GA - S	0	0	0	65,700	0	65,700
Avi Suquilla	GA - P	0	75,000	100,000	0	12,000	187,000
Avra Valley	RL - P	250,000	0	0	0	12,000	262,000
Bagdad	GA - P	0	75,000	0	28,000	0	103,000
Benson Municipal (New)	GA - P	0	0	0	0	0	0
Bisbee Douglas International	GA - P	0	10,000	0	0	0	10,000
Bisbee Municipal	GA - P	0	0	0	0	0	0
Bowie	GA - S	0	0	0	28,900	0	28,900
Buckeye Municipal	GA - P	0	75,000	0	8,000	0	83,000
Casa Grande Municipal	GA - P	0	0	0	3,000	12,000	15,000
Chandler Municipal	RL - P	250,000	0	0	0	12,000	262,000
Chinle	GA - S	0	75,000	100,000	73,200	0	248,200
Cliff Dwellers Lodge	GA - S	0	0	0	55,900	0	55,900
Cochise College	GA - P	0	75,000	0	3,000	12,000	90,000
Cochise County	GA - P	0	75,000	100,000	3,000	0	178,000
Colorado City Municipal	GA - P	0	0	100,000	0	0	100,000

Table 11-8

SYSTEM AIRPORT FACILITY ESTABLISHMENT COSTS

Airport	Airport Roles	MALSR / SSALS[1]	Establishment Cost ($) AWOS[2]	AWOS-3 Upgrade[3]	VISAIDS[4]	GCO[5]	Total
Coolidge Municipal	GA - P	0	10,000	0	0	0	10,000
Cordes Lake (New)	GA - P	0	10,000	0	0	0	10,000
Cottonwood Municipal	GA - P	0	75,000	0	0	12,000	87,000
Douglas Municipal	GA - P	0	10,000	0	0	0	10,000
Duncan-O'Connor Field (Closed)	GA - S	0	0	0	29,000	0	29,000
Eloy Municipal	GA - P	0	75,000	0	23,000	12,000	110,000
Ernest A. Love Field	CS - P	0	0	0	0	0	0
Estrella Sailport	GA - P	0	0	0	22,500	0	22,500
Flagstaff-Pulliam	CS - P	0	0	0	0	0	0
Flying J Ranch	GA - S	0	0	0	65,500	0	65,500
Ganado	GA - S	0	0	0	71,000	0	71,000
Gila Bend Municipal	GA - P	0	75,000	100,000	20,000	0	195,000
Glendale Municipal	RL - P	150,000	10,000	0	0	0	160,000
Globe-San Carlos Regional	GA - P	0	75,000	100,000	0	0	175,000
Grand Canyon Bar-Ten	GA - S	0	0	0	31,600	0	31,600
Grand Canyon Caverns	GA - S	0	75,000	100,000	78,600	0	253,600

Table 11-8

SYSTEM AIRPORT FACILITY ESTABLISHMENT COSTS

Airport	Airport Roles	Establishment Cost ($) MALSR / SSALS[1]	AWOS[2]	AWOS-3 Upgrade[3]	VISAIDS[4]	GCO[5]	Total
Grand Canyon National Park	CS - P	0	0	0	0	0	0
Grand Canyon West	GA - S	0	10,000	0	76,000	0	86,000
Greasewood (Closed)	GA - S	0	0	0	78,200	0	78,200
Greenlee County	GA - P	0	10,000	0	25,000	0	35,000
H.A. Clark Memorial Field	GA - P	0	75,000	100,000	20,000	0	195,000
Holbrook Municipal	GA - P	0	0	0	0	0	0
Hualapai Tribal	GA - S	0	0	0	73,200	0	73,200
Kayenta	GA - P	0	75,000	0	23,000	0	98,000
Kearny	GA - S	0	0	0	22,900	0	22,900
Kingman	CS - P	0	0	0	3,000	0	3,000
Lake Havasu City Municipal	CS - P	250,000	0	0	0	12,000	262,000
Laughlin/Bullhead International	CS - P	250,000	75,000	100,000	0	12,000	437,000
Libby AAF/Sierra Vista	GA - P	250,000	0	0	0	0	250,000
Low Mountain (Closed)	GA - S	0	0	0	61,100	0	61,100
Lukachukai	GA - S	0	0	0	70,100	0	70,100
Marble Canyon	GA - S	0	10,000	0	65,700	0	75,700

Table 11-8

SYSTEM AIRPORT FACILITY ESTABLISHMENT COSTS

Airport	Airport Roles	Establishment Cost ($) MALSR / SSALS[1]	AWOS[2]	AWOS-3 Upgrade[3]	VISAIDS[4]	GCO[5]	Total
Memorial Airfield	GA - S	0	10,000	0	74,200	12,000	96,200
Mesa-Falcon Field	RL - P	250,000	75,000	0	0	0	325,000
Nogales International	GA - P	0	0	0	79,100	0	79,100
Page Municipal	CS - P	250,000	0	0	0	0	250,000
Payson	GA - P	0	75,000	100,000	3,000	0	178,000
Pearce Ferry	GA - S	0	0	0	60,600	0	60,600
Phoenix-Deer Valley	RL - P	250,000	0	0	0	0	250,000
Phoenix-Goodyear	RL - P	250,000	75,000	0	0	0	325,000
Phoenix Sky Harbor International	CS - P	0	0	0	0	0	0
Pinal Airpark	GA - P	0	10,000	0	23,000	0	33,000
Pine Springs	GA - S	0	0	0	71,700	0	71,700
Pinon	GA - S	0	0	0	69,200	0	69,200
Pleasant Valley International	GA - S	0	0	0	66,700	0	66,700
Polacca	GA - S	0	75,000	100,000	38,000	0	213,000
Quartzsite (New)	GA - P	0	10,000	0	0	0	10,000
Rock Point	GA - S	0	0	0	72,800	0	72,800

Table 11-8

SYSTEM AIRPORT FACILITY ESTABLISHMENT COSTS

Airport	Airport Roles	Establishment Cost ($) MALSR / SSALS[1]	AWOS[2]	AWOS-3 Upgrade[3]	VISAIDS[4]	GCO[5]	Total
Rocky Ridge	GA - S	0	0	0	63,000	0	63,000
Rolle Airfield	GA - S	0	0	0	59,800	0	59,800
Ryan Airfield	RL - P	0	0	0	3,000	0	3,000
Safford Regional	GA - P	0	0	0	3,000	0	3,000
San Carlos	GA - S	0	0	0	32,300	0	32,300
San Manuel	GA - S	0	10,000	0	0	0	10,000
Scottsdale	RL - P	250,000	0	0	0	0	250,000
Sedona	GA - P	0	0	0	0	0	0
Seligman	GA - S	0	0	0	29,500	0	29,500
Sells	GA - S	0	75,000	100,000	83,000	0	258,000
Shonto	GA - S	0	0	0	71,000	0	71,000
Show Low Municipal	CS - P	250,000	75,000	100,000	0	0	425,000
Springerville Babbit Field	GA - P	0	75,000	0	0	0	75,000
St. Johns Industrial Airpark	GA - P	0	0	0	0	0	0
Stellar Airpark	GA - P	0	10,000	0	42,000	12,000	64,000
Sun Valley	GA - S	0	0	0	62,200	0	62,200

Table 11-8

SYSTEM AIRPORT FACILITY ESTABLISHMENT COSTS

Airport	Airport Roles	Establishment Cost ($) MALSR / SSALS[1]	AWOS[2]	AWOS-3 Upgrade[3]	VISAIDS[4]	GCO[5]	Total
Superior Municipal	GA - S	0	0	0	28,500	0	28,500
Taylor Municipal	GA - P	0	0	0	0	0	0
Temple Bar	GA - S	0	75,000	0	64,000	0	139,000
Tombstone Municipal	GA - S	0	0	0	75,700	0	75,700
Toyei School (Closed)	GA - S	0	0	0	75,200	0	75,200
Tuba City	GA - P	0	75,000	100,000	3,000	0	178,000
Tucson International	CS - P	0	0	0	0	0	0
Tuweep	GA - S	0	75,000	0	28,400	0	103,400
Whiteriver	GA - P	0	0	0	25,000	0	25,000
Wickenburg Municipal	GA - P	0	75,000	100,000	0	0	175,000
Williams Gateway	RL - P	0	75,000	0	8,000	0	83,000
Window Rock	GA - P	0	0	0	0	0	0
Winslow Municipal	GA - P	0	0	0	0	0	0
Dateland (non-airport)	Not Apl	0	75,000	100,000	0	0	175,000

Table 11-8

SYSTEM AIRPORT FACILITY ESTABLISHMENT COSTS

Airport	Airport Roles	Establishment Cost ($)					
		MALSR / SSALS[1]	AWOS[2]	AWOS-3 Upgrade[3]	VISAIDS[4]	GCO[5]	Total
GPS / AWOS / VISAID / GCO Total		2,900,000	2,230,000	1,600,000	2,463,000	132,000	9,325,000
Weather Network							204,000
Category I ILS or TLS Optional Installation[6]							2,000,000
System Total Without Optional ILS or TLS Facilities							9,529,000
System Total With Optional ILS or TLS Facilities							11,529,000

Note: See Appendix A for acronym definitions.

Sources:
1. Table 5-6 and Table 11-7.
2. Table 7-3 and Table 11-7.
3. Chapter 7 and Table 11-7.
4. Table 6-2 and Table 11-7.
5. Chapter 8 and Table 11-7.
6. Chapter 11 (Kingman, Lake Havasu City, Laughlin / Bullhead nd Show Low)

Funding Options

Certain of the capital improvements recommended in this study may be eligible for funding under the FAA AIP. Federal participation for eligible projects was estimated at 91.06 percent of the establishment cost. Such funding would apply to all the facilities except those associated with the Weather Center, representing an investment of $204,000, and the optional establishment of Category I ILS or transponder landing system facilities at 4 airports at a total cost of $2,000,000. The latter costs are assigned in total to the State. However, due to limited federal funding levels, participation for eligible items may not be viable and possibly not without long lead times. Consequently, the allocation of establishment costs among the federal, state and local airport sponsor/owner entities is presented for three scenarios as shown in Table 11-9.

Table 11-10 presents possible ranges of federal, State and local sponsor financial requirements to establish the required facilities based on the data presented in Table 11-8 and Table 11-9.

ADOT Aeronautics derives revenues from several principal sources. These include flight property taxes, aviation avgas fuel taxes, aircraft lieu taxes and aircraft registration fees. Of these, the flight property tax assessed on the value of scheduled airline aircraft has, over the past 5 years, represented about 80 percent of all revenues. In fiscal year 1997, total revenues were slightly more than $23.1 million and represented an increase of nearly 60 percent from the level received in fiscal year 1993. Over the past 5 years, revenues have averaged some $18.7 million.

Revenues are used to offset the administrative expenses of the ADOT Aeronautics which over the past 5 years has averaged about $740,000 and airport development grants which accounted for an investment of some $10,270,000 on average. The latter are used to match federal grants for eligible projects, or to fund improvements that are not otherwise federally-eligible but meet State eligibility requirements and satisfy airport and aviation system needs.

Through fiscal year 1997, expenditures have kept pace with revenues although a moderate reserve was accrued. Future budgets for ADOT Aeronautics through fiscal year 2003 reflect a spend-down of the accumulated reserve, however, the values reflect outlays for capital development consistent with previous years' levels, averaging nearly $18.5 million annually.

The financial requirement of the State to establish the facilities recommended in this study could range from about $2.8 million to $10.8 million over a 10-year period. Assuming that no federal funding participation is received, as represented by funding Scenario 3 in Table 11-10, the required investment averages slightly more than $1 million per year. This sum represents about five percent of the average annual revenues in past years and, on surface, appears to be financially viable. As always, the investment in required facilities to serve the aviation public is competitive. Because the facility requirements presented in this study have been based on technical needs and tests of economic justification, their competitive advantage is enhanced and support for their establishment is strengthened.

Maintenance Costs

The on-going need to fund annual maintenance and operating expenses for the facilities and their replacement fund represents an additional expense item to be borne by the local airport owner/operator and the State. Those annual costs related to approach lighting systems, AWOS and GCO facilities are best allocated to the local airport owner/operator and account for $663,200. The State's annual costs to maintain, operate and provide replacement funds for the NADIN data entry, telecommunications and Weather Center are $65,000. Upon the upgrade of 16 AWOS-3 units to AWOS-4 capability, the annual costs for these units would shift to the State.

Telecommunications Costs

The primary telecommunications costs include the local telephone number and modem line to each AWOS location ($360 annually) for connection to the TRANSNET or Project EAGLE facilities. It is assumed that no charges will be assessed to transmit data over these State communications networks and facilities. There is an annual allowance of $10,000 for the vendor interface to NADIN. At each airport equipped with an AWOS-3, the telephone number and modem connection to DUATS/OASIS will incur an annual cost of $360.

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Table 11-9

FUNDING PARTICIPATION SCENARIOS

Airport System Role	Distribution Applicable to	Scenario 1 Funding Distribution (percent)			
		Federal	State	Local	Total
Commercial Service	All	91.06	4.47	4.47	100.00
Reliever	All	91.06	4.47	4.47	100.00
General Aviation	All	91.06	4.47	4.47	100.00
Non-Airport Location	All	0.00	100.00	0.00	100.00
Weather Center Facilities	All	0.00	100.00	0.00	100.00
Category I ILS or TLS (Optional)	All	0.00	100.00	0.00	100.00

Airport System Role	Distribution Applicable to	Scenario 2 Funding Distribution (percent)			
		Federal	State	Local	Total
Commercial Service	All	91.06	4.47	4.47	100.00
Reliever	50%	91.06	4.47	4.47	100.00
Reliever	50%	0.00	90.00	10.00	100.00
General Aviation - Primary	All	0.00	90.00	10.00	100.00
General Aviation - Secondary	All	0.00	95.00	5.00	100.00
Non-Airport Location	All	0.00	100.00	0.00	100.00
Weather Center Facilities	All	0.00	100.00	0.00	100.00
Category I ILS or TLS (Optional)	All	0.00	100.00	0.00	100.00

Airport System Role	Distribution Applicable to	Scenario 3 Funding Distribution (percent)			
		Federal	State	Local	Total
Commercial Service	All	0.00	90.00	10.00	100.00
Reliever	All	0.00	90.00	10.00	100.00
General Aviation - Primary	All	0.00	90.00	10.00	100.00
General Aviation - Secondary	All	0.00	95.00	5.00	100.00
Non-Airport Location	All	0.00	100.00	0.00	100.00
Weather Center Facilities	All	0.00	100.00	0.00	100.00
Category I ILS or TLS (Optional)	All	0.00	100.00	0.00	100.00

See Appendix A for acronym definitions.

Source: QED.

Table 11-10

ESTABLISHMENT FUNDING SOURCES SCENARIOS

Airport System Role	Distribution Applicable to	Scenario 1 Funding Distribution ($) Federal	State	Local	Total
Commercial Service	All	1,258,449	61,775	61,775	1,382,000
Reliever	All	1,743,799	85,601	85,601	1,915,000
General Aviation	All	5,329,742	261,629	261,629	5,853,000
Non-Airport Location	All	0	175,000	0	175,000
Weather Center Facilities	All	0	204,000	0	204,000
Category I ILS or TLS (Optional)	All	0	2,000,000	0	2,000,000
Total		8,331,990	2,788,005	409,005	11,529,000

Airport System Role	Distribution Applicable to	Scenario 2 Funding Distribution ($) Federal	State	Local	Total
Commercial Service	All	1,258,449	61,775	61,775	1,382,000
Reliever	50%	871,900	42,800	42,800	957,500
Reliever	50%	0	861,750	95,750	957,500
General Aviation - Primary	All	0	2,700,720	300,080	3,000,800
General Aviation - Secondary	All	0	2,709,590	142,610	2,852,200
Non-Airport Location	All	0	175,000	0	175,000
Weather Center Facilities	All	0	204,000	0	204,000
Category I ILS or TLS (Optional)	All	0	2,000,000	0	2,000,000
Total		2,130,349	8,755,636	643,016	11,529,000

Airport System Role	Distribution Applicable to	Scenario 3 Funding Distribution (percent) Federal	State	Local	Total
Commercial Service	All	0	1,243,800	138,200	1,382,000
Reliever	All	0	1,723,500	191,500	1,915,000
General Aviation - Primary	All	0	2,700,720	300,080	3,000,800
General Aviation - Secondary	All	0	2,709,590	142,610	2,852,200
Non-Airport Location	All	0	175,000	0	175,000
Weather Center Facilities	All	0	204,000	0	204,000
Category I ILS or TLS (Optional)	All	0	2,000,000	0	2,000,000
Total		0	10,756,610	772,390	11,529,000

See Appendix A for acronym definitions.

Note: State and grand totals in each scenario are each reduced by $2,000,000 if optional Category I ILS or TLS facilities are not established.

Sources: Table 11-8 and Table 11-9.

State Versus Contract Management

The State does not presently have the technical manpower to install, monitor, operate or maintain the approach lighting systems and AWOS facilities. To provide for this capability, the State would need to hire new staff experienced in the field of electronics and certified by the FAA on each type of facility. Alternatively, the State could procure the required professional services and provide overall program management direction. The appropriate course of action essentially involves a policy decision by State government. This decision making process must also consider the element of liability and the degree of risk the State wishes to assume. Generally, the cost to provide a total in-house capability should be about 15 percent less than the use of contract services, exclusive of the State's cost to hire, train and administer these new personnel. Therefore, when all costs are considered, the difference between an in-house capability and contract services is substantially narrowed. The use of contract services provides the State with a reduced liability exposure. Because there is a large source of experienced personnel in the private sector within the State, and in view of the potential liability exposure, contract services are preferable.

This reasoning can be extended to the individual airport sponsor/owner. This party, through acceptance of an approach lighting system and/or AWOS unit established with full or partial State funding, will be required to effect a maintenance program for the facility. When the elements of cost and liability are reviewed by the sponsor, it is likely that the procurement of a qualified outside service for the maintenance function will also be elected. Therefore, there exists a situation wherein the State can serve in a program management role to organize a contractor service to maintain all equipment established. This arrangement provides the benefits of economies of scale, continuity in the means and procedures followed to effect the maintenance and monitoring functions, and an ability to minimize startup and commissioning time. Further, the contractor can establish a statewide program involving such management issues as hiring, training, administration, spare parts management, record keeping, and interface with the FAA through non-federal certification procedures. Consequently, it is suggested that the State establish a contract service for the approach lighting systems and AWOS units. This conclusion then leads to the consideration of whether it is better to procure the services of a single contractor or multiple contractors. Further, there may be a need to separate the contractor function by geographic region and/or skill specialty.

The single contractor provides the opportunity for more efficient coordination and reduced administrative expenses. However, there may not be a sufficient number of such single-source capability contractors spanning the range of technology requirements. Consequently, contractual costs may be higher due to

the reduced competitive environment. The use of multiple contractors incorporates additional coordination and administrative requirements on the State. This would occur for awards based on a geographic region or specialty basis. However, the contractual cost could be reduced because of shorter travel distances involved to service the facilities in the case of a geographic distribution, or because highly specialized skills may be procured at a lower rate due to the efficiency with which these individuals perform their work.

Ultimately, the marketplace will establish the most effective means to acquire the contractual services. The State should announce its requirements to monitor and maintain the facilities and allow the respondent to formulate an appropriate proposal. The State should be willing to entertain all proposals that address its specified needs. It must be emphasized that the provision of contract services be in accordance with standards and procedures developed by the FAA for each specific type of equipment.

Public Versus Private Funding Participation

This section seeks to identify potential public versus private sector solutions to establish and maintain certain of the capital improvements recommended in this study. In order to promote private sector participation to establish and maintain facilities, there needs to be a means to generate revenue from such activities. Consequently, only those facilities associated with the collection and dissemination of weather data, products and services lend themselves to such a situation. This would apply to the AWOS units, Weather Center, on-airport PC and telecommunications facilities. There is also the opportunity to consider a public/private partnership arrangement due to the existing and planned improvement of telecommunications facilities by the State. The advantages and disadvantages for each avenue of action are summarized in Table 11-11 through Table 11-13 and discussed below.

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Table 11-11

WEATHER CENTER ORGANIZATION
PUBLIC SECTOR OPTION

Advantages	Disadvantages
1. Total control by State.	1. Diverts limited public funds from other potential projects.
2. Eligible to receive federal funding.	2. Requires training of staff to operate and maintain Weather Center equipment and facilities.
3. Contributes to multimodal response from within Arizona DOT.	3. State not accustomed to commercialization role.
4. Enhances working relationship with other State agencies.	
5. Opportunity for commercialization of travel information and advertising.	
6. Potential for ITS demonstration program.	

Source: QED.

Table 11-12

WEATHER CENTER ORGANIZATION
PRIVATE SECTOR OPTION

Advantages	Disadvantages
1. State receives required services per contractual agreement.	1. Control by State limited by contractual agreement.
2. Provides own staff and training to operate, maintain and replace Weather Center equipment and facilities.	2. Requires preparation of a contract without comparable precedent and State oversight.
3. Contributes to multimodal response.	3. Not eligible for federal funding participation.
4. Utilizes State telecommunications network.	4. Net cost to State could exceed Public Sector option.
5. Costs must be offset by commercialization of travel information and advertising; familiar activities for the private sector.	5. Success predicated on untested market demand.
6. Trial program possible.	6. Failure of private sector could necessitate State takeover.
	7. Eliminates potential for synergy among State agencies to solve mutual objectives.
	8. State telecommunications network requires protection from unauthorized access.

Source: QED.

Table 11-13

WEATHER CENTER ORGANIZATION
PUBLIC / PRIVATE PARTNERSHIP OPTION

Advantages	Disadvantages
1. State receives required services per contractual agreement.	1. Control by State limited by contractual agreement.
2. Eligible to receive federal funding participation.	2. Requires preparation of a contract without comparable precedent and State oversight.
3. Contributes to multimodal response.	3. Net cost to State could exceed Public Sector option.
4. Each partner contributes within area of control / specialization / capability to establish, operate, maintain and replace Weather Center.	4. Success predicated on untested market demand.
5. Costs can be offset by commercialization of travel information and advertising.	5. Failure of private sector could necessitate State takeover.
6. Potential for intelligent transportation system demonstration program.	6. State telecommunications network requires protection from unauthorized use.
7. Trial program possible.	

Source: QED.

Public Sector

The Weather Center serves not only the specific needs related to aviation system users, but also has applicability to a wide range of public and private sector entities throughout the State including the general public. The wide appeal of real-time weather data and value-added products and services speaks to the rationale for establishing the Weather Center through a central agency within State government. Possible entities to serve in this role are the Arizona departments of Agriculture, Commerce, Public Safety or Transportation and Arizona State University. Direct funding of any of these agencies to collect and disseminate the raw data as well as generate user-specific weather products and services presents a straight forward and logical extension of providing a public service. These or other State agencies could assist in the maintenance of the facilities and in the provision of the required telecommunications equipment. Internal State accounting practices could be utilized to track the allocation and use of funds. However, the public sector option is essentially a program funded by the State and, indirectly, through the collection of taxes imposed on its citizens and businesses operating in the State. The imposition of user fees or charges to offset all or a portion of the costs to establish, operate and maintain the Weather Center could be another means to raise the required capital. These options are a continuation of the traditional means of government responding to the needs of the public and allows for total control by the State.

Thus, the public sector option represents the scenario wherein a State agency, perhaps in cooperation with other State agencies, operates the Weather Center in such a manner as to provide users with the products and services they require to support their operations. These costs are expected to be outweighed by the gains in mobility, productivity and enhanced safety that are achieved by the users of the Weather Center.

Private Sector

As described in a previous section, the State could elect to contract out the establishment and operation of the Weather Center to the private sector. This action requires the careful preparation of bid documents including performance standards. The proposal request should allow for the private sector respondents to be creative and innovative in proposing potential solutions. The contract between the State and the private sector entity would establish the extent of control that could be exercised by the State.

Under this option, the entire facilities cost of the Weather Center, with the exception of the telecommunications network, is borne by the private sector inasmuch as federal funding for eligible components would not apply. Communications costs would likely continue to be made the responsibility of the State so that the private sector entity can utilize the extensive Statewide TRANSNET and Project EAGLE telecommunications network. State control over the telecommunications facilities also maintains security over the sensitive data and communications transmitted on the network. The private sector would recover its investment and allowance for profit by charging user fees or a subscription to those public and private sector entities requesting the information.

There are limited examples of the market for the sale of weather data. The "Weather Channel", a television program, provides continuous weather data on a nationwide, regional and local basis for subscribers to a cable television operator. Additional services are available for a fee based on the time length of a telephone call to a specific "Weather Channel" number. In the absence of revenue and cost data, one may assume that the service is profitable otherwise it would not be offered. Similar call-for-weather information services exist, but market data is held proprietary.

The cost to the private sector entity could be reduced by selling advertising space on the Weather Center. For example, each call for information would be greeted by a recording, or graphic display if by computer access, of an advertising announcement. Kiosk displays, strategically positioned in high traffic areas for use by the traveling public, could be used to include information on local area facilities (restaurants, hotels, attractions) each of which would pay a fee for this exposure.

Because State agencies would be contracting to receive certain weather data and value-added products and services (or obtain this information at no charge in return for providing the private sector entity with access to the State-maintained telecommunications network), the availability of such data in a State file could be construed as public information. This could dilute the potential market for the private sector by those interested in historical data, for example, and thus the contract between the State and the private sector entity would need to specify how this matter is to be resolved.

The use of the private sector is not necessarily the least costly option to the State inasmuch as it, together with other users, are paying indirectly to cover the costs of the Weather Center and an allowance for profit. Failure on the part of the private sector to perform could require the State to assume total control and financial responsibility, or provide operating subsidies over a period of time until the private sector entity reached a breakeven or marginal profit status.

The private sector has not enjoyed the benefit of learning from previous solicitations of this type because few have been offered by a governmental agency. Exploratory discussions with potential private sector entities should be conducted to gauge their level of interest and identify contractual terms that would present the potential for a "win-win" solution. These discussions could lead to a trial of the Weather Center concept limited to a regional application or an initial phase. This would test the feasibility of the concept and allow for fine-tuning of a longer term contract for expansion Statewide if the trial was found potentially viable. Additionally, a market research study could be funded by the State to identify the market and test the financial viability for commercialized real-time Weather Center products and services. Business faculty and student resources at Arizona State University or an outside market research firm could be utilized to conduct such a study.

Public/Private Partnership

This concept attempts to combine the benefits of a public-only and private-only establishment and operation of the Weather Center to meet individual objectives to achieve a common goal. The primary objective of the public sector is to employ the resources of the private sector to meet public operational needs. The private sector partner seeks to participate in a project activity that meets its strategic business objectives and provides a commensurate rate of return. This latter objective can be better achieved if certain costs can be reduced. For example, the private sector entity and/or State could fund the nonfederal share of the establishment costs of those components of the Weather Center. Given the planned extent and capabilities within the State telecommunications network, the State could accept responsibility for all communications costs. The private sector partner could be responsible for funding the operational costs including maintenance and facilities replacement and in the commercialization of the weather products and services. The role and responsibilities of each and ownership rights of the raw data collected and value-added products and services would be specified in the contract.

As in the case of the private sector-only concept, it may be prudent to consider a public/private partnership on a trial basis, perhaps as an intelligent transportation system (ITS) demonstration program, and after conducting market research and financial feasibility/commercial viability studies. In addition to taking advantage of potential federal funding participation, a trial public/private partnership would permit both parties to address not only the technical but the more abstract institutional challenges associated with the eventual deployment of a statewide weather network. Key institutional challenges relate to:

1. Lack of market information – The size of the market demand for these services by pubic and private sector entities. The public sector, aside from its own use of the weather data, is concerned about how this information will be used by the public and potential influences on travel behavior. The private sector is interested in these same issues from the marketing and level of service points of view, and equally focused on the economic return on its financial investment.

2. Inexperience in partnerships – Both the public and private sectors have limited experience in the formation and operation of partnerships to disseminate/commercialize travel information. The willingness of the private sector to enter into a partnership is affected by the extent to which the public sector recognizes the need to balance operating rights with market risk.

A trial program also indirectly provides input to the U.S. Department of Transportation in its role of facilitating the deployment of ITS technologies by the public and private sectors. This can lead to fundamental changes in the way transportation development has been conducted in the past throughout the country.

Appendix

A

GLOSSARY

AAF — **Auxiliary Airfield**
Usually an unmanned landing strip or runway with limited terminal area facilities developed by the Department of Defense to enable aircraft training activity.

ADAS — **AWOS/ASOS Data Acquisition System**
A FAA (see below) network linking certain AWOS and ASOS (see below) units to the controlling ARTCC (see below) for purposes of data acquisition and subsequent dissemination.

ADOT — **Arizona Department of Transportation**
An agency of the State of Arizona government responsible for the planning, design, construction and maintenance of transportation facilities.

ADS-B — **Automatic Dependent Surveillance Broadcast**
Aircraft transponder reports of aircraft position, based on GPS (see below) transmitted in air-to-air and air-to-ground modes.

AFOS — **Automation of Field Operations and Services**
A NWS system supporting forecast operations through data processing, analysis, storage and display capabilities. AFOS will be replaced by AWIPS (see below).

AFSS — **Automated Flight Service Station**
An air traffic facility which provides pilot briefing and en route communications; receives and processes flight plans; and offers other services to aviators. Some of these services are provided on an automated basis.

AIA	**Annual Instrument Approach** The number of instrument approaches conducted during a year. An instrument approach is an approach made to an airport by an aircraft on an IFR flight plan when the visibility is less than three statute miles or the ceiling is at or below the minimum initial approach altitude.
AIP	**Federal Aviation Administration Airport Improvement Program** A grant-in-aid program funded by the Airport and Airway Trust Fund.
ALS	**Approach Lighting System** A generic term used to describe a form of approach lighting system.
AMOS	**Automatic Meteorological Observing System** An on-site sensor suite that monitors surface weather parameters for transmission over ground lines to the controlling agency.
ARC	**Airport Reference Code** A coding system of aircraft approach speed and wingspan used to relate to operational and physical airport design standards.
ARSR	**Air Route Surveillance Radar** Radar system intended to detect and display the position of the aircraft in the en route air system. Coverage of the ARSR can extend up to a 200-mile radius.
ARTCC	**Air Route Traffic Control Center** A FAA facility established to provide air traffic control service to aircraft operating on IFR flight plans within controlled airspace and principally during the en route phase of flight.
ASOS	**Automated Surface Observing System** A joint NWS, FAA and DOD program providing for the automated generation of surface observations. The NWS is the lead agency.

ASR — **Airport Surveillance Radar**
Approach control radar used to detect and display an aircraft's position in the terminal area. Coverage of the ASR can extend up to a 60-mile radius.

ATCT — **Air Traffic Control Tower**
A facility at an airport operated by appropriate authority to promote the safe, orderly and expeditious flow of air traffic within the airport traffic area.

ATIS — **Automatic Terminal Information Service**
The continuous broadcast of recorded noncontrol information intended to improve controller effectiveness and relieve frequency congestion by automating the repetitive transmission of essential but routine information.

ATM — **Air Traffic Management**
A term to designate the control and use of airspace for navigation.

AWIPS — **Advanced Weather Interactive Processing System**
The replacement for AFOS (see above) intended to support frequency increases and quality improvements in terminal area routine and hazardous weather forecasting, nowcasting, and en route forecasting. AWIPS is supported by a network to realize improvements to interfacility and interagency communications.

AWOS — **Automated Weather Observing System**
A FAA program providing for the automated generation of surface observations. There are currently five levels of AWOS defined by the FAA -- A, 1, 2, 3 and 4. An AWOS-F is an AWOS-3 installed under the FAA F&E Program (see below).

BC — **Back Course**
A nonprecision instrument approach procedure that uses the back end of the localizer (see below) signal for lateral course guidance to the runway.

C	**Center** A suffix used to distinguish a specific runway end among parallel runways. For example, Runway 30C is assigned to identify the center Runway 30.
CAT I ILS	**Category I Instrument Landing System** A terminal navigational aid system that provides lateral, along-course and vertical guidance (collectively referred to as precision) to aircraft attempting to land. Category II ILS and Category III ILS are also designated and apply to approaches made during progressively poorer weather conditions. Runways served by Category II ILS or Category III ILS approaches also have additional facilities and meet higher operational and safety standards.
CSMA	**Carrier Sense Multiple Access** A form of radio communications technology.
CS-P	**Commercial Service - Primary** A classification of airport used in the Arizona aviation system.
CNS	**Communications/Navigation/Surveillance** A term used to denote principal components associated with an air traffic control/management system.
CTAF	**Common Traffic Advisory Frequency** A frequency designed for the purpose of carrying out airport advisory practices while operating to or from an uncontrolled airport. The CTAF may be a Unicom, Multicom, Flight Service Station or air traffic control tower frequency and is identified in appropriate aeronautical publications.
DFT	**Discrete Frequency Transmitter** A radio transmitter broadcasting at an assigned frequency channel.

DH — **Decision Height**
The lowest height above the highest runway elevation in the touchdown zone to which a precision instrument approach may be flown without visual contact with the runway end environment. If visual contact is made at the DH, the approach procedure may be continued. If visual contact is not achieved, a missed approach procedure must be initiated.

DME — **Distance Measure Equipment**
Equipment (airborne and ground) used to measure, in nautical miles, the slant range distance of an aircraft from the DME-equipped navigational aid.

DOD — **United States Department of Defense**

DOT — **Department of Transportation**
May refer to the United States DOT or may be preceded by the name of the state to which it is a governmental unit.

DUATS — **Direct User Access Terminal System**
A program offered by FAA-designated private industries to provide pre-flight weather and airport data, and flight plan filing services via personal computer. This is a free service; however, the private sector may offer value-added services and products for a fee.

EAGLE — **Project EAGLE**
A program to upgrade state and local government telecommunications capabilities within the State of Arizona.

EGNOS — **European Global Navigation Overlay System**
A system of geostationary satellites operated under the joint powers of European countries to provide augmentation to global positioning system signals. A European counterpart to the United States Wide Area Augmentation System.

F&E — **Facilities and Equipment Program**
A FAA program to install and maintain visual and terminal navigational aids, AWOS-3 and other facilities at public-use airports.

FAA	**Federal Aviation Administration** A branch of the United States Department of Transportation responsible for the aviation component of the nation's transportation infrastructure and safety.
FAR	**Federal Aviation Regulations** A series of regulations promulgated by the Federal Aviation Administration and codified by law to govern the use and control of the national airspace system, airports, pilots and those engaged in air commerce.
FBO	**Fixed Base Operator** A private sector enterprise providing fuel sales, aircraft sales and maintenance, flight instruction, charter and other services at an airport.
FCC	**Federal Communications Commission** A unit of federal government responsible for administering all aspects of voice, data and graphics communications in the United States including frequency spectrum allocation.
FCWOS	**Federal Contract Weather Observing Site** Location where the federal responsibility for taking manned weather observations by the FAA (see above) is contracted to the private sector or other government agency.
FSS	**Flight Service Station** The predecessor to the AFSS (see above) facility and remaining in current use.
GA-P	**General Aviation - Primary** A classification of airport used in the Arizona aviation system.
GA-S	**General Aviation - Secondary** A classification of airport used in the Arizona aviation system.
GCO	**Ground Communications Outlet** A device which facilitates radio communication between a remote air traffic control facility and the aircraft while on the ground.

GLONASS — **Global Orbiting Navigation Satellite System**
The Russian government global navigation satellite system based on the use of global positioning system technology.

GNSS — **Global Navigation Satellite System**
The general term for a satellite-based positioning system that is used for air navigation.

GPS — **Global Positioning System**
A satellite-based navigational system operated by the United States Department of Defense and made available for civilian use for en route navigation, aircraft instrument approaches and other purposes.

HAA — **Height Above Airport**
The height of the minimum descent altitude (MDA, see below) above the published airport elevation and designated as a component of the circling minimums.

HAT — **Height Above Touchdown**
The height of the decision height (DH, see above) or minimum descent altitude (MDA, see below) above the highest runway elevation in the touchdown zone published as a component of straight-in minimums.

HIRL — **High Intensity Runway Lights**
Runway edge lighting used to define the lateral limits of a runway. The intensity of the lights may be preset or controlled to high (HIRL), medium (MIRL) or low (LIRL) depending on the category of the airport and use of the runway.

HITL — **High Intensity Taxiway Lights**
Taxiway edge lighting used to define the lateral limits of a taxiway. The intensity of the lights may be preset or controlled to high (HITL), medium (MITL) and low (LITL).

HIWAS — **Hazardous Inflight Weather Advisory Service**
A recorded continuous broadcast of hazardous inflight weather conditions using the voice transmission capabilities of selected navigational aids.

IAP — **Instrument Approach Procedure**
A series of predetermined maneuvers for the orderly transfer of an aircraft under instrument flight conditions from the beginning of the initial approach to a landing or to a point from which a landing may be made visually.

ICAO — **International Civil Aviation Organization**
A specialized agency of the United Nations whose objective is to develop the principles and techniques for international air navigation and to foster planning and development of international civil air transport.

IFR — **Instrument Flight Rules**
Rules governing the procedures for conducting instrument flight. Also a term used by pilots and controllers to indicate type of flight plan.

ILS — **Instrument Landing System**
A precision instrument approach system that normally consists of the following electronic components and visual aids: localizer, glide slope, outer marker, middle marker and approach lights. Categories of ILS (I, II, IIIA, IIIB and IIIC) are defined for specific approach minimums (ceiling and runway visual range) and require compliance with airport landing surface and facility design standards.

ISDN — **Integrated Services Digital Network**
Communications links operating at T1 (1.544 mb/s) speed for the simultaneous transmission of voice, data and imagery products.

L — **Left**
A suffix used to distinguish a specific runway end among parallel runways. For example, Runway 30L is assigned to identify the left Runway 30.

LAAS — **Local Area Augmentation System**
A system of ground-based facilities providing differential corrections for GPS (see above) satellites and intended to support aviation navigation for the Category II/III precision approaches phases of flight.

LAWRS — **Limited Aviation Weather Reporting Station**
Airport locations at which the FAA or contractors take surface weather observations.

LLWAS — **Low-level Wind Shear Alert System**
Ground sensors that monitor conditions conducive to the formation of wind shear at low altitudes and transmit warnings to the air traffic control facility.

LDA — **Localizer-type Directional Aid**
A localizer (see below) facility used to provide nonprecision instrument approaches when the lateral course alignment is offset from the extended runway centerline by 3 degrees or less.

LIRL — **Low Intensity Runway Lights**
Runway edge lighting used to define the lateral limits of a runway. The intensity of the lights may be preset or controlled to high (HIRL), medium (MIRL) and low (LIRL) depending on the category of airport and use of the runway.

LITL — **Low Intensity Taxiway Lights**
Taxiway edge lighting used to define the lateral limits of a taxiway. The intensity of the lights may be preset or controlled to high (HITL), medium (MITL) and low (LITL) depending on the category of airport and use of the taxiway.

LOC — **Localizer**
The component of an ILS (see above) which provides lateral course guidance to the runway.

LORAN — **Long Range Navigation**
An electronic navigational system that determines positioning based on the time differential in receiving signals from two fixed transmitters. **Loran-C** is used for air navigation in the 100 kHz to 110 kHz frequency band.

MALSR — **Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights**
An approach lighting system generally used to support Category I ILS (see above) procedures and to assist pilots in identifying the runway end environment.

MAS — **Missed Approach Surface**
An imaginary sloping surface used to evaluate obstacles associated with missed approach procedures.

MASPS — **Minimum Aviation System Performance Standards**
Standards (United States) for navigational aids and receivers intended to meet RNP (see below) criteria.

MAWP — **Missed Approach Waypoint**
A waypoint used to designate the missed approach point and used for construction of the missed approach surface.

MDA — **Minimum Descent Altitude**
The lowest altitude, expressed in feet above mean sea level, to which descent is authorized on final approach or during circle-to-land maneuvering in execution of a standard instrument approach procedure where no electronic glide slope is provided.

METAR — **Meteorological Aviation Report**
Surface aviation weather observations taken and reported in a standard international format.

MIRL — **Medium Intensity Runway Lights**
Runway edge lighting used to define the lateral limits of a runway. The intensity of the lights may be fixed to high (HIRL), medium (MIRL) and low (LIRL) depending on the category of airport and use of the runway.

MITL — **Medium Intensity Taxiway Lights**
Taxiway edge lighting used to define the lateral limits of a taxiway. The intensity of the lights may be fixed to medium (MITL) and low (LITL) depending on the category of airport and use of the taxiway.

MLS — **Microwave Landing System**
A precision instrument approach system operating in the microwave spectrum that normally consists of an azimuth station, elevation station and precision distance measuring equipment. MLS categories are designated consistent with the approach minimums defined for instrument landing systems (ILS, see above) and provide an equivalent function with different technologies.

MSL — **Mean Sea Level**
A datum for defining elevations; usually termed as above mean sea level.

NADIN — **National Airspace Date Interchange Network**
A national network used to facilitate interfacility and interagency communications operated by the FAA.

NAVAID — **Navigational Aid**
Any visual or electronic device airborne or on the surface which provides point-to-point guidance information or position data to aircraft in flight.

NAWP — **National Aviation Weather Processor**
FAA facilities located in Atlanta, Georgia and Salt Lake City, Utah which house and otherwise support the weather message switching center replacements.

NDB — **Nondirectional Beacon**
A low/medium frequency (L/MF) ultrahigh frequency (UHF) radio beacon transmitting nondirectional signals whereby the pilot of an aircraft equipped with direction finding equipment can determine his/her bearing to or from the radio beacon and "home" on or track to or from the station.

NDB-A — **Nondirectional Beacon Circling Approach**
A designation for the use of an NDB (see above) to conduct a circling approach to a runway. Alternative procedures may be designated using the same NDB and these are identified by a hyphen and sequentially by letter in alphabetical order.

NEXCOM — **Next Generation Air/Ground Communications**
A FAA (see above) program to modernize air and ground communications capabilities with digital radios to transmit both voice and data.

NEXRAD — **Next Generation Weather Radar**
A Doppler weather radar to replace conventional weather radar. The NEXRAD program is jointly funded by the NWS, FAA and DOD.

NOAA — **National Oceanic and Atmospheric Administration**
An agency of the U.S. Department of Commerce responsible for the collection of weather data and its translation into products and services.

NOAAPORT — **National Oceanic and Atmospheric Administration Data Transmission System**
A communications system internal to the NOAA and external to others for the dissemination of NOAA data. NOAAPORT will eventually become a part of the AWIPS (see above) program.

n.m. — **Nautical Mile**
A unit of measurement typically used in aviation and water transportation. One nautical mile is equivalent to 6,076 feet.

NPIAS — **National Plan of Integrated Airport Systems**
A FAA plan intended to identify those airports within the United States that have national significance and are eligible to receive federal grants.

NWS — **National Weather Service**
An agency of the U. S. Department of Commerce and a branch of NOAA (see above) responsible for providing nationwide meteorological services to the public and nonmilitary government agencies.

NWSTG — **National Weather Service Telecommunications Gateway**
A communications gateway which provides access to the services and products available from the NWS (see above).

OASIS — **Operational and Supportability Implementation System**
A replacement for the AFSS (see above) infrastructure.

OCS — **Obstacle Clearance Surface**
An identification clearance surface associated with a glide path angle (precision approach).

OFZ — **Obstacle Free Zone**
The airspace defined as the runway OFZ and the inner approach OFZ, which is clear of object penetrations other than frangible NAVAIDS (see above).

PAPI — **Precision Approach Path Indicator**
A type of landing aid providing vertical visual guidance to aircraft during the approach to landing. Numbers following the acronym indicate the number of light units.

PC — **Personal Computer**
An electronic device that by means of stored instructions and information performs rapid, often complex calculations or compiles, correlates and selects data. The term personal is used to denote a device that is smaller in capacity and slower in operating speed than computer workstations and mainframes.

PCL — **Pilot Controlled Lighting**
A system of inflight radio communication that activates airfield lighting systems when the airport is unattended.

PVASI — **Pulsating Visual Approach Slope Indicator**
A type of landing aid providing vertical visual guidance to aircraft during the approach to landing. Numbers following the acronym indicate the number of light units.

R — **Right**
A suffix used to distinguish a specific runway end among parallel runways. For example, Runway 30R is assigned to identify the right Runway 30.

RAIM — **Remote Autonomous Integrity Monitoring**
A process which tests the validity of satellite-generated positioning data from several satellites to determine those which may best be used to compute true positioning.

RCF — **Remote Communications Facility**
An unmanned very high frequency/ultrahigh frequency (VHF/UHF) transmitter/receiver facility which is used to expand ARTCC (see above) air/ground communications coverage and to facilitate direct contact between pilots and controllers.

RCO — **Remote Communications Outlet**
An unmanned air/ground communications station remotely controlled, providing ultrahigh frequency (UHF) and very high frequency (VHF) transmit and receive capability to extend the service range of the AFSS/FSS.

REIL — **Runway End Identifier Lights**
Two synchronized flashing lights, one on each side of the runway threshold which provide rapid and positive identification of the approach end of particular runway.

RL-P — **Reliever Airport - Primary**
A classification of airport used in the Arizona aviation system.

RNAV — **Radio Navigation**
A method of navigation that permits aircraft operations on any desired course within the coverage of station-referenced navigation signals or within the limits of self-contained system capability.

RNP — **Required Navigation Performance**
International standards associated with the conduct of instrument flight procedures.

ROFA — **Runway Object Free Area**
An area on the ground centered on a runway and provided to enhance the safety of aircraft operations by having the area free of objects, except those needed to be located within this area for air navigation or aircraft ground maneuvering purposes. The dimensions of the area are dependent on the design classification of the critical aircraft operating on the runway and approach minimums.

RRCS — **Remote Radio Communication System**
A FAA communication facility used to activate visual landing aids from the aircraft while in flight.

RSA — **Runway Safety Area**
A defined surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot or excursion from the runway. The dimensions of the area are dependent on the design classification of the critical aircraft operating on the runway and approach minimums.

RTCA — **RTCA, Inc.**
Formerly, Radio Technical Commission for Aeronautics. A body of United States government and industry representatives developing standards for air navigation, communications and surveillance in accordance with international guidelines.

RTR — **Remote Transmitter/Receiver**
Term used for an RCF (see above).

R / W — **Runway**
A defined rectangular area on a land airport prepared for the landing and takeoff run of aircraft along its length.

RWIS — **Roadway Weather Information System**
A system of pavement, subsurface and meteorological sensors connected to a remote processing unit and used to detect, monitor and predict pavement conditions.

SANS — **1995 State Aviation Needs Study**
An aviation system plan prepared by ADOT Aeronautics.

SAVASI — **Simplified Abbreviated Visual Approach Slope Indicator**
A type of landing aid providing vertical visual guidance to aircraft during the approach to landing. Numbers following the acronym indicate the number of light units.

SAWRS — **Supplemental Aviation Weather Reporting Station**
Airport locations at which NWS-certified observers take weather observations to support their internal operations.

SCAT-I — **Special Category I**
A private use approach using differential GPS (see above) signals to conduct instrument approach procedures to minimums associated with Category I operations and authorized by the FAA (see above) for specific users under special terms and conditions.

SDF — **Simplified Directional Facility**
A localizer (see above) facility used to provide nonprecision instrument approaches when the lateral course alignment is offset from the extended runway centerline by more than 3 degrees but less than 30 degrees.

s.m. — **Statute Mile**
A unit of measurement used in ground transportation. One statute mile is equivalent to 5,280 feet.

SOC — **Systems Operations Center**
A NWS (see above) facility which is a component of the nationwide collection and dissemination of NWS data to public and private users.

SSALS — **Simplified Short Approach Lighting System**
A type of approach lighting system that is generally used to support nonprecision instrument approaches and to assist pilots in identifying the runway end environment.

TDMA — **Time Division Multiple Access**
A form of radio communications technology.

TDWR — **Terminal Doppler Weather Radar**
A Doppler weather radar installed in the airport terminal area to detect microbursts, gust fronts, wind shifts and precipitation. The deployment of TDWR is a FAA program.

TERPS — **Terminal Instrument Procedures**
A FAA manual that prescribes the methodology to design instrument approach procedures.

TIBS — **Telephone Information Briefing System**
A continuous telephone recording of meteorological and/or aeronautical information.

TLS — **Transponder Landing System**
Currently, a special category precision landing aid that utilizes a Mode A transponder to transmit and receive flight guidance information that is displayed on instrument landing system avionics.

TRANSNET — **Transportation Network**
The name of the telecommunications network utilized by the Arizona Department of Transportation for internal voice, data and imagery transmissions.

TSO — **Technical Service Order**
The means by which the FAA (see above) establishes performance specifications for equipment and facilities used in aeronautical purposes.

VAGI — **Visual Approach Guidance Indicator**
Generic term for any type of visual landing aid which assists the pilot in achieving a defined descent gradient to the landing runway end.

VASI — **Visual Approach Slope Indicator**
A type of landing aid providing vertical visual guidance to aircraft during the approach to landing. Numbers following the acronym indicate the number of light units.

VFR — **Visual Flight Rules**
Rules that govern the procedures for conducting flight under visual conditions. The term is also used by pilots and controllers to indicate a type of flight plan.

VHF — **Very High Frequency**
The frequency band between 30 and 300 MHz (mega hertz). Portions of this band, 108 to 118 MHz, are used for certain navigational aids; 118 to 136 MHz are used for civil air/ground voice communications. Other frequencies in this band are used for purposes not related to air traffic control.

VIS — **Visibility**
The component of published approach minimums expressed in units of distance, which prescribe the visibility required for the pilot to establish visual reference with the landing runway environment.

VISAID — **Visual Landing Aid**
Generic name for a variety of visual landing aids including those associated with visual and instrument approaches.

VOR — **Very High Frequency Omnidirectional Range Station**
A ground-based electronic navigation aid transmitting very high frequency navigation signals 360 degrees in azimuth, oriented from magnetic north and used as a basis for navigation in the national airspace system.

VOR-A — **Very High Frequency Omnidirectional Range Station Circling Approach**
A designation for the use of a VOR (see above) to conduct a circling approach to a runway. Alternative procedures may be designated using the same VOR and these are identified by a hyphen and sequentially by letter in alphabetical order.

VORTAC — **Very High Frequency Omnidirectional Range Station with Tactical Air Navigation**
A VOR (see above) which also provides continuous bearing and distance information to suitably equipped aircraft.

WAAS — **Wide Area Augmentation System**
A system of ground-based facilities providing differential corrections for GPS (see above) satellites and intended to support aviation navigation for the en route, terminal area, nonprecision and Category I precision approaches phases of flight.

WFO — **Weather Forecast Office**
The facility operated by the NWS (see above) that is responsible for generating weather forecasts for its assigned region.

WSCMO — **Weather Service Contract Meteorological Office**
Location where the federal responsibility for taking manned weather observations by the NWS (see above) is contracted to the private sector or other government agency.

WMSC — **Weather Message Switching Center**
Facilities located at the NAWP (see above) to transmit weather data to FAA air traffic control and AFSS/FSS (see above) locations.

WSO — **Weather Service Office**
Facilities operated by the NWS (see above) to collect and transmit weather data to the general public and internally.

WSR-88D — **Weather Service Doppler Radar, Model Year 1988**
A NWS (see above) model number for a particular Doppler radar.

Sources: **Airman's Information Manual, FAA**
United States Standard for Terminal Instrument Procedures (TERPS)
QED

Appendix

B

GENERAL AVIATION PILOT SURVEY

A survey of registered pilots in Arizona was conducted to obtain a profile of:

- Ratings
- Activity levels
- Other measures of aircraft usage
- Aircraft equipage
- Source and use of weather information data
- Assessment of airport facilities
- Assessment of services provided by airport operators and ADOT Aeronautics

The 500-sample survey distribution was segregated by region and further by VFR and IFR ratings based on statistics available from FAA records. Although survey respondents were not asked to provide their names, many did and this information was used to identify the appropriate response region. Otherwise, the postmark on the return envelope provided that indication. A total of 9 responses were unknown as to their origin as they bore neither a respondent address nor a postmark from within Arizona.

Table B-1 summarizes the distribution of the sample size and number of responses. Of the total pilots registered in Arizona, 51.5 percent hold only a VFR rating and 9.3 percent of all pilots are located in the northwest region of the State. Consequently, the VFR-only sample equated to a total of 258 pilots from which a sample size of 24 was selected from the northwest region.

Not all pilots responded to each question and therefore totals do not balance. Averages were calculated for certain questions and these are noted on the consolidated survey forms Exhibit B-1 and B-2 with associated attachments.

Table B-1
PILOT SURVEY SAMPLE DISTRIBUTION

Region	County	VFR-Only Rated Pilots		IFR Rated Pilots	
		Sample	Responses	Sample	Responses
Northwest		24	0	19	6
	Mohave				
	Yavapai				
Northeast		3	1	2	0
	Apache				
	Coconino				
	Navajo				
Southwest		48	14	46	19
	La Paz				
	Pima				
	Yuma				
Valley		166	31	165	48
	Maricopa				
Southeast		17	1	10	3
	Cochise				
	Giles				
	Graham				
	Greenlee				
	Pinal				
	Santa Cruz				
Unknown		--	5	--	3
Total		258	52	242	79

VFR-Only Rated Pilots

Responses to Questions 1 through 6 give a general profile of VFR-only pilots. Nearly all fly single-engine piston aircraft an average about 2.1 hours per flight. Some 86 percent of all the flights are less than 200 nautical miles and nearly all are less than 500 nautical miles. Most pilots are flying to airports in Maricopa, Pima, Yavapai and Yuma counties; however, this factor is influenced by the resultant regional distribution and number of responses. These pilots tend to fly for personal or pleasure flying; about 24 percent use the aircraft for business or for non-recreational purposes.

Responses to questions related to facilities and services at airports most utilized by each respondent are summarized in Attachment B-1. The fact that some airports are listed as having "Excellent" and "Poor" conditions for a particular facility by different respondents highlights the subjective quality of these responses. These survey results may be best used by noting those airports with poor condition assessments and comparing them with facilities considered as excellent. This may then lead to a distinction of those factors or characteristics which pilots associate with a particular standard level.

Question 8, provides insight to the aviation services these pilots require. The responses support a need for low-lead avgas which is consistent with the types of aircraft flown (Question 2) and a strong preference for areas where flight planning activities can be conducted. The latter is demonstrated in the relatively high demand for weather, telephone and flight planning room facilities. Services related to off-airport items such as places of lodging and rental cars to visit area attractions are relatively low in demand. Because 17 or nearly 33 percent of the respondents rent the aircraft they fly (Question 10), those expressing a need for aircraft maintenance service account for about one-half of those responding.

Question 9 provides a summary of aircraft equipage used by VFR-only pilots. The results shown are to be expected for the type rating held and aircraft used. It is interesting to note that 13 or 25 percent of the respondents are using VHF radios of the 360 channel/50kHz spacing and that few upgrades in radio communications are likely in the next five years (Question 10). Also, the survey responses indicate that nearly 37 percent of the aircraft being flown are equipped with a VFR GPS receiver and a comparable percentage are glide slope- and DME-capable.

The series of queries from Questions 12 through 20 relate to the need and use of weather data. Most pilots check weather conditions during 3 time periods – the night before, about 3 to 4 hours before and immediately prior to planned departure. These pilots rely primarily on data available from the FSS/AFSS,

although this is complemented with reports broadcast directly from the National Weather Service. Nearly 62 percent of the pilots take a more direct role in obtaining weather data by accessing DUATS and AWOS/ASOS units. When asked to rate the frequency of update/quality of these data sources, the pilots were most satisfied with the serviced offered by the FSS/AFSS. Other Very Satisfactory ratings were given to DUATS. Satisfactory ratings were more broadly distributed with network television broadcasts most preferred followed by FSS/AFSS briefings. Of those responding to Unsatisfactory sources, broadcast radio appears to be the least favored.

Although AWOS units have been installed at airports since the mid-1980's, and ASOS facilities in more recent years, about 35 percent of the respondents were unfamiliar with this weather data source. Those who are accessing the facilities for pre-flight purposes generally obtain a voice report. About 36 percent of these pilots are utilizing computer/modem units for this purpose. Most pilots seek out departure and destination weather observations reported by the automated units and while en route (Question 19).

These pilots recognize the benefits of AWOS/ASOS facilities for flight-related purposes, but most do not utilize this information to support other activities (Question 18). When queried as to their willingness to pay a user fee to support the establishment and operation of a statewide aviation weather network, the majority of those responding (about 80 percent) were not so disposed. Of those in favor (some 20 percent), user fees ranged as high as $2.00 per call with an average charge value equal to $0.90.

Questions 21 through 24 relate to ADOT, Aeronautics Division services. In particular there appears to be positive reaction to a renewal of the Arizona Aeronautical Chart, interest in publications which address flight safety and describe airport facilities in the State, and the development of an aviation education/seminar geared to pilots.

The matter of State licensing airports and pilots (Question 23) received mixed reaction; however, some pilots expressing a "Not Important" selection used the open comment section (Question 24) to embellish on their perception that the FAA is accomplishing these licensing activities and that State involvement is not necessary.

With regard to Question 24 (open comments), few pilots used this opportunity; however, their comments are noted in Exhibit B-1.

Exhibit B-1

VFR GENERAL AVIATION PILOT SURVEY

1. Indicate your current highest ratings held:

52 Private pilot
0 Commercial pilot
0 Airline transport pilot

0 Instrument rating
11 Airplane single-engine land rating
1 Airplane multi-engine land rating
0 Rotorcraft rating
___ Other rating (specify) _____

2. What type of aircraft do you typically operate?

46 Single-engine piston
1 Multi-engine piston
0 Turbojet

0 Single-engine turboprop
0 Multi-engine turboprop
0 Rotorcraft

3. How many flights (a roundtrip is considered 2 flights) do you make and how many hours do you fly annually under VFR and IFR regulations? *Average Values Indicated*

49 VFR flights
0 IFR flights

104 VFR hours
0 IFR hours

4. What percent of your nonstop flights (stage lengths) are within the following ranges?

29 local to within 50 nautical miles
36 51 to 100 nautical miles
19 101 to 200 nautical miles
6 201 to 300 nautical miles

4 301 to 400 nautical miles
4 401 to 500 nautical miles
0 501 to 600 nautical miles
1 greater than 600 nautical miles

5. To which counties in Arizona do you fly and how frequently? *Average Values Indicated*

County	Number of Annual Trips	County	Number of Annual Trips
Apache	2	Mohave	2
Cochise	3	Navajo	3
Coconino	3	Pima	16
Gila	2	Pinal	4
Graham	4	Santa Cruz	3
La Paz	4	Yavapai	7
Maricopa	16	Yuma	13

And, how frequently do you fly to the following neighboring states?

States	Number of Annual Trips
CA	5
CO	2
NM	2
NV	2
UT	5
Mexico	22

6. For which purposes do you utilize airport facilities? (Check all that apply)

51 Personal use
10 Business use
1 Emergency use (a result of a search & rescue, firefighting, disaster, etc.)
0 Medical evacuation
___ (Other) _____

7. From a pilot's perspective, please rate the public airport facilities that you visit in the State most frequently for the factors listed below and indicate the names of those airports which you rate as Excellent or Poor.

Facility	Names of Airports: Excellent	Names of Airports: Poor
Runway pavement		
Apron, tiedown area		
Aircraft hangars		
Fuel availability		
Fuel service	*Refer to Attachment B-1 for Summary of Responses*	
Airport lighting		
VASI/PLASI/PAPI		
Airport Navaids		
Terminal facilities		
FBO services		
Airport communications		

8. What aviation services do you require at the airports you use? (Check all that apply)

50 Fuel (100LL)
0 Fuel (Jet A)
18 Maintenance (engine)
14 Maintenance (airframe)
15 Avionics
25 Weather
17 Rental car
1 Oxygen
37 Telephone
7 Lodging
24 Flight planning room
37 Tiedown
13 Aircraft rental
24 Lounge/waiting area
2 Other: *80 Fuel (1)* *Restaurant (1)*

9. What types of radio communications and avionics are installed in the aircraft identified in Question 2 above? (Check all that apply)

1 No VHF radio
13 VHF radio (360ch/50kHz)
31 VHF radio (720ch/25kHz)
13 Dual VHF receivers
1 Transponder Mode A
48 Transponder Mode C
2 Transponder Mode S
29 ADF receiver
33 VOR receiver
18 Dual VOR receivers
18 Glide slope receiver
21 DME receiver
8 Loran-C receiver (VFR-only)
2 Loran-C receiver (IFR en route)
2 RNAV equipment
19 GPS receiver (VFR-only)
0 GPS receiver (IFR-certified)
1 Inertial navigation system
0 Omega navigation system

10. If you own the aircraft described in Question 9 above, what upgrades to your radio communications and avionics are you likely to make in the next 5 years?

17 Do not own the aircraft
11 No upgrades
0 VHF radio (360ch/50khz)
4 VHF radio (720ch/25khz)
3 Dual VHF receivers
0 Transponder Mode A
0 Transponder Mode C
0 Transponder Mode S
0 ADF receiver
0 VOR receiver
0 Dual VOR receivers
0 Glide slope receiver
0 DME receiver
0 Loran-C receiver (VFR-only)
0 Loran-C receiver (IFR en route)
0 RNAV equipment
3 GPS receiver (VFR-only)
7 GPS receiver (IFR-certified)
0 Inertial navigation system
0 Omega navigation system

11. In your opinion, which Arizona airports need first-time or additional instrument approaches and, importantly, why? Also indicate the potential type instrument approach to be considered and evaluated for this airport(s):

Most frequently mentioned airports included: Phoenix-Deer Valley needs an ILS (very busy, especially training activity); Sedona should have an instrument approach (treacherous terrain); Phoenix-Goodyear should have an ILS (intensive training).

12. There is a natural tendency to check the weather prior to flight depending on the expected general conditions. Assuming you anticipate generally ***VFR*** conditions at your departure, destination and alternate airports and along your intended route of flight, how often and when do you check weather conditions? (Check all that apply)

3 Do not check weather if VFR
18 1.8 days in advance (indicate number of days) *Average Value Indicated*
32 The night before
28 3.2 hours before departure (indicate number of hours) *Average Value Indicated*
35 Immediately before departure
0 Other (please specify) _____

13. Assuming that there is or may be expected to be ***IFR*** weather, how often and when do you check weather conditions in advance of your flight? (Check all that apply)

52 I am not an IFR-rated pilot
0 – days in advance (indicate number of days) *Average Value Indicated*
1 The night before
___ – hours before departure (indicate number of hours) *Average Value Indicated*
3 Immediately before departure
0 Other (please specify) _____

14. What sources do you use to obtain pre-flight aviation weather and forecast information? (Check all that apply)

47 FSS/AFSS
18 National Weather Service
10 Broadcast radio
28 Television station
17 DUATS
15 AWOS or ASOS
0 Commercial vendor
2 Other (please specify) *Internet (1) The Weather Channel (1)*

15. How would you rate the frequency of update and quality of service of the aviation weather data you receive from the sources you checked in Question 14 above? Frequency and quality of service are defined as being responsive to your needs for aviation weather data and reports for flight planning.

Source	Very Satisfactory	Satisfactory	Unsatisfactory
FSS/AFSS	31	20	3
NWS	4	13	0
Broadcast radio	1	11	4
Television station	3	23	5
DUATS	12	18	1
AWOS or ASOS	12	11	3
Commercial vendor	2	4	0
Other: *Internet*	1	0	0
Weather Channel	1	0	0

16. When you access an AWOS or ASOS on the ground, do you? (Check all that apply)

15 Am unfamiliar with the AWOS or ASOS equipment
18 Telephone one or more AWOS/ASOS units directly for a voice report
6 Utilize a computer and modem at home or office
4 Utilize a computer and modem at an airport location

17. How do you use AWOS/ASOS facilities in your flight activities? (Check all that apply)

17 Departure airport, latest report
21 Destination airport, latest report
5 Alternate airport, latest report
9 En route airports, latest report
5 All of the above
7 Latest report for other airports near your departure, destination and alternate airports
1 Earlier reports for those airports checked extending back every _____for _____
(for example, every 30 minutes for 2 hours) *Average Value Indicated*

18. Do you access an AWOS or ASOS on the ground or for purposes other than flight planning?

9 Yes If yes, indicate purposes and how frequently you use service:
28 No *General weather information; kite flying; conditions during storms*

19. While en route airborne, do you routinely tune in AWOS/ASOS frequencies along your intended route of flight to monitor weather conditions?

22 Yes 20 No

20. ADOT, Aeronautics Division is studying the technical and financial feasibility of a statewide real-time aviation weather information system. There is also the likelihood that this data will be linked to the national weather network. Would you be willing to pay a user fee for the establishment and maintenance costs for such a system?

9 Yes If Yes, indicate a suggested user fee: a user charge of *$0.90* per call
35 No *Average Value Indicated*

21. Earlier, ADOT, Aeronautics Division published an Arizona Aeronautical Chart. Would you like to see this chart published and distributed (the chart would not be authorized for aeronautical use, but for reference/informational purposes only)?

36 Yes 5 No 10 No opinion

22. What other services should ADOT, Aeronautics Division develop, pursue and encourage which address aviation needs in Arizona?

36 Guide to AZ airports
14 Monthly Newsletter
24 Safety Letter/Accident Briefs
20 Flying Tips (quarterly)
15 Fly – In's
5 Conferences
23 Aviation Education/Seminars – Adult
9 Aviation Education/Seminars - High School
2 Art Contests
3 Other (please specify) *Fly-In Campgrounds (2); Re-open grapevine for general aviation use airstrip (1)*

23. Some states regulate/license some aspects of aviation for the purpose of standardizing procedures and/or maintaining a certain level of quality/professionalism. Please indicate your opinion of the importance of ADOT Aeronautics licensing.

	Very Important	Not Important	No Opinion
AZ Pilots Licensed	*17*	*25*	*8*
AZ Airports Licensed	*18*	*14*	*10*
Other (please specify)			
_____	_____	_____	_____

24. Thank you for participating in this survey. Please use the space below to provide additional comments.

Comments offered by respondents are presented below, in no order of priority. Where the comment is similar to others made, the frequency of similar comments are noted in ( ).

The State of Minnesota offers an aviation weather channel in conjunction with Public Broadcast System television. It is the best weather source I have ever seen in any state.

I am discouraged at the slow growth of recreational airports in Arizona.

ADOT should only be concerned with factors affecting its fiscal requirements for facilities, i.e., airport construction and grant sharing. Brief communication on activities and facilities in the State is a part of this activity.

The FAA has recently dropped promotion of aviation from its mission statement. I feel that ADOT Aeronautics should include this function as a high priority, particularly with respect to children and teenagers. This could best be done with the ultralight, sport aviation (EAA) and soaring elements of general aviation. It is this environment where most pilots started and where future pilots will be born.

25. The following information request is optional:

Name _____
Address _____
_____
Telephone _____

Please return this survey form in the pre-addressed and stamped envelope to:

QED
P.O. Box 174
Ridgefield, Connecticut 06877

VFR GENERAL AVIATION PILOT SURVEY

Response to Survey Question 7

This question requested the respondent to identify those airports in Arizona which he/she finds to have Excellent and Poor conditions with respect to one of several facilities. The responses were reviewed and summarized below, in alphabetical order. Those which were listed more frequently are **highlighted** for each category of facility and condition.

EXCELLENT CONDITIONS	POOR CONDITIONS
Runway Pavement	
Avra Valley, Buckeye, **Chandler**, Coolidge, Chandler, **Ernest A. Love**, Flagstaff, **Glendale**, Kingman, Lake Havasu City, Laughlin/Bullhead, **Mesa-Falcon**, Nogales, **Payson**, **Phoenix-Deer Valley**, Phoenix-Goodyear, **Phoenix Sky Harbor**, Pinal, **Ryan**, Scottsdale, Sedona, Stellar, **Tucson**, Williams Gateway, **Yuma**	Casa Grande, San Manuel
Taxiway Pavement	
Avra Valley, Buckeye, **Chandler**, **Ernest A. Love**, Flagstaff, Glendale, Kingman, Laughlin/Bullhead, Mesa-Falcon, Nogales, Payson, **Phoenix- Deer Valley**, **Phoenix-Goodyear**, **Phoenix Sky Harbor**, **Ryan**, **Scottsdale**, Stellar, **Tucson**, Williams Gateway, Yuma	Buckeye, San Manuel, Sedona, Stellar
Apron/Taxiway Area	
Avra Valley, **Chandler**, Ernest A. Love, Flagstaff, Glendale, Laughlin/Bullhead, **Mesa-Falcon**, Nogales, Payson, **Ryan**, **Phoenix-Deer Valley**, **Phoenix Sky Harbor**, Scottsdale, Sedona, Stellar, **Tucson**, Williams Gateway, Yuma	Chandler, Ernest A. Love, Gila Bend, San Manuel
Aircraft Hangars	
Avra Valley, Buckeye, Chandler, Douglas Municipal, Flagstaff, Kingman, Laughlin/Bullhead, **Mesa-Falcon**, Nogales, **Phoenix Deer Valley**, Phoenix-Goodyear, Phoenix Sky Harbor, **Ryan**, Scottsdale, Sedona, Stellar, Tucson, Williams Gateway	Avra Valley, Glendale, Ernest A. Love, San Manuel, Yuma
Fuel Availability	
Avra Valley, Chandler, Ernest A. Love, Glendale, Flagstaff, Kingman, **Mesa-Falcon**, Nogales, **Phoenix-Deer Valley**, Phoenix-Goodyear, **Phoenix Sky Harbor**, **Ryan**, Scottsdale, Sedona, Stellar, **Tucson**, Williams Gateway, **Yuma**	Phoenix-Goodyear, San Manuel
Fuel Service	
Avra Valley, Chandler, Ernest A. Love, Glendale, Flagstaff, Kingman, Laughlin/Bullhead, Mesa-Falcon, Nogales, Phoenix-Deer Valley, Phoenix-Goodyear, **Phoenix Sky Harbor**, **Ryan**, **Scottsdale**, Sedona, Stellar, **Tucson**, Williams Gateway, **Yuma**	Phoenix-Deer Valley, San Manuel, Stellar

EXCELLENT CONDITIONS	POOR CONDITIONS
Airport Lighting	
Avra Valley, Casa Grande, Chandler, Ernest A. Love, Flagstaff, Glendale, Laughlin/Bullhead, Mesa-Falcon, Nogales, **Phoenix-Deer Valley**, Phoenix-Goodyear, Phoenix Sky Harbor, Ryan, Scottsdale, Sedona, Stellar, **Tucson**, Williams Gateway, **Yuma**	San Manuel
VASI/PLASI/PAPI	
Avra Valley, **Chandler**, Ernest A. Love, Glendale, Laughlin/Bullhead, **Mesa-Falcon**, Nogales, Payson, Phoenix-Deer Valley, **Phoenix Sky Harbor**, Ryan, Scottsdale, Sedona, Stellar, **Tucson**, Williams Gateway, **Yuma**	San Manuel
Airport NAVAIDS	
Avra Valley, Chandler, Ernest A. Love, Glendale, Kingman, Laughlin/Bullhead, Mesa-Falcon, Nogales, Phoenix-Deer Valley, **Phoenix Sky Harbor**, Ryan, Scottsdale, Sedona, **Tucson**, Williams Gateway, Yuma	Phoenix-Deer Valley, San Manuel
Terminal Facilities	
Avra Valley, **Chandler**, Ernest A. Love, Glendale, Lake Havasu City, **Mesa-Falcon**, Nogales, **Phoenix-Deer Valley**, Phoenix-Goodyear, **Phoenix Sky Harbor**, Ryan, Scottsdale, Sedona, Stellar, **Tucson**, Williams Gateway, Yuma	Ernest A. Love, Ryan, San Manuel
FBO Services	
Avra Valley, **Chandler**, Ernest A. Love, Flagstaff, Glendale, Kingman, Laughlin/Bullhead, **Mesa-Falcon**, Nogales, Phoenix-Deer Valley, Phoenix-Goodyear, **Phoenix Sky Harbor**, **Ryan**, Scottsdale, Sedona, Stellar, **Tucson**, Williams Gateway, Yuma	Ernest A. Love, Mesa-Falcon, Payson, Phoenix-Deer Valley, San Mauel, Sedona
Airport Communications	
Avra Valley, **Chandler**, Ernest A. Love, Flagstaff, Glendale, Kingman, Laughlin/Bullhead, Mesa-Falcon, Nogales, **Phoenix-Deer Valley**, Phoenix-Goodyear, **Phoenix Sky Harbor**, **Ryan**, Scottsdale, Sedona, Stellar, **Tucson**, Williams Gateway, **Yuma**	San Manuel

IFR-Rated Pilots

The survey results based on responses provided by IFR-rated pilots are presented below. Where appropriate, comparisons with those from VFR-only rated pilots are offered to reflect the characteristics and user needs represented by each type of pilot group.

A general profile of the IFR-rated pilots in Arizona responding to the survey (Questions 1 through 6) indicate that a relatively high percentage, 43 percent, have airline transport ratings. This is due to the bases established in Phoenix by America West and Southwest airlines. These pilots also participate in general aviation activities and the majority of their responses reflected such participation. IFR-rated pilots tend to fly a wider range of aircraft types than those pilots with only a VFR rating (Question 2) and their activity levels are higher as well, averaging about 3 hours per VFR flight and nearly 1.8 hours per IFR flight (Question 3). These results also help account for the greater nonstop flight distances flown (Question 4). Travel destinations within and without Arizona for IFR-rated pilots show greater distribution by county than those of VFR-only rated pilots (Question 5) This result is consistent with general activity levels of more trips of longer duration. IFR-rated pilots are more apt to fly for business-related purposes (51 percent) than those pilots with a VFR-only rating.

IFR-rated pilots identified airports with excellent and poor conditions for a range of facilities and services (Question 7) as shown in Attachment B-2. As in the case of VFR-only rated pilots, some airports received both excellent and poor ratings depending on the subjective view of the respondent. Nonetheless, some insight may be gained from the comparison of excellent and poor airports to determine appealing characteristics.

Aviation services required by IFR-rated pilots are quite similar to those indicated by VFR-only rated pilots on a percentage of response basis. Most IFR-rated pilots require fuel (a higher percentage need access to Jet A fuel), weather data, telephone access and an area for flight planning purposes (Question 8).

Aircraft operated by IFR-rated pilots are equipped with a higher level of radio transceivers, transponders and avionics than those used by VFR-only rated pilots. In particular, the IFR-rated pilot operate aircraft equipped with dual VHF receivers, and dual VOR, glide slope, DME and GPS (VFR- and IFR-certified) avionics (Question 9). About the same percentage of IFR-rated and VFR-only rated pilots do not own the aircraft they operate. The remaining owners are, however, more likely to upgrade the radio communications and avionics which are installed in their aircraft. Preferred upgrades are both VFR- and IFR-certified GPS receivers (Question 10).

IFR-rated pilots check weather conditions at about the same rate as VFR-only rated pilots when VFR or IFR conditions are expected. This result appears reasonable given that the severity of IFR conditions in terms of ceilings and visibilities will determine whether the pilot will conduct the flight. As in the case of VFR-only rated pilots, IFR-rated pilots rely on the FSS/AFSS as a primary source of pre-flight weather and forecast conditions (Question 14). However, as opposed to the VFR-only rated pilots, they also are more likely to engage the services of a commercial vendor. An assessment of the quality of service offered by these sources (Question 15) tracks generally with the responses to this question by VFR-only rated pilots. Most find the service offered by the FSS/AFSS to be very satisfactory and are more favorably disposed to that provided by the NWS. Media broadcasts of weather are utilized by IFR-rated pilots and these sources are considered satisfactory in fulfilling operating needs.

IFR-rated pilots are more familiar with and utilize the data from AWOS and ASOS units to a greater extent than VFR-only rated pilots (Question 16). Nonetheless, nearly 23 percent of all IFR pilots were unfamiliar with the equipment. As expected, given the nature of IFR flying, those pilots utilizing AWOS and ASOS facilities obtain data from as many airport locations involving their route of flight as possible (Question 17). Interestingly, IFR-rated pilots make little use of AWOS and ASOS data for non-flight purposes than do VFR-only rated pilots (Question 18). Use of AWOS and ASOS data awhile en route is about evenly mixed and comparable to that expressed by VFR-only rated pilots (Question 19). IFR-rated pilots were more inclined to financially support a statewide real-time aviation weather information system than VFR-only rated pilots, 20 percent versus 17 percent, but they placed a comparable average value to a user fee charge of about $0.92 per call (Question 26).

IFR-rated pilots also support the re-introduction of an Arizona Aeronautical chart and are receptive to receiving other publications related to flight safety (Questions 21 and 22). Yet, the inclination toward ADOT Aeronautics licensing of pilots and airports was not given overriding support (Question 23). These results are comparable to those expressed by VFR-only rated pilots.

Question 24 provides the IFR-rated pilot an opportunity to offer any additional comments. These are summarized in Exhibit B-2.

IFR GENERAL AVIATION PILOT SURVEY

1. Indicate your current highest ratings held:

15 Private pilot
30 Commercial pilot
34 Airline transport pilot

79 Instrument rating
42 Airplane single-engine land rating
50 Airplane multi-engine land rating
11 Rotorcraft rating
18 Other rating (specify) CFI (7) CFII (6) SES (1) FE (1) Glider (3)

2. What type of aircraft do you typically operate?

46 Single-engine piston
18 Multi-engine piston
21 Turbojet

2 Single-engine turboprop
8 Multi-engine turboprop
7 Rotorcraft

3. How many flights (a roundtrip is considered 2 flights) do you make and how many hours do you fly annually under VFR and IFR regulations? *Average Values Indicated*

153 VFR flights
154 IFR flights

465 VFR hours
280 IFR hours

4. What percent of your nonstop flights (stage lengths) are within the following ranges?

33 local to within 50 nautical miles
14 51 to 100 nautical miles
13 101 to 200 nautical miles
12 201 to 300 nautical miles

7 301 to 400 nautical miles
7 401 to 500 nautical miles
3 501 to 600 nautical miles
11 greater than 600 nautical miles

5. To which counties in Arizona do you fly and how frequently? *Average Values Indicated*

County	Number of Annual Trips	County	Number of Annual Trips
Apache	5	Mohave	11
Cochise	56	Navajo	11
Coconino	156	Pima	29
Gila	27	Pinal	33
Graham	15	Santa Cruz	11
La Paz	18	Yavapai	134
Maricopa	144	Yuma	12

And, how frequently do you fly to the following neighboring states?

States	Number of Annual Trips
CA	66
CO	33
NM	46
NV	56
UT	33
Mexico	12

6. For which purposes do you utilize airport facilities? (Check all that apply)

50 Personal use
51 Business use
3 Emergency use (a result of a search & rescue, firefighting, disaster, etc.)
3 Medical evacuation
6 (Other) Training

7. From a pilot's perspective, please rate the public airport facilities that you visit in the State most frequently for the factors listed below and indicate the names of those airports which you rate as Excellent or Poor.

Facility	Names of Airports: Excellent	Names of Airports: Poor
Runway pavement		
Apron, tiedown area		
Aircraft hangars		
Fuel availability		
Fuel service	*Refer to Attachment B-2 for Summary of Responses*	
Airport lighting		
VASI/PLASI/PAPI		
Airport Navaids		
Terminal facilities		
FBO services		
Airport communications		

8. What aviation services do you require at the airports you use? (Check all that apply)

48 Fuel (100LL)
26 Fuel (Jet A)
18 Maintenance (engine)
19 Maintenance (airframe)
20 Avionics
41 Weather
21 Rental car
6 Oxygen
44 Telephone
17 Lodging
36 Flight planning room
43 Tiedown
10 Aircraft rental
29 Lounge/waiting area
5 Other: *80/87 Fuel (2) Restaurant (3)*

9. What types of radio communications and avionics are installed in the aircraft identified in Question 2 above? (Check all that apply)

0 No VHF radio
10 VHF radio (360ch/50kHz)
50 VHF radio (720ch/25kHz)
61 Dual VHF receivers
11 Transponder Mode A
66 Transponder Mode C
7 Transponder Mode S
60 ADF receiver
43 VOR receiver
63 Dual VOR receivers
70 Glide slope receiver
63 DME receiver
14 Loran-C receiver (VFR-only)
6 Loran-C receiver (IFR enroute)
28 RNAV equipment
28 GPS receiver (VFR-only)
13 GPS receiver (IFR-certified)
12 Inertial navigation system
4 Omega navigation system

10. If you own the aircraft described in Question 9 above, what upgrades to your radio communications and avionics are you likely to make in the next 5 years?

28 Do not own the aircraft
9 No upgrades
0 VHF radio (360ch/50khz)
0 VHF radio (720ch/25khz)
0 Dual VHF receivers
0 Transponder Mode A
0 Transponder Mode C
2 Transponder Mode S
0 ADF receiver
1 VOR receiver
1 Dual VOR receivers
0 Glide slope receiver
1 DME receiver
0 Loran-C receiver (VFR-only)
0 Loran-C receiver (IFR enroute)
0 RNAV equipment
6 GPS receiver (VFR-only)
9 GPS receiver (IFR-certified)
0 Inertial navigation system
0 Omega navigation system

11. In your opinion, which Arizona airports need first-time or additional instrument approaches and, importantly, why? Also indicate the potential type instrument approach to be considered and evaluated for this airport(s):

Most frequently mentioned airports included: Show Low needs ILS (NDB is poor/unreliable; mountainous setting); Sedona (NDB unreliable); Scottsdale should have an ILS (heavy use airport, impact of McDowell Mountains, and possible alternate); Phoenix-Deer Valley needs ILS and GPS (for student training); Phoenix-Goodyear needs GPS or ILS (student training); Mesa-Falcon Field needs an ILS 22 (NDB has poor reception. Other airports mentioned include Lake Havasu City Municipal (GPS), Avi Suquilla (GPS/ILS), Laughlin/Bullhead International (ILS/GPS), Payson (GPS to support search/rescue mission)) and Safford Rgional (GPS for air cargo and based medical evacuation unit).

12. There is a natural tendency to check the weather prior to flight depending on the expected general conditions. Assuming you anticipate generally ***VFR*** conditions at your departure, destination and alternate airports and along your intended route of flight, how often and when do you check weather conditions? (Check all that apply)

_6_ Do not check weather if VFR
_21_ _1.3_ days in advance (indicate number of days) *Average Value Indicated*
_29_ The night before
_49_ _3.5_ hours before departure (indicate number of hours) *Average Value Indicated*
_36_ Immediately before departure
_2_ Other (please specify) _As Required/Necessary_

13. Assuming that there is or may be expected to be ***IFR*** weather, how often and when do you check weather conditions in advance of your flight? (Check all that apply)

_0_ I am not an IFR-rated pilot
_25_ _1.7_ days in advance (indicate number of days) *Average Value Indicated*
_37_ The night before
_53_ _2.7_ hours before departure (indicate number of hours) *Average Value Indicated*
_45_ Immediately before departure
_2_ Other (please specify) _As Necessary_

14. What sources do you use to obtain pre-flight aviation weather and forecast information? (Check all that apply)

_59_ FSS/AFSS
_23_ National Weather Service
_13_ Broadcast radio
_34_ Television station
_34_ DUATS
_23_ AWOS or ASOS
_17_ Commercial vendor
_5_ Other (please specify) _Internet (2) AOPA Channel (2) The Weather Channel (2)_

15. How would you rate the frequency of update and quality of service of the aviation weather data you receive from the sources you checked in Question 14 above? Frequency and quality of service are defined as being responsive to your needs for aviation weather data and reports for flight planning.

Source	Very Satisfactory	Satisfactory	Unsatisfactory
FSS/AFSS	41	20	3
NWS	15	13	0
Broadcast radio	3	11	4
Television station	11	23	5
DUATS	18	18	1
AWOS or ASOS	15	11	3
Commercial vendor	12	4	0
Other: *Internet*	1	1	0
AOPA Channel	1	1	0
Weather Channel	1	1	

16. When you access an AWOS or ASOS on the ground, do you? (Check all that apply)

18 Am unfamiliar with the AWOS or ASOS equipment
27 Telephone one or more AWOS/ASOS units directly for a voice report
12 Utilize a computer and modem at home or office
16 Utilize a computer and modem at an airport location

17. How do you use AWOS/ASOS facilities in your flight activities? (Check all that apply)

31 Departure airport, latest report
37 Destination airport, latest report
18 Alternate airport, latest report
23 En route airports, latest report
18 All of the above
7 Latest report for other airports near your departure, destination and alternate airports
1 Earlier reports for those airports checked extending back every 1 hour for 3 hours
(for example, every 30 minutes for 2 hours) *Average Value Indicated*

18. Do you access an AWOS or ASOS on the ground or for purposes other than flight planning?

2 Yes — If yes, indicate purposes and how frequently you use service:
52 No — *As a training aid for students*

19. While en route airborne, do you routinely tune in AWOS/ASOS frequencies along your intended route of flight to monitor weather conditions?

38 Yes 32 No

20. ADOT, Aeronautics Division is studying the technical and financial feasibility of a statewide real-time aviation weather information system. There is also the likelihood that this data will be linked to the national weather network. Would you be willing to pay a user fee for the establishment and maintenance costs for such a system?

21 Yes — If Yes, indicate a suggested user fee: a user charge of $0,92 per call
47 No — *Average Value Indicated*

21. Earlier, ADOT, Aeronautics Division published an Arizona Aeronautical Chart. Would you like to see this chart published and distributed (the chart would not be authorized for aeronautical use, but for reference/informational purposes only)?

45 Yes 9 No 18 No opinion

22. What other services should ADOT, Aeronautics Division develop, pursue and encourage which address aviation needs in Arizona?

33 Guide to AZ airports
14 Monthly Newsletter
32 Safety Letter/Accident Briefs
16 Flying Tips (quarterly)
20 Fly – In's
11 Conferences
30 Aviation Education/Seminars – Adult
14 Aviation Education/Seminars - High School
0 Art Contests
5 Other (please specify) *Recreation Airports, Encourage New Student pilot Training, Hot Weather Operations and Survival, Fly-In Campgrounds and Free Instructor Renewal Clinic*

23. Some states regulate/license some aspects of aviation for the purpose of standardizing procedures and/or maintaining a certain level of quality/professionalism. Please indicate your opinion of the importance of ADOT Aeronautics licensing.

	Very Important	Not Important	No Opinion
AZ Pilots Licensed	13	38	11
AZ Airports Licensed	19	25	1
Other (please specify)			
_____	_____	_____	_____

24. Thank you for participating in this survey. Please use the space below to provide additional comments.

Comments offered by respondents are presented below, in no order of priority. Where the comment is similar to others made, the frequency of similar comments are noted in ( ).

In my experience flying around Arizona, I think most facilities are well maintained. Fill in the ditches along R/W 3L-21R to help traffic flow and reduce potential for incidents.

Need more ILS approaches.

A list of all airports with emergency use capabilities is badly needed.

I am not aware that you can telephone access the AWOS reporting point.

Aviation is already over-regulated by the Feds. No additional State requirements are needed or wanted. Cost of annual State registration is excessive and detrimental to encouraging aircraft ownership. (10)

Thank you for the interest in conducting this survey and the great efforts you put forth to keep the skies safe. (4)

An ILS approach in the northern half of the Phoenix area would be very useful for training purposes. It's hard to stay sharp on IFR techniques in Arizona.

GPS is the answer.

Airports are a zoning problem not a "licensing" situation. The local airports have operational rules that are basically FAA coordinated. The "business" rules are locally developed. The ADOT should review these "rules" and maybe "jaw bone" some municipalities if necessary, but stay out of further regulation.

A single GPS landing system ground station strategically located could provide landing guidance to DVT, GEU and Litchfield as well as Sky Harbor. This should be high on the priority list.

I think that it is unnecessary to build an AWOS/ASOS system in Arizona as low IFR conditions are rare. When I lived in Colorado, I would have paid a user fee to access weather data where there is none now. The only thing that I would like as far as weather information in Arizona is live WX radar that I could access by computer. I would like to see more recreational flying facilities built. With shoreline access to some of the big lakes, nothing fancy, just a runway and tiedown area. I wouldn't even spend the money that they did in Payson, just bulldoze it and it.

I feel for the most part Arizona aviation is adequately supported. While things like real time weather would be nice about 5 to 6 days a year, I don't think the service would be worth the cost. More value could be attained from more telephone accessible ASOS and AWOS facilities, especially in the north and southeast areas of the State.

Possibly change the CTAF at Wickenburg Airport to another not so congested frequency. While airborne around Wickenburg it becomes difficult to give valuable position reports when Buckeye traffic is congesting the radio.

25. The following information request is optional:

Name _____
Address _____
_____
Telephone _____

Please return this survey form in the pre-addressed and stamped envelope to:

QED
P.O. Box 174
Ridgefield, Connecticut 06877

IFR GENERAL AVIATION PILOT SURVEY

Response to Survey Question 7

This question requested the respondent to identify those airports in Arizona which he/she finds to have Excellent and Poor conditions with respect to one of several facilities. The responses were reviewed and summarized below, in alphabetical order. Those which were listed more frequently are **highlighted** for each category of facility and condition.

EXCELLENT CONDITIONS	POOR CONDITIONS
Runway Pavement	
Avra Valley, Chandler, Douglas Municipal, **Ernest A. Love**, **Glendale**, Laughlin/Bullhead, Libby AAF/Sierra Vista, Mesa-Falcon, Payson, **Phoenix-Deer Valley**, **Phoenix-Goodyear**, **Phoenix Sky Harbor**, Ryan, **Scottsdale**, **Tucson**, Williams Gateway, **Yuma**	Bagdad, **Casa Grande**, Eloy, Libby AAF/Sierra Vista, **Sedona**, Sells, **Show Low**, Tombstone
Taxiway Pavement	
Avra Valley, Chandler, Flagstaff, Glendale, **Libby AAF/Sierra Vista**, Payson, **Phoenix-Deer Valley**, **Phoenix-Goodyear**, **Phoenix Sky Harbor**, Ryan, **Scottsdale**, **Tucson**, Williams Gateway, Yuma	Avi Suquilla, Bisbee-Douglas, **Casa County**, Cochise County, Ernest A. Love, Flagstaff, **Greenlee County**, Laughlin/Bullhead, Libby AAF/ Sierra Vista, Payson, **Sedona**, **Tombstone**
Apron/Taxiway Area	
Avra Valley, Laughlin/Bullhead, Libby AAF/ Sierra Vista, Payson, **Ryan**, Phoenix-Deer Valley, **Phoenix Sky Harbor**, Scottsdale, Sedona, Tucson	Bagdad, Bisbee, Casa Grande, Ernest A. Love, Flagstaff, Grand Canyon National, Greenlee County, Laughlin/Bullhead, Page, Phoenix-Goodyear, Sedona
Aircraft Hangars	
Avra Valley, Cottonwood, Douglas Municipal, Flagstaff, Mesa-Falcon, Phoenix Deer Valley, **Phoenix Sky Harbor**, Ryan, **Scottsdale**, Tucson, Wickenburg	Grand Canyon National, Phoenix-Goodyear, Phoenix Sky Harbor, Tucson
Fuel Availability	
Avra Valley, Flagstaff, Mesa-Falcon, Phoenix-Deer Valley, Phoenix-Goodyear, **Phoenix Sky Harbor**, **Ryan**, Scottsdale, **Tucson**, Williams Gateway, Yuma	Gila Bend, Greenlee County
Fuel Service	
Avra Valley, Douglas Municipal, Ernest A. Love, Flagstaff, Phoenix-Deer Valley, Phoenix-Goodyear, **Phoenix Sky Harbor**, **Ryan**, **Scottsdale**, Tucson, Williams Gateway	Grand Canyon National, Page

EXCELLENT CONDITIONS	POOR CONDITIONS
Airport Lighting	
Avi Suquilla, Casa Grande, Flagstaff, Lake Havasu City, Libby AAF/Sierra Vista, Mesa-Falcon, Page, **Phoenix-Deer Valley**, Phoenix-Goodyear, **Phoenix Sky Harbor**, Ryan, Scottsdale, **Sedona**, **Tucson**	Winslow
VASI/PLASI/PAPI	
Casa Grande, Douglas Municipal, Ernest A. Love, Payson, **Phoenix Sky Harbor**, Ryan, Scottsdale, **Tucson**, Williams Gateway	Bisbee-Douglas, Sedona
Airport NAVAIDS	
Casa Grande, Ernest A. Love, Mesa-Falcon, **Phoenix Sky Harbor**, Ryan, **Tucson**, Williams Gateway	Greenlee County, Phoenix-Goodyear, Scottsdale
Terminal Facilities	
Avra Valley, Page, Phoenix-Deer Valley, Phoenix-Goodyear, Phoenix Sky Harbor, Scottsdale, Sedona, Tucson	Greenlee County, Libby AAF/ Sierra Vista, Ryan
FBO Services	
Casa Grande, Ernest A. Love, Lake Havasu City, Phoenix-Deer Valley, **Phoenix Sky Harbor**, Scottsdale, Sedona, Tucson	Flagstaff, Grand Canyon National, Libby AAF/Sierra Vista, Page, Phoenix-Goodyear, Ryan, Sedona
Airport Communications	
Douglas Municipal, Phoenix-Goodyear, Payson, Phoenix Sky Harbor, Ryan, Scottsdale, Tucson, Yuma	Avra Valley, Gila Bend, Mesa-Falcon

Comparison With Other Surveys

The results of the surveys conducted in Arizona may be compared to those reflecting nationwide and the FAA Western-Pacific Region (Arizona, California and Nevada) data, and those obtained from a similar effort prepared by QED for the State of Iowa. These other surveys reflect 1995 conditions. Table B-2 presents a summary comparison of the survey data. The national and Western-Pacific Region data as reported by the FAA in its "General Aviation and Air Taxi Activity and Avionics Survey" is limited for comparison purposes to aircraft equipage. The Iowa survey data addresses both equipage and source and use of aviation weather data.

The results of the comparison indicate that Arizona has higher values of equipage than the national, regional and Iowa indices. This may be attributable, in part, to the three-four year time difference in the survey periods. Yet, the results are interesting given that Arizona generally enjoys a VFR climate during most of the year and 30 airports in its 87-airport system, or some 35 percent, have published instrument approaches. This contrasts with a higher percentage of Iowa pilots expressing an intent to upgrade to GPS-VFR or GPS-IFR receivers than expected in Arizona.

Accessing weather sources and the use of AWOS and ASOS facilities were surveyed in Arizona and Iowa. The results are summarized in Table B-3 for comparison purposes. Although the same measures were surveyed, operating conditions in Iowa with regard to weather data sources and quite different than those currently in Arizona. By 1995, the Iowa Department of Transportation had the Iowa Aviation Weather System (IAWS) operational based on the concept defined earlier by QED. The IAWS included the deployment of 32 AWOS-3 units linked on a real-time basis to a host computer. Users could access individual AWOS units as is common to this equipment, or dial a local telephone number to reach the host computer and receive the data via a computer with modem connection. There is no cost to the user to contact the IAWS host computer. Accordingly, Iowa pilots are more accustomed to obtaining aviation weather through this means than pilots in most other states including Arizona. Comparison of the data in Table B-3 supports this situation. Iowa pilots make more use of AWOS and ASOS network technology than those users in states which do not have similar capabilities. Consequently, the values for Arizona and Iowa might be viewed as a potential "before and after" scenario. Pilots from both states access available AWOS and ASOS data for comparable purposes. And, both groups of pilots share in their minority view , about 25 percent on average, concerning the payment of a user fee to support a statewide real-time aviation weather information system.

Table B-2

SURVEY COMPARISON
COMMUNICATIONS AND AVIONICS

Communications and Avionics	Arizona Pilots Survey (1997) (%)			Iowa Pilots Survey (1995) (%)	FAA Survey Data (1995) (%)		
	VFR	IFR	Total		State of Arizona	Western-Pacific Region	United States
No VHF Radio	1.9	0.0	0.8	3.3	5.0	3.4	5.6
VHF Radio (360/50)	1.9	12.7	17.6	28.5	23.9	22.0	22.7
VHF Radio (720/25)	59.6	96.2	61.8	28.5	53.5	54.0	51.1
Dual VHF Radios	25.0	77.2	56.5	67.6	50.6	50.9	48.1
Transponder Mode A	1.9	13.9	9.2	Not Avl	4.2	5.3	5.8
Transponder Mode C	92.3	83.5	87.0	42.3	64.5	65.9	59.8
Transponder Mode S	3.8	8.9	6.9	3.3	1.6	1.3	1.3
ADF Receiver	55.8	75.9	67.9	62.6	39.2	36.6	40.1
VOR Receiver	63.5	54.4	58.0	33.3	44.7	43.7	41.4
Dual VOR Receivers	34.6	79.7	61.8	54.5	45.7	47.0	43.9
Glide Slope Receiver	34.6	88.6	67.2	58.5	44.4	45.9	42.5
DME Receiver	40.4	79.7	64.1	43.9	34.7	32.6	29.1
Loran-C Receiver (VFR)	15.4	17.7	16.8	43.1	16.9	27.3	27.3
Loran-C Receiver (IFR)	3.8	7.6	6.1	8.1	2.5	1.5	3.3
RNAV Equipment	3.8	35.4	22.9	0.8	8.5	9.0	10.6
GPS Receiver (VFR)	36.5	35.4	35.9	16.3	23.8	24.4	23.3
GPS Receiver (IFR)	0.0	16.5	9.9	Not Avl	2.2	2.2	2.8
Omega Navigation System	0.0	5.1	3.1	5.7	0.0	0.2	0.3
Upgrade to GPS Receiver (VFR)	5.8	7.6	6.9	25.8	Not Avl	Not Avl	Not Avl
Upgrade to GPS Receiver (IFR)	13.5	11.3	12.2	43.8	Not Avl	Not Avl	Not Avl

Table B-3

SURVEY COMPARISON
WEATHER DATA SOURCES AND USE

Source of Weather Data, Ground Access Options and AWOS / ASOS Data Requirements	Arizona Pilots Survey (1997) (%)			Iowa Pilots Survey (1995) (%)	FAA Survey Data (1995) (%)		
	VFR	IFR	Total		State of Arizona	Western-Pacific Region	United States
Source of Weather Data							
FSS / AFSS	90.4	74.7	80.9	91.6	Not Avl	Not Avl	Not Avl
National Weather Service	34.6	29.1	31.3	26.0	Not Avl	Not Avl	Not Avl
Broadcast Radio / Television	73.1	55.7	64.9	74.7	Not Avl	Not Avl	Not Avl
DUATS	32.7	43.0	38.9	37.3	Not Avl	Not Avl	Not Avl
AWOS / ASOS	28.8	29.1	29.0	(IAWS) 42.3	Not Avl	Not Avl	Not Avl
Commercial Vendor	0.0	21.5	13.0	9.6	Not Avl	Not Avl	Not Avl
Internet	1.9	2.5	2.3	Not Avl	Not Avl	Not Avl	Not Avl
Weather Channel	1.9	2.5	2.3	5.0	Not Avl	Not Avl	Not Avl
Ground Access of AWOS / ASOS							
Telephone One or More AWOS / ASOS	34.6	34.2	34.4	81.0	Not Avl	Not Avl	Not Avl
Utilize Computer / Modem at Home / Office	11.5	15.2	13.7	17.0	Not Avl	Not Avl	Not Avl
Utilize Computer / Modem at Airport	7.7	20.2	12.2	41.5	Not Avl	Not Avl	Not Avl
AWOS / ASOS Data Requirements							
Departure Airport	32.7	39.2	36.6	Not Avl	Not Avl	Not Avl	Not Avl
Destination Airport	40.4	46.8	44.3	Not Avl	Not Avl	Not Avl	Not Avl
Alternate Airport	9.6	22.8	17.6	Not Avl	Not Avl	Not Avl	Not Avl
En Route	17.3	29.1	24.4	Not Avl	Not Avl	Not Avl	Not Avl
All of the Above	9.6	22.8	17.6	Not Avl	Not Avl	Not Avl	Not Avl
Future AWOS Network							
Support of AWOS Network User Fee	17.3	26.6	22.9	26.5	Not Avl	Not Avl	Not Avl

Appendix

C

AIRPORT OWNER / SPONSOR SURVEY

A survey of selected airport owners and sponsors was conducted to identify services provided by them and their perspective of unmet needs. Surveys were sent to a total of 73 airports ranging in size from large air carrier facilities to small general aviation fields. There were 32 responses received representing a response rate of nearly 44 percent.

The responses differ from those obtained from a separate survey of fixed base operators and tenants which provide these services and interact more frequently with the users at the airport (see Appendix D). The results are summarized on the composite survey form presented as Exhibit C-1 from which the following observations can be made:

The 32 airports queried account for a total of 3,715 aircraft or some 73 percent of the Arizona registered fleet (Question 1).

A variety of facilities and equipment at airports are being operated and maintained by the airport owner/sponsor. The majority of these systems are relatively less technically demanding visual landing aids, radio communications facilities and AWOS units. Some airport owners/sponsors are also responsible for operating and maintaining terminal nonprecision navigagtional aids such as the NDB. These results are comparable to those highlighted in Table 2-1. (Question 2).

Airport owners/sponsors as a whole are providing a wide range of services to pilots. The distribution of the types of services offered illustrate that those commonly expected by pilots and less costly to provide are available. However, it is interesting to note that 21, or 66 percent of the respondents, offer access to a public telephone and fewer (14 respondents or 44 percent) provide a separate area for flight planning facilities. Some 15 airport owners/sponsors, or about 47 percent of those responding, provide some form of access to weather data sources either through computer access to public or private providers, television and facsimile service. Of these, only one airport owner/sponsor (at a large air carrier airport) provides access to both a public weather and private weather data source. (Question 3).

Many of the services which are provided by the airport owner/sponsor may also be available from their fixed base operators and tenants as indicated in the survey results of these providers in Appendix D.

Airport owners/sponsors indicated a number of needs/services requested by pilots. These responses should be considered to reflect the shortcomings in services offered by both the airport owner/sponsor and their operating tenants inasmuch as the pilots may not be able to distinguish which entity is responsible for their provision when expressing unmet needs. The responses confirm those expressed by the fixed base operators and tenants.

The responses can be summarized as follows:

Unmet Service/Facility Needs	Number of Responses
GPS approach	5
Hangars/T-Shades	5
Courtesy/rental cars	4
Food/restaurant/ice	4
Computer access to weather	3
Plane washing	3
Flight planning room	2
Avionics sales/service	1
AWOS	1
Jet fuel	1
Terminal building	1
"Weather Channel"	1

AIRPORT OWNER/SPONSOR SURVEY

ADOT, Aeronautics Division is conducting a survey of airport owners/sponsors concerning the services provided at airports throughout Arizona in order to enhance flight safety. Please respond to the following questions and return the survey in the enclosed pre-addressed and stamped envelope. All responses will be aggregated.

1. How many aircraft are based at the airport? A based aircraft is one which utilizes a hangar or tiedown space on a recurring basis, excluding transient aircraft.

   2915 Single-engine piston
   360 Multi-engine piston/turboprop
   50 Jet
   125 Rotorcraft
   16 Ultralight
   249 Unspecified
   3715 Total

2. Do you, as the ***airport owner/sponsor,*** operate and maintain any of the following facilities and equipment? (Check all that apply)

   8 NDB
   1 LOC/LDA/SDF
   1 Glide slope
   18 VASI, PAPI
   8 AWOS
   4 Approach lighting system
   20 Unicom
   14 Pilot controlled lighting system
   1 Remote communications outlet
   3 Other: (please specify) *REIL (2) Windsock (1)*

3. What services do you, as the airport owner/sponsor, provide to pilots operating into and out of your airport? Do not include a terminal service provided by a fixed base operator (FBO) unless you provide that service as well.

   11 Fuel/Oil
   7 Maps/Charts
   15 Food snacks
   23 Restrooms
   6 Rental car
   2 Courtesy car
   17 Lodging information
   22 Waiting/Lounge area
   0 Computer access to DUATS (fee basis)
   6 Computer access to DUATS (free)
   21 Public telephone
   14 A separate area for flight planning
   3 Television for weather channel broadcast reception
   4 Facsimile access to weather data
   1 Computer access to private vendor weather data services and products (e.g., WSI, Kavouras, PanAM, etc.)
   4 Other (please specify) *Restaurant (1) Direct Line to FSS (1) Maintenance (1) Conference Rooms and Shuttle (1*

4. Are there services which are not presently provided at the airport, but which pilots have requested? Your response is intended to identify pilot needs. Please list these below with any additional comments you have.

   Avionics (2) WX Channel (1) Wash Rack (3) GPS Approach (5) Food (3) Full Maintenance (1) Hangars/Shade T (5) Courtesy /Rental Cars (4) Ice Machine (1) Terminal (1) Self-Serve Maintenance (1) FBO Services Other Than Fuel (1)

   Comments:

   Need improved vehicular access (1) Full length taxiway (1)

5. Please identify the respondent to this survey:

   Name _____
   Airport _____
   Telephone _____

Please return this survey form in the pre-addressed and stamped envelope to:

QED
P.O. Box 174
Ridgefield, CT 06877

Appendix

D

FIXED BASE OPERATOR / TENANT SURVEY

Fixed base operators and tenants at 73 airports were requested to respond to a survey which addressed services they provide and those which they expect pilots would prefer but which are presently not available at the airport. In some instances, there were several respondents from the same airport. A total of 65 fixed base operators and tenant surveys were returned. A summary of the responses is presented in Exhibit D-1 and the following observations can be made from this information.

Various business entities operating at the airports responded (Question 1).

Pilots are being provided a wide range of services, many of which complement and supplement those offered by the airport owner/sponsor as indicated in Appendix C.

Fixed base operators and tenants identified, from their perspective, several unmet pilot needs. These may be summarized as follows:

Unmet Service/Facility Needs	Number of Responses
Computer access to weather data	4
Courtesy/rental cars and taxis	4
Flight planning room	3
Food/restaurant	3
Avionics maintenance	2
AWOS	2
Lounge/waiting area	2
Plane washing/wash rack	2
Instrument approach	1
Visual landing aids	1

FIXED BASE OPERATOR / TENANT SURVEY

ADOT, Aeronautics Division is conducting a survey of those enterprises conducting a business at public-use airports in order to enhance flight safety. Please respond to the following questions and return the survey to the public official which oversees the management and operation of the airport who, in turn, will send the survey to our consultant QED. All responses will be aggregated.

1. What is the name of the business being conducted at the airport?

   (Various names Indicated)

2. What services are provided to based and transient pilots?

   - 26 Flight training
   - 27 Aircraft maintenance
   - 10 Avionics installed/repair
   - 12 Sale/Lease aircraft
   - 29 Fuel/Oil
   - 18 Maps/Charts
   - 22 Food snacks
   - 35 Restrooms
   - 12 Rental car
   - 12 Courtesy car
   - 10 Oxygen
   - 21 Lodging information
   - 34 Waiting Lounge area
   - 2 Computer access to DUATS (fee basis)
   - 9 Computer access to DUATS (free)
   - 30 Public telephone
   - 12 Facsimile access to weather data
   - 24 A separate area for flight planning
   - 6 Television for weather channel broadcast reception
   - 5 Computer access to private vendor weather data services and products (i.e., WSI, Kavouras, PanAM, etc.)
   - 6 Other (please specify) *Scenic Tours/Charter (2) Restaurant (1) Inside Aircraft Storage (1) Game Room (1) FAA Written Exams (1)*

3. What does your customer want? Are there terminal services which the pilots using the airport would like to have, information needs they cannot obtain, or other unmet service needs?

   Rental Cars (2) Hangar Space (4) Avionics, Wash Rack (2) Food/Restaurant (3) Taxi /Limo Service (2) Weather Flight Planning Computer/DUATS Access (5) FAA Written Exams (2) Aircraft Rental (2) AWOS (3) Meeting Room (2) Showers (2) Flight Planning Room (2) Single Responses – VASI, PAPI, Maps, Ice Machine, Waiting Areas, Jet Traffic Services, Direct Phone to FSS, Pilot Sleep Room, Air Charter, Radio, Public Phone

4. Please identify the respondent to this survey:

   Name _____
   Airport _____
   Telephone _____

Please return this survey form in the pre-addressed and stamped envelope to:

QED
P.O. Box 174
Ridgefield, CT 06877

Appendix

E

WEATHER INFORMATION USE SURVEY

The survey concerning the use of weather data by certain agencies of the State of Arizona was intended to assess their need and use of such data to support daily activities. A total of 13 surveys were distributed and 11 forms were returned. The responses are summarized in Exhibit E-1 from which the following observations may be made:

A review of the survey responses indicates that about one-half of the agencies responding utilize weather data to carry out their mission. (Question 1).

Their use of the data is essentially limited to internal activities; only one agency makes the data available to the public. A majority apply the weather data to decide on travel routes and scheduling. Other responses to this question relate to emergency purposes. (Question 2).

Questions 3 and 4 are related in that they inquire as to the type of weather data which is desired and the users' ability to obtain that information. The majority of the respondents were interested in the physical characteristics of the weather phenomenon (for example, wind speed, type of precipitation, identification of a thunderstorm event) rather than their impact on facilities (pavement surface, river and stream levels, as examples). Importantly, most of the respondents were able to obtain the data of interest to them.

The means by which the users obtain the data is less varied. Most of the eight respondents to this question employ more than one source with a preference for obtaining direct observations which are communicated by voice or by modem to a computer network for retrieval on demand. The use of radio/television announcements also appears to be a common means for data acquisition. One respondent indicated use of the Internet. (Question 5).

Of the eight respondents to Questions 6 and 7, six expressed a need for obtaining weather data on a real-time basis. These same respondents had a range of frequency update for the data. One preferred the data on a per minute basis during the early hours of the day while others use the data at specific times/reasons. The overriding factor, however, is that there is a strong preference for obtaining real-time data when the report is required.

Question 8 seeks to identify opportunities to use weather and condition data to support efficiency and enhance safety. The six respondents presented such insights as to monitor severe weather movement and offer available data as a service to motorists entering Arizona year-round, particularly during the winter season and at the Grand Canyon. Emergency response/readiness was also suggested.

Responses to Question 9 imply that these State agencies could benefit from the availability of real-time weather and condition information. However, their willingness to share in the costs of delivering this capability (Question 11) was mixed. Of the 10 respondents to this question, a total of 3 indicated a preference to participate financially, either on a cost share basis with ADOT Aeronautics Division or on a user fee basis. Two other respondents provided conditional comments ("depends" or "maybe") to either option. The other five respondents were not inclined to participate financially in a statewide real-time weather network on either basis.

Question 10 was intended to determine how the surveyed agencies use aircraft in conducting their mission. Ten of the 11 agencies responded and the results were equally divided. Of those using aircraft, activity levels ranged from between 10 to 50 flight hours per year and 50 to 9,000 hours annually. Flight purposes included air rescue and support, aerial survey/patrol and aerial observation/survey.

The last survey question (Question 12) solicited additional comments and four respondents expressed that:

- Weather data is useful when responding to complaints related to the application of pesticides.
- The State Emergency Notification (system) is sufficient; however, additional information should not be overlooked.
- The Division of Emergency Management has access to real-time weather data from the NOAA and NWS.

In summary, the State agencies contacted and responding indicated that they use weather data in their daily activities and could benefit from access to a real-time source. The ability to establish, operate and maintain a weather network on a cost-share or user fee basis is possible, but should be subject to more investigation. The potential intermodal application of weather data was recognized by one respondent and this observation could be used as a feature in a statewide weather data network.

Exhibit E-1

WEATHER INFORMATION USE SURVEY

ADOT, Aeronautics Division is evaluating the need and use of weather data in order to enhance flight safety and user operations. Please respond to the following questions and return the survey in the pre-addressed and stamped envelope. All responses will be aggregated.

1. Do you use weather information in conducting your daily State business activities?

   _6_ Yes — If Yes, continue to Question 2
   _4_ No — If No, skip to Question 8

2. How do you use the weather and condition information you are presently obtaining? (Check all that apply)

   _2_ Weather forecasting
   _2_ Manpower planning (e.g. snow plowing)
   _1_ Provide as a public service
   _3_ Provide to own staff on their request
   _2_ Provide to own staff on periodic basis
   _0_ To decide whether and when to open or close
   _5_ To select travel routes and scheduling
   _5_ Other (please specify) *Flight Go/No-Go Decision (1) Fire Severity Planning (1) Emergency Response (1) Lightning Activity (1) Moisture/Wind Information (1)*

3. What types of weather and condition information are useful to you? (Check all that apply)

   _7_ Wind speed and direction
   _7_ Temperature
   _5_ Barometric pressure
   _4_ Dew point
   _7_ Type of precipitation
   _7_ Amount of precipitation
   _4_ Ceiling height
   _5_ Forward visibility
   _6_ Freezing level
   _0_ Other (please specify) _____
   _4_ Cloud cover and front location
   _6_ Thunderstorm
   _6_ Lightning
   _2_ Soil temperature/moisture
   _0_ Pavement temperature
   _2_ Pavement surface conditions
   _2_ River/stream levels
   _2_ Snow pack depth

4. Can you now obtain the weather and condition data you would like to have? (Indicate Yes or No for each weather product)

   _7_ Wind speed and temperature
   _8_ Temperature
   _5_ Barometric pressure
   _3_ Dew point
   _6_ Type of precipitation
   _6_ Amount of precipitation
   _5_ Ceiling height
   _4_ Forward visibility
   _4_ Freezing level
   _0_ Other (please specify) _____
   _5_ Cloud cover and front location
   _5_ Thunderstorm
   _4_ Lightning
   _3_ Soil temperature/moisture
   _3_ Pavement temperature
   _3_ Pavement surface conditions
   _3_ River/stream levels
   _3_ Snow pack depth

5. How do you presently obtain the weather and condition data you monitor? (Check all that apply)

   _5_ By radio/telephone, direct from an observer
   _2_ By telephone using a recorded message
   _5_ By computer with modem
   _1_ By facsimile machine
   _4_ Listening/watching the radio/television
   _2_ Satellite download to a monitor
   _0_ Purchase products/services from a private, commercial vendor
   _0_ Other (specify) _____

6. Is the weather and condition data you obtain provided on a real-time (up to the minute) basis?

_3_ Yes, it needs to be for my operations
_0_ Yes, but real-time reporting is not required for my operations
_3_ No, but it should be to be useful for my operations
_2_ No, and it does not need to be on a real-time basis for my operations
_0_ Am unsure if the data received is being provided on a real-time basis

7. How frequently do you monitor the weather and conditions?

_1_ Every minute between the hours of _12 a.m._ and _12 p.m._
_2_ Every hour between the hours of _5 a.m._ and _7 a.m._
_3_ Times daily at _0700 1800_ (indicate clock hours)
_2_ Times daily at _0600 1200_

8. Can you name any instances when the availability of real-time (up to the minute) weather information would save you time, money, and/or life resources? (Please describe)

Emergency Response Operations (1) Rural AZ Flight Operations (1) Welcome Center at I-40 (1)
Progress of Thunderstorm Movement, Lightning Activity, Precipitation Patterns and Weather Movement (2)

9. Would the availability of automated, real-time weather and condition information at locations across the State of Arizona be of value to you?

_9_ Yes
_2_ No

10. Does your agency utilize nonairline aircraft in conducting its activities? If Yes, for which purposes and how many flights and hours are flown in aircraft annually?

_5_ No	_5_ Yes	_40 - 50_ Annual flights	_?_ Annual hours
		_50 - 300_	_1,000_
		_?_	_9,000_
		_?_	_3,000_

Purposes _Emergency Response and Damage Assessment (1) Air Rescue/Support/Executive Transport (2)_
Wildlife Suppression Airborne Relief Act (1) Administrative Purposes (1)

11. ADOT, Aeronautics Division is studying the technical and financial feasibility of a statewide real-time weather information system. There is also the likelihood that this data will be linked linked to the national weather network. Would you be willing to pay a user fee or otherwise participate financially in the establishment and maintenance costs for such a system?

_2_ Yes, on a cost sharing basis with Aeronautics and other users.
_4_ Yes, on a user fee basis. A suggested user charge is $_0.90 (Average)_ per contact.

_5_ No, not on a cost sharing basis with Aeronautics and other users.
_5_ No, not a user fee basis.

12. Thank you for your participation in this survey. Please use the space below to provide any additional comments concerning the topic of real-time weather information systems.

13. Please identify the respondent to this survey:

Name _____
Agency _____
Address _____
_____
Telephone _____

Please return this survey form in the pre-addressed and stamped envelope to:

QED
P.O. Box 174
Ridgefield, CT 06877

Appendix

F

AUTOMATED WEATHER FACILITIES

Introduction

This appendix provides background information on the two primary types of automated weather facilities in use at airports across the United States and internationally. The two units are named automated weather observing system (AWOS) and the automated surface observing system (ASOS). The characteristics of the facilities are described below. Each has a role in the real-time acquisition and dissemination of aviation weather and in the development of responsive weather data networks.

AWOS Background

Automated weather observing systems (AWOS) were first introduced in the mid-1950's when the Federal Aviation Administration (FAA) established an automated meteorological observation station at Front Royal, Virginia. The system reported weather parameters at the unattended, low frequency range location via a teletypewriter network on a 24-hour basis.

The present AWOS and automated surface observing systems (ASOS) are an outgrowth of the advances made in the computer and weather sensor technologies. The new technologies that are employed in the current AWOS and ASOS are based on the use of digitized data, computer processing, voice synthesizing, and customized software programs, all operating at speeds that approach real-time.

The National Weather Service (NWS) has established standards for the implementation of ASOS for itself, the FAA and the military. The FAA, in turn, in anticipation of a proliferation of the AWOS, has prepared a set of standards and specifications for non-federal AWOS facilities. Compliance with these standards will permit vendors to obtain certification for their systems and consideration for incorporation of their units in the national weather network. As of this date, several manufacturers have received FAA certification for four levels of AWOS facilities -- AWOS-A, AWOS-1, AWOS-2 and AWOS-3.

An AWOS is a hands-off set of equipment that collects desired weather parameters from the environment by using a variety of sensors; formats this weather data, processes it into digital and voice signals, and disseminates this data to telephones, computer terminals, storage devices and radio transmitters. This data can then be intercepted by pilots in the air from a navigational aid or a dedicated frequency channel; by users on the ground by telephone, personal computer, or by monitoring an appropriate navigational aid or dedicated frequency channel. The AWOS is an unbiased weather observing system that performs without human intervention unless a manually augmented report is desired, generating a complete weather report each minute of every hour for 24 hours a day. Each AWOS has a group of sensor devices, a data collection module, a formatting processor and gateway module(s). The number of sensors that are associated with the AWOS is dependent upon the type, the purpose for which it is to be used, and the sophistication desired.

Sensory Devices

Presently, there are four types of AWOS. They differ by their degree of sophistication (type of sensors). AWOS-A is the least sophisticated and the AWOS-3 is the most sensor laden system. Categorizing the types of AWOS with the appropriate sensors creates the index presented earlier in Table 2-6. Additional sensors may be added to each AWOS-type dependent on certification by the FAA.

Data Collection Module

This unit receives the data from the sensors and along with the processor formats and controls the information and prepares it for dissemination.

Formatting Processor

In printed form, the AWOS report resembles the present NWS report. The same information can be disseminated by a near-human voice synthesizer. This synthesized voice broadcast is especially practical for transmission to pilots because the voice quality from each AWOS remains constant. The details of the AWOS report are also summarized in the earlier Table 2-5.

Gateway Module (Dissemination Group)

The weather information (report) with the help of the gateway module(s) can be accessed by a variety of communications types and users. The information can be dispatched to a user via a telephone, data terminal, digital printer and ground-to-air transmitter. The mediums that are available are telephone, UHF/VHF

radio, microwave link and other communications transmission means including geostationary satellite telemetry.

The user has several reception options:

1. Random interrogation. The user requests the information whenever desired.

2. Pre-selected time intervals. The user receives the data those times that previous arrangements have been made; equipment has been provided for by the user; the reception is automatic.

3. Random dependent intervals. The user receives the information when certain parameters have been reached. The user will receive the data automatically.

4. Alert signals can be programmed into each of the reception intervals.

Output Modes

The output mode of the AWOS report is controlled by one of four modes of operation. Mode 1 is the full-time automated response without a weather observer input to the observation report, unless an agreement with the NWS is in effect to maintain a manual backup capability. Mode 2 is a full-time automated operation with provision for local input of notice to airmen (NOTAM). The NOTAM is appended verbally to the AWOS broadcast and addresses items related to the operation of the airport. The NOTAM is not transmitted digitally to the weather data collection network. A third mode of operation provides for a full-time automate response with manual augmentation of the weather report and an option to include NOTAM information. Both verbal augmentation and manual entry into the weather data network is permitted. Mode 4 is termed part-time manual and is normally used for backup. The intent is to allow a weather observer to enter a complete manual observation which modifies the AWOS report to certain other NWS standards. The manual entry is broadcast as well as distributed over the weather data network.

Operationally, Mode 1 is the standard and the manual augmentation must be made by a NWS-certified observer. Modes 2, 3 and 4 require that the AWOS be equipped with an operator terminal with which the inputs can be made. Modes 3 and 4 also require that the location be designated as a supplemental aviation weather reporting station (SAWRS) by the NWS and that the observer be NWS-certified.

For the purposes of this plan, the AWOS requirements should have the capability to meet Mode 2 standards unless the airport in question opts to certify observers in which case Modes 1, 3 and 4 are applicable.

ASOS Background

ASOS represents the NWS response to automating the collection of certain weather data. The ASOS includes all those sensors that comprise the AWOS-3 and, to meet additional data requirements specific to the NWS, other sensors complement the ASOS unit. These include a precipitation identification sensor that is capable of distinguishing between light, moderate and heavy rains or snow; or mixed precipitation. This sensor data is also referred to as the present weather sensor. A second additional sensor to the ASOS is the freezing rain sensor. Some sensors on the ASOS are designed to more stringent performance specifications than those required in the AWSO family. Consequently, the cost of the ASOS is nearly three times that of the AWOS-3.

Appendix

G

PROJECT ADVISORY COMMITTEE MEETING MINUTES

The following pages present the minutes of meetings held by the Project Advisory Committee during the course of the Study. Three meetings of the Committee were held. Members of the Committee received draft copies of the working papers and reports prepared for review and comment prior to each meeting.

NAVIGATIONAL AIDS AND AVIATION SERVICES SPECIAL STUDY

PLANNING ADVISORY COMMITTEE MEETING #1 MINUTES

MEMBERS PRESENT

Stacy Howard, AOPA
Wayland K. Adams, Honeywell
Denis Kelleher, Honeywell
Roger Sims, Sawyer Aviation
Sean Jeralds, Embry-Riddle
Skip Paschke, Phoenix TRACON
Gary Adams, ADOT Aeronautics
Glen Wilson, ADOT Aeronautics
Ray Boucher, ADOT Aeronautics
Mike Covalt, AZAA
Jerry Gleich, Allied Signal
Arv Schultz, Arizona Flyways
Ron Price, QED

MEMBERS ABSENT

Michael Lewis, Mesa Airlines
Joe Gibson, AIREvac
Jim Timm, AAA
Roger Carlin, HAI

The first Planning Advisory Committee (PAC) was held at 1:30 PM, August 5, 1997, in the Executive Conference Room at the Arizona Department of Transportation (ADOT), in Phoenix, Arizona. Following is a brief resume of the meeting and the subjects discussed:

A. Welcome by Gary Adams, Director, Aeronautics Division: Mr. Adams discussed the uniqueness in this study in comparison with other studies of this nature in that the State will be seeking some guidance on what the "customers" (pilots, fixed base operators, airport managers, etc.) desire from the State. A major portion of the study will be spent on determining what these needs are, determining the best way of providing them, building a plan to deliver these needs and then organizing the resources to deliver the equipment or services to the "customers".

B. Ron Price, Principal, QED, Aviation & Airport Consultants, provided a short sketch of his background and experience in developing studies of this kind and alluded to the uniqueness in making the users of navigational aids and services a part of the study. He then discussed the major objectives of the study, the existing working papers and what the PAC can expect at the next meeting.

C. Existing System Facilities:

1. The initial working papers provided an inventory of the States navigational aids and determined that all but 2 terminal aids (NDB, VOR, ILS, etc.) are maintained by the federal agencies. Notable exceptions are Nogales and Scottsdale NDB's and Avra Valley, Lake Havasu City, Colorado City, Chandler, Ryan Field, Sedona

and Taylor AWOS-3's. On the contrary, most all of the landing and lighting aids at airports in the State are maintained by the airports. Notable exceptions are the approach lighting systems at the airports with ILS approaches that are maintained by the FAA or military and some VASI and REIL systems.

2. The working papers described the salient characteristics of each navigational aid and communication system used in the State as well as the weather equipment. There were a few AWOS and NDB facilities awaiting frequencies in order to be placed within the system. The National Weather Radar system provided nearly 90 percent coverage of the State with noticeable weak coverage in the southeastern areas and the "Four Corners" area.

B. Forecasts of Aviation Activity: Refer to the working papers.

C. Technological Assessment:

1. The full spectrum of GPS and the FAA's approach to the new technology were discussed. Important points to consider are FAA's intention to divest itself of maintaining all navigational aids by 2010. The schedule listed in the working papers is considered preliminary as many political as well as technical issues have to be resolved. But the GPS systems, WAAS and LAAS, are planned for deployment as soon as the vendors can provide the equipment. In the meantime, the SCAT-1 system is being employed at a few airports to accommodate needs of some of the users who cannot wait for a precision approach where conventional ILS does not provide a suitable signal. FAA is not very supportive of the SCAT-1 system but will consider it on a case -by-case basis. SCAT-1 may be viewed as an interim solution until LAAS is operational.

2. AWOS-3 facilities output can be transmitted to the federal weather circuits when certain protocols are met. ASOS units located at towered airports do not broadcast observations when the tower is in operation. As the State initiates an upgrade to its telecommunications system, there may be opportunities to link non-federal AWOS units as well as similar systems such as roadway weather information systems, to serve the wide variety of weather users in Arizona. This data can also be routed to the federal weather circuit.

3. We see the distinction between non-precision and precision instrument approaches diminishing within the GPS technology. The capability to provide precision instrument approach capability at an airport will not be the limiting factor. Terrain, obstructions, inability to meet minimum separation standards, etc. will be the determinants in whether or not a precision approach can be obtained at an airport. Equipment, both ground and aircraft, will not be the limiting factors. These factors will be assessed in the next working paper and weighted to determine priorities and resources required.

D. Discussion: There might be a problem with traffic congestion at Prescott created by the high level of student pilot training and the regular traffic to Ernest A. Love Field. It appears many solutions are available but not all interested parties are agreed on any action plan. A radar facility has been proposed that could satisfy traffic at three airports (Flagstaff-Pulliam, Grand Canyon National Park and Ernest A. Love Field).

E. Working Paper Two: Next meeting the following subjects will be covered:

1. Visual Aid Requirements
2. TERPS Requirements
3. Communications Requirements
4. Survey Results

Enclosed is a comment sheet for you to indicate any corrections/comments you wish to make on the first Working Paper. We encourage you to make any comments you wish and we will do our best to accommodate them or indicate to you why we did not. An updated PAC list (we apologize for the misspelled names in the previous submittal) is also enclosed.

Ron Price, QED

RB/rp

Enclosures

NAVIGATIONAL AIDS AND AVIATION SERVICES SPECIAL STUDY

PLANNING ADVISORY COMMITTEE MEETING #2 MINUTES

MEMBERS PRESENT

Richard Dawson, AIREvac
Wayland K. Adams, Honeywell
Burnie Rundall, Allied Signal
Roger Sims, Sawyer Aviation
Sean Jeralds, Embry-Riddle
Jim Timm, APA
Gary Adams, ADOT Aeronautic
Ray Boucher, ADOT Aeronautics
Darrell Purcell, AZAA
David Pankoutz, Allied Signal
Ron Price, QED
Harry Wolfe, MAG Transportation

MEMBERS ABSENT

Arv Schultz, Arizona Flyways
Stacy Howard, AOPA
Skip Paschke, Phoenix TRACON
Roger Carlin, HAI
Michael Lewis, Mesa Airlines
Denis Kelleher, Honeywell

GUESTS

Jim Mc Cue, Glendale Airport Manager
Mark Meyers, Mesa-Falcon Field
Arnold Pokorski, Phoenix-Sky Harbor

The second Planning Advisory Committee (PAC) was held at 1:00 PM, February 6, 1998, in the Board Room at the Arizona Department of Transportation (ADOT), in Phoenix, Arizona. Following is a brief resume of the meeting and the subjects discussed:

A. The meeting was opened by Gary Adams, Director, Aeronautics Division. He emphasized that one of the outcomes of the meeting was to achieve a consensus on the criteria used to evaluate the GPS approaches for airports in Arizona.

B. Ron Price, Principal, QED, Aviation & Airport Consultants, provided a short synopsis of the first meeting and the initial draft working papers. He then discussed the major objectives of the study, the existing working papers and what the PAC can expect at the next meeting.

C. Comments from PAC:

1. Wayland Adams, Honeywell, provided an update on the WAAS/LAAS and DGPS programs from the FAA perspective. DGPS, as currently approved by the FAA, can achieve minimums down to and including 250 feet and 1/2 mile. FAA has indicated that they will approve lower decision heights for DGPS systems down to 200 ft for future installations. The Honeywell system CAT 1 DGPS can be purchased at a cost of 390K. Installation, on average, will cost about 100K and the total system about 500K. LAAS is planned for implementation in 1999 with CAT 3 approaches to begin in 2003.

2. The PAC indicated that there was a shortage of instrument approach practice facilities in the northern part of Arizona and we should consider this aspect in the NAVAIDS study.

3. In prioritizing IFR approach facilities, access to particular airports for medical emergency should be placed in the list of priorities. Helicopter operations into facilities at night and in IFR weather are extremely limited by a lack of IFR approaches lighting, services, etc.

4. Heliports were not reviewed in the study nor are there any IFR facilities setup for helicopters, especially in the northern region. This needs to be looked into in the next study.

5. Approval of the airport analysis for GPS approaches: The committee agreed to use the FAA TERPS and Airport Design guidelines to determine the ability of airports to meet GPS criteria.

6. The committee agreed to the criteria that all commercial service airports and Relievers should be programmed for GPS precision instrument approaches (CAT 1, 200 ft and 1/2 mile visibility).

7. The committee approved the criteria that all other paved runway, public use airports in the State should be reviewed for non-precision instrument approaches (300 ft and 3/4 mile; 400 ft and 1 mile). The committee also approved adding all active Native American Airports. The following airports will be included in the inventory of airports to be analyzed: Chinle, Grand Canyon West, Lukachukai, Pine Springs, Polacca, Rock Point, Rocky Ridge, San Carols and Shonto.

8. Air Services: The major items coming out of the Air Services questionnaires were:

(1) Pilots desired an Arizona Aeronautical Chart with airport diagrams and appropriate information.

(2) Pilots requested electronic connection to ADOT Aeronautics Airport database through a web-site or a disc containing airport 5010 and other useful information.

(3) Pilots requested more information seminars on subjects such as how the Aviation Revenues are distributed/used, aviation safety and aviation information in general.

9. The following text changes to the Working Papers were recommended and will be addressed in the final documents:

a. Glendale Airport: Revise Tables 5-3, 5-5 and 5-6.
b. Stellar Airport: Obstruction to Rwy 35 not indicated.
c. Review Williams-Gateway Peak Hour IFR operations.
d. Provide an explanation/definition of the Groupings in the text prior to introducing the Groupings in a table.
e. Expand the section on Differential GPS (Page 5-65) based on the briefing by Mr. Adams.
f. Figure 5-1: Indicate any existing military airport GPS coverage and include a footnote that the GPS is available only with prior permission or in an emergency.
g. Figure 5-2: Note the area without coverage with a shade/color and note that GPS coverage is/is not provided by airport(s) in other states. Include military airport GPS coverage .
h. For more clarity, change titles of Tables 5-7 and 5-4 to "Non-alphabetical Sort". Place footnotes on each page of a table, not just the last page.
i. Table 5-7: Add a footnote indicating that new airports are assumed to meet the requirements of an IAP.

The meeting closed with a discussion of the subjects for the next PAC.

Ron Price, QED

RB/rp

NAVIGATIONAL AIDS AND AVIATION SERVICES SPECIAL STUDY

PLANNING ADVISORY COMMITTEE MEETING #3 MINUTES

MEMBERS PRESENT
Arv Schultz, Arizona Flyways
Stacy Howard, AOPA
Skip Paschke, Phoenix TRACON
Glen Wilson, ADOT
David Bostrom, Embry-Riddle
Tom Rabourn, APA
Gary Adams, ADOT Aeronautic
Ray Boucher, ADOT Aeronautics
Darrell Purcell, AZAA
Ron Price, QED
Harry Wolfe, MAG Transportation

MEMBERS ABSENT
Richard Dawson, AIREvac
Wayland K. Adams, Honeywell
Burnie Rundall, Allied Signal
Roger Carlin, HAI
Michael Lewis, Mesa Airlines
Denis Kelleher, Honeywell

GUESTS
Greg Chenowith, Chandler Arpt Manager
Charlie Mangum, Mesa-Falcon Field
Arnold Pokorski, Phoenix-Sky Harbor

The third Planning Advisory Committee (PAC) was held at 1:00 PM, July 28, 1998, in the Board Room at the Arizona Department of Transportation (ADOT), in Phoenix, Arizona. Following is a brief resume of the meeting and the subjects discussed:

A. The meeting was opened by Gary Adams, Director, Aeronautics Division.

B. Ron Price, Principal, QED, Aviation & Airport Consultants, provided a short synopsis of the previous meetings and the draft final working papers. He then discussed the activities that have been conducted subsequent to the last PAC meeting:

1. Pilot Information Meetings: Although well publicized, they were not well attended, however, the comments received were constructive. Among the suggestions were:

a. Incorporate reflective material in the paint used to mark movements surfaces on an airport.

b. Improve the number of Recreational Airports in the State.

c. Publish the "State Map" and include airport directory information.

d. Place an RTR facility on the top of Navajo Mountain as communications in this area are marginal.

e. Provide a practice GPS approach facility in the phoenix metropolitan area.

f. Promote and inform airports/sponsors about low interest loan program.

g. Pilots complimented ADOT Aeronautics for allowing them an opportunity to provide input in the study.

C. Ron Price then went over the highlights of each new Chapter submitted in the final draft. In sequential order, the following comments were recorded:

1. Comments from the PAC on Chapter Six:

a. The PAC agreed to the minimum standard guidelines with one exception. Add lighted segmented circle to the minimum standards.

b. Yuma International is listed as a GA airport in Table 6-2, page 6-8.

2. Comments from the PAC on Chapter Seven:

a. Clarify the text to indicate the 25 mile radius of the "circles" used in the exhibits in this chapter represent radio transmission range, not weather data range. Weather data is only appropriate for on the airport.

b. How many AWOS-3's can be contacted by phone? Indicate in the text or table which ones ***do not*** have a telephonic connection.

c. Flight Service Stations (FSS) obtain their weather information from NWS, and not from monitoring the State's ASOS/AWOS facilities. This limits the weather data available to the FSS as only a few ASOS's communicate with NWS.

3. Comments from the PAC on Chapter Eight:

a. Include a requirement for an RCO facility in northern Arizona between Prescott & Flagstaff, preferably on or near V-12 airway.

b. How much does a GCO cost ? Answer: $10,000.

c. Review the operational data on Memorial Airfield. It is difficult to understand how an airport that is closed and generating very little activity can obtain a cost-benefit ration of "1". (NOTE: Don't eliminate the airport from consideration for a GCO if other factors besides cost warrant the installation.)

d. Were cellular phones considered as economical alternative to a GCO? Answer: No. Further study of this issue may be required.

4. Comments from the PAC on Chapter Nine: Discussion on the aviation services assessment was that some of the suggestions offered by users of airports may not be within the ability of ADOT Aeronautics to control (wash racks, hangars, etc.).

Aeronautics may be able to promote their use/installation but the airport itself is primarily responsible for obtaining these facilities.

5. Comments from the PAC on Chapter Ten: Discussion centered on what factors/steps should be accomplished to obtain a State weather network. Not enough detail was given in the text as to what agencies/resources existed within the State (existing facilities, points of contact, type of equipment, etc.) to allow Aeronautics to determine the feasibility of establishing a Statewide weather network. This chapter dealt with a "generic" concept and needs to be specific to what is available in Arizona.

6. Comments from the PAC on Chapter Eleven: In the Tables developed for the information disseminated in this chapter, a factor was used to diminish the impact of the forecast data used to determine the staging of facilities and costs. Forecast data may not be very accurate, especially when it exceeds five years from the base year. To diminish the effect of long range forecasts over a 20 year period, the staging for facilities was reduced to a ten-year planning period. In other words, if an airport was not *forecast* to need a facility until the end of the 20-year planning period, that facility would be programmed to be installed in a maximum of 10 years from the time of the study.

7. GENERAL COMMENTS:

a. The Transponder Landing System (instead of a precision instrument GPS) was programmed to be installed at four airports in Arizona. These were not indicated in the text and need to be included in Chapter 11.

b. The FAA's current F&E program for Arizona needs to be included in the document as an appendix or addendum to the Tables in Chapter 11.

c. In the prioritization of navaid equipment during the 10-year planning period, communication associated equipment needs to be given highest priority among the navaids.

d. In the executive summary and/or text of the document we need to discuss the "finding" that the Northeast are of the State is the weakest in navaid facilities and what steps should be taken to improve navaid coverage in the area.

The meeting closed with a request to the PAC members to submit their comments no later than August 10 in order to allow the QED adequate time to correct/ammend the final document. Gary Adams thanked all the PAC members for their support and input during the study and stated that it was an essential and important factor to the successful conclusion of the Navaids and Aviation Services Study.

Ray Boucher, Aviation Program Analyst

Enclosures

August 10, 1998

Mr. Ray Boucher
Arizona Department of Transportation
Aeronautics Division
1833 W Buchanan St
Phoenix AZ 85007-3335

Dear Ray:

Thank you for including AOPA as a member of your advisory team for ADOT's Navigational Aids and Aviation Services Special Study.

The Navaids Study reveals a host of facilities and services which could be provided all or in part by ADOT Aeronautics Division. Recent changes in the amount of funding to the department, however, will make state participation in these improvements difficult if not impossible It is essential that funding levels for the State Aviation Program be restored to pre 1998 levels to assure that planned airport projects and recommended improvements to navigational aids and aviation services are implemented, and that the time, money and talent expended on this study is not wasted.

Instrument Approach Procedure Analyses
I agree with study conclusions for establishment of GPS-IAP improvements at **Libby**, **Page** and **Showlow** airports. System area coverage for the State of Arizona justifies proposed improvements at these airports. The state should also consider that **Tuba City** is an important airport for medical transport and provides critical relief services to the reservation during heavy winter storms. The cost/benefit ratio of improvements at Tuba City could easily be out weighed by system need. In light of recent FAA efforts to reduce IAP capability at **Yuma**, and because Yuma is the only airport in southeast Arizona which currently has an ILS, I believe the study should weigh in more heavily on the continuing need for precision an IAP at this airport.

AWOS
State Aeronautics could play an important part in the national AWOS program to assure that AWOS installations meet the system needs of the state as opposed to providing minimal reductions to DH at metropolitan reliever airports. We endorse new AWOS installations as depicted in Figure 7-5 to provide maximum coverage and utility, and believe they should be coupled with state sponsored education programs to inform pilots about the usefulness of this improved AWOS system as a tool for interpreting current weather and weather trends along their route of flight.

Remote Communication Outlet Requirements
As with GPS-IAP and AWOS, we believe ground based remote communications outlets could significantly improve Arizona's airport system, however, the candidate list as provided by the study should be revised based upon more current data.

Aviation Services Assessment

Telephone - The study indicates that telephone service is a capability which appears to be well accommodated. The exception to this is Tuba City. This airport is frequently used for Life Flight operations and it's location several miles out of town warrants the installation of telephone service. The state could play a role in funding such service directly, or encouraging tribal funding of telephone service.

Education Seminars/Publications - We support the involvement of ADOT Aeronautics in pilot education and information programs. This is an area sorely neglected by State Aeronautics in recent years. Partnering activity as suggested by the study could be accomplished through the FAA Aviation Safety Program, AOPA Air Safety Foundation and others. Through partnering, educational programs meeting the specific needs of Arizona pilots could be provided at considerable savings when compared to programs funded solely by the state. Criteria and curriculum outlines can be developed by the state and supplied to prospective service providers.

Weather Data Network

The concept of a weather data network is appealing, and we would support state investigation into such a program, but only after above recommendations for improving GPS and AWOS systems have been met. Current policies within the NWS make establishment of the system as described in the study a far in the future possibility

Implementation Program

The implementation program for both GPS procedures and AWOS installations should be influenced more than the four factors suggested in the study, i.e. dependence upon WAAS, ability of airports to mee design standards, economic justification, and further standards surveys. A fifth factor should be added to the list which considers contributions selected approach and AWOS improvements can make to overall aviation safety. Surrounding terrain, distance from suitably equipped alternate landing sites, and the airport's propensity for inclement or rapidly changing weather should also influence and airport's priority rating in the staging program. By applying this additional criteria, airports such as **Laughlin/Bullhead, Libby AAF/Sierra Vista, Page Municipal, Showlow Municipal, Tuba City and San Manuel**, could easily move into an earlier stage of system development.

Sincerely,

Stacy Howard
Western Regional Representative
Aircraft Owners and Pilots Administration

Appendix

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PILOT INFORMATION MEETINGS

Pilot information meetings represent another means of seeking user input to the development of the Navigational Aids and Aviation Services Special Study. Separate pilot information meetings were held consecutively in Flagstaff, Phoenix and Tucson to present the goals, objectives, planning approach and preliminary findings and recommendations of the Study. Announcements of the meetings were disseminated to airports statewide as well as placed in the "Arizona Flyways" magazine. Those airports that hosted the meetings (Flagstaff-Pulliam, Glendale Municipal and Tucson International) also distributed the meeting bulletins to their tenants and persons on their mailing lists. Each meeting attracted pilot interest and the sessions generated certain comments appropriate to the purpose of the Study. These included:

1. More use of reflective paint on aircraft movement areas.

2. Promoting the use of the more remote airports for camp sites as was done at the Payson Airport.

3. Re-publication of the Arizona Aeronautical Chart.

4. Establishment of a remote transmitter/receiver at Navajo Mountain to enable en route voice communications with air traffic control.

5. The establishment of more GPS approaches offer additional opportunities for practice and training, especially in the Phoenix area.

6. There is a need for more aircraft storage protection, preferably sun shades (in the Phoenix area).

7. Expansion of the State's funding program to include participation of private sector investors at public-use airports. Additionally, there is a need for increased promotion of the funding program.

8. Support for balancing airport and aviation system needs with operational and safety benefits and the costs to implement improvements.