Preparing Busy General Aviation Airports for Next Generation Technologies

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PSRC

SeaTec
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For additional information or to obtain copies of the *Preparing Busy General Aviation Airports for NextGen Technologies* report, go to www.psrc.org/transportation/airtrans/nextgen/ or contact the Puget Sound Regional Council's Information Center at 1-206-464-7532 or infoctr@psrc.org

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Contents

Chapter 1 Background and Project Purpose

The Puget Sound Regional Council's (PSRC) mission is to ensure a thriving central Puget Sound through planning for regional transportation, growth management and economic development. PSRC collaborates with the central Puget Sound counties (King, Pierce, Snohomish and Kitsap), cities and towns, ports, tribes, transit agencies, and the state to develop policies and make decisions about regional issues.

The PSRC works with local government, business and citizens to build a common vision for the region's future, expressed through three connected major activities: VISION 2040, the region's growth strategy; Transportation 2040, the region's long-range transportation plan; and Prosperity Partnership, which develops and advances the region's economic strategy.

Transportation 2040 is an action plan for transportation in the central Puget Sound region for the next 30 years. By the year 2040, the region is expected to grow by roughly 1.5 million people and support more than 1.2 million new jobs. All of these new people and new jobs are expected to boost demand for travel within and through the region by about 40%. Recognizing that some uncertainties exist regarding the economy, transportation funding, energy supply, technology and climate change, Transportation 2040 outlines a long-term template for how this region should invest in transportation to accommodate rising travel demand, while at the same time embracing the need to be flexible and responsive to the ways people – and the world – actually will change.

Transportation 2040 identifies investments to support the region's expected growth and improve the service transportation provides to people and businesses. The plan lays out a financing strategy that suggests a long-term shift in how to fund transportation improvements, with more reliance on users paying for transportation improvements. The plan also proposes a strategy for reducing transportation's contribution to climate change and its impact on important regional concerns such as air pollution and the health of Puget Sound.

In 2006 the PSRC published the Regional Air Cargo Strategy report, which identified a strategic approach intended to guide airport sponsor and industry investments at the region's airports and to coordinate investments in the regional intermodal transportation system to better meet the region's future air cargo needs.

In 2011 the PSRC published an update to the Airport Compatible Land Use Program Report which identified planning measures designed to prevent incompatible urban development by evaluating existing and planned land use impacts on the region's 28 public-use airports. In Washington, all airports that have general aviation activity are considered general aviation airports, including Sea-Tac. Planning to discourage incompatible uses adjacent to general aviation airports is mandated by the State Growth Management Act (RCW 36.70A.510) and the State Planning Enabling Act (RCW 36.70.547).

This study, *Preparing the Region's Busy General Aviation Airports for NextGen Technologies*, presents a regional / system planning approach to identifying the General Aviation benefits that can be realized through the deployment and implementation of the Federal Aviation Administration's NextGen program.

Busy General Aviation Airports will benefit from substantial improvements in efficiency, access, surveillance, environment, and safety. Surveillance, situational awareness and safety will improve at airports with air traffic control radar services as the FAA deploys Automatic Dependent Surveillance-Broadcast (ADS-B) ground stations across the National Airspace System (NAS) and as they update their automation systems.

These NextGen based initiatives will provide efficiency and reliability improvements during inclement weather, and will relieve or eliminate conflicts among routes into or out of airports that are close to one another. At the busiest airports, air traffic controllers, operators and airport personnel will share surface situational awareness information to reduce taxi times collaboratively.

NextGen will make the national and regional airspace systems more flexible, enabling the FAA Air Traffic Managers to respond to changing demands on flight operations.

The premise of this PSRC NextGen study is to help the region's airports get ready for emerging aviation technology. The FAA has plans to publish Wide Area Augmentation System Localizer Performance with Vertical Guidance approach procedures for all suitable runway ends by 2016, and to implement additional Performance Based Navigation (PBN) capabilities at airports within the PSRC metropolitan area.

The implementation of NextGen technologies will allow more aircraft to safely fly closer together on more direct routes, reducing delays and providing unprecedented benefits for the environment and the economy by reducing carbon emissions, fuel consumption, and noise.

Although new satellite and aircraft technologies are the foundation of NextGen, the Puget Sound region's airports will need to be prepared in order to take advantage of the new system's benefits. The FAA defines specific criteria for airports to accommodate

NextGen-type technology, and these criteria may require some airfield modification to meet the applicable design standards. PSRC's NextGen project is designed to identify these improvements and help the region's airport prepare for and realize the benefits of emerging technology.

Taking advantage of new technology will require airports to meet FAA design standards. This report - *Preparing the Region's Busy General Aviation Airports for NextGen Technologies* - includes a system planning analysis of the following five tasks:

1. Identify busy general aviation airports where NextGen technology could be beneficial.
2. Inventory these airports to determine their preparedness to implement NextGen.
3. Identify airport design and operational deficiencies ("gap" analysis) that show the difference between existing airport conditions and FAA design requirements to meet NextGen criteria.
4. Develop a capital improvement plan (CIP) for each airport listing improvements to implement NextGen.
5. Identify individual airport NextGen strategies and PSRC system applications.

Scope of the Project

The primary goal of *Preparing Busy General Aviation Airports for NextGen Technologies* is to increase the utility of busy general aviation (GA) airports that already have precision approaches, and to facilitate the process of publishing new approaches at the busy GA airports that do not currently have at least one precision instrument approach procedure, or an approach procedure with vertical guidance (APV).

An additional goal of the project includes obtaining satellite-based APV approaches, preferably with minima of 1 statute mile and 350' height above touchdown (HAT) or better.

In order to accomplish this goal, airports must meet certain FAA design standards, including full-length parallel taxiway(s) at specified separation distance from the runway(s), a standard runway safety area (RSA), and other applicable criteria in Advisory Circular (AC) 150/5300-13, especially Appendix 16. Moreover, to qualify for procedures development, the airport (runway) must also meet FAA's Airports Graphical Information System (AGIS) survey and obstruction clearance criteria prescribed in the current editions of Advisory Circulars 150/5300-16, -17, and -18.

Through the course of this project, a thorough inventory of the busy GA airports in the PSRC area will be accomplished to document the existing conditions of each airport. At the conclusion of the inventory process, a gap analysis will be completed for each Busy GA Airport to identify the improvements needed to satisfy the criteria of Advisory Circular (AC) 150/5300-13 for publishing precision instrument approach procedures, or approach procedures with vertical guidance (APV).

The conclusion of the report will include an implementation plan or capital improvement program (CIP) for each busy GA airport specifically to document the resource needs to accomplish the improvements.

This CIP will not consider financial feasibility or other facility needs at the airports or the sponsors' existing CIPs. The CIP is purely a rough "order-of-magnitude" of the given project scopes with planning-level cost estimates necessary to meet criteria of the NextGen-type improvements.

Additionally, the CIP will include beneficial improvements that may be considered beyond the short term (5 year) planning period. These recommendations will describe longer term and "evolving" technology advancements relating to the broad range of issues being addressed by the FAA. For example: ADS-B (in and out), public PBN approach, departure and STAR procedures, potential GPS spectrum interference, virtual control towers, and other technologies may be included.

It is important to note, the individual airport sponsors will determine how these projects will fit with their own master planning recommendations, capital improvement plans, and their other priorities. It is anticipated that FAA will also use these results to identify potential candidates for discretionary funding to meet NextGen-type goals for busy GA airports.

Chapter 2 NextGen Overview[1]

At its most basic level, NextGen represents an evolution from a ground-based system of air traffic control to a satellite-based system of air traffic management. NextGen is a brand name or term commonly used to describe the ongoing transformation of the National Airspace System (NAS). This evolution is vital to meeting future demand, and to avoiding gridlock in the sky and at our nation's airports. NextGen will open America's skies to continued growth and increased safety while reducing aviation's environmental impact. These goals will be realized through the use of Satellite Navigation, Global Positioning System (GPS), and other new technologies.

NextGen is a comprehensive overhaul of our National Airspace System to make air travel more convenient and dependable, while ensuring flights are safe, secure and as hassle free as possible. The NextGen architecture is designed as a continuous roll-out of improvements and upgrades allowing the FAA the capability to guide and track air traffic more precisely and efficiently in order to save fuel, reduce noise, and reduce pollution.

NextGen has beneficial impact on all three aspects of operation in the NAS: Communication, Navigation, and Surveillance (CNS).

Through the implementation of NextGen based improvements, traveling by air will be more predictable. There will be fewer delays, less time waiting on the ground, less time holding in the air, and more options and flexibility to navigate around hazardous weather problems.

The implementation of NextGen technologies will reduce aviation's impact on the environment. Flying will be quieter, cleaner and more fuel-efficient. More precise flight paths help minimize airport DNL noise contours and limit the amount of noise that communities experience.

The use of new / alternative aviation fuels, new and more efficient aircraft engines, and new Air Traffic Control procedures will cumulatively lessen the aviation industry's impact on the climate and environment.

[1] This section has been reproduced in part from the FAA web site http://www.faa.gov/nextgen

Safety is a key component of NextGen. NextGen focuses on getting the right information to the right people at the right time. Advanced safety management systems will enable the FAA, local and regional governmental agencies, and aviation industry partners, to better predict risks and thereby identify and resolve hazards.

NextGen data systems will help controllers and operators make better time sensitive decisions. And moreover, these data systems will assist operators in keeping employees and passengers better informed.

Our nation's economy and the Puget Sound region's economy depend on aviation. The pending NextGen improvements will lay a foundation that will allow for continuously improving and accommodating future needs of air travel while strengthening the economy with one seamless global air transportation system.

NextGen will help PSRC communities make better use of their airports. More robust airports can help the communities attract new jobs, help current employers expand their businesses, and help promote local tourism and regional attractions.

By implementing NextGen technologies the PSRC region economy will be strengthened and the local communities will realize the positive economic benefits fostered by private and commercial air service.

NextGen technology implementation will also assist the PSRC region's airports to fulfill their responsibilities and requirements of the national aeronautical security and threat awareness programs to ensure that private and commercial air travelers benefit from the highest levels of security and safety.

Chapter 3 The Details of NextGen

At a high level, the FAA NextGen program includes three broad areas of technological improvements that have been approved to transform the National Airspace System (NAS) from the current legacy infrastructure system into a new structure.

1. **Communication:**
   a. System Wide Information Management (SWIM).
   b. NextGen Data Communications
   c. Next Generation Network Enabled Weather (NNEW).
   d. NAS Voice Switch (NVS).

2. **Navigation:**
   a. WAAS
   b. Instrument Approaches (LPV, RNAV, & RNP)

3. **Surveillance:**
   a. Automatic dependent surveillance-broadcast (ADS-B)

NextGen Communication

System Wide Information Management (SWIM).

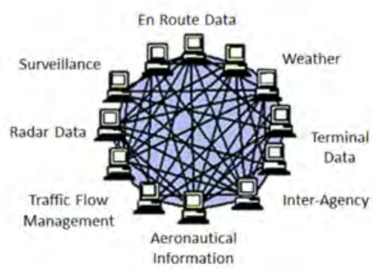
SWIM is designed to provide a single infrastructure and information management system that delivers high quality, timely data to many users and applications.

By reducing the number and types of interfaces and systems, SWIM will reduce data redundancy and better facilitate multi-user information sharing. SWIM will also enable new modes of real-time decision making because the information will be easier to access.

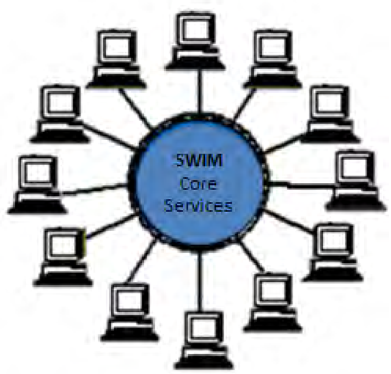
Currently, the state of the art for connecting two systems requires a fixed network connection and custom, point-to-point, application-level data interface. Current National Airspace System (NAS) operations depend upon these legacy information systems with some systems entirely unconnected. The FAA has identified a need to reduce the high degree of interdependence among systems and move away from the proliferation of unique, point-to-point application interfaces.

The need for broad information sharing among collaborating decision-makers has been described in the NAS Concept of Operations. The SWIM integration of NAS information systems, along with information from NAS users and other information producers, will benefit the NAS by ensuring the electronic exchange of information, allowing for seamless communications.

How SWIM Enhances Information Sharing



Current NAS Communications Technology



NextGen Enhanced Information Sharing

NextGen Data Communications

Currently, communications between aircrew and air traffic control, and between air traffic controllers, are largely accomplished through voice communications. Initially, the introduction of data communications will provide an additional means of two-way communication for air traffic control clearances, instructions, advisories, flight crew requests and reports. When the majority of aircraft are data link equipped, the exchange of routine controller-pilot messages and clearances via data link will enable controllers to handle more traffic. This will improve air traffic controller productivity, enhance capacity, and improve safety.

The Federal Aviation Administration (FAA) and its partners in the aviation industry are moving forward with the Data Communications program. The Data Communications program will improve and modernize our nation's aviation infrastructure.

The FAA's investment in Data Communications technologies is a critical step for improving air safety, reducing delays, increasing fuel savings, improving the environment, and leading U.S. aviation into the 21st century.

In today's National Airspace System (NAS) air traffic management depends on voice communications to relay a wide array of critical information between air crews and controllers. The use of voice communication is labor intensive, time consuming, and limits the ability of the NAS to effectively meet future traffic demand.

Data Communications will assume an ever-increasing role in air traffic control, ground management and flight crew communications. The introduction of Data Communications represents the first phase of the transition from the current decades old analog voice system to a predominantly digital mode of communication.

Data Communications will support the NextGen vision by providing data transmissions directly to pilots and their flight management systems. The new system will enable more efficient operations, including trajectory based routing, which allows air traffic control to managing flights strategically gate-to-gate.

Data Communications will support safety-of-flight command, control and information services by providing comprehensive data connectivity, including:

1. Ground automation message generation
2. Automated data transmission
3. Automated routing services

Data Communications will automate repetitive tasks, supplement voice communications with less workload-intensive data communications and enable ground systems to use real-time aircraft data to improve traffic management.

Data Communications will supplement existing voice communications and provide two-way data exchange between controllers and flight crews for clearances, instructions, advisories, flight crew requests and reports. Data Communications will provide comprehensive data connectivity for critical services and enhance air traffic safety with:

1. More timely and effective clearances.
2. More time for controllers and pilots to think and select appropriate actions.
3. More orderly communications during peak traffic.
4. More reliable messaging and reduced operational errors associated with voice communications.

The FAA's NextGen Data Communications program will allow the National Airspace System to handle more traffic, reduce flight delays, route aircraft more efficiently, and enhance safety, all while reducing operational costs for airspace users.

As Data Communications becomes the norm, the majority of pilot-controller exchanges will be handled by Data Communications for appropriately equipped users. The operations enabled by Data Communications will have the added financial benefits of reducing ground delays and significantly increasing fuel savings through more efficient routes and optimized profile descents. Reduced fuel use will have the important environmental benefit of reducing aviation carbon dioxide and other greenhouse gas emissions.

Next Generation Network Enabled Weather (NNEW).

Seventy percent of NAS delays are attributed to weather every year. The goal of NNEW is to cut weather-related delays at least in half. Tens of thousands of global weather observations and sensor reports from ground, airborne, and space-based sources will fuse into a single national weather information system that is updated in real time. NNEW will provide a common weather picture across the national airspace system, and enable better air transportation decision making.

NNEW is part of an interagency effort to provide quick, easy, and cost effective access to weather information. NNEW will define and provide the FAA's portion of the interagency infrastructure known as the 4-Dimensional Weather Data Cube (4-D Wx Data Cube). The 4-D Wx Data Cube will provide common, universal access to aviation weather data. All categories of weather users will have improved access to timely and accurate weather information to support improved decision making, while enhancing aviation safety.

The 4-D Wx Data Cube consists of:

1. Weather data published in various databases within FAA, National Oceanic and Atmospheric Administration (NOAA), and Department of Defense (DoD), as well as commercial weather data providers that may participate.
2. Registries/repositories needed to locate and retrieve published data.
3. The capability to translate among various standards that will be employed, and to provide data in user required units and coordinate systems.
4. The capability to support retrieval requests for data volumes (for example, along flight trajectories).

A subset of the data published to the 4-D Wx Data Cube will be designated the Single Authoritative Source (SAS). The SAS identifies the preferred data source that should be used to support collaborative air traffic management decisions and ensures that decisions are based on consistent data.

The NNEW Implementation Plan defines four needs for reducing weather impact in the NAS:

1. **Observation**: Users around the country will require a single, consistent, comprehensive picture of current weather, assembled from every available data source, which incorporates diverse data types. A National Weather Service worker on the West Coast should be able to view the same weather snapshot as a Department of Defense employee on the East Coast. Furthermore, this snapshot should be as complete as possible, incorporating data on precipitation, echo tops (cloud heights), storm motion, lightning, satellite infrared imagery, icing, and much more.
2. **Forecasting**: In addition to up-to-the-minute snapshots of current weather, users will also require comprehensive short and long term weather forecasts.

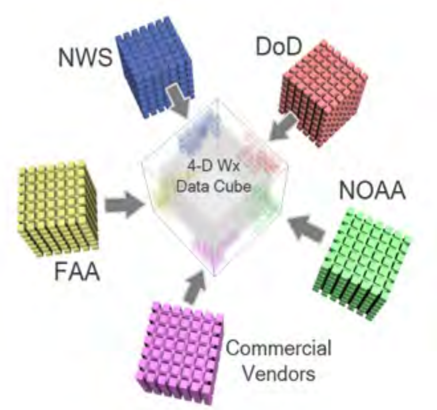
3. **Dissemination**: As the 4-D Wx Data Cube will be distributing a single, comprehensive picture of current weather to a wide variety of users, each of which may be using unique or proprietary software to read and interpret the Cube data, it will be built on a Service-Oriented Architecture (SOA). This design model allows users to plug their software system into the Cube's data stream, regardless of what operating systems they are using or what use they will put the data to.

4. **Integration**: To ease the strain on end users, rather than simply aggregating and disseminating weather data from thousands of source sensors, the data will be ready to integrate into other NextGen-related systems, such as arrival/departure management tools for air traffic controllers.

Development of the 4-D Weather Data Cube has been delegated to both the FAA and the National Weather Service (NWS). NNEW is an FAA funded program that exists to build the FAA's portion of the Cube and fulfill the dissemination need describe above. Additionally, the Cube will act as an enabler for integration by providing access to improved forecasts and observations.

The Four Dimensional Weather Data Cube

The Four Dimensional Weather Data Cube, or 4-D Wx Data Cube, is a virtual data repository of all weather information for any given point in space and time. Any NextGen user looking for up-to-the-minute weather observations or forecasts will connect to the 4-D Wx Data Cube in order to retrieve the desired data.



The key aspect of the 4-D Wx Data Cube is that it only exists virtually. In reality, data remains distributed among the source systems, while NNEW's software serves as a sort of data moderator. End users need only utilize NNEW services and standards to connect to the 4-D Wx Data Cube and find weather data; the Cube will in turn return the requested information available from among its networked systems.

In the above diagram, each of the colored cubes represents one or more file systems hosted by the:

1. National Weather Service (NWS).
2. Department of Defense (DoD).

3. Federal Aviation Administration (FAA).
4. National Oceanic and Atmospheric Administration (NOAA).
5. Other, commercial data vendors.

Data chosen for inclusion in the 4-D Wx Data Cube (the smaller, colored blocks) are "stored" virtually by the 4-D Wx Data Cube in the center. While the data actually still resides at the source, users can access the centralized "weather picture" from the 4-D Wx Data Cube.

Four Data Dimensions

The "4-D" in the term "4-D Wx Data Cube" refers to the weather data itself. A specific location's weather forecast is stored with four key pieces of data, one for each dimension. The three spatial dimensions are used to log the forecast's location - longitude, latitude, and altitude. The fourth dimension, time, is used to log the period over which the given forecast takes place. Thus, a piece of weather forecast data contains a given location's change in weather over a period of minutes or hours.

Single Authoritative Source

A subset of the data published to the 4-D Wx Data Cube will be designated the Single Authoritative Source (SAS). The SAS is that data that must be consistent (only one answer) to support collaborative (more than one decision maker) air traffic management decisions. The SAS provides a "common weather picture" to all users of the Cube.

NAS Voice Switch (NVS)

There are currently 17 voice-switching systems in the NAS; some have been in use for more than 20 years. **NVS** will replace these systems with a single air/ground and ground/ground voice communications system.[2]

The National Airspace System Voice Switch System program is a forward-looking program to replace national airspace system voice switches with a new technology switching system capable of supporting future requirements for the Next Generation Air Transportation System.

With a networked communication system that will be enabled by the NAS Voice System, controllers in Denver will be able to talk to airplanes over San Francisco. This will allow for better utilization of the controller work force. It will also provide a more robust system that will allow one facility to take over for another in the rare event that one facility becomes inoperable.

Future air traffic operations as envisioned by the Next Generation (NextGen) Air Transportation System will require a new voice communication system with flexible

[2] The NVS is currently in a planning phase but is scheduled to be operational by the year 2016.

networking capabilities. NVS will be the key voice communication component enabling program for the NextGen System.

The FAA conducted a study of voice switching, which concluded the current switch bases are old with looming supportability problems.

One of the key transformations with NVS is that air-to-ground voice communication will no longer be limited by geographical facility boundaries. This will allow for greater flexibility in developing and using airspace/traffic assignments in all airspace. NextGen voice communication paths will be controlled by an intelligent network.

Implementation of NVS

The FAA Voice Switching & Recording Group is located at FAA headquarters, and has been responsible for overseeing the development and deployment of solid state voice switches.[3]

A voice "switch" provides intercom, interphone, and radio communications via digitized voice and data buses. The voice switch provides voice communications between air traffic control positions and other local air traffic control positions or remote positions (through intercom functions), Air Traffic control positions in adjacent and remote facilities (through telephone functions), and with aircraft (through radio functions).

Radio communications are provided by push-to-talk voice switching that interfaces with standard radio transmitter/receiver equipment. The voice Switch interfaces with live lines, trunks, and radios associated with the intercom, telephone, and radio communications.

A diversity of voice switches are used in the Air Traffic Control tower, terminal, TRACON and ENROUTE environments to provide air-to-ground and ground-to-ground communication. The Voice Switch enables air traffic controllers to quickly select radio and telephone assets to give radio instructions to pilots to provide for safe aircraft separation and for weather-related flight plan adjustments.

The Voice Switching and Recording Group will support the Next Generation Air Transportation System by developing the National Air Space System Voice System (NVS).

Improvements provided by the National Airspace System Voice Switch System will benefit the FAA and the airspace user. Flexible access to communications assets will support dynamic response to various contingencies including: weather, equipment or facility outages (and other events that demand load balancing or sharing), dynamic airspace reconfiguration, or business continuity

[3] More than 527 solid state voice switches have been installed dating back to the mid-1980s.

planning operations. These operations lead, in turn, to a better balance of air traffic controller workloads and more efficient use of the airspace.

1. Improves ability of air traffic controllers to plan arrivals and departures far in advance.
2. Reduces the cost of the infrastructure needed to operate the National Airspace System.

NextGen Navigation

There are a number of NextGen technologies that enhance aircraft navigation to produce more accurate flight trajectories (flight paths), reduce pilot workload, increase flight efficiency, allow achievement of lower weather minima, and improve flight safety. The principle such technologies are derived from Wide Area Augmentation Systems (WAAS) of the GPS signals, Local Area Augmentation Systems (LAAS) of GPS signals, and application of Performance Based Navigation (PBN).

Based on data provided in the FAA's 2012 NextGen Implementation Plan, the following table shows the percentage of air transport category aircraft and general aviation aircraft that are equipped to operate using the capabilities made available through the NextGen technologies.

	Air Transport	General Aviation
RNP 10	58%	<5%
RNP 4	58 %	<5%
RNAV 1, RNAV2	92%	80%
RNP with RF	57%	<5%
LNAV/VNAV	45%	0%
LPV	<5%	30%
RNP AR	36%	<5%
ADS-B Out	0%	0%
Airborne/Ground CDTI	<5%	<5%
ITP	0%	0%
FANS 1/A (Satcom)	36%	0%
FANS 1/A+(VDL mode2)	12 %	0%
HUD /ILS	15%	0%
EFVS	<5%	<5%
FIS-B	0%	<5%

Wide Area Augmentation System

The Wide Area Augmentation System (WAAS) allows airports to obtain approaches similar to Instrument Landing System (ILS) without having to purchase or install ground-based navigation equipment at the airport. Currently, WAAS is already being used at airports across the U.S. to achieve minimums as low as 200' height above touchdown and ½ mile visibility.

WAAS Benefits to Airports

WAAS is a navigation service using a combination of Global Positioning System (GPS) satellites and the WAAS geostationary satellites to improve the navigational service provided by GPS.

WAAS improves the navigational system accuracy for en route, terminal, and approach operations over all of the continental United States and significant portions of Alaska, Canada and Mexico.

The WAAS navigational technology supports vertically guided instrument approaches to all qualifying runways in the U.S.

Vertically guided approaches are called LPV approaches, which stands for "localizer performance with vertical guidance" and are flown by pilots like an Instrument Landing System (ILS). LPV minimums can be as low as 200 feet at qualifying airports, and actual minimums are based on an airport's current infrastructure, as well as an evaluation of any existing obstructions. LPV approaches are published as "RNAV (GPS) RWY XX" charts with the LPV minima included in the chart minimums section.

Advantages of WAAS-enabled Approaches

The advantages of WAAS-enabled LPV approaches include:

1. LPV procedures don't require ground-based transmitters at the airport.
2. Navigation equipment is not required to be placed on the airport, eliminating the requirement of clear zones around the equipment, and providing access for equipment maintenance.
3. LPV approaches don't require protecting localizer and glideslope critical areas.
4. From a pilot's operational perspective, an LPV approach flies like an ILS.
5. WAAS equipped users can fly area navigation (RNAV) and basic required navigation performance (RNP) procedures, as well as LPV procedures.
6. General aviation aircraft are the primary users of LPV procedures with approximately 30% of the GA fleet equipped for LPV approaches.

Local Area Augmentation Systems

Local Area Augmentation Systems (LAAS) provide an even more accurate GPS signal for a specified area by correcting GPS errors through a ground installation of Ground Based Augmentation System (GBAS). GBAS and LAAS are primarily associated with major airports to produce lower weather minima approach procedures independent of ILS signals.

GBAS can support GLS approach procedures for all runways at an airport from a single ground system installation. GBAS will yield the high accuracy, availability and integrity necessary for Category II and III precision approaches. The FAA has elected to not install GBAS for Category I approaches. However, an airport can elect to install a non-federal GBAS for Category I approaches, as the Port Authority of New York and New Jersey has done at EWR.

The FAA, along with the international aviation community, is pursuing further development and validation of GBAS for Category II and III approaches. GBAS could augment the existing ILS Category II and III installations at airports throughout the NAS. System validation, including end-to-end system performance demonstration, is expected in 2014.

Performance Based Navigation Systems

One of the NextGen technologies is called Performance Based Navigation (PBN), an application of GPS-based flight procedures that encompass all phases of flight, including Arrivals, Approaches, Missed Approaches, and Departures. PBN procedures require special equipage of aircraft avionics, currently standard on transport category and high-end general aviation aircraft.

Modern navigation receivers and processors in recent versions of small general aviation aircraft have the processing power and calculating algorithms that apply to PBN procedures. Currently, special pilot training is required for PBN procedures, although over the next few years, PBN procedure usage may become a standard competency within the training programs for instrument-rated pilots. The level of precision provided by a PBN procedure is specified as the Required Navigation Performance (RNP) and is expressed as the required performance of the system in Nautical Miles in its ability to calculate aircraft position. Hence, a PBN flight procedure with an RNP of 0.3 will calculate aircraft position within 0.3 nautical miles from the reference trajectory or path.

RNP approaches are published as "RNAV (RNP) Y RWY XX" with the RNP level specified in the minimums section of the chart.

Currently, the overall FAA strategy, in collaboration with the aviation industry, has been towards publishing RNAV approaches everywhere, and publishing RNP approaches where they would be beneficial. According to 76 FR 77939, "The FAA plans to transition from defining airways, routes and procedures using VHF Omni-directional Range (VOR) and other legacy navigation aids (NAVAIDs) towards a NAS based on Area Navigation (RNAV) everywhere and Required Navigation Performance (RNP) where beneficial."

Advantages of RNP procedures

1. PBN (RNP) procedures provide a path that can be linear or curved, thus allowing a trajectory that avoids terrain, airspace conflict areas, community noise sensitive areas, or politically mandated avoidance areas. RNP procedures are particularly useful in resolving such conflicts for departures.
2. RNP technologies provide the pilot with alert signals if the Actual Navigation Performance (ANP) exceeds the RNP.
3. The airspace occupied by a RNP approach procedure is rectangular and does not increase in width with distance from the airport served. This is a contrast from ILS, LPV, and LNAV/VNAV approaches that occupy a trapezoidal airspace sector that becomes wider with distance from the airport. Thus, RNP approach and missed approach procedures make more efficient use of airspace.
4. From a pilot's operational perspective, a RNP approach flies like an ILS.

Airport Managements' Role

Even though no navigational equipment is necessary on the airport for LPV and RNP procedures, there are requirements that an airport manager needs to consider prior to having an LPV or RNP approach published.

Even without locating navigation equipment on the airport, compliance with the FAA airport design standards of AC 150/5300-13 will be necessary. Because a new published LPV or RNP approach may improve the existing capability of an airport, the airport infrastructure may require upgrading to accommodate the new procedure. An evaluation should be performed to determine if further actions, such as land acquisition, obstacle clearing, and upgrading the runway markings are required to achieve the full benefit of the LPV or RNP procedure. Once the scope of the infrastructure needs are understood, the local FAA Airports Office and the Airport Manager can discuss the feasibility of implementation of the approach, along with options for funding the needed improvements.

The FAA plans to publish LPVs to all qualified runway ends in the National Airspace System by 2016, and the FAA Navigation Services may decide to conduct surveys at airports with Facilities and Equipment (F&E) funding.

The Gap Analysis section and Capital Implementation Planning sections of this report discusses the needed improvements and funding requirements for the PSRC Busy GA Airports to obtain an LPV or RNP instrument approach with a 350' Height Above Touchdown (HAT) with one mile visibility requirements.

Determining Minimums

There are several factors that determine the minimums for an instrument approach, and implementing a NextGen (LPV or RNP) approach is no different.

Two primary factors are the obstructions surrounding the airport and the existing airport configuration or layout.

1. The height above touchdown (HAT) of the LPV or RNP approach is based exclusively on the obstacles (natural or manmade) and how close they are to penetrating the glide slope and obstacle clearance surfaces of the approach. Many times, these obstructions are beyond the control of the airport manager and will affect the HAT for the approach. For example, trees or obstructions located outside the boundaries of the airport property typically require purchasing the property or an avigation easement in order to remove the obstruction.

2. The visibility requirement for an instrument approach is partially dependent upon the airfield layout and infrastructure. Achieving the lowest visibility requires approach and departure paths without obstructions and an appropriate airport system to support the approach.

Airport infrastructure requirements are based on desired minimums and the Airport Reference Code (ARC) for runway length, lighting, and all-weather markings, airport dimensional standards, such as runway-taxiway separation and the need for a parallel taxiway.[4]

Survey Requirements

After the airport infrastructure needs have been determined, the next step is to collect the appropriate airport data to develop the instrument approach.

New instrument approach procedures (IAP) require accurate airport data meeting FAA requirements. The data collection effort begins by reviewing the guidance provided in the following FAA advisory circulars:

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[4] See Advisory Circular 150/5300-13.

AC 150/5300-16[5]
AC 150/5300-17[6]
AC 150/5300-18[7]

Advisory Circular -16a provides guidance for establishing Primary and Secondary (PACS and SACS) geodetic control. AC-17b describes the methodology for acquisition and use of aerial imagery and AC-18b details survey data acquisition standards as well as GIS feature collection and data attribution.

Using the guidance provided in the FAA Advisory Circulars, airport managers can determine what information it currently has and what information they need to collect or update.

With the requirements determined, the airport sponsor is in a position to start the process of collecting the required survey data. Typically, most airports will require a new high accuracy survey to gather the most current data on the airport and obstacles surrounding the airport. The instrument approach development process cannot begin until the survey data is provided and verified. The FAA procedure development and publishing process requires a considerable amount of time, which can range between 12-18 months.

Procedure Application Process

Once the survey data is collected, the airport manager should submit an official request for development of the procedure to the FAA. The application process is a straight forward process and available on the World Wide Web at:

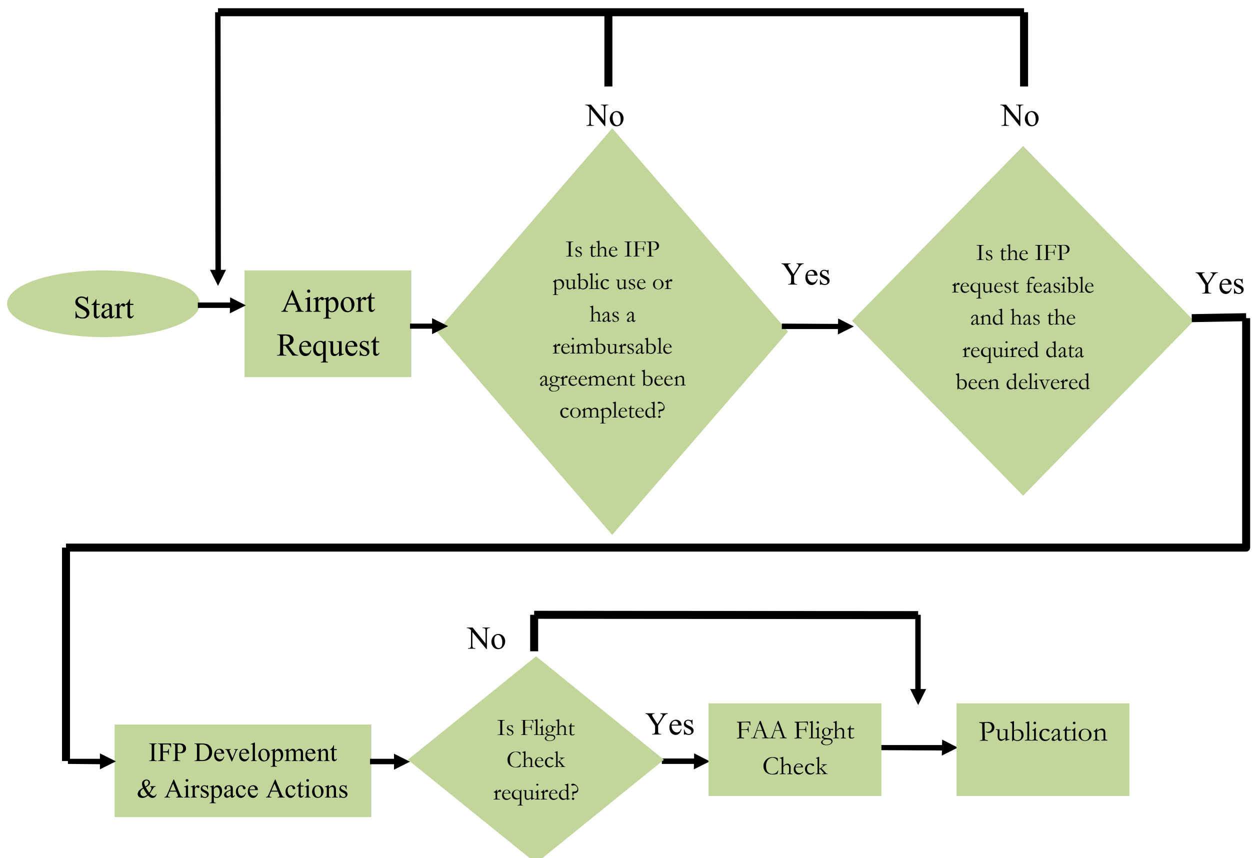
http://www.faa.gov/air_traffic/flight_info/aeronav/ifpinitiation/

This submission must include specific airport data as well as the originator's information. Once submitted, it is reviewed by the FAA's Regional Airspace and Procedures Team (RAPT). This review incorporates FAA airports, flight procedures, flight standards, and air traffic control to provide a single coordinated review of the request.

Once approved by the RAPT, the priority for publication is established and the procedure development scheduled.

With the request, including the current survey and the RAPT's schedule recommendation, the package is sent to the FAA's flight procedures group located in Oklahoma City where the procedure is designed, checked, and handed off for flight inspection. After completing a successful flight inspection, the procedure is scheduled for charting in the next available publication cycle. The following flow chart depicts the process for establishing a new instrument approach.

[5] General Guidance and Specifications for Aeronautical Surveys
[6] General Guidance and Specifications for Aeronautical Surveys
[7] General Guidance and Specifications for Submission of Aeronautical Surveys to NGS



NextGen Surveillance

Automatic dependent surveillance-broadcast (ADS-B)

ADS-B uses the Global Positioning System (GPS) satellite signals to provide air traffic controllers and pilots with accurate information that helps to keep aircraft separated in the sky and on the runways. Aircraft transponders receive GPS signals to determine the aircraft's precise position in the sky. These and other data are then broadcast to other aircraft and air traffic control. Once fully established, both pilots and air traffic controllers will, for the first time, see the same real-time display of air traffic, which will substantially improve safety.

The NextGen implementation of ADS-B will change the nation's air traffic control system from one that relies on radar technology to a system that uses precise location data from the global satellite network.

ADS-B is a crucial component of the nation's Next-Generation Air Transportation System (NextGen), and its implementation over the next 20 years will turn the NextGen vision into a reality. After years of research and development, and use by general aviation pilots in Alaska and air transport carriers in the Ohio River Valley, the FAA determined in 2005 that ADS-B was ready to be implemented throughout the national airspace system.

With ADS-B, both pilots and controllers will see radar-like displays of traffic – the displays update next to real time and do not degrade with distance or terrain. The ADS-B system also gives pilots access to weather services and flight information services.

The gains in safety, capacity, and efficiency as a result of moving to a satellite-based NextGen system will enable the FAA to meet the growth in air traffic that is predicted in coming decades. ADS-B is a flexible and expandable platform that can change and grow with the evolving national aviation system.

Installation of the ADS-B ground stations is scheduled for completion in 2013.

Aircraft Receivers

Under Automatic Dependent Surveillance-Broadcast (ADS-B), aircraft equipped with GPS receivers automatically transmit their location, altitude, and velocity to ATC ground stations and nearby aircraft. Unlike today's Mode C transponders, these broadcasts do not result from an interrogation by ATC radar or another aircraft's collision avoidance system. Cost savings from a reduced ATC radar infrastructure is one of NextGen's benefits.

Nationwide ADS-B implementation will use two different data links: Mode S data link for airliners and other high-flying aircraft, and Universal Access Transceiver (UAT) for lighter aircraft. The systems operate on different frequencies, and cannot "see" each other. For ADS-B to provide comprehensive traffic information to aircraft capable of receiving and displaying it, a network of ground stations will receive Mode S ADS-B position reports and rebroadcast them to UAT-equipped aircraft—and, similarly, will relay UAT broadcasts to aircraft receiving Mode S data links. This is Automatic Dependent Surveillance-Rebroadcast.

The FAA plans a network of about 800 ADS-B ground stations to provide ATC separation services throughout the country, located 150 to 200 miles apart to assure coverage at the rule's required minimum transmission power (16 watts for UAT, and 125 watts for 1090 MHz ES). This will support ATC in areas where radar service now exists. Other than the Gulf of Mexico, where ADS-B is used to control helicopters serving offshore oil platforms, capabilities are not being extended into non radar airspace.[8]

[8] The ground stations are scheduled to be operational by 2013.

On May 27, 2011 the FAA published its final rule mandating what owners will be required to have on board their aircraft in order to operate in the new satellite-based NextGen air traffic control system. By 2020, Automatic Dependent Surveillance-Broadcast Out (ADS-B Out) will be required equipment in all airspace that currently requires a transponder: Class A, B, and C; Class E airspace within the 48 contiguous states and the District of Columbia at and above 10,000 feet MSL, excluding the airspace at and below 2,500 feet above the surface; Class E airspace at and above 3,000 feet MSL over the Gulf of Mexico from the coastline of the United States out to 12 nautical miles; and around those airports identified in 14 CFR part 91, Appendix D.

ADS-B Benefits

1. Provides air-to-air surveillance capability.
2. Provides surveillance to remote or inhospitable areas that do not currently have coverage with radar.
3. Provides real-time traffic and aeronautical information in the cockpit.
4. Allows for reduced separation and greater predictability in departure and arrival times.
5. Supports common separation standards, both horizontal and vertical, for all classes of airspace.

General Aviation Cost and Benefit Considerations

Costs to an aircraft operator are broken down into capital and operating costs. Capital costs reflect the expenses incurred when purchasing an aircraft or implementing major system upgrades. Operating costs reflect the costs of operating the aircraft, and include such factors as fuel, labor, depreciation, and maintenance.

When considering avionics purchases, a large part of the justification is dependent upon the benefits provided by the air traffic service provider that allow the avionics to be used to their full potential within realistic timeframes for return on investment (ROI). To ensure adequate equipage, manufacturers must be able to project sufficient demand and/or a mandate may be required.

The associated costs and benefits of avionics equipage are valued differently for GA than they are for commercial operations. Some GA operators may not be willing to invest in upgrades that constitute a significant percentage of the aircraft hull value and cannot be recovered in the resale marketplace. Others may choose to install all of the latest avionics capabilities, regardless of a quantifiable ROI. The cost/benefit case is an important factor that must be considered in the overall planning and implementation of NextGen and magnifies the importance of integrating the aircraft and Air Traffic Control's capabilities. Operating costs are greatly influenced by the efficiency of the NAS. Enhanced services can significantly improve the benefit ratio for both normal and non-normal operations (such as those affected by adverse weather conditions). Initially, trajectory based operations (TBO) will enable commercial operators to have greater predictability for their operations, generally reducing flight times and, as a result, block times. Improved schedule reliability will result in lower costs and a better product for their customers. Non-commercial operators who equip appropriately will also benefit because it will improve access either to or through high-density terminal areas, resulting in reduced fuel requirements, emissions, and lower costs overall.

Typically, a new aircraft purchased today will be equipped with advanced NextGen avionics, so that the costs will be embedded in the total purchase price and the avionics will be integrated into the aircraft systems. Retrofitting older aircraft may require extensive modifications to the aircraft, resulting in significantly higher costs. It is worth pointing out that new generation aircraft that are being delivered today, and perhaps into the far-term (2012 and beyond), are likely to require retrofit.

This emphasizes the importance of finalizing NextGen avionics requirements as soon as practical to allow the appropriate amount of time for development, certification, and implementation.

NextGen avionics must be developed within retrofitting constraints, including avionics weight, power consumption, antenna pace, antenna cable paths, panel space, conventional form factor, and software performance requirements.

These are issues for many aircraft, and especially the legacy GA fleet. Size, weight, and power consumption will remain issues even for new low-end GA aircraft. New technologies can be phased in gradually while maintaining infrastructure for the technologies they are replacing.

It is important to note that both avionics and air traffic management (ATM) system demands will continue to evolve past the present definition and expectations of long-term NextGen, so that even a fully NextGen capable aircraft will become a legacy aircraft once future air traffic management system upgrades are implemented.

Chapter 4 Regional Airport System

The Puget Sound Regional Council serves the central Puget Sound region of the state of Washington. The PSRC region is made up of King County, Kitsap County, Pierce County and Snohomish County, which together encompass 6,290 square miles and contain 82 cities and towns.

The five major cities are Seattle and Bellevue in King County, Tacoma in Pierce County, Everett in Snohomish County, and Bremerton in Kitsap County. The region's population was estimated at 3,700,000 in 2010.

The PSRC airport system planning study identifies 28 public use airports in the four counties. These airports have a total of 3,298 based aircraft and approximately 1.4 million operations annually. The public-use airport system in the PSRC region is an integral component of the Washington State and national air transportation system.

The system of airports is also an important stimulus for economic growth and development in the region. These airports are significant generators of revenue, jobs, and wages, as general aviation alone creates thousands of jobs and produces millions of dollars of economic impact throughout the region each year.

The PSRC airport system provides for a safe and efficient method for the movement of people and goods, and numerous visitors that arrive in the PSRC area via air travel each year support a variety of business activities such as lodging, dining, retail, and entertainment.

The PSRC airports also serve as the base of operation for numerous businesses, including fixed base operators, flight schools, government entities, and many others.

As described in Chapters 2 and 3, NextGen is a suite of technologies that apply to aviation CNS (Communication, Navigation, and Surveillance). The NextGen capabilities applicable directly to PSRC airports will be predominantly associated with Navigation; specifically to flight procedures that use GPS satellite signals enhanced with WAAS (Wide Area Augmentation) to create LPV approach procedures, and those which use PBN (Performance Based Navigation) procedures for approach, missed approach, and departure applying a specified RNP (Required Navigation Performance) level.

Every airport has a unique situation as regards proximate terrain, community noise sensitivity, airspace conflicts with neighbor airports, and politically defined areas that must be avoided.

Each airport also has a unique set of stakeholders, including tenants, businesses, commercial operations, itinerant traffic, physical infrastructure constraints, and political influences from its ownership entity and surrounding communities.

In the following sections of this study, a notes section is included for each "Busy Airport" which captures some of the individual airport factors associated with implementation of NextGen technologies, specifically the impact of LPV and PBN procedures.

The important airport factors include:

1. Weather, identifying typical challenges associated with the airport and weather minima that will satisfy a large proportion of the airport operational needs.

2. Users and their private or commercial orientation.

3. Users' Equipage - what avionics and aircraft capability are likely to be involved in airport operations.

4. Flight Challenges, describing the flight procedure challenges including terrain, community, airspace conflicts, and politically sensitive operational areas.

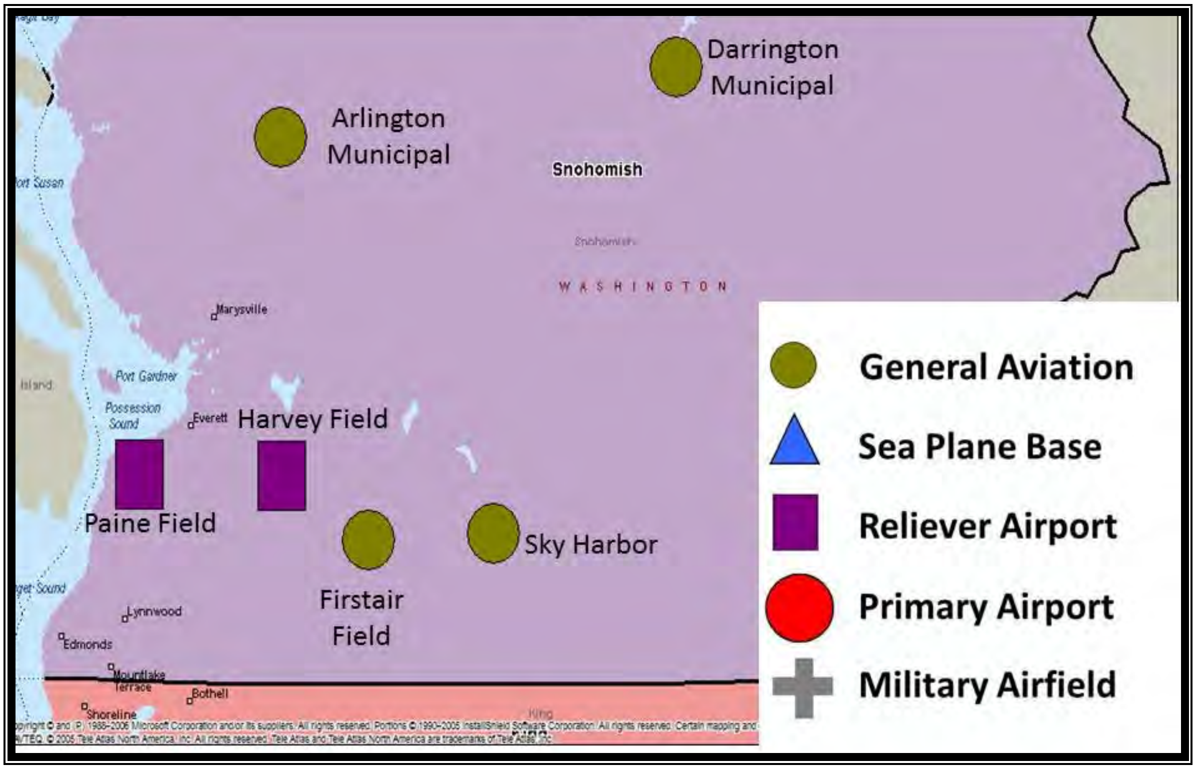
5. Ground Challenges, describing the airport physical infrastructure suitability for implementation of LPV or PBN procedures and changes that may be required.

6. Potential Solutions, describing if NextGen Navigation technologies may be warranted to resolve or ameliorate the airport challenges.

7. Recommendation, which suggests if a more detailed analysis of the airport as regards NextGen Navigation procedures implementation is warranted. Such a detailed analysis would be conducted as part of the Gap Analysis, and include airport improvement feasibility, possible trades between infrastructure investment and weather minima, examination of similar airport procedure implementation precedents, and ROM (Rough Order of Magnitude) assessments of costs, benefits to stakeholders, and political and community viability.

Once the detailed analysis is complete and submitted to PSRC, it would be up to the airports, WSDOT, and FAA to determine if airport-planning incorporation of the study results is warranted.

A. Snohomish County Airports



Darrington Municipal Airport

Darrington Municipal Airport is located in northern Snohomish County, on the north side of Darrington. There are three single-engine aircraft and four helicopters based at the Airport. The latest available data indicate that Darrington Municipal Airport had a total of 1,600 annual operations. Runway 10-28 is the sole runway serving the Airport. This runway is 2,491 feet long, 40 feet wide, and has an asphalt surface.

Photo courtesy of WSDOT Aviation

Approaches to both runway ends are visual. Darrington Municipal Airport currently does not have an FBO located on the field. The airport does not offer fuel service, and there are no aviation related businesses located on the airport.

According to the WSDOT Aviation Economic Impact Study, the airport supports three jobs in the regional economy, (2 direct, and 1 indirect) with a total regional economic impact of $223,900 annually. The estimated economic impacts of visitor spending through users of the airport are $15,900, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $11,000.

Arlington Municipal Airport

Arlington Municipal Airport is located in northwest Snohomish County adjacent to Washington Highway 531, three miles southwest of Arlington. The Airport has 580 based aircraft, including 447 single-engine, 7 multi-engine piston-powered, 10 turbojets, and 11 helicopters. The latest available data indicate that Arlington Municipal had a total of 134,000 annual operations.

Photo courtesy of WSDOT Aviation

The Airport has two runways. Runway 16-34 is 5,333 feet long, 100 feet wide, has an asphalt surface, and is equipped with medium intensity runway lights. Runway 16 is equipped with runway end indicator lights, precision approach path indicators (PAPI 2), and is a visual runway. Runway 34 is equipped with precision approach path indicators (PAPI 2) and a pilot controlled medium intensity approach lighting system (MALS).

A published instrument approach to Runway 34 includes a non-precision localizer approach, which, in combination with the MALS, provides this approach with a three-quarter-mile visibility minimum. Runway 34 also has an NDB and a RNAV (GPS) non-precision approach. Runway 11-29 is 3,500 feet long, 75 feet wide, and has an asphalt surface. Approaches to both ends of this runway are visual.

Arlington Municipal Airport currently has 19 FBOs located on the field that provides services such as: air ambulance transportation, medical transportation, aircraft parts manufacturing, aerial surveying, flight training, and civil air patrol. The airport offers both

Jet A and 100 LL fuel service. According to the WSDOT Aviation Economic Impact Study, the airport supports 1,018 jobs in the regional economy, (566 direct, 411 indirect, and 41 visitor jobs) with a total regional economic impact of $55.2 million annually. The estimated economic impacts of visitor spending through users of the airport are $4.3 million, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $1.6 million.

Paine Field (GA reliever)

Paine Field is located in Snohomish County, six miles southwest of Everett. The Airport has 630 based aircraft, including 555 single-engine, 57 multi-engine piston-powered, 9 turbojets, and 14 helicopters. The latest available data indicate that Snohomish County/Paine Field had a total of 114,000 annual operations.

Photo courtesy of WSDOT Aviation

Paine Field has three runways. Runway 16R-34L is 9,010 feet long, 150 feet wide, has a grooved asphalt surface, and is equipped with pilot controlled high intensity runway edge lights and centerline lighting. Runway 16R is equipped with precision approach path indicators. This runway is also equipped with medium intensity approach lighting system with Runway Alignment Indicator Lights (MALSR), which, in conjunction with an instrument landing system, provides the runway with a CAT I precision approach. Other approaches to Runway 16R include VOR and RNAV (GPS) non-precision approaches. Runway 16R also has a Precision Approach Path Indicator system (PAPI 4). Runway 34L is equipped with a Medium Intensity Approach Lighting System with Sequence Flashing Lights (MALSF) and has a RNAV (GPS) non-precision approach. Vertical guidance is provided by precision approach path indicators (PAPI 4). The Airport has a control tower which is staffed on a part-time basis.

Runway 11-29 is 4,514 feet long, 75 feet wide, has an asphalt surface, and is equipped with MIRL. Vertical guidance to each runway is provided by visual approach slope indicators. Runway 16L-34R is 3,000 feet long, 75 feet wide with a 799' displaced threshold on Runway 11, has an asphalt surface, and is equipped with MIRL. Both runway ends are equipped with runway end indicator lights, while vertical guidance to each runway is provided by precision approach path indicators (PAPI 2).

As with King County International Airport/Boeing Field and Renton Municipal Airport, Paine Field provides critical support for the Boeing Company and numerous other aerospace businesses in their production, testing, and delivery of commercial transport aircraft. It is home to the Boeing manufacturing plant for 747, 767, 777, and 787 aircraft and recently saw the first flights of the first 787 Dreamliners and the first 747-8. Aviation Technical Services is the largest third-party aircraft inspection and repair facility in North America and provides repair and maintenance services for airlines such as Alaska, Delta, Southwest and UPS.

Paine Field has become a major tourist destination with the opening of the new Future of Flight Aviation Center & Boeing Tour, the Flying Heritage Collection and the Historic Flight Foundation. The airport offers both Jet A and 100 LL fuel service. Paine Field has one full service FBO and six limited service FBOs.

According to the WSDOT Aviation Economic Impact Study, the airport supports 65,469 jobs in the regional economy, (34,262 direct, 31,168 indirect, and 39 visitor jobs) with a total regional economic impact of $19.8 billion annually. The estimated economic impacts of visitor spending through users of the airport are $4.1 million, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $78 million.

Harvey Field (GA reliever)

Photo courtesy of WSDOT Aviation

Harvey Field is located in Snohomish County adjacent to Washington Highway 9, one mile southwest of the town of Snohomish. There are 315 aircraft based at the airport, including 296 single-engine, 4 multi-engine piston-powered, 2 turboprops, and 4 helicopters. The latest available data indicate that Harvey Field had a total of 142,000 annual operations. Runway 15L-33R, is 2,671 feet long, 36 feet wide, has an asphalt surface and is equipped with a non-standard runway lighting system. Runway 15L is displaced 451 feet and runway 33R is displaced 241 feet. Runway 15R-33L is 2,430 feet long, 100 feet wide, and is a turf runway with a tri-color Visual Approach Slope Indicator (VASI) on both ends. Neither runway end has a published instrument approach; however, RNAV (GPS) approach is published for the airport.

Harvey Field currently has 1 FBO located on the field that provides services such as: skydiving, aerial tours, flight training, and commercial/charter operations. The airport offers both Jet A and 100 LL fuel service.

According to the WSDOT Aviation Economic Impact Study, the airport supports 331 jobs in the regional economy, (199 direct, 44 indirect, and 88 visitor jobs) with a total regional economic impact of $21.6 million annually. The estimated economic impacts of visitor spending through users of the airport are $9.2 million, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $1.0 million.

First Air

Firstair Field is located two miles northwest of Monroe in Snohomish County. The Airport has 74 based aircraft, including 68 single-engine and 4 multi-engine piston-powered and 1 jet. The latest available data indicate that FirstAir Field had a total of 18,000 annual operations. Runway 7-25, which is unlighted, is the Airport's only runway. This runway is 2,087 feet long, 34 feet wide, and has an asphalt surface. Both runway ends have visual approaches.

Photo courtesy of WSDOT Aviation

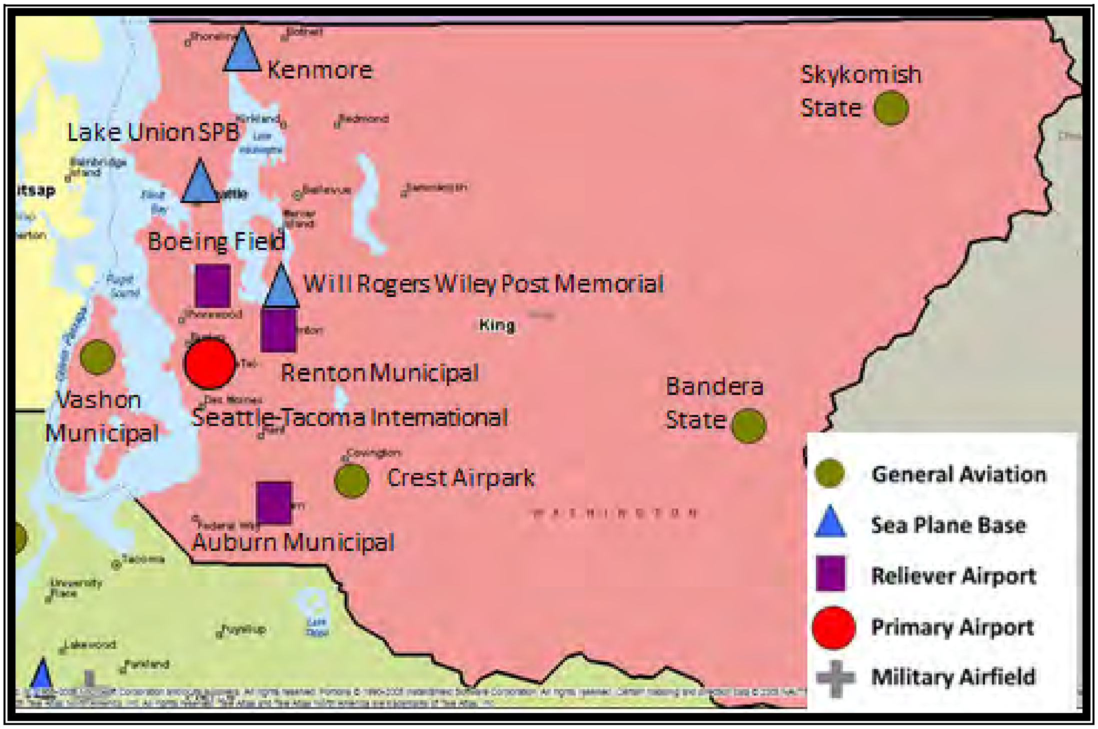
The threshold of Runway 25 is displaced 500 feet. FirstAir Field currently does not have an FBO located on the field, and no services are available. Very little economic data are available for this airport. According to the WSDOT Aviation Economic Impact Study, the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $47,200.

Sky Harbor

Sky Harbor is located one mile east of Sultan in Snohomish County. The Airport has 3 single-engine based aircraft. The latest available data indicate that Sky Harbor had a total of 600 annual operations. Runway 7-25, which is unlighted, is the Airport's only runway. This runway is 1,930 feet long, 100 feet wide, and has a turf surface.

Photo courtesy of WSDOT Aviation

No economic data are available for the Sky Harbor airport.



B. King County Airports

Vashon Municipal

Vashon Municipal Airport is located in King County, one mile northwest of Vashon. There are 31 single-engine aircraft based at the airport. The latest available data indicate that Vashon Municipal had a total of 10,000 annual operations. The Airport has a single turf-gravel runway. Runway 17-35 is 2,001 feet long, 60 feet wide, and has non-standard runway lights. There are no published approaches to the Airport.

Photo courtesy of WSDOT Aviation

Vashon Municipal does not currently have an FBO located on the field. The services provided are medical transport and flight training. Fuel service is not available. According to the WSDOT Aviation Economic Impact Study, the airport supports five jobs in the regional economy, (3 direct, and 2 indirect jobs) with a total regional economic impact of $313,000 annually. The economic impacts of taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $479,050.

Auburn Airport (GA reliever)

Photo courtesy of WSDOT Aviation

Auburn Municipal Airport is located in King County adjacent to Washington Highway 167, two miles north of Auburn. The airport has 209 based aircraft, including 190 single-engine, 15 multi-engine piston-powered, and 4 helicopters. The latest available data indicate that Auburn Municipal had a total of 165,000 annual operations.

Runway 16-34, the Airport's sole runway, is 3,400 feet long, 75 feet wide, has an asphalt surface, and is equipped with HIRL. Approaches to both runway ends are visual, and each is supported by visual approach slope indicators.

Auburn Municipal Airport does not currently have an FBO on the field. Flight training and civil air patrol services are available at the airport. The airport offers 100 LL fuel service.

According to the WSDOT Aviation Economic Impact Study, the airport supports 69 jobs in the regional economy, (42 direct, 15 indirect, and 12 visitor jobs) with a total regional economic impact of $6.9 million annually. The estimated economic impacts of visitor spending through users of the airport are $1.3 million, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $443,700.

King County International Airport - Boeing Field (GA reliever)

Boeing Field is located in King County, west of Interstate 5, four miles south of Seattle. Boeing Field has 471 based aircraft, including 257 single-engine, 89 multi-engine piston-powered, 77 turbojets, and 34 helicopters. The airport averages more than 300,000 operations (takeoffs and landings) each year.

Photo courtesy of WSDOT Aviation

The airport serves small commercial passenger airlines, cargo carriers, private aircraft owners, helicopters, corporate jets, and military and other aircraft. It is also home to the Boeing Company's 737 aircraft flight-test program, along with other Boeing operations. The Museum of Flight is located there, with its wide variety of aircraft and exhibits showcasing aviation history.

Boeing Field has an air traffic control tower and two runways. Runway 13R-31L is 10,000 feet long, 200 feet wide, has a grooved-asphalt surface, and is equipped with high intensity runway lights. Runway 13R has a medium intensity approach lighting system with sequenced flashing lights as well as precision approach path indictors (PAPI). Runway 31L, the threshold of which is displaced 800 feet, is equipped with runway end indicator lights and PAPIs. Runway 13R and 31L each have CAT I precision approaches provided by instrument landing systems. Runway 13R has a LOC/DME approach as well as a published visual approach. Runway 13R also has a RNAV (GPS) Y, and a RNAV (RNP) Z approach. Runway 13L and 31R is 3,710 feet long, 100 feet wide, is equipped with medium intensity runway lights, PAPIs, and Runway End Identifier Lights.

Boeing Field currently has 3 FBOs located on the field that provides services such as: air ambulance transportation, medical transportation, aircraft parts manufacturing, flight training, and civil air patrol. The airport offers both Jet A and 100 LL fuel service. According to the WSDOT Aviation Economic Impact Study, the airport supports 35,536 jobs in the regional economy, (18,408 direct, and 18,128 indirect) with a total regional economic impact of $9.2 billion annually. The estimated economic impacts of visitor spending through users of the airport are $17.3 million, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $75.6 million.

Renton Municipal (GA reliever)

Renton Municipal Airport is located in King County, immediately south of Lake Washington. The Airport has 322 based aircraft, including 293 single-engine, 14 multi-engine piston-powered, 14 helicopters, and 1 jet. The latest available data indicate that Renton Municipal had a total of 96,000 annual operations. Runway 16-34, the Airport's only runway, is 5,382 feet long, 200 feet wide, has an asphalt-concrete surface, and is equipped with medium intensity runway lights.

Photo courtesy of WSDOT Aviation

Runway 16 is equipped with runway end indicator lights (REIL) and precision approach path indicators (PAPI). This runway end, which is displaced by 300 feet, has NDB and RNAV (GPS) Y & Z non-precision approaches. Runway 34 is also equipped with REILs and PAPIs. This runway end is displaced by 340 feet and has no published approaches. The Airport has an air traffic control tower which is staffed on a part-time basis.

Renton Municipal currently has 2 FBOs located on the field that provide services such as: aircraft parts manufacturing, flight training, and civil air patrol. The airport offers both Jet A and 100 LL fuel service.

According to the WSDOT Aviation Economic Impact Study, the airport supports 18,788 jobs in the regional economy, (10,268 direct, 8,483 indirect, and 37 visitor jobs) with a total regional economic impact of $6.14 million annually. The estimated economic impacts of visitor spending through users of the airport are $1.8 billion, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $38.6 million.

Will Rogers/Wiley Post Memorial Sea Plane Base

Will Rogers/Wiley Post Seaplane Base is located on Lake Washington, immediately adjacent to Renton Municipal Airport. There are no sea planes based at the facility; however, the latest available data indicate that there were a total of 2,392 annual operations. The Waterway 12-30 is the Seaplane Base's only waterway and is 5,000 feet long and 200 feet wide. Renton Airport management combines the economic activity of Will Rogers/Wiley Post with Renton Municipal.

Photo courtesy of WSDOT Aviation

Crest Airpark

Crest Airpark is located 5 miles southeast of Kent in King County. The Airport has 332 based aircraft, including 327 single-engine, and 5 multi-engine piston-powered. The latest available data indicate that Crest Airpark had a total of 99,000 annual operations. Runway 15-33 is the Airport's sole runway. This runway is 3,288 feet long, 40 feet wide, has an asphalt surface, and is equipped with low intensity runway lights. The end of Runway 33 has been displaced 283 feet. Both runway ends have visual approaches.

Photo courtesy of WSDOT Aviation

Crest Airpark does not currently have an FBO located on the field, and the only services provided on the field are flight training services. The airport offers 100 LL fuel service. According to the WSDOT Aviation Economic Impact Study, the airport supports 150 jobs in the regional economy, (13 direct, 9 indirect, and 128 visitor jobs) with a total regional economic impact of $26.9 million annually. The estimated economic impacts of visitor spending through users of the airport are $13.9 million, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $1.8 million.

Kenmore Air Harbor

Photo courtesy of WSDOT Aviation

Kenmore Air Harbor Seaplane Base is located in King County on Lake Washington, one mile north of Seattle. There are 25 seaplanes based at the Seaplane Base. The latest available data indicate that the facility had a total of 41,000 annual operations. Kenmore Air provides service from Kenmore to its Lake Union facility, from which it serves Washington's San Juan Islands and various waterways in Victoria, British Columbia. The Seaplane Base has two waterways. Waterway 16-34 is 10,000 feet long and 1,000 feet wide, while Waterway 18-36 is 3,000 feet long and 1,000 feet wide.

Kenmore Air Harbor currently does not have an FBO located on the field, and the only services provided on the field are commercial air service. No fuel service is available at the field. According to the WSDOT Aviation Economic Impact Study, the airport supports 62 jobs in the regional economy, (20 direct, 14 indirect and 28 visitor jobs) with a total regional economic impact of $7.3 million annually. The estimated economic impacts of visitor spending through users of the airport are $3.0 million, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $167,700.

Skykomish State

Photo courtesy of WSDOT Aviation

Skykomish State Airport is located just east of the town of Skykomish. Glider operations and occasional forest fire fighting activities occur in the summer. The 100 foot wide runway is marked with edge reflectors.

Trees surround the airport and are tallest on the west end of the field. The field elevation is estimated at 1,002 feet. No aircraft are based at the airport. The airport is generally open from June 1 to October 1.

The airport does not currently have an FBO located on the field. No fuel or other services are available. According to the WSDOT Aviation Economic Impact Study, the economic impacts of taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $300.

Bandera State

Constructed in 1948, Bandera was one of the state's first airports. The airport is located in the upper Snoqualmie Valley 14 miles east of North Bend, and serves as an emergency airport for aircraft flying across the Cascade mountain range. The airport is located adjacent to Interstate 90 and is frequently used by instructors for training students in soft field work and in mountain flying.

Photo courtesy of WSDOT Aviation

Bandera has a 2,344 foot long turf runway which is 200 feet wide. Field elevation is 1,636 feet. No aircraft are based at the airport. Trees surround the airport close in, and there are trees close to each end of the field in the approaches. The airport is usually open from June 1 to October 1. The airport does not currently have an FBO located on the field. No fuel or other services are available. According to the WSDOT Aviation Economic Impact Study, the airport supports two visitor jobs in the regional economy, with a total regional economic impact of $21,900 annually as a result of visitors using the field. The economic impacts of taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $1,000.

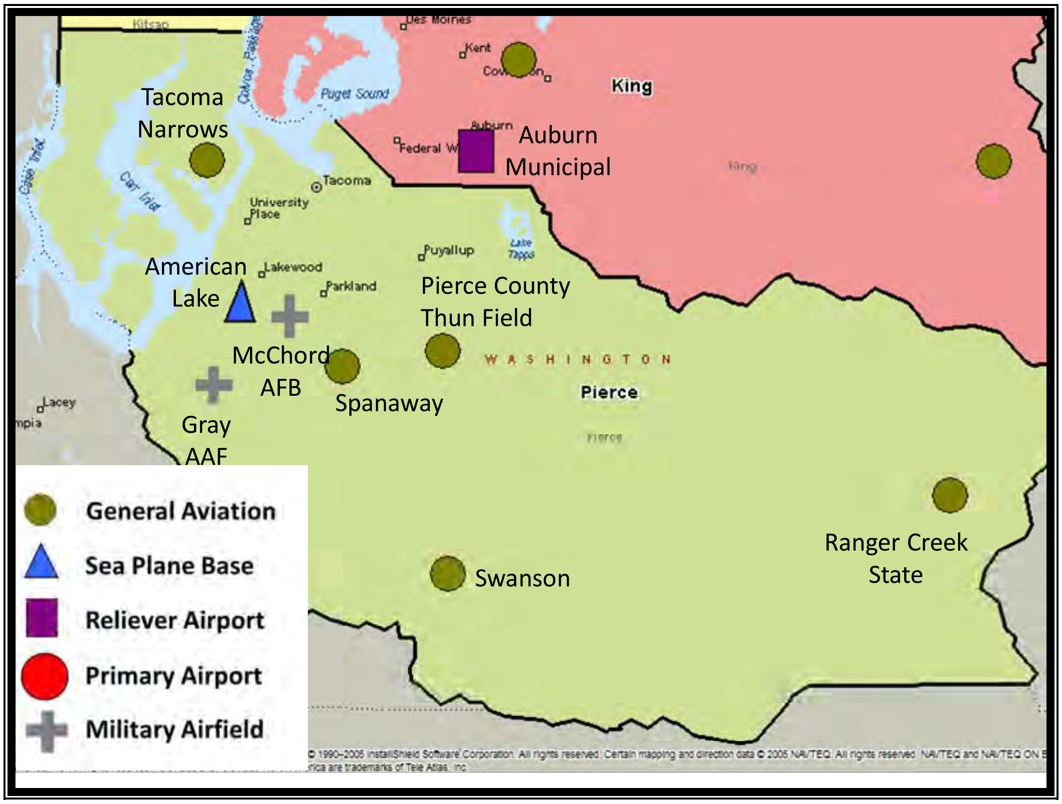
Seattle Seaplanes (Lake Union Seaplane)

Seattle's Lake Union has been a hub of seaplane activity in the Northwest since 1916, when the first Boeing aircraft — a wooden two-seater — made its maiden flight from the lake. Today, more than 100,000 passengers annually pass through the facility on seaplane flights to/from the San Juan Islands and Victoria. The Seattle Seaplanes waterway is 5,000 feet long and 500 feet wide. No aircraft are based at the facility. Seattle Seaplanes currently does not have an FBO located on the field.

Photo courtesy of WSDOT Aviation

The services provided on the field are commercial air service, flight training, cargo service, and airplane parts manufacturing. Both 100 LL and Jet A fuel service is available at the field. According to the WSDOT Aviation Economic Impact Study, the airport supports 516 jobs in the regional economy, (232 direct, 162 indirect and 122 visitor jobs) with a total regional economic impact of $48.5 million annually. The estimated economic impacts of visitor spending through users of the airport are $13.2 million, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $808,000.

C. Pierce County Airports



American Lake

The American Lake Seaplane Base is located in Pierce County, seven miles south of Tacoma. There are no seaplanes based at the facility. The latest available data indicate that the SPB had a total of 50 annual operations. Waterway 2-20, the Base's only waterway, is 5,500 feet long and 500 feet wide.

Photo courtesy of WSDOT Aviation

According to the WSDOT Aviation Economic Impact Study, the airport contributes $8,370 total regional economy.

Pierce County – Thun Field

Thun Field Airport is located in Pierce County, adjacent to Washington Highway 161, 5 miles south of Puyallup. The Airport has 239 based aircraft, including 220 single-engine, 10 multi-engine piston-powered, and 3 rotor driven aircraft. The latest available data indicate that Pierce County/Thun Field had a total of 100,000 annual operations.

Photo courtesy of WSDOT Aviation

Runway 16-34, the Airport's sole runway, is 3,650 feet long, 60 feet wide, has an asphalt surface, and is equipped with pilot controlled medium intensity runway lights. Vertical guidance is provided to each runway end by precision approach path indicators. Additionally, both ends are equipped with runway end indicator lights. The approach to Runway 16 is visual, while Runway 34 has a published non-precision GPS approach.

Pierce County/Thun Field does not currently have an FBO located on the field. The services provided on the field are flight training services, civil air patrol and medical transport services. The airport offers 100 LL fuel service.

According to the WSDOT Aviation Economic Impact Study, the airport supports 176 jobs in the regional economy, (50 direct, 86 indirect and 40 visitor jobs) with a total regional economic impact of $14.7 million annually.[9] The estimated economic impacts of visitor spending through users of the airport are $4.1 million, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $479,050.

[9] Total impact includes jobs, value of goods and services, and multiplier effect in 2010 dollars.

Tacoma Narrows

Photo courtesy of WSDOT Aviation

The Tacoma Narrows Airport is located in Pierce County, four miles west of Tacoma. The Airport has 156 based aircraft, including 124 single-engine, 17 multi-engine piston-powered, 7 turbojets, and 8 helicopters. The latest available data indicate that Tacoma Narrows had a total of 57,342 annual operations.

Runway 17-35 is the Airport's only runway. This runway is 5,002 feet long, 150 feet wide, has an asphalt surface, and is equipped with medium intensity runway lights. Runway 17 is equipped with precision approach path indicators, as well as a medium intensity approach lighting system with runway alignment indicator lights, which, in conjunction with an instrument landing system, provide this runway end with a CAT I precision approach. This runway end also has a RNAV (GPS) approach.

Runway 35 is equipped with runway end indicator lights, as well as visual approach slope indicators which provide pilots with vertical guidance to the runway. This runway end has a published NDB and RNAV (GPS) non-precision approach.

Tacoma Narrows Airport currently has 2 FBOs located on the field that provide services such as: aircraft parts manufacturing, flight training, and civil air patrol. The airport offers both Jet A and 100 LL fuel service.

According to the WSDOT Aviation Economic Impact Study, the airport supports 62 jobs in the regional economy, (26 direct, 14 indirect, and 22 visitor jobs) with a total regional economic impact of $6.14 million annually.[10] The estimated economic impacts of visitor spending through users of the airport are $2.3 million, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $293,400.

[10] Total impact includes jobs, value of goods and services, and multiplier effect in 2010 dollars.

Spanaway

The Spanaway Airport is located in Pierce County adjacent to Highway 7, one mile south of the city of Spanaway. The Airport has 12 based aircraft, including 10 single-engine, 2 multi-engine piston-powered aircraft. The latest available data indicate that Spanaway had a total of 2,000 annual operations. Runway 16-34 is the Airport's only runway.

Photo courtesy of WSDOT Aviation

This runway is 2,724 feet long, 20 feet wide, has an asphalt surface, and is equipped with low intensity runway lights. Neither runway end has a published approach. The end of Runway 16 has been displaced by 200 feet.

Spanaway Airport does not currently have an FBO located on the field. No services are available at the field. According to the WSDOT Aviation Economic Impact Study, the airport supports five jobs in the regional economy, (3 direct, and 2 indirect jobs) with a total regional economic impact of $313,000 annually. The economic impacts of taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $479,050.

Swanson

Swanson Field is located in Pierce County, one mile northeast of Eatonville. There are 12 single-engine aircraft based at the Airport. The latest available data indicate that Swanson had a total of 6,015 annual operations. Runway 16-34, the Airport's sole runway, is 2,990 feet long, 36 feet wide, has an asphalt surface, and is equipped with medium intensity runway lights. Approaches to both runway ends are visual.

Photo courtesy of WSDOT Aviation

Swanson Field does not currently have an FBO located on the field. The services provided are aircraft parts manufacturing. Fuel service is not available.

According to the WSDOT Aviation Economic Impact Study, the airport supports five jobs in the regional economy, (3 direct, and 2 indirect jobs) with a total regional economic impact of $313,000 annually. The economic impacts of taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $59,900.

Ranger Creek

Ranger Creek is located 10 miles southeast of Greenwater, in the White River Valley, close to Mount Rainier. The airport is surrounded by a Forest Service Campground near State Highway 410. The field is frequently used for fly-ins, military training exercises, search and rescue training, and glider operations.

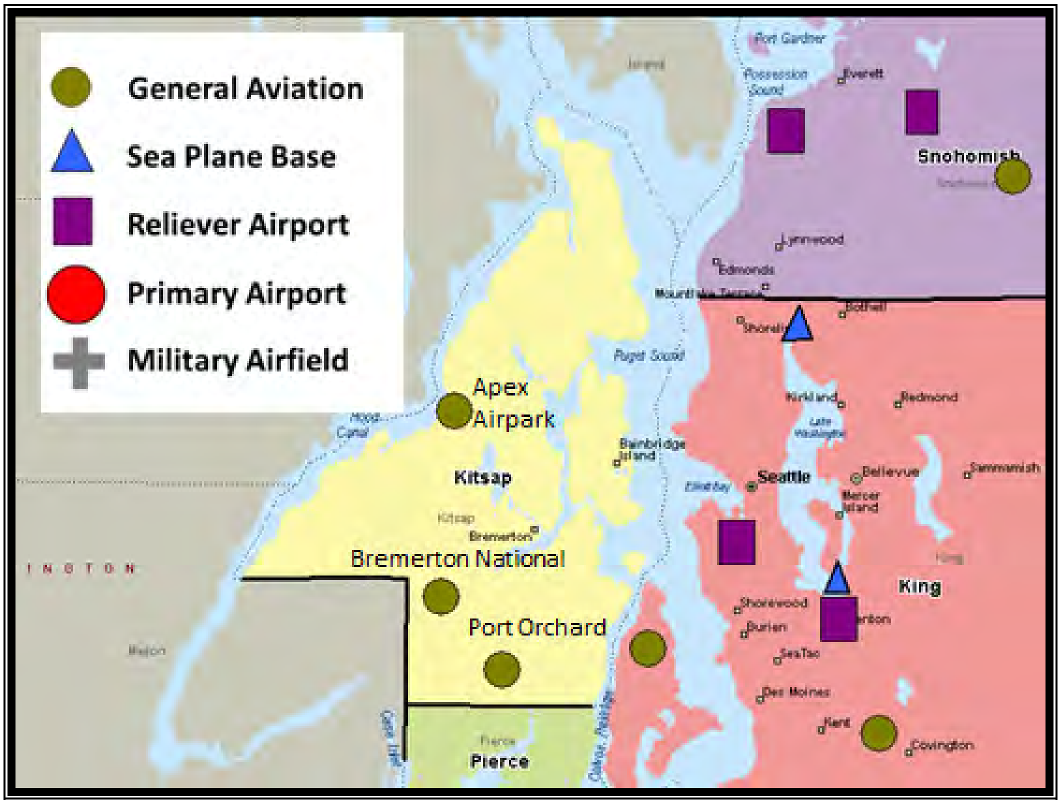
Photo courtesy of WSDOT Aviation

Runway 15-33 is an asphalt runway that is 2,875 feet long and 30 feet wide. The field elevation is 2,650 feet. Ranger Creek is generally open from June 1 to October 1.

Ranger Creek Field does not currently have an FBO located on the field. No fuel or other services are available.

According to the WSDOT Aviation Economic Impact Study, the airport supports two visitor jobs in the regional economy, with a total regional economic impact of $219,000 annually. The economic impacts of taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $4,000.

D. Kitsap County Airports



Port Orchard


Photo courtesy of WSDOT Aviation

Port Orchard Airport is located seven miles southwest of Port Orchard in Kitsap County. Port Orchard Airport has 15 based single-engine aircraft and the latest available data indicate that the airport had a total of 19,000 annual operations. Runway 18-36, the Airport's only runway, is 2,460 feet long, 28 feet wide, and has an asphalt surface, and is equipped with low intensity runway lights.

No economic data are available for Port Orchard.

Bremerton National

Bremerton National Airport is located in Kitsap County adjacent to Washington Highway 3, seven miles southwest of Bremerton. The Airport has 151 based aircraft, including 137 single-engine, 10 multi-engine piston-powered, 4 jets, and 3 helicopters. The latest available data indicate that the Airport had a total of 108,000 annual operations.

Photo courtesy of WSDOT Aviation

Runway 1-19, Bremerton National Airport's sole runway, is 6,000 feet long, 150 feet wide, has a grooved asphalt surface, and is equipped with high intensity runway lights. Runway 1-19 is equipped with precision approach path indicators, which adds a vertical element to the runway's NDB and RNAV (GPS) approaches. Runway 19 is equipped with precision path indicator lights and is also equipped with a medium intensity approach lighting system, which, along with the Runway's instrument landing system, provides the runway with a precision approach. Runway 19 also has a RNAV (GPS) non-precision approach. The end of Runway 19 has been relocated by 990 feet.

Bremerton National Airport currently has one FBO located on the field. The services provided on the field are flight training services and civil air patrol services. The airport offers 100 LL and Jet A fuel service.

According to the WSDOT Aviation Economic Impact Study, the airport supports 549 jobs in the regional economy, (269 direct, 262 indirect and 18 visitor jobs) with a total regional economic impact of $29.4 million annually. The estimated economic impacts of visitor spending through users of the airport are $1.9 million, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $1.9 million.

Apex Airpark

Photo courtesy of WSDOT Aviation

Apex Airpark is located in Kitsap County, 2 miles northwest of Silverdale. Apex Airpark airport has 77 based aircraft, including 70 single-engine, 3 multi-engine, and 3 helicopters. The latest available data indicate that Apex Airpark had a total of 21,000 annual operations. Runway 17-35, the Airport's only runway, is 2,500 feet long, 28 feet wide, has an asphalt surface, and is equipped with low intensity runway lights.

Apex Airpark currently does not have an FBO located on the field, and no services are available at the airport.

According to the WSDOT Aviation Economic Impact Study, the airport supports 14 jobs in the regional economy, (6 direct, 3 indirect and 5 visitor jobs) with a total regional economic impact of $1.5 million annually. The estimated economic impacts of visitor spending through users of the airport are $546,000, and the taxes paid to the various jurisdictions and state by the visitors and airport businesses were estimated to be $221,700.

Chapter 5 Establishing PSRC Busy Airports

Pilots and business travelers experience time savings when they utilize busy general aviation airports. In addition, communities that support and develop their local airport infrastructure systems tend to attract a higher volume of business aviation traffic. There are several subjective and objective aspects that were taken into consideration to assist with establishing which airport facilities in the PSRC area were to be evaluated as "Busy General Aviation Airports" within this study. At a high level, the following items were initially considered:

1. The availability of overnight transient parking for aircraft and vehicles
2. Landing fees apply to all aircraft
3. Transient tiedown Spaces
4. Conference Room rental
5. Fuel (Jet and Avgas)
6. Hangar Availability
7. Aircraft maintenance
8. Flight training
9. Aircraft rental
10. Aircraft sales
11. Aircraft charter
12. Car rental
13. Restaurants
14. Hotel
15. Pilot Supplies

In an effort to define "busy airports" from a purely analytical standpoint, operational data for each of the General Aviation airports in the Puget Sound region was compiled to evaluate airport activity. The purpose of this analysis was to provide an equivalent numerical value for each airport to substantiate the "busy airport" definition. It was determined that factors which indicate significant use and therefore support further study include: Multi-engine and Jet Based Aircraft (BA) as well as Itinerant, Air Taxi and IFR operations.

Factors were derived by dividing operations by 10,000 and based aircraft by 10 and summing the results as shown in the following equation.

(**M**ulti-Engine BA/10) + (**J**et BA/10) + (**I**tinerant operations/10,000) + (**A**ir **T**axi operations/10,000) + (**IFR** operations/10,000) = **MJIATIFR**

The PSRC "Busy Airport" Evaluation Matrix on the following page details the results of this analysis. The airports with a MJIAT factor greater than 1.0 were determined to be "busy airports."

Tabulated Summary of PSRC Busy Airport Based Aircraft and Operations Criteria

PSRC "Busy Airport" Evaluation											
Individual Airport Data		Based Aircraft					Aircraft Operations				
Loc ID	Name	5010 BA	Single	Multi	Jet	Other	Total Ops	GA Itin	Air Taxi	IFR	MJIATIFR>1
BFI	Boeing Field	431	257	89	77	48	228,727	101,724	59,225	67,592	
	Factor	*43.1*	*25.7*	*8.9*	*7.7*	*4.8*	*22.9*	*10.2*	*5.9*	*6.8*	*39.5*
S50	Auburn Municipal	241	221	16	0	4	164,539	98,339	6100		
	Factor	*24.1*	*22.1*	*1.6*	*0*	*0.4*	*16.5*	*9.8*	*0.6*	*0.0*	*12.0*
PAE	Paine Field	630	555	57	9	9	113,070	53,115	2,235	20,178	
	Factor	*63*	*55.5*	*5.7*	*0.9*	*0.9*	*11.3*	*5.3*	*0.2*	*2.0*	*14.2*
S36	Crest Airpark	332	327	5	0	0	113,850	101,200	0		
	Factor	*33.2*	*32.7*	*0.5*	*0*	*0*	*11.4*	*10.1*	*0.0*	*0.0*	*10.6*
PLU	Pierce County - Thun Field	184	163	17	1	3	100,000	62,463	3,388		
	Factor	*18.4*	*16.3*	*1.7*	*0.1*	*0.3*	*10.0*	*6.2*	*0.3*	*0.0*	*8.4*
AWO	Arlington Municipal	582	447	7	10	118	134,032	56,798	520		
	Factor	*58.2*	*44.7*	*0.7*	*1*	*11.8*	*13.4*	*5.7*	*0.1*	*0.0*	*7.4*
TIW	Tacoma Narrows	156	124	17	7	8	53,930	30,943	924	11,026	
	Factor	*15.6*	*12.4*	*1.7*	*0.7*	*0.8*	*5.4*	*3.1*	*0.1*	*1.1*	*6.7*
RNT	Renton Municipal	322	293	14	1	14	82,032	33,625	839	4,556	
	Factor	*32.2*	*29.3*	*1.4*	*0.1*	*1.4*	*8.2*	*3.4*	*0.1*	*0.5*	*5.4*
PWT	Bremerton National	157	137	10	4	6	108,000	42,000	100		
	Factor	*15.7*	*13.7*	*1*	*0.4*	*0.6*	*10.8*	*4.2*	*0.0*	*0.0*	*5.6*
S43	Harvey Field	211	192	6	0	13	139,160	49,524	50		
	Factor	*21.1*	*19.2*	*0.6*	*0*	*1.3*	*13.9*	*5.0*	*0.0*	*0.0*	*5.6*
S60	Kenmore Air Harbor, Inc.	25	23	2	0	0	41,000	500	35,000		
	Factor	*2.5*	*2.3*	*0.2*	*0*	*0*	*4.1*	*0.1*	*3.5*	*0.0*	*3.8*
W55	Kenmore (Union Lake)	0	0	0	0	0	35,500	2,500	25,500		
	Factor	*0*	*0*	*0*	*0*	*0*	*3.6*	*0.3*	*2.6*	*0.0*	*2.8*
W16	Firstair Field	74	68	4	1	1	18,169	13,125	0		
	Factor	*7.4*	*6.8*	*0.4*	*0.1*	*0.1*	*1.8*	*1.3*	*0.0*	*0.0*	*1.8*
8W5	Apex Airpark	77	70	3	0	4	21,330	4,800	0		
	Factor	*7.7*	*7*	*0.3*	*0*	*0.4*	*2.1*	*0.5*	*0.0*	*0.0*	*0.8*
1S2	Darrington	6	3	0	0	3	2,310	762	0		
	Factor	*0.6*	*0.3*	*0*	*0*	*0.3*	*0.2*	*0.1*	*0.0*	*0.0*	*0.1*
4WA9	Port Orchard	15	15	0	0	0	0	0	0		
	Factor	*1.5*	*1.5*	*0*	*0*	*0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
S44	Spanaway	12	10	2	0	0	2,000	500	0		
	Factor	*1.2*	*1*	*0.2*	*0*	*0*	*0.2*	*0.1*	*0.0*		*0.3*
2W3	Swanson	12	12	0	0	0	6,015	4,500	0		
	Factor	*1.2*	*1.2*	*0*	*0*	*0*	*0.6*	*0.5*	*0.0*	*0.0*	*0.5*
2S1	Vashon Municipal	34	31	0	0	3	10,020	7,500	20		
	Factor	*3.4*	*3.1*	*0*	*0*	*0.3*	*1.0*	*0.8*	*0.0*	*0.0*	*0.8*
21W	Ranger Creek State	0	0	0	0	0	450	200	0		
	Factor	*0*	*0*	*0*	*0*	*0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
S86	Sky Harbor	3	3	0	0	0	600	100	0		
	Factor	*0.3*	*0.3*	*0*	*0*	*0*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*
S88	Skykomish State	0	0	0	0	0	300	300	0		
	Factor	*0*	*0*	*0*	*0*	*0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
W37	American Lake	0	0	0	0	0	50	50	0		
	Factor	*0*	*0*	*0*	*0*	*0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
4W0	Bandera State	0	0	0	0	0	300	300	0		
	Factor	*0*	*0*	*0*	*0*	*0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
TCM	McChord AFB										
	Factor	*0*	*0*	*0*	*0*	*0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
	Gray Army Airfield										
	Factor	*0*	*0*	*0*	*0*	*0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*

(Multi-Engine BA/10) + (Jet BA/10) + (Itinerant operations/10,000) + (Air Taxi operations/10,000) + (IFR operations/10,000) = MJIATIFR

Summary of PSRC Busy Airport Economic Impact Criteria

PSRC "Busy Airport" Economic Impacts

Individual Airport Data		Employment				Fiscal/Economic Impact Factors (2010 Dollars)					
		Airport Jobs		Visitor		On Airport Employment		Visitor			
Loc ID	Name	Direct	Induced	Jobs	Total	Direct Income	Induced Income	Employment Impact	Visitor Spending	Taxes Paid	Total Impact
BFI	Boeing Field 46 Factor	18,408	18,128		36,536	6,368,100,000	2,768,200,000	19,700,000	17,300,000	76,358,000	9,249,658,000
S50	Auburn Municipal	42	15	12	69	2,400,000	2,100,000	1,279,000	775,200	443,700	6,997,900
PAE	Paine Field	34,262	31,168	39	65,469	14,862,300,000	4,950,600,000	4,100,000	2,641,200	77,987,000	19,897,628,200
S36	Crest Airpark	13	9	128	150	1,600,000	1,200,000	13,900,000	8,397,500	1,807,400	26,904,900
PLU	Pierce County - Thun Field	50	86	40	176	3,900,000	3,600,000	4,100,000	2,635,200	479,050	14,714,250
AWO	Arlington Municipal	566	411	41	1,018	29,100,000	17,500,000	4,300,000	2,732,700	1,573,000	55,205,700
TIW	Tacoma Narrows	26	14	22	62	1,500,000	574,000	2,300,000	1,472,800	293,400	6,140,200
RNT	Renton Municipal	10,268	8,483	37	18,788	1,298,900,000	452,300,000	4,000,000	2,428,400	38,572,000	1,796,200,400
PWT	Bremerton National	269	262	18	549	14,000,000	10,500,000	1,867,000	1,170,000	1,877,100	29,414,100
S43	Harvey Field	199	44	88	331	3,900,000	1,700,000	9,200,000	5,798,600	1,000,600	21,599,200
S60	Kenmore Air Harbor, Inc.	20	14	28	62	1,600,000	705,000	3,000,000	1,817,100	167,700	7,289,800
W55	Kenmore (Union Lake)	232	162	122	516	18,200,000	8,300,000	13,200,000	8,002,500	808,000	48,510,500
W16	Firstair Field	-	-	-	-	-	-	-	-	47,200	47,200

Tabulated Summary of PSRC Busy Airport Criteria

Airport	Paved Runway	Parallel Taxiway	Airport Operations Analysis		Fuel Available		Existing Instrument Approach		Available Maintenance	
			ALL > 10.0	MJIAT > 1.0	Jet A	100 LL	PIA	NPIA	Air Frame	Power Plant
Auburn – S50	●	●	●	●	●	●		●	●	●
Bandera State – 4W0										
Boeing Field - BFI	●	●	●	●	●	●	●	●	●	●
Crest Airpark – S36	●	●	●	●		●			●	●
Kenmore – W55			●	●						
Renton Municipal - RNT	●	●	●	●	●	●		●	●	●
Seattle-Tacoma Int. - SEA	Commercial Service Airfield, Removed from Analysis									
Skykomish State – S88										
Vashon Municipal – 2S1			●							
Will Rogers/Wiley Post – W36					●	●				
Arlington Municipal - AWO		●	●	●	●	●		●	●	●
Darrington Municipal – 1S2	●	●								
Firstair Field – W16	●		●	●		●			●	●
Harvey Field – S43	●		●	●	●	●		●	●	●
Paine Field – PAE	●	●	●	●	●	●	●	●	●	●
Sky Harbor – S86										
American Lake – W37										
Gray Army Air Field	Dept. of Defense Airfield, Removed from Analysis									
McChord Air Force Base	Dept. of Defense Airfield, Removed from Analysis									
Pierce County - Thun Field – PLU	●		●	●	●	●		●		
Ranger Creek State – 21W	●									
Spanaway – S44	●									
Swanson – 2W3	●									
Tacoma Narrows - TIW	●	●	●	●	●	●	●	●	●	●
Apex Airpark - 8W5	●		●						●	●
Bremerton National - PWT	●	●	●	●	●	●		●	●	●
Port Orchard – 4WA9	●									

Chapter 6 Busy Airport Inventory & Gap Analysis

Airport Design Factors

This chapter identifies the existing airport facilities and the airfield design characteristics that were considered for the 13 airport facilities which underwent detailed analysis in the PSRC NextGen study. Advisory Circular 150/5300-13, Airport Design, is the document produced by the FAA that specifies the various dimensional and physical requirements of an airport.

The Gap Analysis phase of the PSRC NextGen study examines the infrastructure facilities of the 13 airports in the PSRC region and provides a detailed presentation of the existing conditions at each airport. The analysis also calls out the deficiencies or needed improvements at each of the airport facilities based upon the ultimate goal of establishing or enhancing airport instrument approach capabilities through application of NextGen technologies, preferably with minima of 1 statute mile and 350' height above touchdown (HAT) or better.

The design requirements identified in Advisory Circular 150/5300-13 are dependent upon the approved Airport Reference Code or "ARC" for a given airport.

The Airport Reference Code (ARC) is a coding system developed by the Federal Aviation Administration to relate airport design criteria to the operational and physical characteristics of the airplane types that will operate at a particular airport.

The ARC has two components relating to the airport design aircraft. The first component, depicted by a letter, is the "approach category" and is based on aircraft approach speed. The second component, depicted by a Roman numeral, is the airplane "design group" and is based on airplane wingspan.

Generally, aircraft approach speed applies to runways and runway length-related features. Airplane wingspan primarily relates to separation-of-aircraft criteria and width-related features.

Approach Category	Approach Speed (knots)	Design Group	Wingspan (feet)
A	< 91	I	to 48
B	91 - 120	II	49 – 78
C	121 - 140	III	79 – 117
D	141 - 165	IV	118 – 170
E	166 or more	V	171 – 213
		VI	214 - 262

Airports expected to accommodate single-engine airplanes normally fall into Airport Reference Code A-I or B-I. Airports serving larger twin engine general aviation and commuter-type planes are usually ARC B-II or B-III. General Aviation airports serving business jets typically have an ARC of C-II or D-II. Small to medium-sized airports serving air carriers are usually Airport Reference Code C-III, while larger air carrier airports are usually ARC D-V or D-VI. ARC E contains only certain Military Aircraft.

Make/Model	*Airport Reference Code*	*Approx Approach Speed (knots)*	*Wing Span (feet)*
Cessna 152	A-I	55	32.7
King Air	B-I	111	45.8
Gates Learjet	C-I	128	43.7
Boeing 737-4	C-III	139	94.8
Boeing 767-3	C-IV	140	156.1
Boeing 747-2	D-V	150	195.7

The FAA has established airport design criteria commensurate with an airport's role and ARC designation. These criteria provide minimum safety standards with respect to the performance characteristics represented by the airport's critical aircraft. An airport's critical aircraft is determined through the Airport Master Planning process by identifying what the most demanding aircraft is that conducts at least 500 itinerant operations annually.

Reference Code (ARC) Classification

The Existing and Ultimate Airport Reference Code (ARC) for the Busy Airports in the PSRC study are shown below.

Tabulated Summary of PSRC Busy Airport Reference Codes (ARC)

Airport	Existing ARC	Ultimate ARC
Boeing Field - BFI	D-V	D-VI
Auburn – S50	B-I	B-I
Paine Field – PAE	D-V	D-V
Crest Airpark – S36	A-I	A-I
Pierce County - Thun Field – PLU	B-II	B-II
Arlington Municipal - AWO	B-II	B-II
Tacoma Narrows - TIW	D-II	D-II
Renton Municipal - RNT	B-II	D-III
Bremerton National - PWT	B-II	B-II
Harvey Field – S43	A-I	A-I
Kenmore Air Harbor (Lake Union)– W55	Not Applicable	Not Applicable
Kenmore Air Harbor (Lake Washington) – S60	Not Applicable	Not Applicable
First Air - W16	A-I	A-I

Airfield Safety Area Requirements

Compliance with airport design standards is required to maintain a minimum level of operational safety. The major airport design elements, as follows, are established from FAA Advisory Circular 150/5300-13, *Airport Design* and FAR Part 77, *Objects Affecting Navigable Airspace*, and should conform with FAA airport design criteria without modification to standards.

Runway Safety Area (RSA): The RSA is a two-dimensional area surrounding and extending beyond the runway and taxiway centerlines. This safety area is provided to reduce the risk of damage to airplanes in the event of undershoot, overshoot, or excursion from the runway. In addition, it must be cleared and free of objects except those required for air navigation and graded to transverse and longitudinal standards to prevent water accumulation, as consistent with local drainage requirements. Under dry conditions, the RSA must support an airplane without causing structural damage to the airplane or injury to the occupants. The airport must own the entire RSA in "fee simple" title.

Approach Category A&B Airplane Design Group	I	II	III	IV
RSA Width	120'	150'	300'	500'
RSA Length Prior to Threshold	240'	300'	600'	600'
RSA Length Beyond RW End	240'	300'	600'	600'

See AC 150-13A Appendix 7. Tables A 1-7 through A 7-11

Object Free Area (OFA): The OFA is a two-dimensional area surrounding runways, taxiways and taxi lanes. It must remain clear of objects except those used for air navigation or aircraft ground maneuvering purpose, and requires clearing of above-ground objects protruding higher than the runway safety area edge elevation. An object is considered any ground structure, navigational aid, people, equipment, terrain or parked aircraft. It is recommended that the airport own the entire OFA in "fee simple" title.

Approach Category A & B Airplane Design Group	I	II	III	IV
OFA Width	120'	400'	500'	800'
OFA Length Beyond RW End	240'	300'	600'	1000'

See AC 150-13A Appendix 7. Tables A 1-6 through A 7-11 for approach category C, D, & E.

Runway Protection Zone (RPZ): The RPZ is a two-dimensional trapezoid area beginning 200 feet beyond the paved runway end, and extends along the runway centerline. The purpose of the RPZ is to enhance the protection of people and property on the ground, and to prevent obstructions potentially hazardous to aircraft. RPZ dimensions are determined by the type of aircraft expected to operate at the airport (small or large) and the type of approach planned for the runway ends (visual, precision, or non-precision). The recommended visibility minimums for the runway ends are determined with respect to approach procedures, the ultimate runway ARC, airfield design standards, instrument meteorological conditions, and physical constraints beyond the extended runway centerline. The FAA recommends that airports own the entire RPZ in "fee simple" title and that the RPZ be clear of any non-aeronautical structure or object that would interfere with the arrival and departure of aircraft.

RPZ Dimensions				
Approach Category	Length	Inner Width	Outer Width	RPZ Acres
A & B	1,000'	500'	700'	13.770
C & D	1,700'	500'	1,010'	29.465
Approach Visibility Minimums not lower than 1-mile				

Obstacle Free Zone (OFZ): The OFZ is airspace above a surface centered on the runway centerline, and precludes taxiing and parked airplanes and object penetrations except for frangible post mounted NAVAIDs expressly located in the OFZ by function. The runway OFZ extends 200' beyond each end of the runway.

OFZ Dimensions	Width
Runways serving small aircraft & approach minimums less than ¾ statute mile	300'
Runways serving small aircraft with approach speeds of more than 50 knots	250'
Runways serving small aircraft with approach speeds of less than 50 knots	120'
Runways serving large aircraft	400'

Runway Approach Slope / Surface: The approach slope is a three-dimensional trapezoidal FAR Part 77 imaginary surface extending beyond each runway end and has a defined slope requiring clearance over structures and objects beyond the runway threshold. The purpose of the approach surface/slope is to provide proper clearance for the safe approach and landing of aircraft.

Glidepath Qualification Surface (GQS): The GQS is a three-dimensional trapezoid defined in FAA Order 8260.54A that extends a nominal distance of 10,000 feet for planning purposes from the runway threshold along the runway centerline to the Decision Altitude (DA). The GQS extends laterally 100 feet from both edges of pavement at the runway threshold and is 760 feet wide at the DA. When an obstruction penetrates the GQS, an approach procedure with vertical guidance is not authorized until penetrations are removed (except obstacles fixed by function and/or allowable grading).

Runway Visibility Zone (RVZ): The RVZ is used to establish an acceptable line-of-sight that permits mutually visible points to be seen from along the runway centerline, based on the distances between runway ends, taxiway locations and the nearest runway intersection. By design standards, the area within the RVZ should be owned by the airport in "fee simple." The airport sponsor should restrict or minimize crop/vegetation heights based on elevation differences, so they will not interfere with the runway line-of-sight requirements.

Runway Line of Sight: An acceptable runway profile permits any two points 5 feet above the runway centerline to be mutually visible for the entire runway length. The sight distance along a runway from an intersecting taxiway needs to be sufficient to allow a taxiing aircraft to enter safely or cross the runway, in addition to vehicles, wildlife and other hazardous objects. There are no line-of-sight requirements for taxiways.

Taxiway Requirements

Taxiways provide airfield and terminal area access to enhance airport operational safety and capacity by minimizing the time an aircraft is on an active runway.

Primary Taxiway Systems: The following table depicts the FAA design standards for taxiway widths, runway widths, and runway-to-taxiway separation distances for the Design Groups with precision / non-precision instrument approaches of 1-mile visibility and 350 feet Height above Touchdown (HAT).

Airplane Design Group						
	I	II	III	IV	V	VI
TW Width	25'	35'	50'	50'	75'	N/A
Approach Categories A & B						
RW Width	60'	75'	100'	150'	N/A	N/A
RW.CL to TW CL	150'	240'	300'	400'	N/A	N/A
Approach Categories C & D						
RW Width	100'	100'	150'	150'	150'	200'
RW.CL to TW CL	300'	300'	400'	400'	400'	500'

See AC 150-13A Appendix 7. Tables A 7-1 through A 7-11

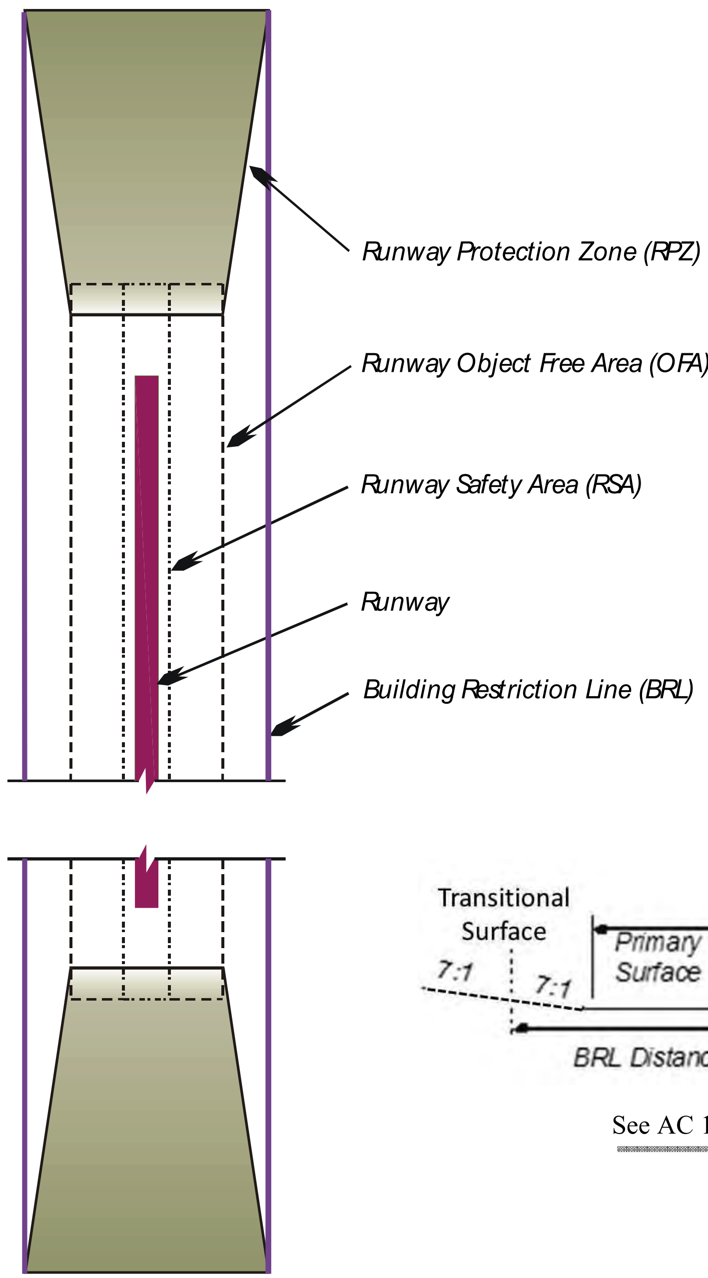
Taxiway Safety Standards: All entry taxiways connecting directly to a runway must provide acceptable hold-short locations in compliance with threshold siting surface (TSS) and obstacle free zone (OFZ) criteria. All non-aeronautical objects must also be located beyond the taxiway object free area (TOFA). The following table shows the dimension standards for the Taxiway Safety Area (TSA) widths and the Taxiway Object Free Area (TOFA) widths.

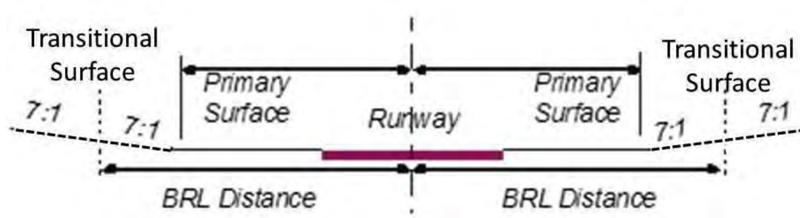
Airplane Design Group						
	I	II	III	IV	V	VI
TW Width	25'	35'	50'	50'	75'	100'
TSA Width	49'	79'	118'	171'	214'	262'
TOFA Width	89'	131'	186'	259'	320'	386'

The figures below depict the RPZ, OFA, RSA, and the FAR Part 77 – Imaginary Airport Surfaces, including the primary and transitional surface and approach slopes. It should be noted that Part 77 regulates procedures for the airport owner to notify FAA of potential hazards to navigation. Penetrations of Part 77 imaginary surfaces do not preclude development of instrument approach procedures. Ideally conformance with Part 77 regulations would provide a completely benign environment for the lowest approach minimums.

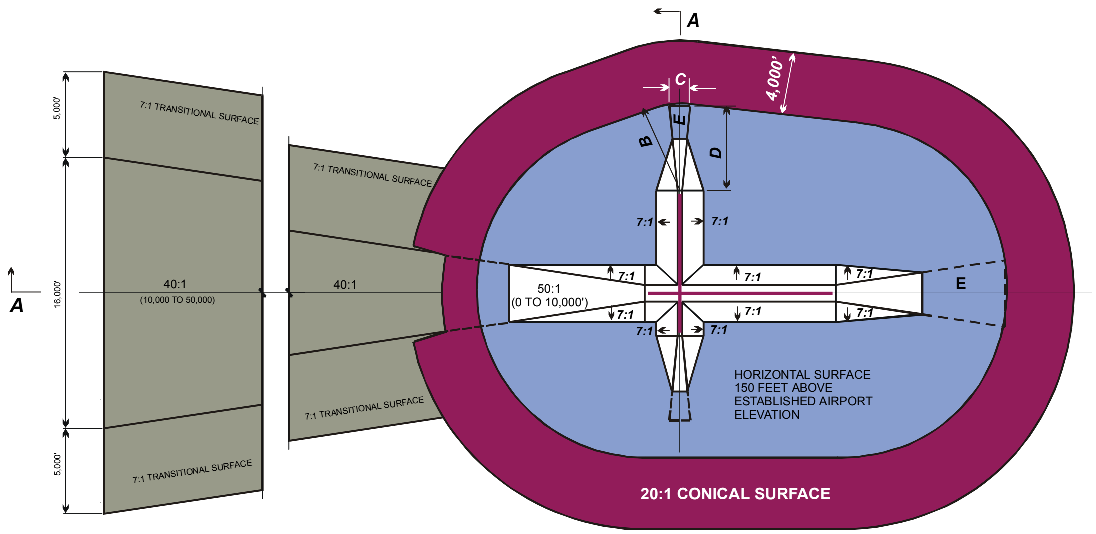
Runway Safety Area Requirements

FAR Part 77 – Imaginary Airport Surfaces



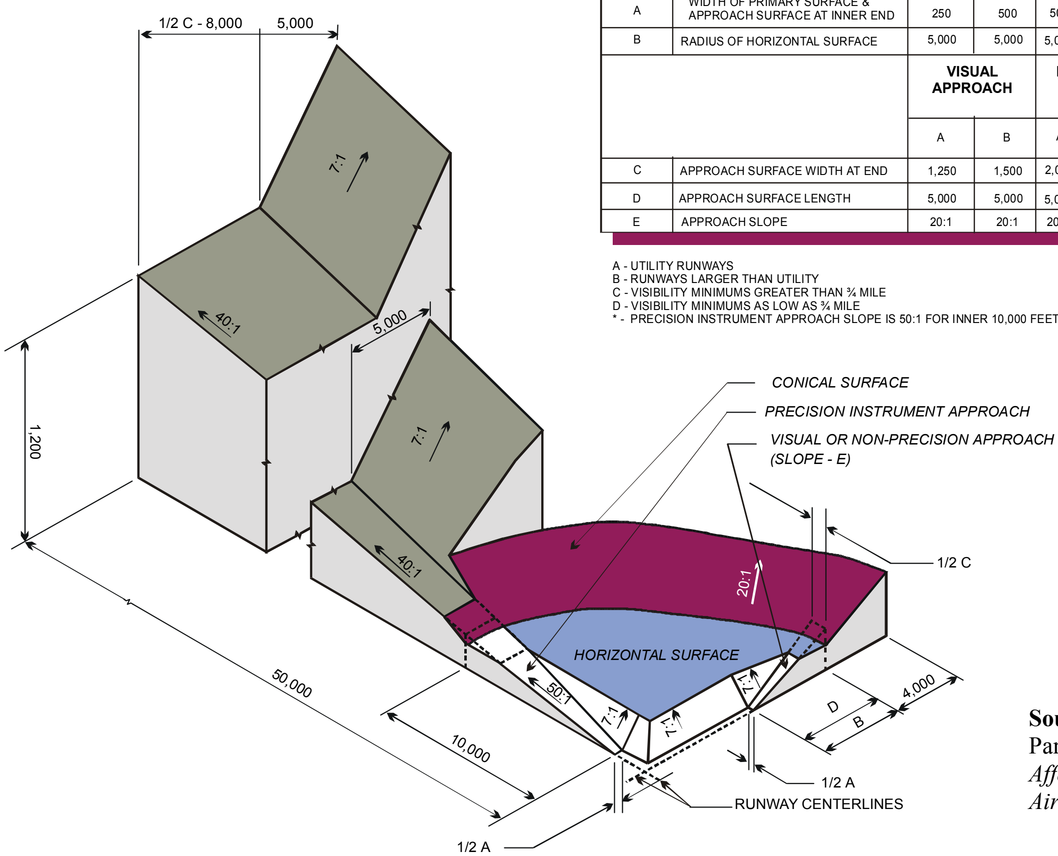


See AC 150-13A Appendix 7. Tables A4-1 & A4-2



DIM	ITEM	DIMENSIONAL STANDARDS (FEET)					
		VISUAL RUNWAY		NON-PRECISION INSTRUMENT RUNWAY			PRECISION INSTRUMENT RUNWAY
		A	B	A	B: C	B: D	
A	WIDTH OF PRIMARY SURFACE & APPROACH SURFACE AT INNER END	250	500	500	500	1,000	1,000
B	RADIUS OF HORIZONTAL SURFACE	5,000	5,000	5,000	10,000	10,000	10,000
		VISUAL APPROACH		NON-PRECISION INSTRUMENT APPROACH			PRECISION INSTRUMENT RUNWAY
		A	B	A	B: C	B: D	
C	APPROACH SURFACE WIDTH AT END	1,250	1,500	2,000	3,500	4,000	16,000
D	APPROACH SURFACE LENGTH	5,000	5,000	5,000	10,000	10,000	*
E	APPROACH SLOPE	20:1	20:1	20:1	34:1	34:1	*

A - UTILITY RUNWAYS
B - RUNWAYS LARGER THAN UTILITY
C - VISIBILITY MINIMUMS GREATER THAN ¾ MILE
D - VISIBILITY MINIMUMS AS LOW AS ¾ MILE
* - PRECISION INSTRUMENT APPROACH SLOPE IS 50:1 FOR INNER 10,000 FEET AND 40:1 FOR AN ADDITIONAL 40,000 FEET



Source: FAA FAR Part 77: *Objects Affecting Navigable Airspace*

Infrastructure Gap Analysis

The Scope of Work for this study identified a goal of establishing new or enhanced instrument procedures based on weather minimums of 350 feet Height Above Threshold (HAT) ceiling and 1-statute mile visibility. The following table A16-1B (taken from Appendix 16 of Advisory Circular 150/5300-13) specifies applicable standards for approach procedures with vertical guidance. Standards for the prescribed minima are highlighted for reference purposes.

Table A16-1B Approach Procedure With Vertical Guidance

Visibility Minimums	< 3/4 statute mile	< 1 -statute mile	1 -statute mile	>1 -statute mile
Height Above Threshold (HAT)	250	300	350	400
TERPS Glidepath Qualification Surface (GQS)	Table A2-1, Row 9, Criteria, and Appendix 2, par. 5a clear			
TERPS Chapter 3, Section 3	34:1 clear	20:1 clear	20:1 clear, or penetrations lighted for night minimums (See AC 70/7460-1)	
Precision Obstacle Free Zone (POFZ) 200' x 800'	Required	Recommended		
Airport Layout Plan	Required			
Minimum Runway Length	4,200 ft (Paved)	3,200 ft (Paved)	3,200 ft	
Runway Markings (See AC 150/5350-1)	Precision	Nonprecision *(precision recommended)*	Nonprecision	
Holding Position Signs & Markings	Precision	Nonprecision *(precision recommended)*	Nonprecision	
Runway Edge Lights	HIRL/MIRL		MIRL/LIRL	
Parallel Taxiway	Required		Recommended	
Approach Lights	MALSR, SSALR, ALSF	Recommended	Recommended	
Runway Design Standards; e.g., Obstacle Free Zone (OFZ)	<3/4 statute mile approach visibility minimums	≥ 3/4 -statute mile approach visibility minimums		
Threshold Siting Criteria To Be Met	Table A2-1, Row 7 and 9	Table A2-1, Row 6 and 9	Appendix 2, Table A2-1, Row 5 and 9	
Survey Required for Lowest Minima	Vertically Guided Airport Airspace Analysis Survey criteria in AC 150/5300-18		Non-Vertically Guided Airport Airspace Analysis Survey criteria in AC 150/5300-18	

Based on the results of the airport inventories conducted for the study, templates were prepared to correlate existing airport infrastructure to current design standards. Where the airport infrastructure consists of a multiple runway configuration, the primary runway was identified for the gap analysis. During the site visit inventory interviews, the consultant specifically asked if the airport sponsor had plans for implementing new or improved instrument procedures for secondary runways. In all applicable circumstances the airport representatives confirmed that no secondary runway procedures were contemplated.

Dimensional standards for the existing and planned Airport Reference Code were compared to the physical characteristics for each primary runway to determine if gaps existed. The following section of this report consists of the Gap Analysis template for each of the study airports and a narrative discussion of the relevant data. For ease of interpretation, where the required standard for the given criterion is not met, the deficiency or violation is highlighted in red. Where a minimum standard is exceeded, the positive variance is highlighted in green. The airports are presented in the final order of ranking based on the "Busy Airport" evaluation criteria.

Survey Requirements

After the airport infrastructure needs have been determined, the next step is to collect the appropriate airport data to develop the instrument approach.

New instrument approach procedures (IAP) require accurate airport data meeting FAA requirements. The data collection effort begins by reviewing the guidance provided in the following FAA advisory circulars:

AC 150/5300-16[11]
AC 150/5300-17[12]
AC 150/5300-18[13]

Advisory Circular -16a provides guidance for establishing Primary and Secondary (PACS and SACS) geodetic control. AC-17b describes the methodology for acquisition and use of aerial imagery and AC-18b details survey data acquisition standards as well as GIS feature collection and data attribution.

[11] General Guidance and Specifications for Aeronautical Surveys

[12] General Guidance and Specifications for Aeronautical Surveys

[13] General Guidance and Specifications for Submission of Aeron nautical Surveys to NGS

Using the guidance provided in the FAA Advisory Circulars, airport managers can determine what information it currently has and what information they need to collect or update.

With the requirements determined, the airport sponsor is in a position to start the process of collecting the required survey data. Typically, most airports will require a new high accuracy survey to gather the most current data on the airport and obstacles surrounding the airport. The instrument approach development process cannot begin until the survey data is provided and verified. The FAA procedure development and publishing process requires a considerable amount of time which can range between 12-18 months.

BFI – King County International Airport / Boeing Field

Boeing Field (BFI) Gap Analysis

Airport Name:	Boeing Field
Associated City:	Seattle, WA
Airport Identifier:	BFI
Ownership / National Classification:	Public / Primary
Airport Reference Code (ARC) - E/F	D-V/D-IV

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	13R/31L	
RWY Length	10,000'	4200'
RWY Width	200'	150'
Runway Safety Area (RSA):		
(Width)	500'	500'
(Length beyond RWY end)	1000'/120'	1000'
Obstacle Free Zone (OFZ)	No Penetrations	400' x 10,400'
Object Free Area (OFA)	800' x 10,250'	800' x 12,000' (**)
Glidepath Qualification Surface (GQS)	3:1 / 40:1	30:1 Clear (*)
Runway Protection Zone		
Fee (F), Easement (E)	F & E	F&E
RWY Marking	PIR/PIR	PIR/PIR
RWY Edge Lighting	HIRL	HIRL
RWY Approach Lighting	MALSF/None	MALSF/None
Parallel TWY (West/East side)	Full/Partial	Full
TWY Width (West/East side)	75'/35'	75'/35'
RWY/TWY Separation (West/East side)	325'/350'	400' (**)
TWY Marking	CL & HLD	CL & HLD
(Hold Line distance from RWY CL)	250'	250'
(Guidance Signs)	Lighted	Lighted
TWY Lighting	MITL	MITL

Operational Data	
	2011
Total Based Aircraft	431
Single Engine	257
Multi Engine	89
Jet	77
Other	48
Total Operations	228,727
Itinerant General Aviation	101,724
Air Taxi	59,225
Instrument Operations	67,592

Related Documentation		
	Existing	Proposed
Airport Master Plan	2004	Strategic Plan
Airport Layout Plan	2007	2012-2016
PACS/SACS (150/5300-16a)	2005	2005
Horiz/Vert Datum	NAD 83/NAVD 88	NAD 83/NAVD 88
Aerial Imagery (-17b)	2005	<24 months prior to use
Obstruction Survey (-18b)	2005	<24 months prior to use
Airport weather reporting	ASOS	ASOS

Published Instrument Approaches		
RWY - Category	**Minima (HAT - Visibility)**	
	Existing	Proposed
RWY 13R - S-ILS 13R	273 - 1	
RWY 13R - RNP 0.15 DA	505 - 1 1/2	350 - 1
RWY 31L - S-ILS 31L	407 - 1 1/2	350 - 1

Notes:
* - Controlling obstructions consist of a fence at the RWY 13R end and a railroad adjacent to RWY 31L.
** ALP dated 2007 reflects an Approved Modification to Standards for the OFA and RWY to TWY separation standard.

Boeing Field is surrounded by industrial development. As a result, the airfield configuration is constrained and compliance with dimensional standards is compromised. As noted on the Gap Analysis template, airport perimeter fencing near the end of Runway 13R violates the requirement for a clear 30:1 Glidepath Qualification Surface (GQS). TERPS criteria covered in Table A2-1 "Approach/Departure Requirements Table" in AC 150/5300-13 dictates that penetrations of the GQS preclude authorization of vertically guided approaches. It should be noted that the existing ILS and RNP approaches tend to conflict with this determination. This difference with respect to emerging technology advances is currently being studied under a separate "Strategic Plan" contract. It is expected that these plans will be documented in the final Strategic

Plan, and updates to the Master Plan and ALP will be forthcoming.

Other controlling obstructions near both runway ends and lateral site constraints limit the ability for the airport to fully comply with separation and Obstacle Free Zone criteria. The current ALP reflects an Approved Modification to Standards for the Runway to Taxiway separation and OFA requirements. While beyond the scope of this study, it is presumed that the higher minima for satellite based approaches are based on controlling obstacle clearances.

S50 – Auburn Municipal

Auburn Municipal (S50) Gap Analysis

Airport Name:	Auburn Municipal
Associated City:	Auburn, WA
Airport Identifier:	S50
Ownership / National Classification:	Public / Regional
Airport Reference Code (ARC)	B-I

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	16/34	
RWY Length	3400'	3200'
RWY Width	75'	60'
Runway Safety Area (RSA):		
(Width)	120'	120'
(Length beyond RWY end)	240'	240'
Obstacle Free Zone (OFZ)	250' x 3800'	250' x 3800'
Object Free Area (OFA)	250' x 3880'	250' x 3880'
Glidepath Qualification Surface (GQS)	18:1 / 13:1 (*)	30:1 Clear
Runway Protection Zone		
Fee (F), Easement (E)	F & E	F & E
RWY Marking	Basic	NPI/VIS
RWY Edge Lighting	MIRL	MIRL
RWY Approach Lighting	N/A	N/A
Parallel TWY	Full	Full
TWY Width (West side)	25'	25'
RWY/TWY Separation	240'	150'
TWY Marking	CL & HLD	CL & HLD
(Hold Line distance from RWY CL)	125'	125'
(Guidance Signs)		
TWY Lighting	MITL	MITL

Related Documentation		
	Existing	Proposed
Airport Master Plan	2002	2012
Airport Layout Plan	2002	2012
PACS/SACS (150/5300-16a)		Temporary
Horiz/Vert Datum	NAD 83/NAVD 88	2012-2016
Aerial Imagery (-17b)		<24 months prior to use
Obstruction Survey (-18b)		<24 months prior to use
Airport weather reporting	None	AWOS

Published Instrument Approaches		
RWY - Category	**Minima (HAT - Visibility)**	
	Existing	Proposed
RWY 16/34 - RNAV - Circling	1257-1 1/2	350 -1

Operational Data	
	2011
Total Based Aircraft	241
Single Engine	221
Multi Engine	16
Jet	0
Other	4
Total Operations	164,539
Itinerant General Aviation	98,339
Air Taxi	6,100
Instrument Operations	Not available - no ATCT

Notes:
* - Controlling obstructions consist of a building NE of RWY 16 and a parking lot south of RWY 34. Per AC 150/5300-13 Appendix 16, approach procedures with vertical guidance are not authorized.
The potential for adjusting runway thresholds to mitigate existing obstructions should be addressed in the Master Plan/ALP update.

The 2002 Master plan for Auburn Municipal Airport shows an existing and future Airport Reference Code of B-I. Based on this classification, the airport meets or exceeds the airfield dimensional criteria for a vertically guided approach procedure. However, the 30:1 Glide path Qualification Surface is significantly obstructed. Consequently a non-precision approach with 350 HAT and 1-mile visibility is suggested. The following Table A16-1C Non-precision Approach Requirements from AC 150/5300-13 shows the criteria for approach procedures without vertical guidance.

Table A16-1C Nonprecision Approach Requirements

Visibility Minimums	< 3/4 statute mile	< 1 -statute mile	1 -statute mile	>1 -statute mile
Height Above Threshold (HAT)	300	340	400	450
TERPS Chapter 3, Section 3	34:1 clear	20:1 clear	20:1 clear, or penetrations lighted for night minimums (See AC 70/7460-1)	
Airport Layout Plan	Required			
Minimum Runway Length	4,200 ft (Paved)	3,200 ft (Paved)	3,200 ft	
Runway Markings (See AC 150/5350-1)	Precision		Nonprecision	
Holding Position Signs & Markings	Precision		Nonprecision	
Runway Edge Lights	HIRL/MIRL		MIRL/LIRL	
Parallel Taxiway	Required		Recommended	
Approach Lights	MALSR, SSALR, ALSF	Required	Recommended	
Runway Design Standards; e.g., Obstacle Free Zone (OFZ)	<3/4 statute mile approach visibility minimums	≥ 3/4 -statute mile approach visibility minimums		
Threshold Siting Criteria To Be Met	Table A2-1, Row 7	Table A2-1, Row 6	Appendix 2, Table A2-1, Row 1-5	
Survey Required for Lowest Minima	Vertically Guided Airport Airspace Analysis Survey	Non-Vertically Guided Airport Airspace Analysis Survey criteria in AC 150/5300-18		

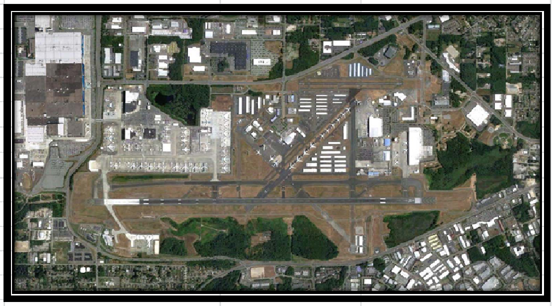
Based on the non-precision approach requirements, Auburn Municipal Airport potentially qualifies for a non-vertically guided approach. Lighting of imaginary surface penetrations and a detailed evaluation of threshold siting criteria based on an Aeronautical survey conforming with AC 150/5300-18 (current edition) criteria is proposed.

This Gap Analysis should not be construed as precluding the potential for investigating alternatives for providing vertically guided procedures. The possibility of adjusting runway thresholds to mitigate existing obstructions should be addressed in the Master Plan/ALP update.

PAE – Snohomish County Airport / Paine Field

Paine Field (PAE) Gap Analysis

Airport Name:	Snohomish County/Paine Field
Associated City:	Everett, WA
Airport Identifier:	PAE
Ownership / National Classification:	Public / National
Airport Reference Code (ARC) - E/F	D-V



Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	16R/34L	
RWY Length	9010'	4200'
RWY Width	150'	150' (*)
Runway Safety Area (RSA):		
(Width)	500'	500'
(Length beyond RWY end)	1000'	1000'
Obstacle Free Zone (OFZ)	400' x 9410'	400' x 9410'
Object Free Area (OFA)	800'x 11010'	800'x 11010'
Glidepath Qualification Surface (GQS)	50:1 / 30:1	30:1 Clear
Runway Protection Zone		
Fee (F), Easement (E)	F&E	F&E
RWY Marking	PIR/NPI	PIR/NPI
RWY Edge Lighting	HIRL	HIRL
RWY Approach Lighting	MALSR/MALSF	MALSR/MALSF
Parallel TWY	Full	Full
TWY Width	75'	75' (*)
RWY/TWY Separation (West side)	540'	507'
TWY Marking	CL & HLD	CL & HLD
(Hold Line distance from RWY CL)	300'	287'
(Guidance Signs)	Lighted	Lighted
TWY Lighting	MITL	MITL

Operational Data	
	2011
Total Based Aircraft	468
Single Engine	404
Multi Engine	37
Jet	12
Other	15
Total Operations	113,311
Itinerant General Aviation	53,232
Air Taxi	2,237
Instrument Operations	20,178

Related Documentation		
	Existing	Proposed
Airport Master Plan	2002	2012-2016 (**)
Airport Layout Plan	2008	2012-2016 (**)
PACS/SACS (150/5300-16a)	2010	2010
Horiz/Vert Datum	NAD 83/NAVD 88	NAD 83/NAVD 88
Aerial Imagery (-17b)		<24 months prior to use
Obstruction Survey (-18b)		<24 months prior to use
Airport weather reporting	ASOS	ASOS

Published Instrument Approaches		
RWY - Category	**Minima (HAT - Visibility)**	
	Existing	Proposed
RWY 16R -S ILS 16R	216 - 1/2	
RWY 16R - LPV	260 -1/2	200 - 1/2
RWY 34L - LPV	311 - 3/4	200 - 1/2

Notes:
* - PAE has a Modification to Standards for operations of the 747-800.
** - No specific date programmed.

Snohomish County Airport / Paine Field serves the Boeing manufacturing plant in Everett, Washington. Paine Field has the highest existing and proposed ARC of all of the study airports. With the exception of the existing runway and taxiway widths, all of the pertinent standards are met for precision vertically guided approaches. An Approved Modification to Standards is currently in place to allow operations of the ARC D-VI Boeing 747-8. It is suggested that lower minimums for satellite based approach procedures may be achieved with the application of Performance Based Navigation technology or re-evaluation of existing LPV TERPS criteria.

S36 – Crest Airpark

Crest Airpark (S36) NextGen Gap Analysis

Airport Name:	Crest Airpark	
Associated City:	Kent	
Airport Identifier:	S36	
Ownership / National Classification:	Private / Non-NPIAS	
Airport Reference Code (ARC) - E/F	A-I	

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	15/33	
RWY Length	3,288'	3200'
RWY Width	40'	60'
Runway Safety Area (RSA):		
(Width)	Undefined	120'
(Length beyond RWY end)	Undefined	240'
Obstacle Free Zone (OFZ)		250' x 3628'
Object Free Area (OFA)		250' x 3728'
Glidepath Qualification Surface (GQS)	4:1 / 0:1 (*)	30:1 Clear
Runway Protection Zone		
Fee (F), Easement (E)	F & E	F & E
RWY Marking	Basic-Non Std	NPI/VIS
RWY Edge Lighting	LIRL	MIRL/LIRL
RWY Approach Lighting	N/A	N/A
Parallel TWY	Full	Full
TWY Width	25'	25'
RWY/TWY Separation	75'	150'
TWY Marking	None	CL & HLD
(Hold Line distance from RWY CL)	50'?	125'
(Guidance Signs)	None	Lighted
TWY Lighting	None	MITL

Operational Data	
	2011
Total Based Aircraft	332
Single Engine	327
Multi Engine	5
Jet	0
Other	0
Total Operations	101,200
Itinerant General Aviation	12,650
Air Taxi	0
Instrument Operations	N/A

Related Documentation		
	Existing	Proposed
Airport Master Plan	N/A	
Airport Layout Plan	1984	2012-2016
PACS/SACS (150/5300-16a)		Temporary
Horiz/Vert Datum		2012-2016
Aerial Imagery (-17b)		<24 months prior to use
Obstruction Survey (-18b)		<24 months prior to use
Airport weather reporting	None	AWOS

Published Instrument Approaches		
RWY - Category	**Minima (HAT - Visibility)**	
	Existing	Proposed
RWY 15	N/A	350 - 1
RWY 33	N/A	VIS

Notes:
* - Close-in obstructions consist of trees on both runway ends and surrounding the airport.

1. Multiple through-the-fence access points.
2. Can't force adjacent property owners to cut down trees.
3. Significant student operations by Green River Community College.

Crest Airpark is a privately owned and operated airport that ranked high in the "Busy Airport" evaluation primarily based on a high level of itinerant traffic. As illustrated in the Gap Analysis template, very few of the requirements are met for establishing a vertically or non-vertically guided approach. The standards that are met, such as existence of a full parallel taxiway or the taxiway width, are overshadowed by the need to replace those facilities to meet other standards (e.g., runway to taxiway separation). Significant tree obstructions surrounding the airport combined with adjacent residential property concerns make infrastructure investments unjustified.

PLU – Pierce County Airport / Thun Field

Pierce County - Thun Field (PLU) Gap Analysis

Airport Name:	Pierce County - Thun Field
Associated City:	Puyallup
Airport Identifier:	PLU
Ownership / National Classification:	Public / Regional
Airport Reference Code (ARC)	B-II

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	16/34	
RWY Length	3650'	3200'
RWY Width	60'	75'
Runway Safety Area (RSA):		
(Width)	150'	150'
(Length beyond RWY end)	300'	300'
Obstacle Free Zone (OFZ)	250' x 4050'	250' x 4050'
Object Free Area (OFA)	500' x 4250'	500' x 4250'
Glidepath Qualification Surface (GQS)	34:1 / 3:1 *	30:1 Clear
Runway Protection Zone		
Fee (F), Easement (E)	F & E	F & E
RWY Marking	Basic	NPI
RWY Lighting	MIRL	MIRL
Parallel TWY	Full	Full
TWY Width	35'	35'
RWY/TWY Separation	240'	240'
TWY Marking	CL & HLD	CL & HLD
(Hold Line distance from RWY CL)	Varies	200'
(Guidance Signs)	Unlighted	Lighted
TWY Lighting	Reflectors	MITL

Operational Data	
	2011
Total Based Aircraft	184
Single Engine	163
Multi Engine	17
Jet	1
Other	3
Total Operations	100,000
Itinerant General Aviation	62,463
Air Taxi	3,388
Instrument Operations	Not available - no ATCT

Related Documentation		
	Existing	Proposed
Airport Master Plan	1999	2013
Airport Layout Plan	1999	2013
PACS/SACS (150/5300-16a)	2007	2007
Horiz/Vert Datum	NAD 83/NAVD 88	NAD 83/NAVD 88
Aerial Imagery (-17b)		<24 months prior to use
Obstruction Survey (-18b)		<24 months prior to use
Airport weather reporting	AWOS-III	AWOS-III

Published Instrument Approaches		
RWY - Category	**Minima (HAT - Visibility)**	
	Existing	Proposed
RWY 16	N/A	350-1
RWY 34 - GPS S-34	662 - 1	350 - 1

Notes:
* Road in approach to RWY 34 and tree obstructions may affect higher minimums. Internal access road had been closed at FAA request.

Pierce County Airport Thun Field has a significant level of itinerant operations and 2 based Business Jets. The existing Master Plan and Airport Layout Plan were prepared in 1999 and are slated for update in 2013. These updates will provide a valuable tool for guiding the long range goals and objectives of the airport. The timing of these plans may also be used to prepare for NextGen technology upgrades. The straight-in GPS approach to runway 34 provides relatively high minimums which may be attributable to an internal access road crossing the approach. It should be noted that the RWY 34 approach is in the opposite direction of most IFR traffic in the Puget Sound region. The potential for a new vertically guided approach to runway 16 is very good. However, residential development north of the airport may be a concern. To facilitate a new approach procedure to the runway 16 end, the ALP should be updated as programmed, the runway pavement width should be increased to 75 feet, and connecting taxiway markings and hold signs should be relocated to a consistent 200 feet from runway centerline. Aerial imagery conforming to AC 150/5300-17b requirements and a new obstruction survey complying with AC 150/5300-18b will also be required.

AWO – Arlington Municipal

Arlington Municipal Airport (AWO) Gap Analysis

Airport Name:	Arlington Municipal
Associated City:	Arlington, WA
Airport Identifier:	AWO
Ownership / National Classification:	Public / Local
Airport Reference Code (ARC) - E/F	B-II/C-II

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	16/34	
RWY Length	5332'	4200'
RWY Width	100'	100'
Runway Safety Area (RSA):		
(Width)	150'	500'
(Length beyond RWY end)	240'	1000'
Obstacle Free Zone (OFZ)	250' x 5812'	250' x 5812'
Object Free Area (OFA)	500' x 5812'	800' x 7332'
Glidepath Qualification Surface (GQS)	22:1 / 50:1	30:1 Clear (*)
Runway Protection Zone		
Fee (F), Easement (E)	F & E	
RWY Marking	Basic/NPI	NPI/PIR
RWY Edge Lighting	MIRL	MIRL
RWY Approach Lighting	MALS	MALSR
Parallel TWY	Full	Full
TWY Width (West side)	35'	35'
RWY/TWY Separation (West side)	400'	400'
TWY Marking	CL & HLD	CL & HLD
(Hold Line distance from RWY CL)	250'	250'
(Guidance Signs)	Reflectors	Lighted
TWY Lighting	Reflectors	MITL

Operational Data	
	2011
Total Based Aircraft	582
Single Engine	447
Multi Engine	7
Jet	10
Other	118
Total Operations	134,032
Itinerant General Aviation	56,798
Air Taxi	520
Instrument Operations	Not available - no ATCT

Related Documentation		
	Existing	Proposed
Airport Master Plan	2002	2012
Airport Layout Plan	2003	2012
PACS/SACS (150/5300-16a)	NGS 2007	NGS 2007
Horiz/Vert Datum	NAD 83/NAVD 88	NAD 83/NAVD 88
Aerial Imagery (-17b)	WSDOT 2009	<24 months prior to use
Obstruction Survey (-18b)	N/A	<24months prior to use
Airport weather reporting	AWOS-III	AWOS-III

Published Instrument Approaches		
RWY - Category	Minima (HAT - Visibility)	
	Existing	Proposed
RWY 16	N/A	350 - 1
RWY 34 - LOC S-34	452 - 3/4	
RWY 34 - LPV	200 - 3/4	200-1/2

Notes:
* - Controlling obstructions consist of trees on the north (RWY 16).

Arlington Municipal Airport is currently undertaking a Master Plan update which will bring the Airport Layout Plan into compliance with current standards. The existing facility meets standards for Airport Reference Code B-II and the LPV approach to runway 34 provides better minimums than the ground based Localizer approach due to the vertical guidance capability of the WAAS based approach. Planned changes from an ARC of B-II to C-II will necessitate airfield infrastructure upgrades. Most significant will be the increase in Runway Safety Area width and length from 150' x 5813' to 500' x 7333'. While the RSA is not specifically spelled out as a requirement for new instrument procedures, it is a basic feature of a safe airfield operational area that needs to be addressed when increased high performance aircraft operations are anticipated. As with Thun Field, the approach to runway 34 conflicts with typical IFR procedures in the Puget Sound region. For this reason, planning for a new LPV approach to runway 16 is proposed.

TIW – Tacoma Narrows

Tacoma Narrows (TIW) Gap Analysis

Airport Name:	Tacoma Narrows
Associated City:	Tacoma, WA
Airport Identifier:	TIW
Ownership / National Classification:	Public / Regional
Airport Reference Code (ARC) - E/F	D-II

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	17/35	
RWY Length	5002'	3200'
RWY Width	150'	100'
Runway Safety Area (RSA):		
(Width)	500'	500'
(Length beyond RWY end)	1000'	1000'
Obstacle Free Zone (OFZ)	400' x 5402'	400' x 5402' (*)
Object Free Area (OFA)	800' x 6382'	800' x 7002'
Glidepath Qualification Surface (GQS)	50:1 / 50:1	Clear 30:1
Runway Protection Zone		
Fee (F), Easement (E)	F & E	F & E
RWY Marking	PIR/NPI	PIR/NPI
RWY Edge Lighting	MIRL	MIRL
RWY Approach Lighting	MALSR	MALSR
Parallel TWY	Full	Full
TWY Width	75'	35'
RWY/TWY Separation	350'	400' (*)
TWY Marking	CL & HLD	CL&HLD
(Hold Line distance from RWY CL)	250'	250'
(Guidance Signs)	Lighted	Lighted
TWY Lighting	MITL	MITL

Operational Data	
	2011
Total Based Aircraft	156
Single Engine	124
Multi Engine	17
Jet	7
Other	8
Total Operations	78,841
Itinerant General Aviation	44,300
Air Taxi	1,400
Instrument Operations	11,026

Related Documentation		
	Existing	Proposed
Airport Master Plan	2003	2012
Airport Layout Plan	2003	2012
PACS/SACS (150/5300-16a)	2007	
Horiz/Vert Datum	NAD 83/NAVD 88	NAD 83/NAVD 88
Aerial Imagery (-17b)	2005	<24 months prior to use
Obstruction Survey (-18b)	2006	<24 months prior to use
Airport weather reporting	ASOS	ASOS

Published Instrument Approaches		
RWY - Category	Minima (HAT - Visibility)	
	Existing	Proposed
RWY 17 - S-ILS 17	200 - 1/2	
RWY 17 - LPV	344 - 1	200 - 1/2 (**)
RWY 35 - LPV	266 - 1	350 - 1

Notes:
* - Reconfiguration of holding apron should be incorporated in parallel taxiway relocation design.
** - Obstruction survey and reevaluation of LPV minimums should be conducted in in association with the 2012/2013 design.

Tacoma Narrows Airport is in the process of a multi-year Capital Improvement Program to upgrade the runway safety area to bring the OFZ into compliance with D-II standards. This program includes constructing a bridge to reroute Stone Drive north of the airport, relocate the localizer to the south, improve drainage and regrade the required 500' x 1000' extended safety area at both runway ends. This project will bring most airfield facilities into current compliance.

The existing parallel taxiway and associated holding aprons will still need to be addressed. The standard separation between runway and taxiway centerlines for D-II airplanes is 400'. Likewise the parking of aircraft on the existing holding aprons at both runway ends violates the 200' x 800' Precision Object Free Area.

The 2012 programmed update to the Airport Master Plan will include an update to the Airport Layout Plan. These planning documents will address resolution of the parallel taxiway standards and should appropriately resolve the difference in minimums published for the ILS and LPV approaches to runway 17.

RNT – Renton Municipal

Renton Municipal (RNT) Gap Analysis

Airport Name:	Renton Municipal
Associated City:	Renton, WA
Airport Identifier:	RNT
Ownership / National Classification:	Public / Regional
Airport Reference Code (ARC) - E/F	B-II

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	16/34	
RWY Length	5382'	4200'
RWY Width	200'	75'
Runway Safety Area (RSA):		
(Width)	150'	150'
(Length beyond RWY end)	300'/340'	300'
Obstacle Free Zone (OFZ)	400' x 5782'	400' x 5782'
Object Free Area (OFA)	500' x 5982'	500' x 5982'
Glidepath Qualification Surface (GQS)	33:1 / 0:1 (*)	30:1 Clear
Runway Protection Zone		
Fee (F), Easement (E)	F & E	F & E
RWY Marking	NPI/NPI	NPI/VIS
RWY Edge Lighting	MIRL	MIRL
RWY Approach Lighting	N/A	N/A
Parallel TWY (West side)	Full	Full
TWY Width (West side)	50' (Apron edge)	35'
RWY/TWY Separation (West side)	300'	240'
TWY Marking	CL & HLD	CL & HLD
(Hold Line distance from RWY CL)	200'	200'
(Guidance Signs)	Lighted	Lighted
TWY Lighting	MITL	MITL

Operational Data	
	2011
Total Based Aircraft	322
Single Engine	293
Multi Engine	14
Jet	1
Other	14
Total Operations	95,791
Itinerant General Aviation	42,173
Air Taxi	1,306
Instrument Operations	4,556

Related Documentation		
	Existing	Proposed
Airport Master Plan	1997	
Airport Layout Plan	2009	2012-2016
PACS/SACS (150/5300-16a)	NGS 2007	
Horiz/Vert Datum	NAD 83/NAVD 88	
Aerial Imagery (-17b)		<24 months prior to use
Obstruction Survey (-18b)		<24 months prior to use
Airport weather reporting	ASOS	ASOS

Published Instrument Approaches		
RWY - Category	**Minima (HAT - Visibility)**	
	Existing	Proposed
RWY 16 - LPV	517 - 1 1/4	350 - 1
RWY 34	Visual	Visual

Notes:
* - Controlling obstructions consist of trees on the north (RWY 16) and a road to the south (RWY 34).

Renton Municipal Airport presents unique challenges and opportunities for application of NextGen technologies. The airport meets or exceeds the criteria for the current ARC of B-II with the exception of GQS clearance for vertically guided approaches to runway 34. Noted site constraints preclude consideration of instrument approaches to Runway 34.

The current and projected increased use of Renton by 737 aircraft manufactured at the Boeing plant warrant review of gaps related to changing the Airport Reference Code to D-III. The following Gap Analysis template provides documentation of issues requiring further analysis and discussion of potential variances.

RNT – Renton Municipal (737 Gap Analysis)

Renton Municipal (RNT) 737 Gap Analysis

Airport Name:	Renton Municipal
Associated City:	Renton, WA
Airport Identifier:	RNT
Ownership / National Classification:	Public / Regional
Airport Reference Code (ARC) - E/F	B-II/D-III (737 Max)

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	16/34	
RWY Length	5382'	4200'
RWY Width	200'	150'
Runway Safety Area (RSA):		
(Width)	150'	500' (**)
(Length beyond RWY end)	300'/340'	1000' (**)
Obstacle Free Zone (OFZ)	400' x 5782'	400' x 5782'
Object Free Area (OFA)	500' x 5982'	800' x 7382' (**)
Glidepath Qualification Surface (GQS)	33:1 / 0:1 (*)	30:1 Clear
Runway Protection Zone		
Fee (F), Easement (E)	F & E	F & E
RWY Marking	NPI/NPI	NPI/NPI
RWY Edge Lighting	MIRL	MIRL
RWY Approach Lighting	N/A	N/A
Parallel TWY (West side)	Full	Full
TWY Width (West side)	50' (Apron edge)	50'
RWY/TWY Separation (West side)	300'	400'
TWY Marking	CL & HLD	CL & HLD
(Hold Line distance from RWY CL)	200'	250'
(Guidance Signs)	Lighted	Lighted
TWY Lighting	MITL	MITL

Related Documentation		
	Existing	Proposed
Airport Master Plan	1997	2012-2016
Airport Layout Plan	2009	2012-2016
PACS/SACS (150/5300-16a)	NGS 2007	
Horiz/Vert Datum	NAD 83/NAVD 88	
Aerial Imagery (-17b)		<24 months prior to use
Obstruction Survey (-18b)		<24 months prior to use
Airport weather reporting	ASOS	ASOS

Operational Data	
	2011
Total Based Aircraft	322
Single Engine	293
Multi Engine	14
Jet	1
Other	14
Total Operations	95,791
Itinerant General Aviation	42,173
Air Taxi	1,306
Instrument Operations	4,556

Published Instrument Approaches		
RWY - Category	**Minima (HAT - Visibility)**	
	Existing	Proposed
RWY 16 - LPV	517 - 1 1/4	
RWY 16 - RNP		350 - 1
RWY 34	Visual	
RWY 34 - RNP		350-1

Notes:
* - Controlling obstructions consist of trees on the north (RWY 16) and a road to the south (RWY 34).
** - Site constraints warrant a detailed survey of obstructions, a Modification to Standards proposal and development of RNP procedures to support increased 737 operations.

Preliminary studies have been conducted to investigate the potential for developing Required Navigation Performance (RNP) procedures for approaches to Runway 16 and departures from Runway 34. The flexibility of PBN technology to provide curved approach procedures, avoiding direct over flight of noise sensitive areas north of the airport (Mercer Island), suggests a real opportunity to demonstrate the value of NextGen to the Puget Sound region.

An update to the Airport Master and associated Airport Layout Plan would be required to establish an RNP approach. Modifications to Standards for extended Runway Safety Area (RSA) and Runway to parallel Taxiway separation criteria would also be required. The existence of the FAA Air Traffic Control Tower provides positive control of ground traffic during critical aircraft operations. This feature supports a variance to the separation standards. Further discussion of variances and opportunities will be addressed in the Implementation Plan and NextGen applications chapters of this study.

PWT – Bremerton National

Bremerton National (PWT) Gap Analysis

Airport Name:	Bremerton National	
Associated City:	Bremerton, WA	
Airport Identifier:	PWT	
Ownership / National Classification:	Public / Regional	
Airport Reference Code (ARC)	B-II	

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	1/19	
RWY Length	6000'	4200'
RWY Width	150'	100'
Runway Safety Area (RSA):		
(Width)	300'	300'
(Length beyond RWY end)	600'	600'
Obstacle Free Zone (OFZ - W x L))	400' x 6,400'	400' x 6,400'
Object Free Area (OFA)	800' x 7,200'	800' x 7,200'
Glidepath Qualification Surface (GQS)	50:1 / 46:1	30:1 Clear
Runway Protection Zone		
Fee (F), Easement (E)	F & E	F & E
RWY Marking	NPI/PIR	NPI/PIR
RWY Edge Lighting	HIRL	MIRL
RWY Approach Lighting	None/MALSR	None/MALSR
Parallel TWY	Full	Full
TWY Width	40'	35'
RWY/TWY Separation	400'	300'
TWY Marking	CL & HLD	CL & HLD
(Hold Line distance from RWY CL)	250'	250'
(Guidance Signs)	Lighted	Lighted
TWY Lighting	MITL	MITL

Operational Data	
	2011
Total Based Aircraft	157
Single Engine	137
Multi Engine	10
Jet	4
Other	6
Total Operations	108,000
Itinerant General Aviation	42,000
Air Taxi	100
Instrument Operations	Not available - no ATCT

Related Documentation		
	Existing	Proposed
Airport Master Plan	2003	2012
Airport Layout Plan	2006	2012
PACS/SACS (150/5300-16a)	NGS 2007	Temporary
Horiz/Vert Datum	NAD 83/NAVD 88	2012-2016
Aerial Imagery (-17b)		<24 months prior to use
Obstruction Survey (-18b)		<24 months prior to use
Airport weather reporting	AWOS-III	AWOS-III

Published Instrument Approaches		
RWY - Category	Minima (HAT - Visibility)	
	Existing	Proposed (*)
RWY 1 - NDB	541 - 1 1/2	
RWY 1 - LNAV	436 - 1 1/4	350 - 1
RWY 19 - ILS	204 - 1/2	
RWY 19 - LPV	322 - 1/2	200 - 1/2

Notes:
* - It is recommended that in the Master Plan/ALP update, approach minimums comparable to the land based navaids be investigated.

Bremerton National Airport generally exceeds the design standards for a B-II airport. Existing ground based navigational aids as well as vertically guided GPS based approaches are provided for both runway ends. As with many of the other study airports, approach minimums for the satellite supported approaches are higher than the ground based approaches. The Master Plan and ALP update programmed for 2013 should address these variances.

It should also be noted that the inventory identified a total of 4 based business jets at Bremerton. It is likely that increased use of the airport by these high performance aircraft may justify a change in the ARC over the planning period.

S43 – Harvey Field

Harvey Field (S43) Gap Analysis

Airport Name:	Harvey Field
Associated City:	Snohomish
Airport Identifier:	S43
Ownership / National Classification:	Private / Local
Airport Reference Code (ARC) - E/F	A-I

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	15/33	
RWY Length	2,671'	2400' (*)
RWY Width	36'	60'
Runway Safety Area (RSA):		
(Width)	120'	120'
(Length beyond RWY end)	1'/100'	240'
Obstacle Free Zone (OFZ)		250' x 2800'
Object Free Area (OFA)	250' x 2,772'	250' x 2880'
Glidepath Qualification Surface (GQS)	N/A	30:1
Runway Protection Zone		
Fee (F), Easement (E)	F & E	F & E
RWY Marking	Basic	NPI/VIS
RWY Edge Lighting	LIRL	MIRL
RWY Approach Lighting	N/A	N/A
Parallel TWY	Partial	Full
TWY Width	16'	25'
RWY/TWY Separation	91'	150'
TWY Marking	CL & HLD	CL & HLD
(Hold Line distance from RWY CL)	Varies	125'
(Guidance Signs)	None	Lighted
TWY Lighting	None	MITL

Operational Data	
	2011
Total Based Aircraft	211
Single Engine	192
Multi Engine	6
Jet	0
Other	13
Total Operations	139,160
Itinerant General Aviation	49,154
Air Taxi	50
Instrument Operations	Not available - no ATCT

Related Documentation		
	Existing	Proposed
Airport Master Plan	2010	2010
Airport Layout Plan	2010	2010
PACS/SACS (150/5300-16a)		Temporary
Horiz/Vert Datum		2012-2016
Aerial Imagery (-17b)		<24 months prior to use
Obstruction Survey (-18b)		<24 months prior to use
Airport weather reporting	None	AWOS

Published Instrument Approaches		
RWY - Category	**Minima (HAT - Visibility)**	
	Existing	Proposed
RWY 15/33 - RNAV Circling	1198 - 1 1/4	350 - 1

Notes:
* - Typical required length is 3200'. Footnote 6 in Appendix 16 Table A16-1B allows 2400' length provided HAT is based on clearing a 200-foot obstacle.
** - Controlling obstructions consist of powerlines to the north (RWY 15L) and trees to the south (RWY 33R). Approaches with vertical guidance are not authorized.

Harvey Field, like Crest Airpark discussed earlier, is a privately owned and operated airport which meets few FAA design standards. Harvey Field, however, recently completed a Master Plan which identifies a Capital Improvement program to bring the airport into compliance with A-I standards. This long-term plan reconfigures the entire airfield infrastructure at a cost of approximately $20 million dollars. During the inventory/interview meeting with the airport owner at the beginning of this study, it was noted that the airport would need to qualify for federal funding support to implement the aggressive reconfiguration plan. It was noted that in order to qualify for federal funding, grant assurances would need to be modified for the private owner. Recently Harvey Field developed and published a circling RNAV procedure to the airport. It is unclear if the survey complies with AC 150-5300-16, -17 and -18 standards.

In any case, a compliant survey would be required within approximately 18 months of developing a new procedure. To accommodate a straight-in vertically or non-vertically guided approach to the airport, the long-range reconfiguration would be necessary.

S60 – Kenmore Air Harbor (Lake Washington)

Kenmore Air Harbor (S60) Gap Analysis

Airport Name:	Kenmore Air Harbor
Associated City:	Kenmore, WA
Airport Identifier:	S60
Ownership / National Classification:	Private / Non-NPIAS
Airport Reference Code (ARC) - E/F	Seaplane Base

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	16/34	
RWY Length	10,000'	
RWY Width	1,000'	
Runway Safety Area (RSA):		
(Width)	N/A	
(Length beyond RWY end)	N/A	
Obstacle Free Zone (OFZ)	N/A	
Object Free Area (OFA)	N/A	
Glidepath Qualification Surface (GQS)	N/A	
Runway Protection Zone		
Fee (F), Easement (E)		
RWY Marking	N/A	
RWY Edge Lighting	N/A	
RWY Approach Lighting	N/A	
Parallel TWY	N/A	
TWY Width	N/A	
RWY/TWY Separation	N/A	
TWY Marking		
(Hold Line distance from RWY CL)	N/A	
(Guidance Signs)	N/A	
TWY Lighting		

Operational Data	
	FAA 5010
Total Based Aircraft	25
Single Engine	23
Multi Engine	2
Jet	0
Other	0
Total Operations	41,000
Itinerant General Aviation	500
Air Taxi	35,000
Instrument Operations	N/A

Related Documentation		
	Existing	Proposed
Airport Master Plan	N/A	
Airport Layout Plan		
PACS/SACS (150/5300-16a)		
Horiz/Vert Datum	N/A	
Aerial Imagery (-17b)	N/A	
Obstruction Survey (-18b)	N/A	
Airport weather reporting		

Published Instrument Approaches		
RWY - Category	**Minima (HAT - Visibility)**	
	Existing	Proposed
RWY 16	N/A	
RWY 34	N/A	

Notes:

Kenmore Air and other seaplane operators using Lake Washington as a base fly VFR operations exclusively. The regulations under which they operate provide reliable service to the San Juan Islands. NextGen ADS-B emergent regulations will apply to these operations.

There are no NextGen navigation technologies that apply. NextGen communications initiatives under the SWIM technology category allowing enhanced crew and passenger communications may apply in the future.

W55 – Kenmore Air Harbor (Lake Union)

Kenmore Air Harbor (W55) Gap Analysis

Airport Name:	Kenmore Air Harbor (Lake Union)
Associated City:	Seattle, WA
Airport Identifier:	W55
Ownership / National Classification:	Private / Non-NPIAS
Airport Reference Code (ARC) - E/F	Seaplane Base

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	16/34	
RWY Length	5000'	
RWY Width	500'	
Runway Safety Area (RSA):		
(Width)	N/A	
(Length beyond RWY end)	N/A	
Obstacle Free Zone (OFZ)	N/A	
Object Free Area (OFA)	N/A	
Glidepath Qualification Surface (GQS)	N/A	30:1 Clear
Runway Protection Zone		
Fee (F), Easement (E)		
RWY Marking	N/A	
RWY Edge Lighting	N/A	
RWY Approach Lighting	N/A	
Parallel TWY	N/A	
TWY Width	N/A	
RWY/TWY Separation	N/A	
TWY Marking		
(Hold Line distance from RWY CL)	N/A	
(Guidance Signs)	N/A	
TWY Lighting		

Operational Data	
	FAA 5010
Total Based Aircraft	0
Single Engine	0
Multi Engine	0
Jet	0
Other	0
Total Operations	35,500
Itinerant General Aviation	2,500
Air Taxi	25,500
Instrument Operations	N/A

Related Documentation		
	Existing	Proposed
Airport Master Plan	N/A	
Airport Layout Plan	N/A	2012-2016
PACS/SACS (150/5300-16a)	N/A	Temporary
Horiz/Vert Datum	N/A	2012-2016
Aerial Imagery (-17b)	N/A	<24 months prior to use
Obstruction Survey (-18b)	N/A	<24 months prior to use
Airport weather reporting		

Published Instrument Approaches		
RWY - Category	**Minima (HAT - Visibility)**	
	Existing	Proposed
RWY 16	N/A	350 - 1
RWY 34	N/A	VIS

Notes:

The Kenmore Air Harbor (Lake Union) seaplane base qualified as a Busy Airport by virtue of the significant level of Air Taxi operations conducted in the Puget Sound region. No Airport Layout Plan exists for the facility. A study relating to the activity from this area currently being prepared will address the location, operational characteristics, environmental compatibility and obstructed approach departure corridor to the south.

Kenmore Air and other seaplane operators using Lake Union as a base fly VFR operations exclusively. The regulations under which they operate provide reliable service to the San Juan Islands. NextGen ADS-B emergent regulations will apply to these operations. There are no NextGen navigation technologies that apply. NextGen communications initiatives under the SWIM technology category allowing enhanced crew and passenger communications may apply in the future.

W16 – First Air Field

Firstair Field (W16) Gap Analysis

Airport Name:	Firstair Field
Associated City:	Monroe, WA
Airport Identifier:	W16
Ownership / National Classification:	Private / Non-NPIAS
Airport Reference Code (ARC) - E/F	A-I

Infrastructure Inventory		
	Existing	Required
Primary RWY Designation	7/25	
RWY Length	2,087'	2400'
RWY Width	34'	60'
Runway Safety Area (RSA):		
(Width)	70' Asymetric	120'
(Length beyond RWY end)	400'/40' (est.)	240'
Obstacle Free Zone (OFZ)		250' x 2600'
Object Free Area (OFA)		250' x 2640'
Glidepath Qualification Surface (GQS)	0:1 / 1:1 (**)	30:1 Clear
Runway Protection Zone		
Fee (F), Easement (E)		F & E
RWY Marking	Non-Std/#s. only	NPI
RWY Edge Lighting	Reflectors	MIRL
RWY Approach Lighting	N/A	N/A
Parallel TWY	Partial	Full
TWY Width	15'	25'
RWY/TWY Separation	100'	150'
TWY Marking		CL & HLD
(Hold Line distance from RWY CL)	N/A	125'
(Guidance Signs)	N/A	
TWY Lighting		MITL

Related Documentation		
	Existing	Proposed
Airport Master Plan	N/A	
Airport Layout Plan	N/A	2012-2016
PACS/SACS (150/5300-16a)		Temporary
Horiz/Vert Datum	N/A	2012-2016
Aerial Imagery (-17b)	N/A	<24 months prior to use
Obstruction Survey (-18b)	N/A	<24 months prior to use
Airport weather reporting	None	AWOS

Published Instrument Approaches		
RWY - Category	Minima (HAT - Visibility)	
	Existing	Proposed
RWY 7	N/A	350 - 1
RWY 25	N/A	VIS

Operational Data	
	FAA 5010
Total Based Aircraft	74
Single Engine	68
Multi Engine	4
Jet	1
Other	1
Total Operations	18,169
Itinerant General Aviation	5,044
Air Taxi	0
Instrument Operations	N/A

Notes:
* - Typical required length is 3200'. Footnote 6 in Appendix 16 Table A16-1B allows 2400' length provided HAT is based on clearing a 200-foot obstacle.
** - Controlling obstructions consist oftrees to the west (RWY 7) and a pole to the east (RWY 25). Approaches with vertical guidance are not authorized.

Firstair Field is the last of the airports that qualified as a Busy Airport based on the evaluation criteria. A moderate level of annual activity combined with 4 based multi-engine and 1 based business jet put Firstair just over the cut line. Like Crest Airpark and Harvey Field, Firstair is a private airport that does not meet FAA design standards. Unlike any of the other study airports Firstair is aligned in an east-west direction. With a road at the eastern end of the runway and hangars on both sides, virtually the entire airport would have to be replaced to meet even the A-I classification. A full length parallel taxiway is not required but recommended.

According to the WSDOT 2012 Aviation Economic Impact Study, Firstair is the only airport that did not generate a positive economic value within the region.

Chapter 7 Busy Airport Implementation Plan

The primary purpose of this chapter is to quantify capital improvements required to mitigate existing infrastructure deficiencies identified in the Gap Analysis for each of the study airports. This focus on airport infrastructure is intended to assist in prioritizing investments which will benefit short term regional compliance with design standards. A graphic display of the FAA Design Standards for the applicable Airport Reference Code (ARC), as well as a table of proposed improvements, are presented for each airport. The airports are described in the order derived from the "Busy Airport" evaluation (Chapter 5).

The FAA's 2012 General Aviation Airport National Asset study identifies new classifications for GA airports that can help in prioritizing development needs throughout the region. Specific guidance on "permitted" and "prohibited" land uses within Runway Protection Zones (RPZ) is slated for publication in the 2013-2014 timeframe.

The FAA NextGen Implementation Plan covers the full range of technologies, timetables for roll-out and program accomplishments. This broader view of the program, including deconflicting traffic flows in the Seattle metropolitan area, is discussed in the final chapter of this study entitled "NextGen Applications."

BFI – King County International Airport / Boeing Field

Boeing Field is classified as a "Primary Airport" in the 2012 National Plan of Integrated Airport Systems (NPIAS). As described in the Gap Analysis, Runway 13R/31L at Boeing Field largely meets the design requirements for existing ARC D-V and future D-IV classification. An approved Modification to Standards exists for the runway to parallel taxiway, runway to parallel runway, runway Object Free Area (OFA) and taxiway centerline to fixed or movable object standards. It is noted that the change to the D-IV classification in the future will lessen the taxiway to fixed or movable object penetration but not negate it.

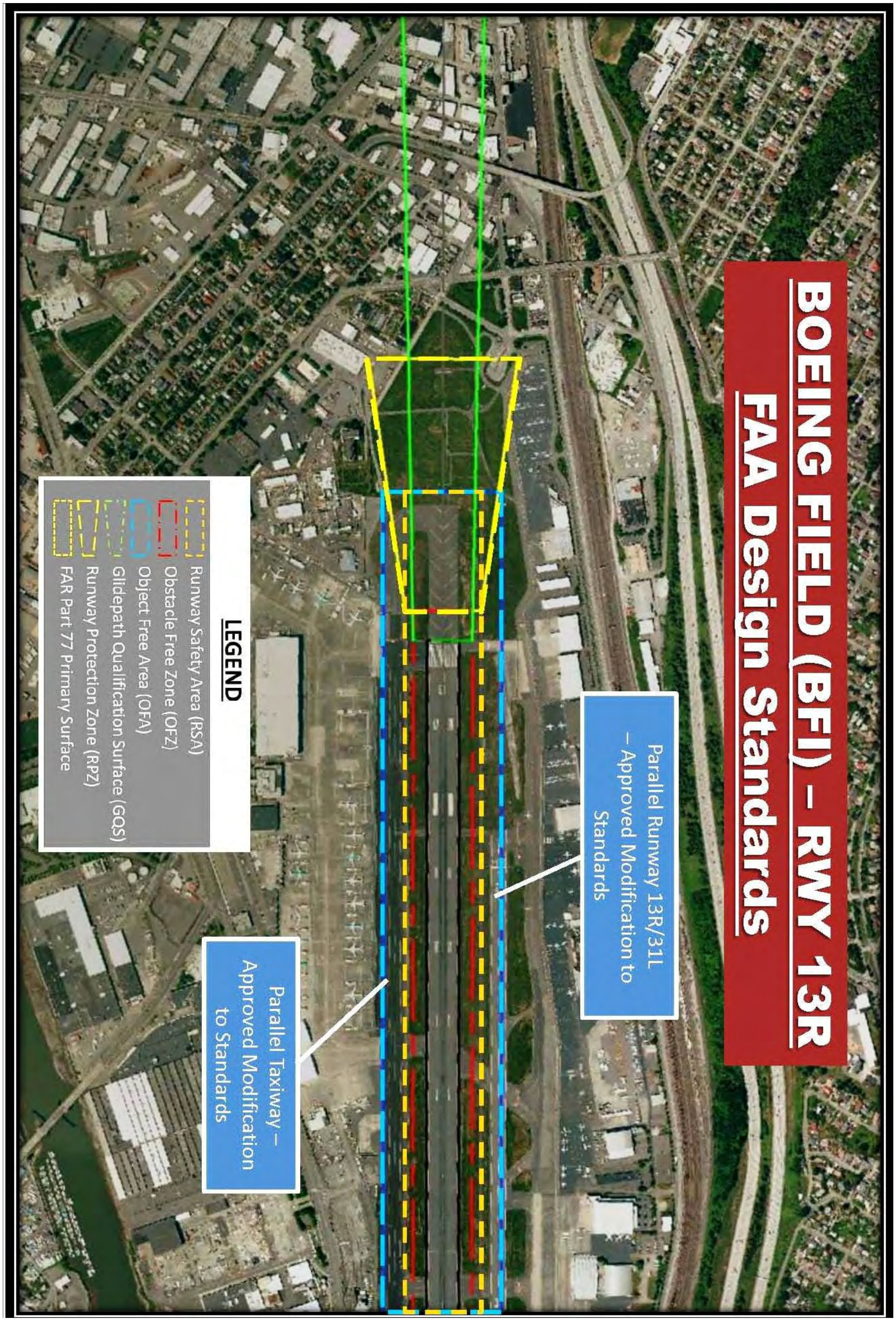
The airport is actively pursuing improved capabilities for RNP instrument approaches to runway 13R. It is anticipated that these improvements will require installation of an on-site Ground Based Augmentation System (GBAS).

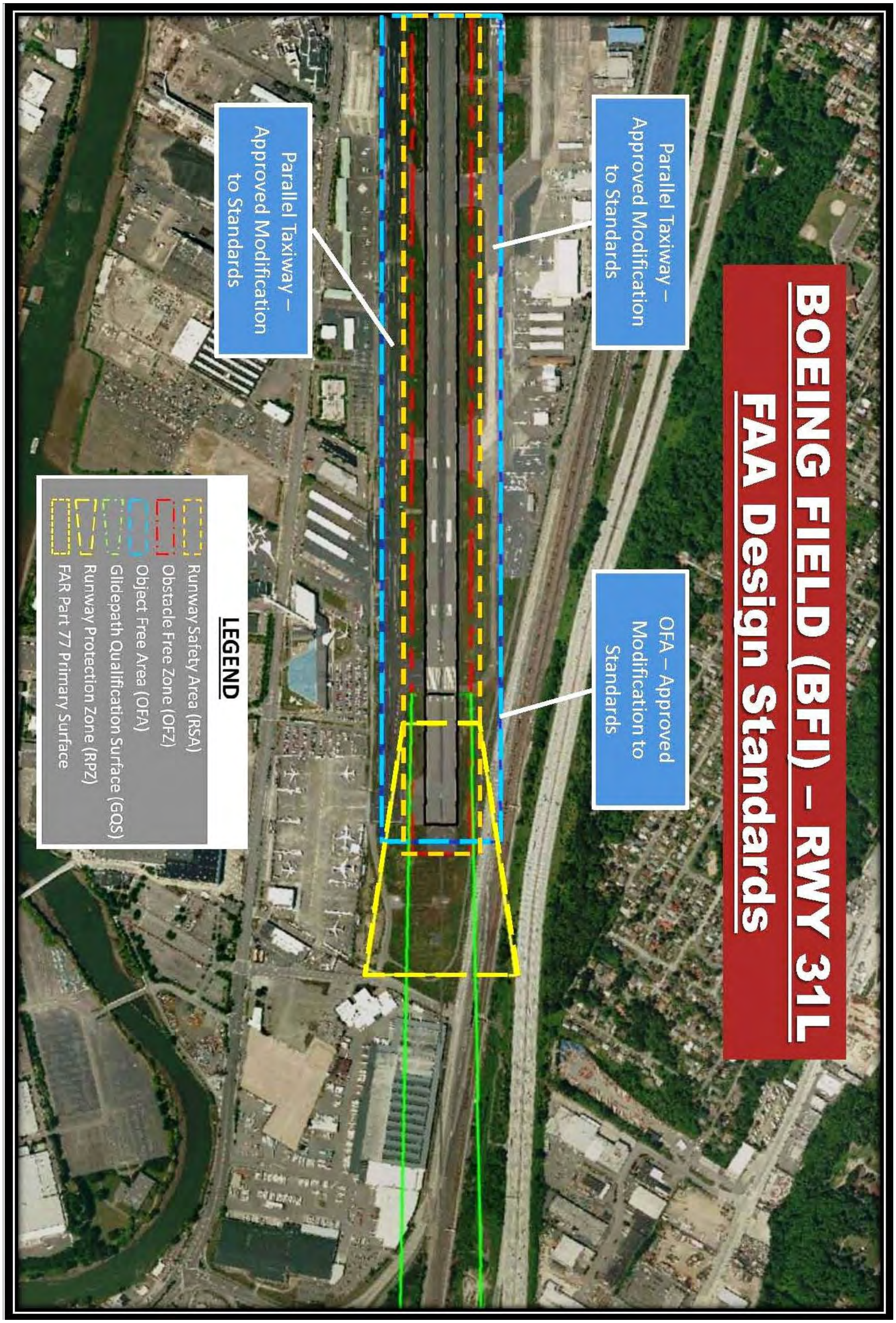
Each ground station is capable of handling 28 different procedures and can cover an area extending in a 20 to 30 mile radius from the station. Installation of GBAS is expected to directly benefit BFI with improved instrument procedure minimums and lessen environmental impacts through dispersing traffic patterns over noise sensitive areas. It will also enhance safety of operations by precisely managing operations and deconflicting operations at Sea-Tac and at other airports in the region.

During this study, airport management confirmed that both the Airport Layout Plan and Obstruction survey data are updated on a regular basis to conform with eALP requirements. The following graphics highlight the design standard compliance issues for each runway end. The table below identifies the airport commitment to specific NextGen related technology enhancements.

Boeing Field (BFI) NextGen Implementation Plan

PROJECT DESCRIPTION	Total $
Update Master Plan and ALP	$ 500,000.00
Prepare Obstruction Survey per AC 150/5300-16, -17 and -18	$ 150,000.00
Install GBAS to Lower RNP Approach Minimums	$ 1,500,000.00
TOTAL	$ 2,150,000.00


BOEING FIELD (BFI) – RWY 13R
FAA Design Standards
LEGEND
Runway Safety Area (RSA)
Obstacle Free Zone (OFZ)
Object Free Area (OFA)
Glidepath Qualification Surface (GQS)
Runway Protection Zone (RPZ)
FAR Part 77 Primary Surface
Parallel Runway 13R/31L – Approved Modification to Standards
Parallel Taxiway – Approved Modification to Standards


BOEING FIELD (BFI) – RWY 31L
FAA Design Standards
Parallel Taxiway – Approved Modification to Standards
Parallel Taxiway – Approved Modification to Standards
OFA – Approved Modification to Standards
LEGEND
Runway Safety Area (RSA)
Obstacle Free Zone (OFZ)
Object Free Area (OFA)
Glidepath Qualification Surface (GQS)
Runway Protection Zone (RPZ)
FAR Part 77 Primary Surface

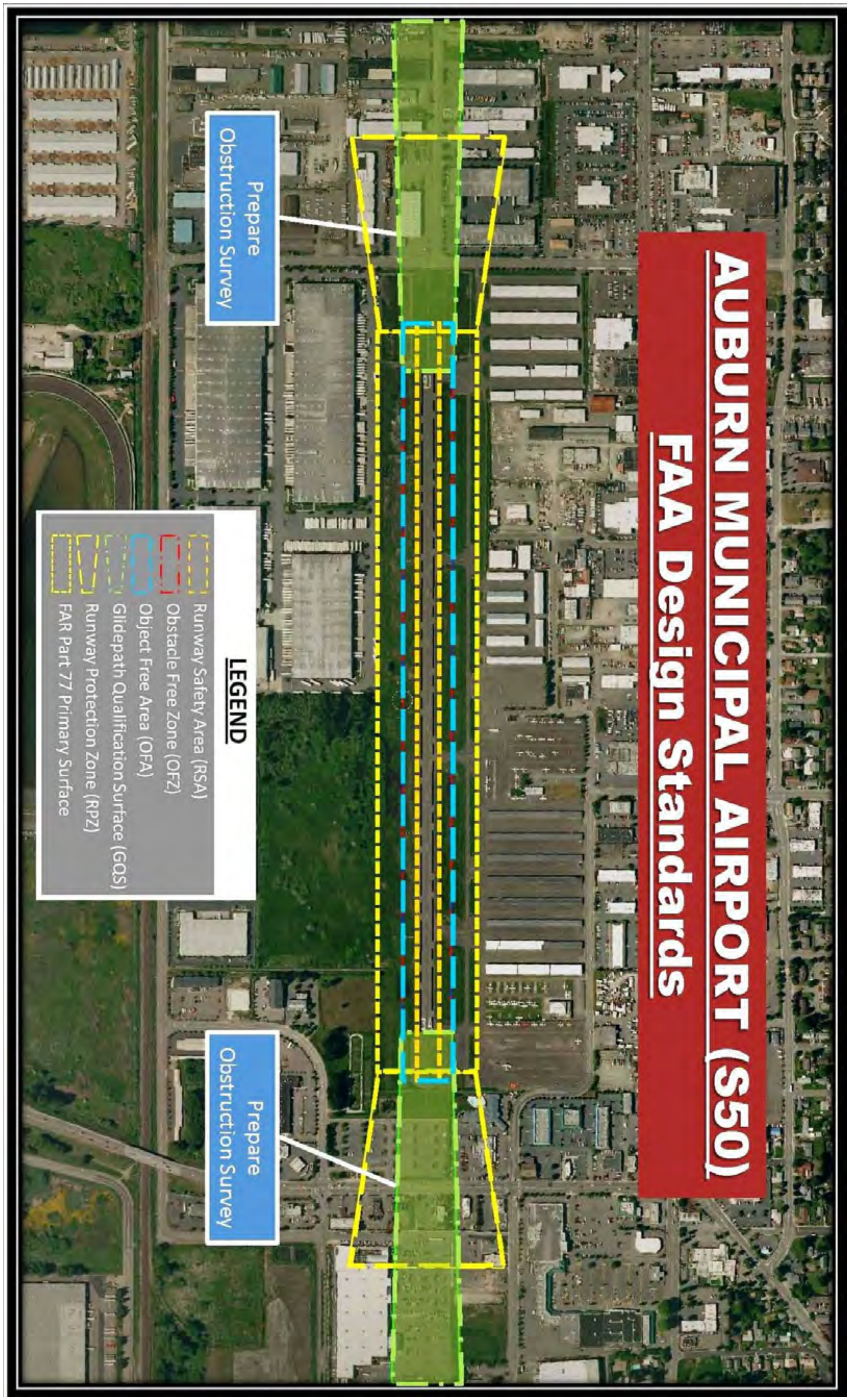
S50 - Auburn Municipal Airport

Auburn Municipal Airport is classified as a "Regional Airport" in the FAA General Aviation National Asset study. On-airport infrastructure meets all current FAA design standards for ARC B-I as shown in the Gap Analysis. Existing instrument procedures provide for only "circling minimums" of 1257 feet ceiling and 1-1/2 mile visibility. Auburn's significant role as one of the region's five general aviation reliever airports warrants a detailed evaluation of improved instrument weather capabilities.

The airport recently started a Master Plan update. A review of the 2002 Master Plan and associated ALP suggests that a vertically guided (LPV) approach is not advised. However, improved minimums should be investigated through a detailed obstruction survey and approach / departure procedure evaluation. Land acquisition and relocation of runway threshold(s) could potentially mitigate obstacles to application of beneficial NextGen technologies.

Auburn Municipal (S50) NextGen Implementation Plan

PROJECT DESCRIPTION	Total $
Update Master Plan and ALP	$ 237,000.00
Prepare Obstruction Survey per AC 150/5300-16, -17 and -18	$ 100,000.00
Obstruction Marking/Mitigation	$ 100,000.00
Preliminary Evaluation of LPV/RNAV Approach Potential	$ 20,000.00
TOTAL	$457,000.00


AUBURN MUNICIPAL AIRPORT (S50)
FAA Design Standards
Prepare Obstruction Survey
Prepare Obstruction Survey
LEGEND
Runway Safety Area (RSA)
Obstacle Free Zone (OFZ)
Object Free Area (OFA)
Glidepath Qualification Surface (GQS)
Runway Protection Zone (RPZ)
FAR Part 77 Primary Surface

PAE – Snohomish County Airport / Paine Field

Paine Field is classified as a "National Airport" with an ARC of D-V. All dimensional standards conform to or exceed this designation. The airport was issued a Modification to Standards for the 747-8 (ARC D-VI) in 2011. However, current activity forecasts do not reach the threshold of 500 annual operations for designation of D-VI as the critical design aircraft.

The Master Plan has not been updated for over 10 years while the ALP (as-built) was revised in 2008. This study proposes an update of both documents within the next few years. Specific NextGen technologies should be addressed in detail as well. Opportunities to improve Paine Field approach capabilities, airspace interactions with Boeing Field and Sea-Tac, land use compatibility and environmental impact mitigation should be addressed in the scoping of planning efforts. Integration of Optimized Profile Descent (OPD) and Category II or III instrument procedures are realistic benefits to be derived from the application of NextGen technologies at Paine Field.

Plans for GBAS could benefit Paine Field. A single GBAS installation can provide guidance for up to 28 different procedures or runway ends. System installation and coordination with other airports within the Puget Sound region could potentially accommodate Category II/III operations at Paine Field.

Paine Field initiated an obstruction survey conforming to AC 150/5300-16a, -17b and -18b. The limited shelf life of obstruction surveys is noted in the Gap Analysis, and Paine Field management should optimize the opportunity to develop improved procedures in the short term planning period. The airport management has confirmed a desire to proceed with removal of obstructions identified in the obstruction survey currently being reviewed by FAA.

Acquisition of an Avigation Easement over a 15 acre parcel in the Runway 34 RPZ is proposed in the 2002 Master Plan document. This land parcel is depicted on the following FAA Design Standards graphic and 2002 estimated cost is listed in the implementation plan table.

Paine Field (PAE) NextGen Implementation Plan

PROJECT DESCRIPTION	Total $
Update Master Plan and ALP	$ 400,000.00
Prepare Obstruction Survey per AC 150/5300-16, -17 and -18	$ 150,000.00
Acquire Avigation Easement for Runway 34 RPZ	$ 8,000,000.00
TOTAL	$8,550,000.00


PAINE FIELD (PAE)
FAA Design Standards
Runway and Parallel Taxiway Widths – Approved by Modification to Standards
Prepare Survey and Remove Obstructions
Acquire RPZ Avigation Easement
LEGEND
Runway Safety Area (RSA)
Obstacle Free Zone (OFZ)
Object Free Area (OFA)
Glidepath Qualification Surface (GQS)
Runway Protection Zone (RPZ)
FAR Part 77 Primary Surface

S36 - Crest Airpark

Crest Airpark is the busiest privately owned (non-NPIAS) General Aviation airport in the Puget Sound region but does not have an approved Master Plan or Airport Layout Plan. This study quantifies challenges to proposing NextGen technology applications to benefit this valuable facility.

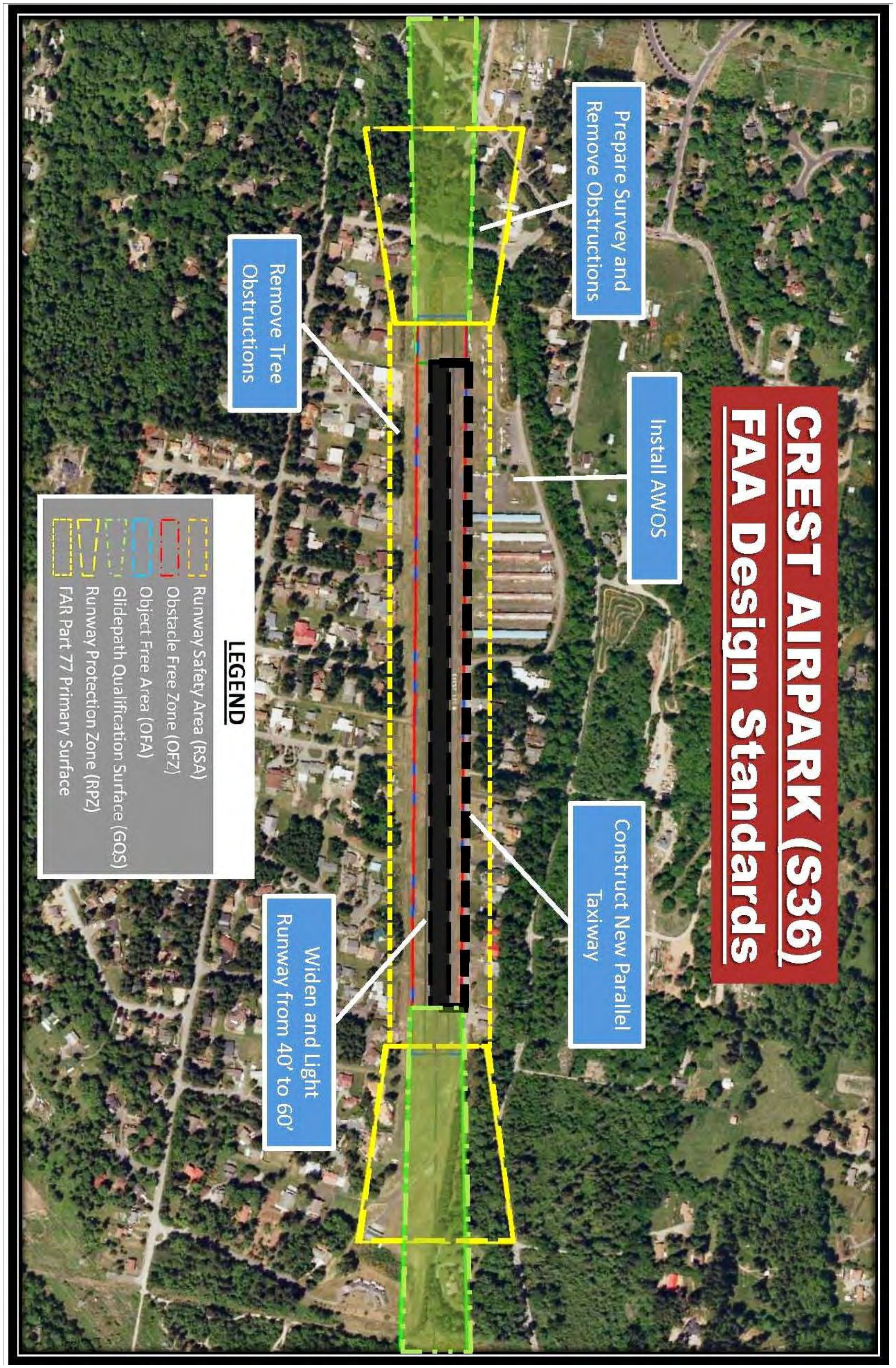
In contrast to publicly owned and federally supported airports in the region, Crest Airpark does not meet most of the standards required of its ARC A-I classification. The airport has a paved runway that meets minimum length requirements and does have a paved parallel taxiway. However, all of the lateral separation requirements and minimum pavement widths are substandard. Consequently, the entire airfield infrastructure would need to be reconstructed or replaced to meet even the lowest of FAA minimum standards. The entire site is surrounded by numerous natural and manmade obstructions (e.g., trees and powerlines) as well as land uses that are typically considered incompatible, such as single family residences.

The following FAA Design Standard graphic conceptually illustrates the various non-conforming challenges for Crest Airpark. The Implementation Plan table quantifies an order of magnitude list of costs to bring the airport up to standards.

It is suggested that the Puget Sound Regional Council support a limited planning effort to develop an ALP and Master Plan to officially document the role of Crest Airpark from a regional perspective.

Crest Airpark (S36) NextGen Implementation Plan

PROJECT DESCRIPTION	Total $
Prepare Master Plan and ALP	$ 250,000.00
Prepare Obstruction Survey per AC 150/5300-16, -17 and -18	$ 100,000.00
Acquire Land for Airfield Reconfiguration	$ 5,400,000.00
Tree Obstruction Removal	$ 100,000.00
Hangar Removal/Relocation	$ 15,000.00
Widen Runway from 40' to 60'	$ 1,600,000.00
Construct and Light New Parallel Taxiway (inc. lts and signs)	$ 800,000.00
TOTAL	$8,265,000.00


CREST AIRPARK (S36)
FAA Design Standards
Prepare Survey and Remove Obstructions
Remove Tree Obstructions
Install AWOS
Construct New Parallel Taxiway
Widen and Light Runway from 40' to 60'
LEGEND
Runway Safety Area (RSA)
Obstacle Free Zone (OFZ)
Object Free Area (OFA)
Glidepath Qualification Surface (GQS)
Runway Protection Zone (RPZ)
FAR Part 77 Primary Surface

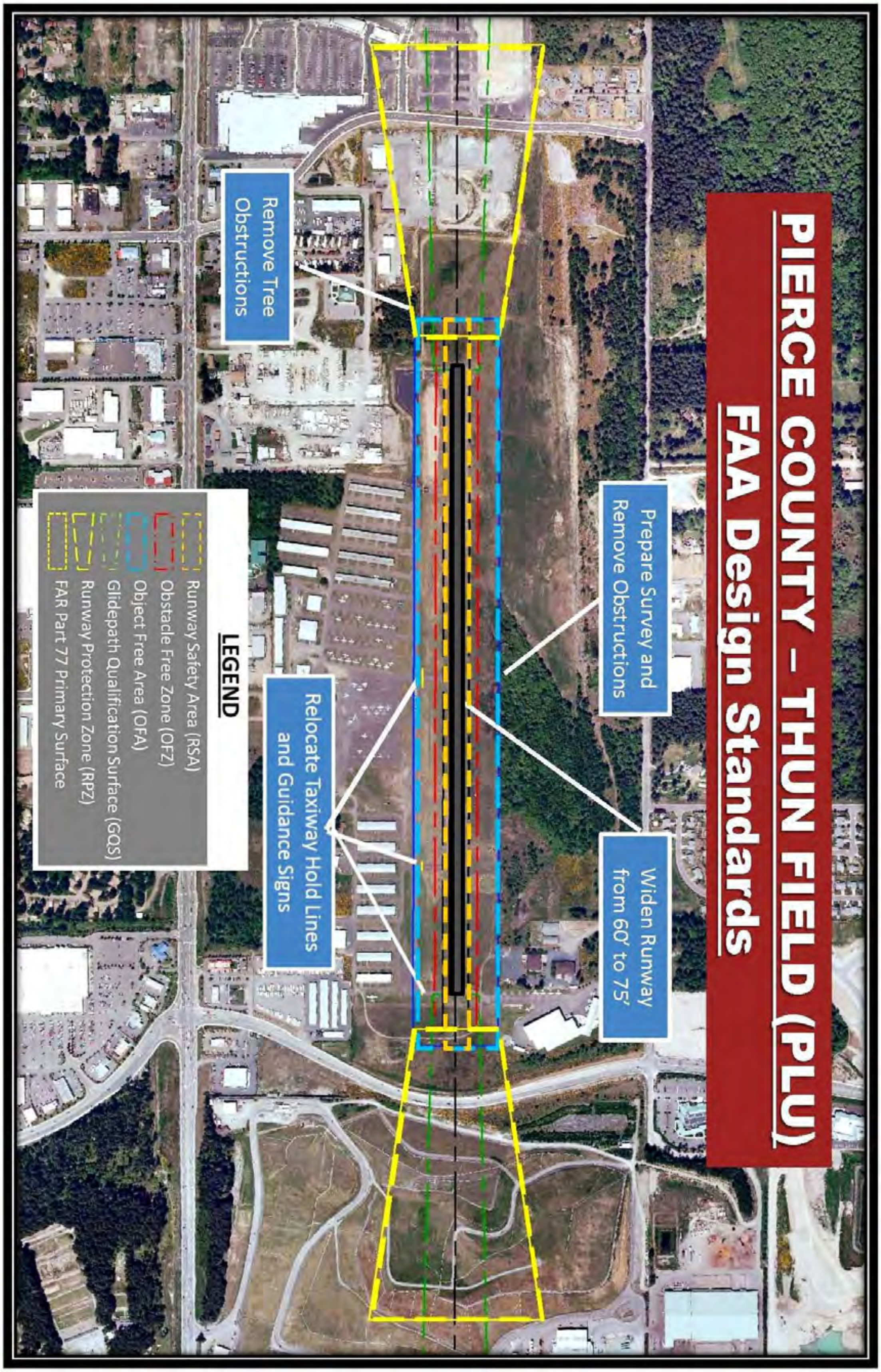
PLU - Pierce County - Thun Field

Pierce County Thun Field is classified as a "Regional Airport" in the General Aviation Airport National Asset study with an ARC of B-II. An update of the Master Plan and Airport Layout Plan are programmed for FY 2013.

The Gap Analysis identified a number of FAA standards that require attention in order to establish new and improved instrument procedures. Widening the runway from 60' to 75', clearing obstructions and relocating taxiway hold lines and signs will bring the airport into compliance with current standards. Establishing an LPV approach to Runway 16 and improving minimums for the existing Runway 34 approach are achievable within the 2012-2016 short term (subject to funding availability).

Pierce County - Thun Field (PLU) NextGen Implementation Plan

PROJECT DESCRIPTION	Total $
Update Master Plan and ALP	$ 180,000.00
Prepare Obstruction Survey per AC 150/5300-16, -17 and -18	$ 100,000.00
Tree Obstruction Removal	$ 20,000.00
Widen Runway 16/34 from 60' to 75'	$ 3,200,000.00
Relocate Guidance Signs and Taxiway Hold Lines	$ 15,000.00
Light Parallel Taxiway including Taxiway Guidance Signs	$ 250,000.00
TOTAL	$3,765,000.00


PIERCE COUNTY – THUN FIELD (PLU)
FAA Design Standards
Remove Tree Obstructions
Prepare Survey and Remove Obstructions
Relocate Taxiway Hold Lines and Guidance Signs
Widen Runway from 60' to 75'
LEGEND
Runway Safety Area (RSA)
Obstacle Free Zone (OFZ)
Object Free Area (OFA)
Glidepath Qualification Surface (GQS)
Runway Protection Zone (RPZ)
FAR Part 77 Primary Surface

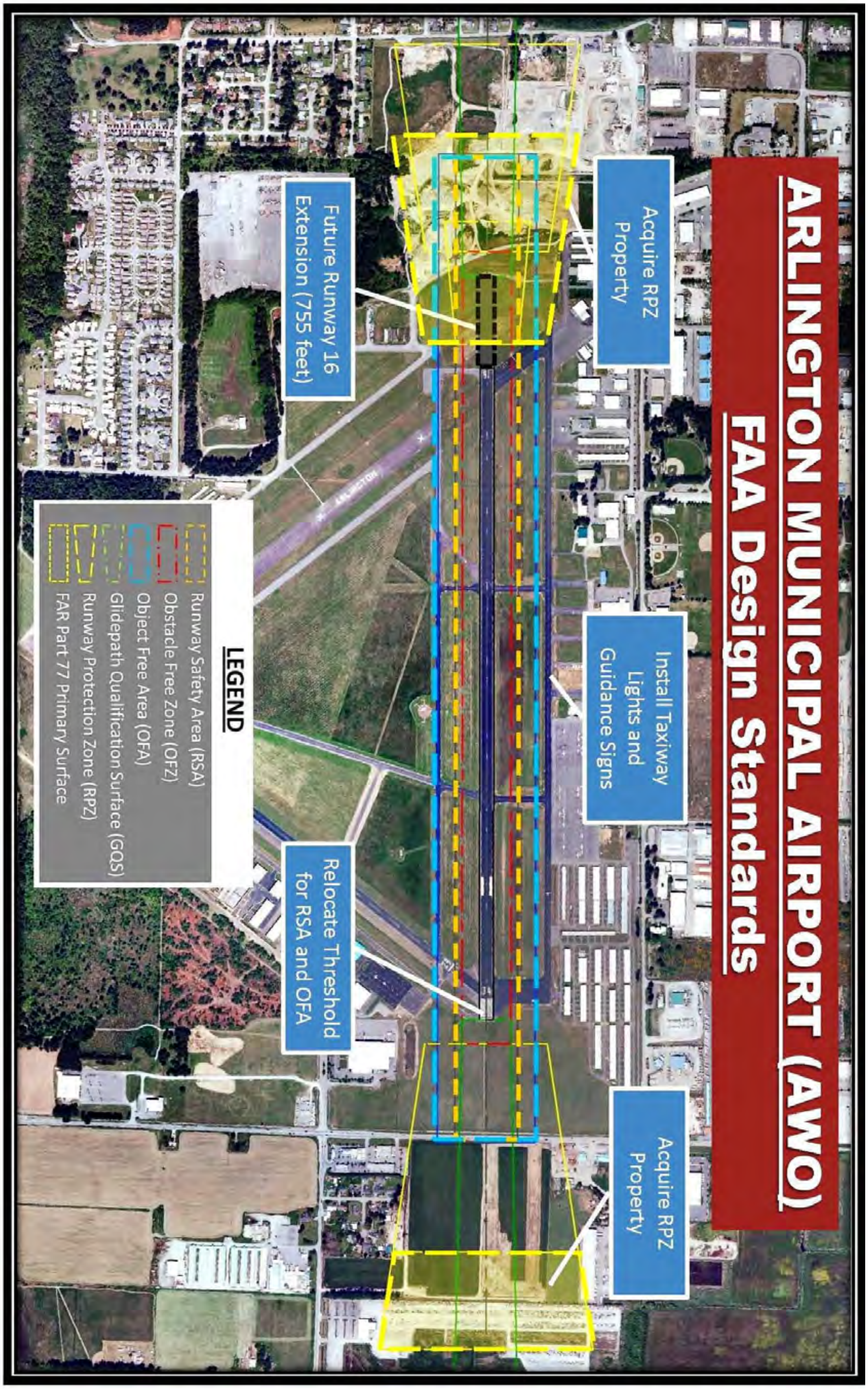
AWO - Arlington Municipal

The Arlington Municipal Airport is classified as a "Local Airport" with an existing and future Airport Reference Code of B-II and C-II, respectively. The current Master Plan and ALP were updated and adopted in May 2012. Several design standards related to the C-II ARC are addressed in the Capital Improvement Program. The following FAA Design Standards graphic shows the major development items related to the Runway 16/34 upgrade to accommodate ARC C-II. Relocation of the Runway 34 threshold is identified as a FY 2014 project. A 755' extension to the Runway 16 end is proposed but not shown in the CIP until the Phase III (11-20 year) time frame. For this reason it is suggested in this plan that developing a Runway 16 LPV approach be considered in association with the Runway 34 threshold relocation. This proposal would maximize the use of the Obstruction survey required to revise the Runway 34 approach procedure.

The following Implementation Plan table lists costs shown in the Master Plan for CIP items related to the Gap Analysis and Runway 16 approach procedure development.

Arlington Municipal Airport (AWO) NextGen Implementation Plan

PROJECT DESCRIPTION	Total $
Improvements for RWY 16 approach	
Prepare Obstruction Survey per AC 150/5300-16, -17 and -18	$ 100,000.00
Tree Obstruction Removal	$ 5,000.00
Acquire Land for RPZ (1 Ac.) - under 2012 FAA grant	$ 350,000.00
Light Parallel Taxiway including Taxiway Guidance Signs	$ 400,000.00
TOTAL	$855,000.00


ARLINGTON MUNICIPAL AIRPORT (AWO)
FAA Design Standards
Acquire RPZ Property
Future Runway 16 Extension (755 feet)
Install Taxiway Lights and Guidance Signs
Relocate Threshold for RSA and OFA
Acquire RPZ Property
LEGEND
Runway Safety Area (RSA)
Obstacle Free Zone (OFZ)
Object Free Area (OFA)
Glidepath Qualification Surface (GQS)
Runway Protection Zone (RPZ)
FAR Part 77 Primary Surface

TIW - Tacoma Narrows Airport

Tacoma Narrows Airport is the second airport owned and operated by Pierce County. It is classified as a "Regional Airport" with an ARC of D-II, accommodating corporate Business Jets. Pierce County has recently completed a multi-year development program for TIW to extend the Runway Safety Area on the north (Runway 17) end. A tunnel was constructed to provide for the 1000 foot extended RSA. The FY 2012 Capital Improvement Program includes rehabilitation of the runway pavement and narrowing the width from 150 feet to 100 feet. This project is in accordance with the D-II design standards. The Master Plan and ALP are also programmed for FY 2013.

While existing minima for approaches to both runway ends are quite good, the Gap Analysis identifies other projects which should be addressed in the planning process. The existing holding aprons on both runway ends encroach on the Precision Obstacle Free Zone (200' x 800'). To enhance safety during IFR operations, these areas should be marked accordingly. Additionally, tree obstructions in the transitional zones should be removed to provide the most benign instrument operational environment.

The existing runway to taxiway centerline separation of 350' is also identified in the gap analysis as sub-standard. It is suggested that in the Master Plan and ALP update process, a Modification to Standards be requested until such time that taxiway pavement requires rehabilitation. At that time, reconstruction at 400-foot separation can be accomplished to bring the airport into full compliance with design standards.

Tacoma Narrows (TIW) NextGen Implementation Plan

PROJECT DESCRIPTION	Total $
Update Master Plan and ALP	$ 250,000.00
Prepare Obstruction Survey per AC 150/5300-16, -17 and -18	$ 100,000.00
Tree Obstruction Removal	$ 20,000.00
Relocate Parallel Taxiway including MITL and Guidance Signs	$ 5,200,000.00
TOTAL	$5,570,000.00


TACOMA NARROWS AIRPORT (TIW)
FAA Design Standards
Remove Holding Apron within POFA
Prepare Modification to Standards and Relocate Parallel Taxiway
Remove Holding Apron within POFA
Remove Tree Obstructions
LEGEND
Runway Safety Area (RSA)
Obstacle Free Zone (OFZ)
Object Free Area (OFA)
Glidepath Qualification Surface (GQS)
Runway Protection Zone (RPZ)
FAR Part 77 Primary Surface

RNT - Renton Municipal Airport (RNT)

Of the study airports, Renton represents the most challenging from a Design Standards standpoint. Renton is classified as a Regional Airport with an Airport Reference Code (ARC) of B-II. Airports classified as B-II typically serve smaller aircraft such as the Beech King Air and Cessna Citation. Within the short term, Renton Airport will see increased activity by the Boeing 737-MAX, which is manufactured at the Boeing plant adjacent to the airport. In the foreseeable future, Boeing 737 MAX flights could reach 500 operations per year. This may warrant a review of the airport reference code – the 737-MAX is classified as a D-III. A change from the current B-II to D-III could trigger a different set of airport design standards.

The Boeing Company has also shown an interest in developing instrument procedures which take advantage of Performance Based Navigation (PBN) and specifically Required Navigation Performance (RNP) capabilities at Renton Airport. The new generation of aircraft is inherently quieter than older planes, and implementing RNP "curved approach" procedures at Renton could significantly reduce noise impacts to sensitive areas such as Mercer Island to the north and the Talbot Hill area in Renton to the south. These issues are discussed in more detail in Chapter 8 "NextGen Applications."

The Gap Analysis identifies several design standards that will be difficult to comply with at Renton to meet potential future D-III standards. Modification to Standards could be justified for some of the unique operational requirements of Boeing. For instance, the runway to taxiway separation standard warrants Modification to Standards consideration. Renton has an Air Traffic Control Tower, and positive monitoring and control of ground traffic during large aircraft operations can be maintained. However, taxiway hold markings, guidance signage, and associated lighting will require adjustments to meet ARC D-III standards.

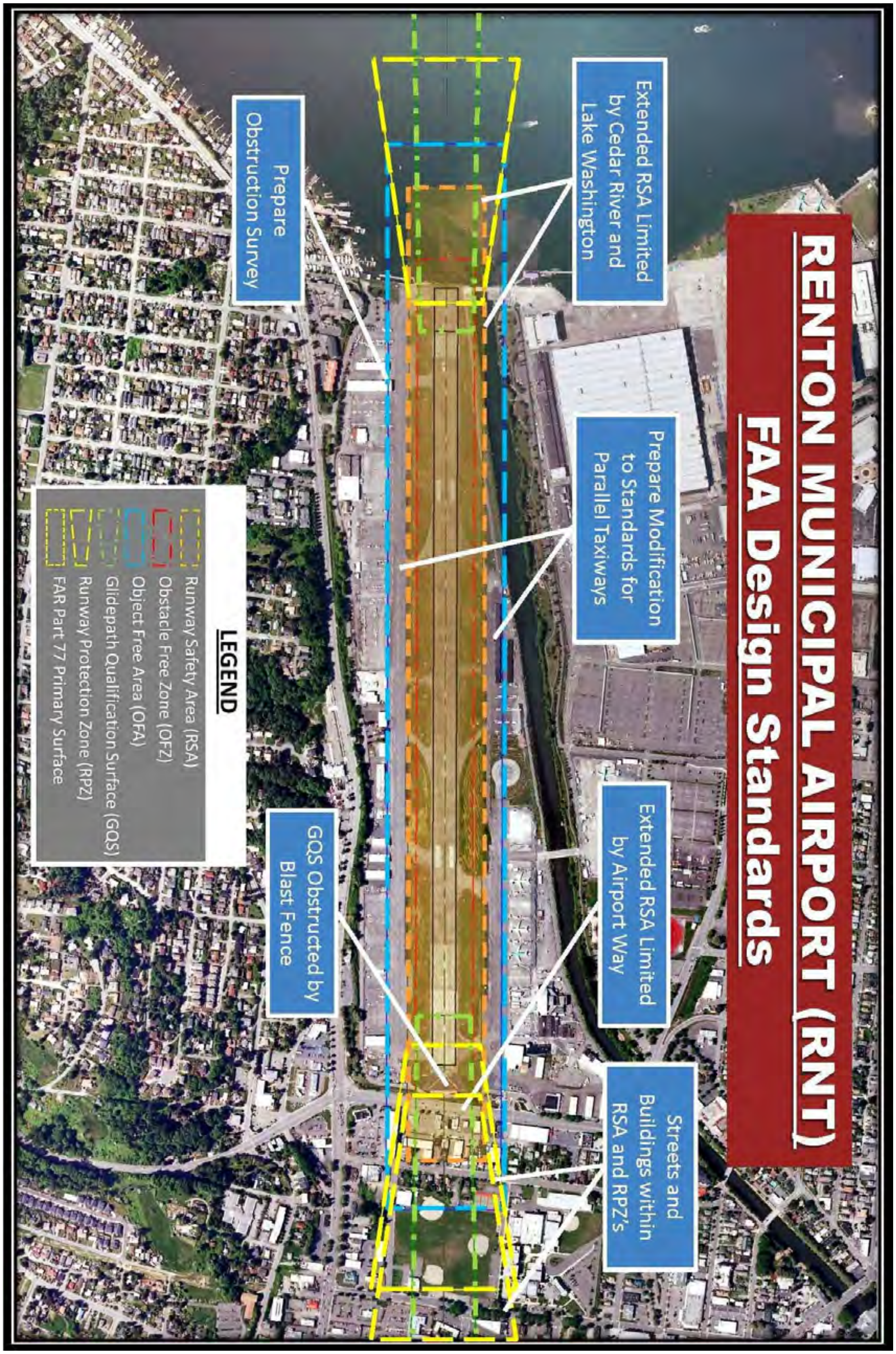
Unlike some design standards, compliance with Runway Safety Area standards cannot be addressed via modifications to standards. If the airport designates the Boeing 737-MAX as its critical aircraft in the future, ARC D-III airport design standards (including the runway safety area) would apply (see gap analysis). Penetrations of Terminal Instrument Procedures (TERPs) imaginary surfaces will have an impact on IFR minimums, but emerging NextGen technologies are specifically aimed at improving precision of operations and may well allow more flexibility in the future.

The focus of this study is to recommend implementation of NextGen technologies in support of developing approach procedures to primary runway ends. For this reason emphasis is put on enhancing approach capabilities to Runway 16. It should be noted that compliance with infrastructure standards at Renton could support development of procedures to Runway 34 as well. Coordinating and resolving airspace conflicts will be a major consideration in final implementation plans.

The following FAA standards graphic depicts issues identified in the NextGen gap analysis. Where appropriate, implementation solutions such as processing a Modification to Standards for the runway to taxiway separation are suggested. Specific recommendations for resolving the Runway Safety Area issue will require a detailed analysis of alternatives, which are more appropriately addressed in a full Airport Master Plan and Airport Layout Plan (ALP) update.

Renton Municipal (RNT) 737 NextGen Implementation Plan

PROJECT DESCRIPTION	Total $
Request FAA evaluation of Current B-737 operations relative to D-III Design Standards Gap Analysis and Special Operating Procedures	
Prepare Obstruction Survey per AC 150/5300-16, -17 and -18	$ 250,000.00
Lower RWY 34 Jet Blast Fence	$ 500,000.00
Develop RNP Procedure	(100% FAA)
Update Master Plan and ALP	$ 500,000.00
Evaluate Extended Runway Safety Area Alternatives	$ 250,000.00
Reconfigure Displaced Thresholds (both RWY ends)	$ 350,000.00
Relocate Guidance Signs and Taxiway Hold Lines	$ 550,000.00
Acquire Land for RWY 34 Approach and Departure RPZ's	$ 20,000,000.00
Reconfigure Connecting Taxiways	$ 800,000.00
Tunnel Airport Way	$ 37,500,000.00
TOTAL	$60,700,000.00


RENTON MUNICIPAL AIRPORT (RNT)
FAA Design Standards
Extended RSA Limited by Cedar River and Lake Washington
Prepare Obstruction Survey
Prepare Modification to Standards for Parallel Taxiways
Extended RSA Limited by Airport Way
GQS Obstructed by Blast Fence
Streets and Buildings within RSA and RPZ's
LEGEND
Runway Safety Area (RSA)
Obstacle Free Zone (OFZ)
Object Free Area (OFA)
Glidepath Qualification Surface (GQS)
Runway Protection Zone (RPZ)
FAR Part 77 Primary Surface

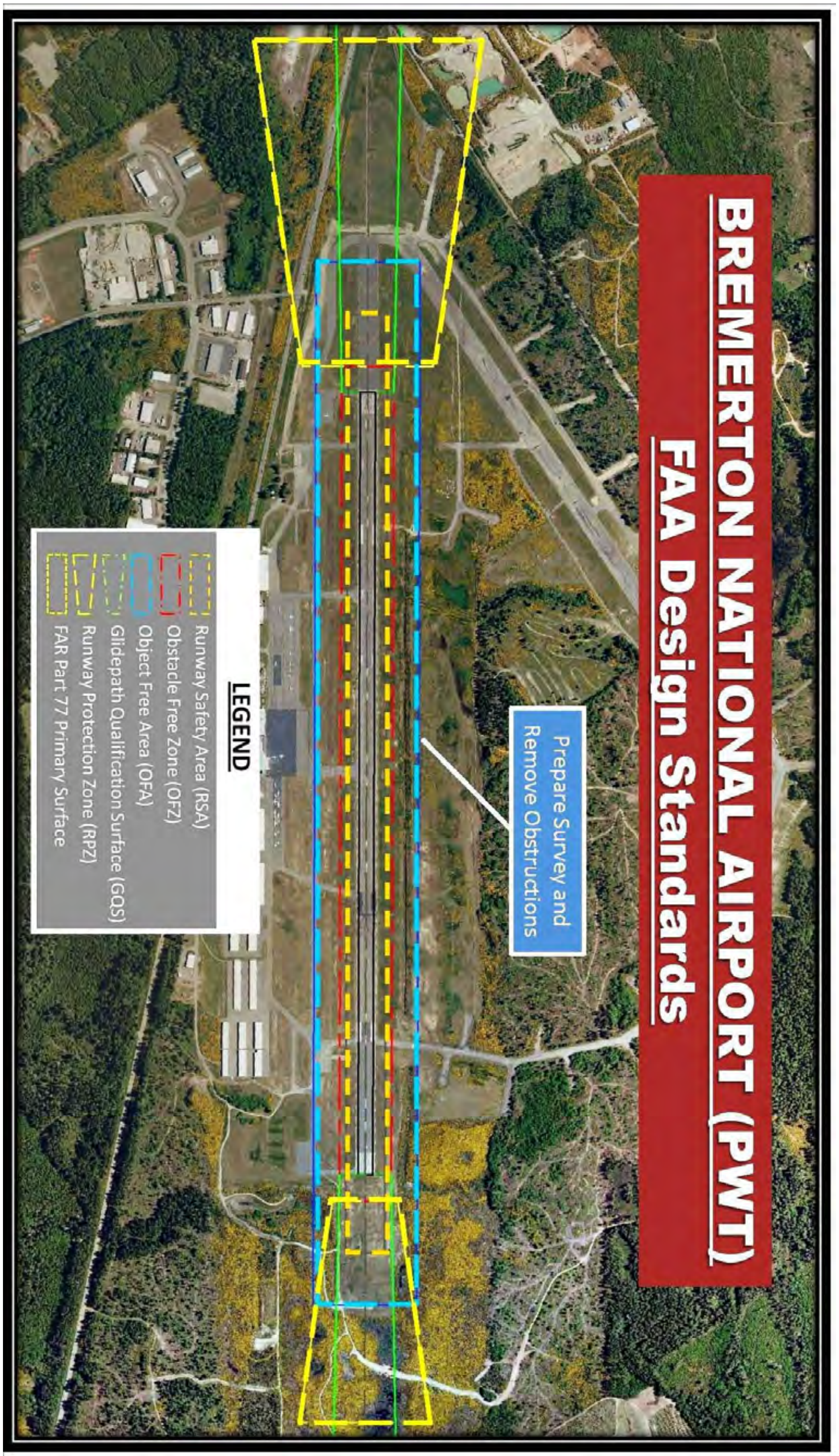
PWT - Bremerton National

Bremerton National Airport is classified as a "Regional Airport." The airport meets or exceeds all of the design standards for the currently recognized Airport Reference Code of B-II. It is noted that the 5010 Master Record for Bremerton lists a total of 4 based jet aircraft. An update of the 2003 Master Plan study was programmed and funded under a 2012 FAA grant. The ongoing study will address the current and forecast critical aircraft designation in light of growing corporate jet traffic.

As discussed in the Gap Analysis, minimums for the GPS based approaches to both runway ends are higher than the conventional ILS and NDB approaches. It is assumed that close in terrain and tree obstructions were contributing factors in establishing the higher LPV and LNAV minima. The Master Plan/ALP update should address these anomalies and may require a new obstruction survey. For this reason the Implementation Plan recommends an aeronautical survey complying with AC 150/5300-18b and obstruction removal as necessary to re-evaluate the Runway 19 LPV minimums and establish an LPV approach to Runway 01.

Bremerton National (PWT) NextGen Implementation Plan

PROJECT DESCRIPTION	Total $
Update Master Plan and ALP	$ 180,000.00
Prepare Obstruction Survey per AC 150/5300-16, -17 and -18	$ 100,000.00
Obstruction Removal	$ 20,000.00
TOTAL	$300,000.00


BREMERTON NATIONAL AIRPORT (PWT)
FAA Design Standards
Prepare Survey and Remove Obstructions
LEGEND
Runway Safety Area (RSA)
Obstacle Free Zone (OFZ)
Object Free Area (OFA)
Glidepath Qualification Surface (GQS)
Runway Protection Zone (RPZ)
FAR Part 77 Primary Surface

S43 - Harvey Field

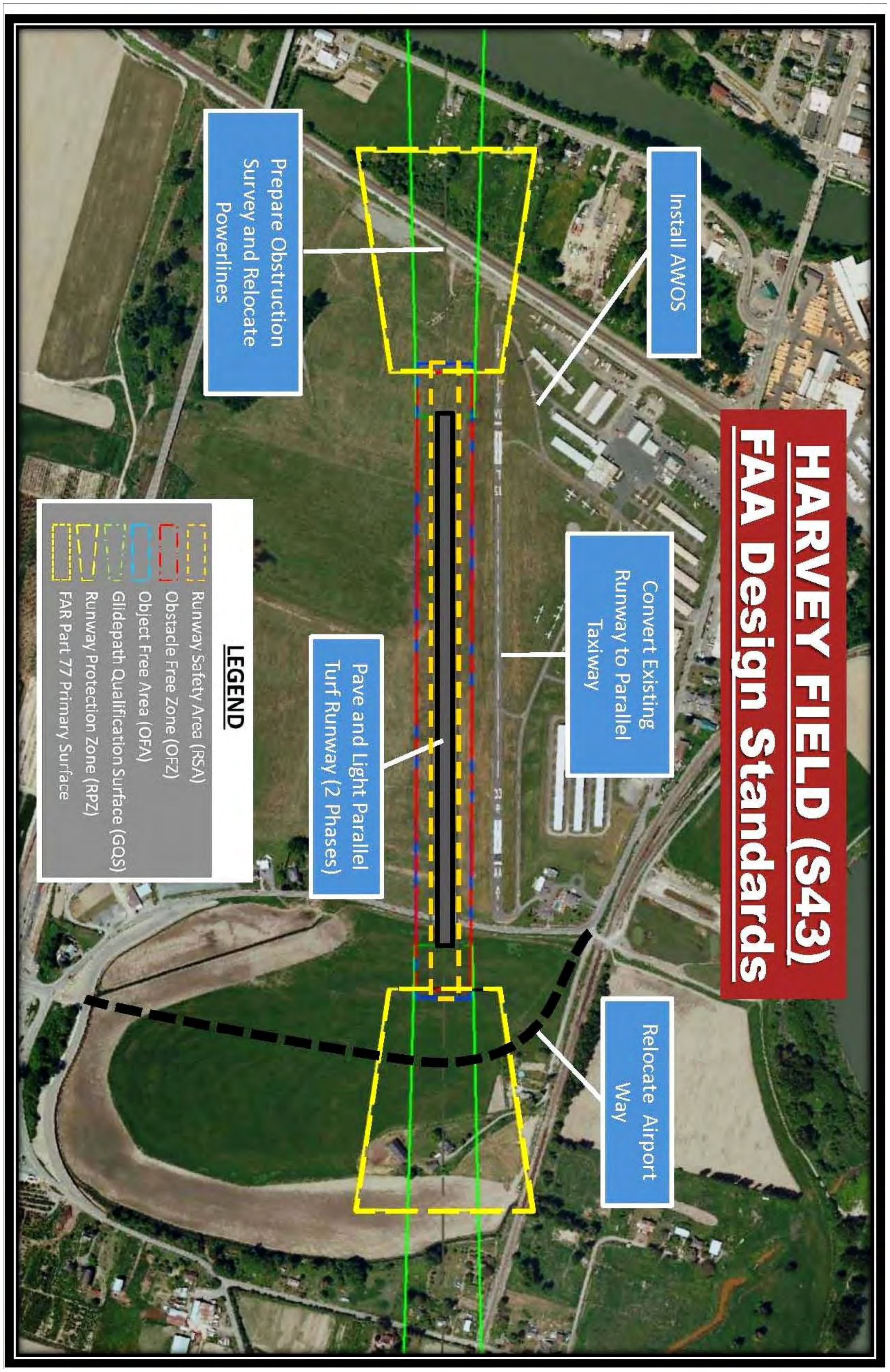
Harvey Field is a privately owned "Local Airport" with an Airport Reference Code of A-I and is listed in the NPIAS. Harvey Field has received federal funding for planning but not for infrastructure development. The airport does not comply with most of the typical design standards identified in the Gap Analysis. The most recent Master Plan, completed in 2010, addresses redevelopment of the airfield infrastructure to meet ARC A-I requirements. An environmental assessment was also prepared in support of the plan.

The following Implementation Plan lists the proposed improvements and estimated costs. If the plan as proposed were fully funded and implemented, it appears that a LPV approach is feasible.

The airport owner has voiced an interest in applying for federal funding to support the Capital Improvement Program. Issues related to accepting federal grant assurances and development within the floodplain fringe area designated by Snohomish County would need to be resolved.

Harvey Field (S43) NextGen Implementation Plan

PROJECT DESCRIPTION	Total $
Prepare Obstruction Survey per AC 150/5300-16, -17 and -18	$ 100,000.00
Relocate Powerlines	$ 86,000.00
Obstruction Removal (Trees)	$ 25,000.00
Pave and Light Existing Turf Runway 15L/33R (1865' x 60')	$ 660,400.00
Convert Existing Asphalt RWY 15/33 to Parallel TWY including MITL	$ 450,000.00
Relocate Airport Way	$ 625,000.00
Extend Runway 15/33 to 2400' x 60'	$ 1,200,000.00
Install Automated Weather Observation System (AWOS)	$ 165,000.00
TOTAL	$3,311,400.00


HARVEY FIELD (S43)
FAA Design Standards
Install AWOS
Prepare Obstruction Survey and Relocate Powerlines
Convert Existing Runway to Parallel Taxiway
Pave and Light Parallel Turf Runway (2 Phases)
Relocate Airport Way
LEGEND
Runway Safety Area (RSA)
Obstacle Free Zone (OFZ)
Object Free Area (OFA)
Glidepath Qualification Surface (GQS)
Runway Protection Zone (RPZ)
FAR Part 77 Primary Surface

W55 – Kenmore Air Harbor (Lake Union)

Kenmore Air Harbor and other seaplane users on Lake Union fly using visual flight rules. The regulations under which they operate provide reliable service to the San Juan Islands. NextGen ADS-B emergent regulations will apply to these operations.

There are no NextGen navigation technologies that apply. NextGen communications initiatives under the SWIM technology category allowing enhanced crew and passenger communications may apply in the future.


KENMORE AIR HARBOR – LAKE UNION (W55)
Seaplane Base
Prepare Obstruction Survey and Evaluate Approach Procedures
Runway 16/34 (5000' x 500' Seaplane Base)
Prepare Obstruction Survey and Evaluate Approach Procedures
LEGEND
Seaplane Waterway Landing Area
Glidepath Qualification Surface (GQS)

Chapter 8 NextGen Analysis and Application

This chapter presents implementation concepts that apply NextGen technologies to Puget Sound Busy Airports.

Primary Considerations:

Application of NextGen-enabling equipage, processes, and procedures to enhance CNS (Communications, Navigation, and Surveillance) performance involves considerations at the airport itself, the surrounding environment, the infrastructure, and the aircraft (tenants and itinerant) that use the airport. The interaction among these aviation stakeholder elements requires analysis of applicable technologies, costs, benefits, possible sources of funding, planning cycles, and opportunities for new operational paradigms.

For the Puget Sound region's busy general aviation airports, there is no "one-size-fits-all" solution that will satisfy all stakeholder needs. Each airport will have to develop a business case applicable to its owners, tenants, itinerants, communities, and services. It is also clear that for NextGen technologies that require airport and aircraft equipage, an iterative "chicken-and-egg" situation prevails involving at least the following three elements:

1. Airports considering NextGen capabilities need aircraft suitably equipped in order that there be usage and advantage.
2. Aircraft considering NextGen equipage need destination and itinerant airports that have necessary procedures published, and infrastructure in place for operational ATC services.
3. Pilots operating equipped aircraft into airports with NextGen infrastructure and procedures need appropriate qualification and training.

All three of the above considerations must prevail to confer an economic benefit to airports, communities, and aircraft owners and realize the growth and inherent safety benefits, and reductions in environmental impact, from application of NextGen technologies to stakeholders at Puget Sound Busy Airports. In the case of some NextGen technologies, equipage of aircraft is required by FAA rules (i.e., ADS-B in 2020). However, others (i.e., LPV and RNP capability) are optional and require a business case to justify investments in airports and aircraft. The analysis that follows will discuss general requirements and conditions, and then recommend how individual airports may go about evaluating and assessing the equipage business case.

Secondary Considerations:

Air traffic control procedures may be disrupted by application of NextGen technologies, particularly during the time period that mixed equipage aircraft operations will occur. Coordination is required between airports and the FAA ATC service provider organizations to assure that ATC workload is not adversely affected by specific NextGen implementations.

Airports approaching saturation operational levels need different NextGen implementation strategies, particularly during the phase-in of new technologies.

Neighbor airports with interacting airspace, traffic patterns and procedures require plans addressing alignment of NextGen implementation in order to avoid a sub-optimized regional condition. Joint planning among affected airports may be desirable.

NextGen & PSRC Airports Context

The original purpose of NextGen was to increase the access of the NAS, while also improving the safety, efficiency, and reducing the environmental impact of airline operations. The economic incentives for major airports and airline operators to apply NextGen technologies are considerable. However, application of NextGen technologies to general aviation airports such as the Puget Sound Busy Airports is a new idea, and is likely to need economic support in order to create the conditions that incentivize aircraft operators and owners to equip their aircraft with updated avionics systems.

The analysis that follows will suggest factors to address these considerations.

The PSRC Busy Airports Scope of Work contains the following instructions:

Although new satellite and aircraft technologies are the foundation of NextGen, the nation's airports will need to be prepared in order to take advantage of the new system's benefits. The Federal Aviation Administration (FAA) defines specific criteria for airports to accommodate NextGen-type technology, and these criteria may require some airfield modifications to meet the applicable design standards. PSRC's NextGen project is designed to help our region's airports prepare for and realize the benefits of emerging technology.

NextGen technologies include airspace infrastructure enablers, new flight procedures, airport enhancements, and aircraft equipage that will be phased in over the next 10 to 15 years. In the near term (approximately 2-5 years), many of these technologies will become pervasive for the commercial air transport sector and their large destination airports. In this time frame, a number of NextGen capabilities will also be available to the general aviation sector. In particular, busy general aviation airports have the near term opportunity to evaluate the costs and benefits of NextGen readiness and provide suitably equipped general aviation aircraft with significant operational advantages.

This section of the report describes the NextGen technologies most relevant to the Busy Airports and provides specific guidance and recommendations that each airport may consider in moving toward NextGen implementation.

With regard to the FAA specific airport criteria for implementing NextGen instrument procedures, there may be occasions in which safety can be enhanced by balancing airport standards against a desired approach procedure minima. For example, an airport may improve the safety of an approach procedure by replacing classical "step down and level off" procedures associated with non-precision approaches with NextGen vertical guidance (APV) procedures. The individual airport analysis assessment tables cite such possibilities where they apply.

Puget Sound "Busy Airports"

Completion of Tasks 1, 2, and 3 reinforced the idea that "each airport has its story" and requires a tailored solution. Each solution must be considered within the context of each airport, neighboring airports, principal users of the airport, and potential benefits to the public. Table 8-1 contains relevant characteristics of recommended "Busy Airports" derived from Task 1. See Chapter 5, "Establishing PSRC Busy Airports," for the analysis and screening criteria that define a busy airport. Table 8-1 lists these airports and contains notations on areas of NextGen Communications, Navigation, and Surveillance that merit attention by each Busy Airport in conducting the next cycle of planning.

Details are provided in each specific Busy Airport NextGen Implementation Assessment Table to expand on the needs of that airport and its stakeholders.

Table 8-1 NextGen Busy Airport Characteristics

Airport	Public or Private	Communications: Tower	Communications: Remote Tower Potential	Communications: CPDLC	Communications: SWIM	Navigation: Current Instrument Approaches (best)	Navigation: GBAS Potential	Surveillance: ADS-B Coverage Lowest Altitude*
Auburn - S50	Public	No	Yes	No	Yes	GPS 1320/1½	No	900-1900 ft. verified
Boeing Field - BFI	Public	Yes (24 hours)	No	Yes	Yes	ILS 273/1	Yes	Ground verified
Crest Airpark - S36	Private	No	No	No	No	None	No	1900 ft. predicted
Kenmore Lake Union - W55	Public - Seaplane base	No	No	No	Yes	None	No	900-1900 ft. verified
Renton - RNT	Public	Yes (0700 - 2100)	Yes	Yes	Yes	LPV 518/1⅜	No	900-1900 ft. verified
Arlington - AWO	Public	No	Yes	Yes	Yes	LPV 200/¾	No	900 ft. predicted
Firstair Field - W16	Private	No	No	No	No	None	No	900 ft. predicted
Harvey Field - S43	Private	No	No	No	No	GPS 1220/1¼	No	900 ft. predicted
Paine Field - PAE	Public	Yes (0700 - 2100)	Yes	Yes	Yes	ILS 200/½	Yes	Ground verified
Pierce County. Thun - PLU	Public	No	Yes	No	Yes	GPS 662/1	No	900 ft. predicted
Tacoma Narrows - TIW	Public	Yes (0800 - 2000)	Yes	Yes	Yes	ILS 200/½	No	900 ft. predicted
Bremerton - PWT	Public	No	Yes	Yes	Yes	ILS 204/½	No	900 ft. predicted
Kenmore Air Harbor - S60	Public - Seaplane base	No	No	No	Yes	None	No	900 ft. predicted

CPDLC – Controller Pilot Data-Link Communications
GBAS – Ground Based Augmentation System
SWIM – System-Wide Information Management
ADS-B – Automatic Dependent Surveillance-Broadcast

General Aviation Airports: Background & General Conclusions

Airports are active participants in the implementation of NextGen. While many investments in NextGen technologies are the responsibility of the FAA or aircraft operators, airports also have opportunities to advance NextGen.

PBN instrument flight procedures are a key component of NextGen because they can improve the efficiency of airport arrivals and departures. For general aviation operators and some regional air carriers, WAAS/LPV approach procedures can provide Category I minimums. Business jet operators and air carriers are more commonly equipped for RNAV and RNP, which can support Category I minimums. The FAA may opt for an incremental phase-out of the ILS Category I installations by 2025, as both WAAS/LPV and RNAV/RNP provide more cost-effective and flexible instrument approach procedures. The FAA continues to evaluate Ground Based Augmentation System technology, which could augment the existing ILS Category II and III installations at airports throughout the region.

Airports have the key role of discussing with their users the need for new or additional PBN procedures. A hub airport may serve air carriers that are actively seeking to expand the use of RNAV or RNP procedures, while a general aviation airport may benefit from a new WAAS/LPV approach procedure. An airport can request that the FAA initiate consideration and design of these procedures. Airports can facilitate the aeronautical survey and obstruction-mitigation and runway-lighting actions that may be needed to achieve lower minimums and approach procedures with vertical guidance (APV). AGIS surveys are eligible if identified in an AIP-funded Master Plan or development project. Obstruction mitigation and runway lighting may be eligible for Airport Improvement Program (AIP) funds.[14]

Surface surveillance and management is another key area for airport involvement in NextGen. In 2011, the FAA completed installation of Airport Surface Detection Equipment–Model X (ASDE-X) at 35 airports. Additionally, the agency aims to install enhancements to airport surface detection equipment, known as the Airport Surface Surveillance Capability (ASSC), at nine other airports between 2014 and 2017. At these facilities, airports can install ADS-B squitters on airport-owned vehicles that regularly operate in the movement area. The squitters would broadcast vehicle positions to air traffic control, aircraft equipped with ADS-B In, and the airport operations center. This

[14] It is important to note that surveys (now all under Airports GIS) are AIP-eligible, but not as stand-alone projects. PGL 12-11 stipulates that AIP-funded surveying must be in conjunction with an AIP-funded master planning study or development project.

would improve situational awareness and safety, particularly during construction projects and winter weather events. For airports that will not receive ASDE-X or ASSC, the FAA is also researching low cost technologies and systems that could provide a surface surveillance capability.

Some airports have elected to install surveillance systems to complement those the FAA has installed and provide coverage of non-movement areas. When airports monitor operations on the airport surface more precisely, there is an overall increase in situational awareness for both the airport operators and the pilot community.

Airports and vendors have made significant efforts to develop systems and tools to improve surface situational awareness. To date, the results show substantial promise, but challenges with data sharing and distribution have emerged. The FAA is refining policy and processes to enable improved access to NAS data to support the emerging surface operational concepts under NextGen by streamlining the approval processes to give aviation users access to appropriate NAS data through the NAS Enterprise Security infrastructure.

Because new runway and taxiway infrastructure is critical to capacity and efficiency, the continued transition of airport layout plans into the Airport Geographic Information System (GIS) application will improve the airport planning process. Airport GIS applications also provide the accurate geospatial data needed for surface moving maps and new instrument flight procedures.

There has been a tremendous amount of NextGen technology development focused on transport category aircraft operations at Class B metroplex airports such as the Seattle Tacoma International Airport. A few NextGen technologies, such as WAAS (Wide Area Augmentation System) have particularly benefitted general aviation. For the Busy Airports study, there are some broad NextGen conclusions that warrant discussion before examining each individual General Aviation Busy Airport identified in Task 1. It is also useful to break "NextGen" into its constituent parts as they affect Communications, Navigation, and Surveillance ("CNS") before proceeding to specific analysis of each airport.

Table 8-1 provides a high level analysis of all the Busy Airports as regards application of certain emergent NextGen Communication, Navigation, and Surveillance technologies. Details are contained in the specific airport NextGen Implementation Assessment Table.

The following analysis applies the general concepts introduced in Chapter 2, "NextGen Overview," and Chapter 3, "The Details of NextGen," to the PSRC Busy Airports

NextGen Communications (the "C" in CNS) involves implementation of several initiatives, such as Remote Tower installations, CPDLC (Controller Pilot Data-Link Communications), and SWIM (System-Wide Information Management). CPDLC will relieve voice communication congestion through digital messaging for air traffic control, particularly important at saturated airports. SWIM is a comprehensive set of programs designed to facilitate greater sharing of Air Traffic Management (ATM) system information. Examples are: airport operational status, weather information, flight data, status of special use airspace, and National Airspace System (NAS) restrictions. SWIM will support current and future NAS programs with a flexible and secure information management architecture for sharing NAS information. SWIM will use commercial off-the-shelf hardware and software to support a Service Oriented Architecture (SOA) to facilitate addition of new systems and data exchanges and increase situational awareness.

Remote Tower technologies are in an emergent state, so it is not possible to attach quantitative costs, benefits, and availability dates. Airports preparing long-term plans should qualitatively assess potential benefits of positive control for their tenant traffic, and possible attraction to itinerant traffic.

Remote Tower: Table 8-1 points to the possible benefit of Remote Tower implementation for Busy Airports where infrastructure, traffic types, and availability timing may justify the cost of implementation. Busy Airports are identified that may benefit from remote tower services by extension of tower operating hours to provide 24/7 positive air traffic control, or by providing positive control services where none exist today.

CPDLC is likely to first emerge in air traffic control starting with airline services at metroplex airports located in Class B airspace. For busy general aviation airports surrounding Class B airspace, particularly those serving advanced business jets, this technology may emerge concurrently with airline equipage. Mid to long term planning at those airports should maintain cognizance of CPDLC evolution in order to be prepared to serve their clientele. Table 8.1 contains a "Yes" in the CPDLC column where it appears these circumstances will prevail.

SWIM is an emergent technology that will likely provide broad benefits to equipped aircraft, and though not currently an available technology, may emerge rapidly to provide very useful flight data, particularly for itinerant traffic flying instrument flight plans. Table 8-1 contains a "Yes" notation at airports whose client base is likely to reflect that kind of operation.

NextGen Navigation (the "N" in CNS) involves enhancement of aircraft path management precision, particularly in terminal areas, through installation of new instrument flight procedures for arrival, approach, and departure, using NextGen technologies. The principle technologies are described below.

LPV (Localizer Performance with Vertical guidance) procedures using GPS WAAS technology are an outgrowth of NextGen developments and well suited for general aviation aircraft. From the pilot's point of view, the implementation of the technology is similar to flying an ILS, substituting GPS for ground-based localizer and glide slope installations and providing equivalent guidance for equipped aircraft. LPV approach procedure design mimics the geometry of ILS, occupying a trapezoidal clearance area of increasing lateral and vertical airspace clearance as a function of distance to the runway.

The FAA has made LPV procedure installation around the nation a priority, with the result that there are now about 3000 such procedures published. Little specialized training is required for general aviation instrument qualified pilots to use LPV procedures. As a consequence, most new general aviation aircraft are equipped with WAAS avionics and databases navigators that allow LPV operations, and the contemporary instrument training syllabi and instrument proficiency checks include demonstration of competence in flying LPV approaches.

A significant portion of the incumbent general aviation fleet has WAAS receivers and navigators retrofitted that are capable of LPV approach procedures. The PSRC study found many of the PSRC Busy Airports have existing published LPV procedures, and in some cases, the FAA is enhancing these procedures with updated criteria with resulting lower weather minima. At other Busy Airports, it appears that investment in LPV procedures would enhance low weather access to the airport provided the airport layout, configuration, and surrounding terrain meet certain criteria.

LPV is a significant safety enhancement compared to classic GPS, VOR, VOR/DME, and NDB procedures in that vertical guidance is provided to eliminate what is colloquially referred to as "dive and drive" procedures, thereby enabling stabilized approaches. Under some conditions, LPV guidance is superior to ILS flying at the same runway in that magnetic aberrations in the ILS localizer and glide slope signals that disrupt guidance are not present in GPS derived guidance.

PBN/RNP (Performance Based Navigation/Required Navigation Performance) procedures using GPS technology are emerging as a NextGen technology previously targeted to commercial transport and high-end business aircraft operations. These procedures provide a specified (e.g., RNP 0.3) flight precision (in nautical miles laterally, with an appropriate corresponding vertical precision) of the flight trajectory expected of the aircraft in both lateral and vertical dimensions, and an alerting function if the Actual Navigation Performance (ANP) approaches the RNP.

RNP procedures can be designed to provide flight path guidance for all aspects of terminal and en-route operations, including arrivals, approaches, missed approaches, and departures. Unlike LPV and ILS, RNP procedures are rectilinear and do not occupy greater airspace as a function of distance from the runway. When applied to en-route operations, RNP and RNP offset routes designed around the future T route and Q route structure will substantially increase airspace capacity.

RNP procedures can contain laterally curved paths in the form of one or more RF (radius to a fix) legs with the result that curvilinear flight paths associated with a specific procedure can be designed to avoid terrain, conflicting airspace, optimize procedural efficiency, and manage community noise concentration.

Particularly when applied to departure procedures, many of which are currently based on an aircraft heading ("maintain runway heading"), RNP departures provide precision flight path guidance and support curvilinear departure paths near the airport to avoid terrain or conflicting airspace, or allow planned distribution of community noise impact.

RNP procedures require no ground equipment. They do require aircraft equipage in the form of an avionics suite designed to fly the RNP path and respond to the ANP alert.

Originally applied to provide lower weather minima for instrument operation approaches to or departures from terrain-challenged airports, RNP is now emerging worldwide as an efficiency tool for aircraft operations.

Current commercial and high-end corporate jets are delivered with RNP capability. Current high-end piston general aviation avionics can fly curved flight paths such as holding patterns, and may have latent capability to fly RNP RF paths, but are not yet qualified and certified to do so. The level of certification for general aviation (Part 23) and airline (Part 25) may be different, and require different levels of equipment redundancy.

The level of precision of RNP procedures varies from about RNP 0.1 to RNP 2.0; commercial transport category aircraft typically can fly the former; and the latter will generally be used for en-route operations as T routes and Q routes begin to proliferate.

RNP procedures in use by commercial airliners require specialized pilot training and qualification, because they are new and many of these procedures are tailored for specific aircraft to achieve maximum gross weight under Part 121 operations, and optimize performance with a failed engine. Because the pilot procedures for future public and generic Part 91 and 135 RNP procedures are similar to flying other instrument procedures, it is probable that RNP qualification for general aviation will evolve toward the level of rigor and training currently used in LPV operations.

GBAS (Ground Based Augmentation System) is a means to use a ground station to enhance the accuracy of the GPS derived position and allow improved low weather minima, possibly to the level of Cat II and eventually Cat III ILS. GBAS can be used to enhance approach, landing, departure, and surface operations within its area of coverage. GBAS can be combined with other GPS procedures such as RNP. Because the ground station corrects errors in the GPS signal, great precision capability is possible leading to the potential for Category II and Category III approach guidance as the technology and certification basis emerges. GPAS is traditionally called "Local Area Augmentation System (LAAS) in the U.S. The technology may, in some cases, be able to support procedures at neighbor airports to the location of the ground station.

Table 8-1 lists the current best instrument approach for each of the Busy Airports, if one exists. A notation is provided if there is potential for future application of GBAS technologies. Details of the potential for improving navigation access for arrival, approach, and departure are provided in the individual tables analyzing each of the Busy Airports.

NextGen Surveillance (the "S" in CNS) involves improving or replacing classic radar surveillance service provided by ATC. Current NextGen technology being implemented for surveillance is Automatic Dependent Surveillance, (ADS-B) which uses GPS technology, transmitted from the aircraft to ATC via ADS-B ground stations, as the means of determining aircraft position. Radar surveillance locates the aircraft once every several seconds and has accuracy deficits that increase with distance from the radar. ADS-B provides location determination several times per second, and its accuracy is independent of distance. ADS-B has or will have ground stations located so as to cover the entire continental United States and oceanic areas such as the Gulf Coast. The FAA has committed to an installation schedule that ADS-B will be complete in 2013.

ADS-B coverage has two electronic formats, a Universal Access Transceiver (UAT) operating at 978 MHz, and a 1090 MHz Extended Squitter (1090ES). New avionics offerings on the commercial market targeting general aviation provide a variety of choices for the general aviation pilot, some of them receiving both UAT and 1090 transmissions. ADS-B surveillance coverage extends to the ground near the ground station, and typically at or somewhat above traffic pattern altitudes for airport locations away from the ground station.

"ADS-B Out" refers to the transmission from aircraft to ATC, and the signal contains a number of aircraft parameters so as to fully inform ATC of position, identity, and to some extent, flight path intention.

"ADS-B In" refers to a signal transmitted back to the aircraft that contains additional useful information which, in the case of UAT general aviation equipage, may include weather and traffic data so that the aircraft can identify weather and traffic hazards and take appropriate avoidance action. Commercially available traffic and weather avionics may be based on direct satellite signal transmission, and unlike the free ADS-B In signal, can be used by the pilot while still on the ground before flight. Therefore the utility and procedures to use commercial and ADS-B In services are somewhat different.

NextGen ADS-B functionality is not under the direct control of airports in the Busy Airports study; however, ADS-B may have sufficient ground station installation density in the region associated with the PSRC study such that aircraft surveillance service can be provided to a lower altitude than classic radar, in some cases close to the ground. In such cases, certain airports that previously required ATC sequencing "one-in-one-out" for instrument arrivals and departures might be provided improved ATC service. Such service requires ATC assessment of the associated workload before it can be assumed available.

Table 8-1 contains an estimate of the altitude at which ADS-B Out coverage exists at the Puget Sound Busy Airports, based on the current ADS-B station installations and recent FAA testing.

ADS-B Out equipage for aircraft is a requirement by January 1, 2020 for aircraft typically based at the Busy Airports, and the general aviation avionics industry is currently developing a plethora of portable and installed equipment, some of which meets the FAA 2020 requirement and provides services and information previously not available to the general aviation pilot. Airport planning using 10-year horizon needs to consider that ADS-B equipage will be close to universal after 2019, and should include assessment of altitude at which ADS-B coverage begins.

Airport NextGen Implementation Assessment

Each airport that maintains a planning cycle can incorporate an analysis of costs and benefits from NextGen implementation. The overriding issue for an airport is to assess NextGen implementation options against the airport's goals and objectives in the service of its community. In many cases this will require at least a qualitative business case analysis, identifying the costs and benefits for the airport stakeholders and the airport itself. The elements of such an analysis will be airport-specific, and involve assessment of airspace and neighbor airports, airport infrastructure, flight procedures and weather minima requirements, and considerations of tenants, itinerant aircraft, community and the environment.

Trade Studies: WX Minima Needs

A number of the PSRC Busy Airport NextGen Implementation Assessment tables shown on the following pages open a concept of "trading" weather minima for the safety benefit associated with replacing a VFR or "step down and level off" procedure with an approach with vertical guidance (APV). Current approaches with vertical guidance are ILS, LPV, and RNP. It is widely agreed among aviation safety experts that a stabilized approach enhances safety.

There currently does not exist a routine process in procedure design that allows a trade of weather minima for airport infrastructure criteria in order to balance safety of a stabilized approach with minimums. Approach procedure design applies airport infrastructure standards associated with the Airport Reference Code (ARC) as described in detail in Chapter 6; including specifications of Runway Safety Area (RSA), Object Free Area (OFA), Runway Protection Zone (RPZ), Glidepath Qualification Surface (GQS), Runway Visibility Zone (RVZ), Runway and Taxiway dimensions and separation.

The provision of an instrument approach with vertical guidance and the associated minima are one of the products of applying Terminal Instrument Procedures Tools (TERPS). In some cases, such as runway ends at Auburn Airport (S50) and Renton Airport (KRNT), this process does not allow the desired approach with vertical guidance. Airport investments to modify infrastructure, and/or acquire land, allow consideration of an approach with vertical guidance, though the expense may be outside the scope of available financing.

In practice, airport infrastructure requirements may be adjusted by specific modifications to standards, based on expert applicant and regulatory assessment of the safety mitigation associated with higher decision heights or visibility requirements, than ordinarily produced in TERPS analyses.

In some of the Airport NextGen Implementation Assessment Tables a reference is made to "trade studies" or "exchange" of weather minima for approach with vertical guidance in lieu of a "step down and level off" procedure. The intention is for the airport to consider the following process:

1. Research historical weather data, and tenant and itinerant needs, to determine weather minima that will produce a desired low weather usage of the airport by tenants and itinerants.

2. Establish feasibility and costs of a hypothetical "reference airport" with infrastructure that satisfies TERPS criteria for an approach with vertical guidance.

3. If the result of step 1 is a higher weather minimum than usually produced by TERPS analysis of the "reference airport," conduct trade studies of costs versus access to determine a balanced economic solution with a business case that satisfies needs of airport stakeholders.

4. Approach the FAA to determine the viability of modifications to standards that will allow the approach with vertical guidance at a higher than ordinary weather minimum.

NextGen Analysis Template for Busy Airports

The following assessment table contains a general outline of factors that may be considered by an airport sponsor for NextGen implementation and associated business case analysis. The PSRC NextGen analysis will provide a specific application of these factors for each Busy Airport.

NextGen Assessment Strategy for Busy Airports

Airport Goals & Objectives	• Assess NextGen options with respect to airport goals and objectives • Identify stakeholders • Identify costs and benefits from NextGen technology implementation
Airspace Infra-structure	• Availability of low altitude ADS-B coverage • Airspace overlaps or conflicts / interaction with neighbor airport airspace and procedures • ATC impact from new NextGen procedures and practices • Regional airspace considerations (dominant airport determines traffic flows?) • ATC challenges managing procedures as is and with NextGen • Availability of neighbor airport cooperation
Airport Infra-structure	• Airport survey currency and format • Airport design compliance with LPV and/or RNP TERPS requirements • Airport control of near obstacles, roads, etc.
Flight Procedures & Minima	• Existing instrument approaches and departures • Prospective NextGen instrument approaches and departures • Seasonal weather analysis • Lower weather minima benefits versus costs
Tenants & Itinerants	• Commercial aircraft, typical NextGen equipage • Private aircraft, typical NextGen equipage • Anticipated new tenants/itinerants, typical NextGen equipage
Community & Environment	• Community expectations • Airport advisory committee(s) • Anticipated new services and community business impact • Community noise sensitivity and mitigation possible with NextGen • Communications strategies to inform neighbors
NextGen CNS 10 yr horizon	• Comm: evaluate specific effect of NextGen communications technologies • Nav: evaluate specific effect of NextGen navigation technologies • Surveillance: evaluate specific effect of NextGen surveillance technologies
Business Case Analysis	• NextGen implementation costs • NextGen implementation benefits • Funding sources • Time frame to implement

NextGen Applications to PSRC General Aviation Busy Airports

Tasks 4 and 5 of this study involve a determination of potential application of some or all of the NextGen technologies cited above to the 13 busy airports. For each airport in Table 8-1, a NextGen Implementation Assessment Table is provided, suggesting an analysis focus that may be adopted by the airport in order to identify the costs, benefits, and qualitative considerations that may be incorporated into the next planning cycle by the airport sponsor. In this table, the airport's goals and objectives are derived or inferred from the airport manager interviews conducted during study Task 1.

The potential to apply LPV and RNP procedures to airports that currently do not have instrument approaches with vertical guidance is a major benefit to flight safety. Some of these airports currently have an instrument approach procedure that involves one or more level-off segments before the final approach segment, requiring reconfiguration, power changes, and in the case of a light twin flying with an inoperative engine, considerable pilot finesse to adjust lateral and directional controls for the power changes.

The recommendations for each Busy Airport covered in Task 4 and 5 of this study suggest a course of action that the airport manager or owner may choose to apply, in a time frame that suits the airport operational need and normal planning cycle. In many cases the suggestion is to incorporate NextGen with the specific elements recommended into the next normal airport planning cycle. Potential funding sources cited vary, and may include local, tenant, FAA, or other sources of funding.

For the PSRC Busy Airports Study, the airspace south of Boeing Field involves airports of Renton, Auburn, and Sea-Tac. A special study is warranted to determine the potential synergy from application of NextGen technologies to these airports in a regional cooperative effort.

Following are NextGen Implementation Assessment Tables for each PSRC Busy Airport assessing the current NextGen capability and actions necessary to implement additional NextGen capability.

BFI – King County International Airport/Boeing Field Implementation Strategy

Airport Goals & Objectives	• Serve Boeing Flight Test, package freight, & general aviation client base, including rotorcraft • Participate in Boeing/AlaskaAir/FAA Greener Skies initiative as active partner • Complete new Strategic plan and align Airport Master Plan • Complete an EALP • Pioneer a GBAS infrastructure for the Puget Sound region airports
Airspace Infra-structure	• Location in SEA Class B north occupies 100/11, 100/18 & 100/20 altitude restriction areas • Integrate KBFI RNP and Visual procedures with Greener Skies initiative • Participate in consecutive independent RNAV & RNP/ILS KSEA approaches • Secure ATC Approach Control use of Boeing Special RNP procedures • Develop RNP approach/departure procedures to serve Boeing & other clients • Coordinate with KRNT, KSEA, & S50 (Auburn).
Airport Infra-structure	• Working with Hughes (consultant) on RNP procedure applications and usage • Use Harbor Visual Approach procedure to validate community benefits of RNP paths with package freighter operations of aircraft not equipped for RNP • Pioneer a GBAS infrastructure for KBFI to provide IFR better than Cat I

Flight Procedures & Minima	• Current approaches:
	  o ILS RWY 13R [273/1]; ILS RWY 31L [407/1½]
	  o RNAV (RNP) Z RWY 13R [702/1] (published, but may be Boeing Special)
	• Current departures; runway headings expect vectors
	• Desired approaches: RNP RWY 31L coordinated with KRNT& S50, improve RNP RWY 13R minima
	• Desired departures: RNP RWY 31L overflying harbor & RNP RWY 13R coordinated with KRNT, KSEA, S50

Tenants & Itinerants	• Boeing Flight Test • Package freighter arrivals serving greater Seattle area • High end business jets based at & using Galvin & Clay Lacy FBOs • General aviation training Galvin, rotorcraft, and several others • General Aviation owners & itinerant parking • Special flights serving Museum of Flight and outsize cargo arrivals
Community & Environment	• Densely populated area • Community noise sensitivity, particularly to night freighter operations, mitigated by flight over harbor areas using published visual procedures • Future RNP operations will allow IFR flying of current visual procedure paths
NextGen CNS 10 yr horizon	• Comm: Evaluate benefits of possible CPDLC & SWIM implementation • Nav: Evaluate potential costs and benefits of RNP approaches and departures to both runways; explore partnerships for GBAS with KSEA & KPAE • Surveillance: ADS-B coverage will probably extend to ground
Business Case Analysis	• Work with regional airports to explore sharing of GBAS implementation costs • Explore FAA, community, and tenant funding sources • Timing: next airport master plan release

S50 - Auburn Municipal Airport NextGen Implementation Strategy

Airport Goals & Objectives	• Serve GA tenant community; install AWOS, improve IFR capability • Use NextGen for better approach minima, encourage tenant aircraft to equip • Secure better ATC handling of IFR arrivals and departures • Serve Cirrus Aircraft Service Center tenant located on the field with better customer aircraft access; attracts over 100 customer airplanes per year
Airspace Infra-structure	• Location in SEA Class B east in 100/30 altitude restriction area • Determine if ADS-B Out makes "one-in-one-out" IFR handicap avoidable • ATC service for IFR arrivals/departures involves Approach Control workload • Explore departures/arrivals to/from east to minimize flight in SEA Class B • Align procedures with KBFI & KRNT; consider KSEA & ATC Approach Control workload
Airport Infra-structure	• Determine WX minima that satisfies tenant & itinerant needs • Provide AWOS because Auburn has a "microclimate"; actual conditions at S50 may not be reflected by KSEA/KBFI/KRNT ATIS • Evaluate displaced thresholds, modification to standards for RWY Width, GQS, RWY/TWY separation criteria in exchange for vertical guidance to replace "step down & level off" procedures • Determine costs of obstruction survey & possible removals, and making RWY marking compliant, survey may remove night IFR operations restrictions • Consider benefits of future Virtual Tower services
Flight Procedures & Minima	• Current approach: GPS –A [1320/1¼] • Current departure: runway heading, then specified headings to VOR intercepts • Desired approach LPV [350/1], using initial approach segment from east for RWYs 16 & 34 • S50 needs a GPS Departure; ATC currently clears IFR departures with special instructions, does not use the Auburn One published VOR departure
Tenants & Itinerants	• General aviation tenants mostly GPS equipped, need economic incentive of lower minima to equip for WAAS/LPV procedures • The airport Cirrus Aircraft Service Center will realize improved access by a large LPV-equipped Cirrus SR20/22 client fleet
Community & Environment	• Dense population area close to Seattle, serving largely general aviation ownership • Noise sensitive neighborhoods will require proactive relationship development
NextGen CNS 10 yr horizon	• Comm: Evaluate potential costs/benefits for AWOS & Remote Tower service • Nav: Evaluate potential costs and benefits of LPV approaches and GPS departures to both runways • Surveillance: Assume aircraft compliant with ADS-B Out & evaluate potential to eliminate IFR "one-in-one-out"; ADS-B coverage may extend to ground
Business Case Analysis	• Determine if improvements can contain costs to runway marking & compliant airport survey • Explore FAA, community, and tenant funding sources • Timing: next airport master plan release

PAE – Snohomish County Airport / Paine Field NextGen Implementation Strategy

Airport Goals & Objectives	• Serve Boeing Flight Test tenant • Serve the GA tenant community • Serve region with comprehensive IFR training and practice environment • Develop as a business jet destination north of Seattle & Redmond • Respond to interest in commercial airline service
Airspace Infra-structure	• Location in SEA Class B north in 70/60 altitude restriction area • Optimize Approach Control and TRACON handling of IFR traffic • Participate in regional GBAS enhancement to IFR minima • Provide IFR practice supporting north traffic flow (accomplished in 2012) • Remain cognizant of regional airspace initiatives (i.e. Greener Skies)
Airport Infra-structure	• Create GPS/LPV approach to RWY 34L (accomplished summer 2012) • Continue support for general aviation operations & training RWYs 16L & 34R • Develop GBAS capability, support regional GBAS development • Consider benefits of future Virtual Tower to expand tower service to 24 hours
Flight Procedures & Minima	• Current procedures: o ILS RWY 16R [200/½]; ILS Z RWY 16R SA CAT II [100/RVR16] o RNAV (RNP) Z RWY 16R (Special Boeing) o Multiple GPS/LPV/VOR-DME approaches to RWY 16R & 34L o Departures; runway headings expect vectors • Desired Procedures: o Public or Special GBAS & RNP approaches and departures may emerge to serve Boeing client or potential commercial airline service
Tenants & Itinerants	• Boeing tenant uses airport for 747/767/777/787 operations, including first flight and production testing; aircraft are RNP & GBAS capable • Extensive itinerant well equipped piston aircraft • Logical location for itinerant and tenant business jet operations • Interview comment: "KPAE is largest base of general aviation aircraft in WA"
Community & Environment	• Extensive activism regarding proposals to initiate commercial airline service • Noise sensitive areas to south and east and west of airport • RNP arrivals, approaches and departures could provide precision flight paths and be a mitigating factor in community sensitivity to potential airline service
NextGen CNS 10 yr horizon	• Comm: Evaluate benefits of possible Virtual Tower for 24 hour service, and CPDLC & SWIM implementation • Nav: Evaluate potential costs and benefits of RNP approaches and departures to from north and south to mitigate community noise • Surveillance: ADS-B coverage will probably extend to ground; determine if ADS-B Out makes "one-in-one-out" IFR handicap avoidable when tower closed
Business Case Analysis	• Work with regional airports to explore sharing of GBAS implementation costs • Explore FAA, community, and tenant funding sources • Timing: next airport master plan release

S36 - Crest Airpark NextGen Implementation Strategy

Airport Goals & Objectives	• Serve tenants & home owners in a "through-the-fence" residential operation • Work constructively with homeowners association • Acquire a GPS instrument approach • Acquire AWOS and VASI
Airspace Infra-structure	• Location in SEA Class B east in 100/30 altitude restriction area • Operations near but independent of neighbor airports S50 and KRNT
Airport Infra-structure	• Training relationship with Green River College, foreign student flight education • Challenging physical obstructions that do not meet FAA ARC A-I • Obstacle control difficult with tenants & "through-the-fence" environment
Flight Procedures & Minima	• VFR day/night, no instrument approaches or departures • No VASI; homeowner resistance to VASI installation cited as "intrusive" • Interest in GPS approach to circling minima
Tenants & Itinerants	• 114 tenant homeowners "through-the-fence" through calendar year 2025 • Homeowners association has challenging relationship with airport management • 235 airplanes based at airport; 72 hangars; 30 on waiting list; 50 filled tie downs. • Little itinerant traffic
Community & Environment	• Rural area, no known issues regarding aircraft noise
NextGen CNS 10 yr horizon	• Comm: airport would benefit from AWOS due to local WX conditions and distance from nearest ATIS at KRNT • Nav: only potential is GPS which would require considerable funding for airport improvement, improved coordination and relationships between airport management and tenants • Surveillance: ADS-B coverage predicted to 1900 feet MSL/1500 AGL which is 400 ft. above TPA
Business Case Analysis	• Not applicable under current circumstances

PLU - Pierce County - Thun Field NextGen Implementation Strategy

Airport Goals & Objectives	• Support current general aviation operations • Reduce minima on current GPS approach • Explore possible GPS approach to RWY 16 • Explore possibility of LPV to both runway ends
Airspace Infra-structure	• Location in SEA Class B south in 100/40 altitude restriction area • Operations independent of neighbor airports
Airport Infra-structure	• Physical obstructions preclude meeting FAA ARC B-II • Runway and taxiway mods required to meet FAA ARC B-II; in 2014 plan • Determine if ADS-B Out makes "one-in-one-out" IFR handicap avoidable • Evaluate LPV for both runways, avoid "step down & level off" procedure • Well-subscribed restaurant with both ground side and air side business produces itinerant traffic. • Add Jet-A fuel service to broaden FBO customer base • FBO would like 500' runway extension to north
Flight Procedures & Minima	• Current IFR approach: GPS RWY 34 [662/1] • Current IFR departure via SEA VOR radial • Desired IFR approaches: o Reduce WX minima GPS RWY 34 o Explore LPV both runway ends, including displaced thresholds if necessary
Tenants & Itinerants	• General aviation tenants & itinerant traffic
Community & Environment	• Community noise sensitivity
NextGen CNS 10 yr horizon	• Comm: Evaluate benefits of possible Virtual Tower for 24 hour service, and SWIM implementation • Nav: Evaluate potential costs and benefits of LPV approaches; avoid "step down & level off" procedures • Surveillance: determine if ADS-B Out makes "one-in-one-out" IFR handicap avoidable; ADS-B coverage will probably extend to 900 ft.
Business Case Analysis	• Explore FAA, community, and tenant funding sources • Timing: next airport master plan release

AWO - Arlington Municipal NextGen Implementation Strategy

Airport Goals & Objectives	• Support current general aviation and recreational clients and visitors • Acquire RPZ properties to north and south of airport • Extend RWY 16 by about 700 feet to north • RWY 16 GPS LPV instrument approach
Airspace Infra-structure	• Location outside SEA Class B • No interaction with neighbor airports KPAE and KBVS (Skagit Regional) • Determine if ADS-B Out makes "one-in-one-out" IFR handicap avoidable
Airport Infra-structure	• Consider displaced threshold for RWY 16 if necessary to meet GQS and allow LPV approach • Well-subscribed restaurant with both ground side and air side business produces itinerant traffic.
Flight Procedures & Minima	• Current approaches: GPS LPV RWY 34 [200/¾] & NDB RWY 34 • Current departures; specified headings expect vectors • Desired future approach GPS LPV RWY 16
Tenants & Itinerants	• General aviation tenants • Extensive glider operations • Extensive annual itinerant and demonstration activity at Arlington Fly-In
Community & Environment	• Community noise sensitivity in residential area northwest of airport
NextGen CNS 10 yr horizon	• Comm: Evaluate the potential costs and benefits of CPDLC, SWIM, and 24 hr. Remote Tower service • Nav: Evaluate potential costs and benefits of LPV approach to RWY 16 • Surveillance: Assume aircraft compliant with ADS-B Out rules & evaluate potential to eliminate IFR "one-in-one-out"; ADS-B coverage will probably extend down to 900 feet
Business Case Analysis	• Explore FAA, community, and tenant funding sources • Timing: next airport master plan release

TIW - Tacoma Narrows Airport NextGen Implementation Strategy

Airport Goals & Objectives	• Serve general aviation, training and itinerant clients, including business jets • Lengthen runway to accommodate larger jets • Serve the Tacoma/south Seattle area as a business destination
Airspace Infra-structure	• Location in SEA Class B southwest in 100/50 altitude restriction area • Operations independent of neighbor airports
Airport Infra-structure	• Plans to lengthen runway for larger business jets and reduce width for maintenance cost savings • History of restaurant service with both ground side and air side business produces itinerant traffic.
Flight Procedures & Minima	• Current Procedures: o Approaches ILS RWY 17 [200/½]; RNAV GPS LPV RWY 17 [344/1]; RNAV GPS RWY 35 [266/1]; NDB RWY 35 o Departures: heading to OLM and SEA VOR radials
Tenants & Itinerants	• General aviation including jets • Expects to be major destination airport supporting 2015 US Open golf tournament
Community & Environment	• Residential noise sensitivity
NextGen CNS 10 yr Horizon	• Comm: Evaluate benefits of possible Virtual Tower for 24 hour service, and CPDLC & SWIM implementation • Nav: Evaluate potential costs and benefits of RNP approaches and departures to from north and south to mitigate community noise • Surveillance: determine if ADS-B Out makes "one-in-one-out" IFR handicap avoidable when tower is closed; ADS-B coverage will probably extend to 900 ft.
Business Case Analysis	• Explore FAA, community, and tenant funding sources • Timing: next airport master plan release

RNT - Renton Municipal Airport NextGen Implementation Strategy

Airport Goals & Objectives	• Serve Boeing and other airport tenants with improved IFR minima & reduced delay for departures & landings (reference Air Traffic airspace coordination with adjacent facilities) • Serve GA tenant community, including rotorcraft • Reduce community noise
Airspace Infra-structure	• Location in SEA Class B east in 100/30 altitude restriction area • Align procedures with KBFI and S50; consider KSEA • Consider forming an Airspace Infrastructure Committee with membership RNT, BFI, SEA, PAE, S50, FAA/ATC, Boeing Company
Airport Infra-structure	• Determine WX minima & min. delay airspace access to satisfy tenant & itinerant needs • Evaluate Mod to Stds for GQS, RPZ, RWY/TWY separation allowable in exchange for vertical guidance at higher than usual WX minima • Evaluate effect of displaced threshold operations for takeoff and landing • Determine costs of required changes to South and North as trade studies supporting above evaluations • Consider benefits of future Virtual Tower to expand tower service to 24 hours

Flight Procedures & Minima	• Current approaches: GPS LPV RWY 16 [542/1**3/8**] & NDB RWY 16,
	• Current departures; specified headings expect vectors
	• Desired procedures: approaches RNP RWY 16, RNP RWY 34, departures RNP RWYs 16 & 34. Suggested implementation sequence:
	  o Boeing Special RNP RWY 16 Approach & RNP Departure RWY 34 circa 2013; for proprietary company use only
	  o Public RNP RWY 16 Approach & RNP Departure RWY 34 circa 2014
	  o Public RNP RWY 34 Approach & RNP Departure RWY 16 circa 2015

Tenants & Itinerants	• Boeing tenant uses airport for 737 departures, including first flight; aircraft are RNP & GBAS capable; some 737 arrivals occur & expected to increase • Extensive itinerant piston/turboprop aircraft, some jet operations • Enhancing WX minima will accommodate existing business aircraft already based at RNT
Community & Environment	• Dense local populations surround the airport, noise sensitivity localized & vocal • Current VFR flight paths to and from the north are designed to minimize community noise • Current IFR flight paths impinge on the sensitive Mercer Island community • The possibility of RNP procedures to the north will reduce noise by flying a curved path over the lake somewhat overlaying VFR flight paths. Curved IFR RNP procedures from the south will reduce community noise in sensitive areas
NextGen CNS 10 yr Horizon	• Comm: Evaluate the potential costs and benefits of CPDLC, SWIM, and 24 hr. Remote Tower service when current tower closed • Evaluate potential costs and benefits of other RNAV approaches and departures to both runways, pursue RNP initiatives • Surveillance: ADS-B coverage will probably extend to the ground but in any event down to 900 feet
Business Case Analysis	• Balance costs/benefits & explore possible modification to standards to optimize airport & tenant costs, address community noise sensitivity • Explore FAA, community, and tenant funding sources • Timing: urgent need to address Boeing RNP Specials • Timing for other initiatives: next airport master plan release

PWT - Bremerton National NextGen Implementation Strategy

Airport Goals & Objectives	• Serve general aviation, training and itinerant clients, including business jets • Serve Bremerton, Kitsap County, Peninsula area as a business & recreational destination • Respond to community if airline service proposed again
Airspace Infra-structure	• Location outside and west of SEA Class B • Operations independent of neighbor airports
Airport Infra-structure	• Airport would like to enhance IFR approaches to RWY 1 to address a microclimate fog condition occurring in the spring and autumn • Explore LPV RWY 1 to avoid "step down & level off" procedure • Determine if ADS-B Out makes "one-in-one-out" IFR handicap avoidable • Well-subscribed restaurant with both ground side and air side business produces itinerant traffic. • If airline service occurs, may affect airport needs for a tower and possibly enhancing approach and precision departure requirements.
Flight Procedures & Minima	• Current Procedures: o Approaches ILS RWY 19 [204/½]; RNAV GPS LPV RWY 19 [322/½]; RNAV GPS RWY 1 [436/1]; NDB RWY 1 o Departures: direct to NDB reference • Desired Procedures: o GPS LPV RWY 1 with lower minima and eliminate "step down & level off" procedure
Tenants & Itinerants	• General aviation including jets
Community & Environment	• Residential noise sensitivity
NextGen CNS 10 yr Horizon	• Comm: Evaluate the potential costs and benefits of CPDLC, SWIM, and 24 hr. Remote Tower service • Nav: Evaluate potential costs and benefits of LPV RWY 1, avoid "step down & level off" procedure • If airline service initiated, determine if RNP has potential for departure obstacle avoidance; • Surveillance: Assume aircraft compliant with ADS-B Out rules & evaluate potential to eliminate IFR "one-in-one-out"; ADS-B coverage will probably extend to 900 feet
Business Case Analysis	• Explore FAA, community, and tenant funding sources • Timing: next airport master plan release

S43 - Harvey Field NextGen Implementation Strategy

Airport Goals & Objectives	• Serve general aviation tenants • Attain lower WX minima on existing GPS approach • Acquire LPV instrument approach • Acquire AWOS and VASI
Airspace Infra-structure	• Location outside and north of SEA Class B • Operations independent of neighbor airports KPAE and W16 (FirstAir Field) • Determine if ADS-B Out makes "one-in-one-out" IFR handicap avoidable
Airport Infra-structure	• Challenging physical obstructions that do not meet FAA ARC A-I • Airport manager proactive in developing airport capability, low WX access • Airport manager has purchased property to protect airport improvement potential
Flight Procedures & Minima	• Primarily VFR day/night • Current IFR approach: RNAV GPS –A RWY 33R [1220/1¼] • Interest in reducing GPS approach minima • Interest in eventual LPV to higher than usual minima
Tenants & Itinerants	• General aviation tenants • Some itinerant traffic
Community & Environment	• Rural area, no known issues regarding aircraft noise
NextGen CNS 10 yr Horizon	• Comm: airport would benefit from AWOS due to local WX conditions and distance from nearest ATIS at KPAE • Nav: Possible GPS LPV which would require considerable funding for airport improvement • Surveillance: Assume aircraft compliant with ADS-B Out rules & evaluate potential to eliminate IFR "one-in-one-out"; ADS-B coverage will probably extend down to 900 feet
Business Case Analysis	• Explore FAA, community, and tenant funding sources • Timing: next airport master plan release

W55 – Kenmore Air Harbor (Lake Union) NextGen Implementation Strategy

Airport Goals & Objectives	• Serve downtown Seattle with reliable seaplane service to San Juan Islands & Victoria BC • Accommodate intensive downtown Seattle development while addressing community noise sensitivity
Airspace Infra-structure	• Location in SEA Class B north in 100/30 altitude restriction area
Airport Infra-structure	• Continue to interact with community and FAA as regards high rise construction projects at Lake Union
Flight Procedures & Minima	• Current approaches and departures: VFR
Tenants & Itinerants	• Dominant tenant is Kenmore Air, seaplane fleet is currently not IFR capable • There is little or no potential in applying IFR to seaplane operations • Lake Union has extensive watercraft operations, particularly summer recreation
Community & Environment	• Extensive commercial high rise development to the south of the lake • Extensive noise sensitive residential & commercial development around lake • Traveling/tourist community prize unique seaplane service to Islands & Canada
NextGen CNS 10 yr horizon	• Comm: Evaluate potential costs & benefits of SWIM • Nav: No potential application of NextGen Technologies • ADS-B coverage will probably extend to the ground but in any event down to 900 feet
Business Case Analysis	• No business case for NextGen Nav applications • ADS-B equipage will be required in 2020 • Evaluate commercial attractiveness and business model for NextGen SWIM communications applications as they become available

S60 – Kenmore Air Harbor (Lake Washington) NextGen Implementation Strategy

Airport Goals & Objectives	• Serve South Snohomish County and North King County with reliable seaplane service to San Juan Islands & Victoria BC
Airspace Infra-structure	• Location in SEA Class B north in 100/30 altitude restriction area
Airport Infra-structure	• North Lake Washington suburban area with maintenance and training activity
Flight Procedures & Minima	• Current approaches and departures: VFR
Tenants & Itinerants	• Dominant tenant is Kenmore Air, seaplane fleet is currently not IFR capable • There is little or no potential in applying IFR to seaplane operations • Lake Washington has extensive watercraft operations, particularly summer recreation
Community & Environment	• Extensive noise sensitive residential & commercial development around lake • Traveling/tourist community prize unique seaplane service to Islands & Canada
NextGen CNS 10 yr horizon	• Comm: Evaluate potential costs & benefits of SWIM • Nav: No potential application of NextGen Technologies • ADS-B coverage will probably extend to the ground but in any event down to 900 feet
Business Case Analysis	• No business case for NextGen Nav applications • ADS-B equipage will be required in 2020 • Evaluate commercial attractiveness and business model for NextGen SWIM communications applications as they become available

W16 – FirstAir Field NextGen Implementation Strategy

Airport Goals & Objectives	• Serve general aviation tenants
Airspace Infra-structure	• Location outside SEA Class B • No interference or interaction with neighbor airports KPAE and S43 (Harvey Field)
Airport Infra-structure	• Challenging physical obstructions that do not meet FAA ARC A-I
Flight Procedures & Minima	• VFR day, no instrument approaches or departures • No VASI; no AWOS
Tenants & Itinerants	• Some general aviation aircraft • Some visitor activities, located walking distance to Monroe Fairground
Community & Environment	• Rural area, no known issues regarding aircraft noise • Approach over Monroe Fairground challenging and produces obtrusive noise
NextGen CNS 10 yr Horizon	• No logical NextGen applications
Business Case Analysis	• Not applicable under current circumstances

NextGen Acronyms

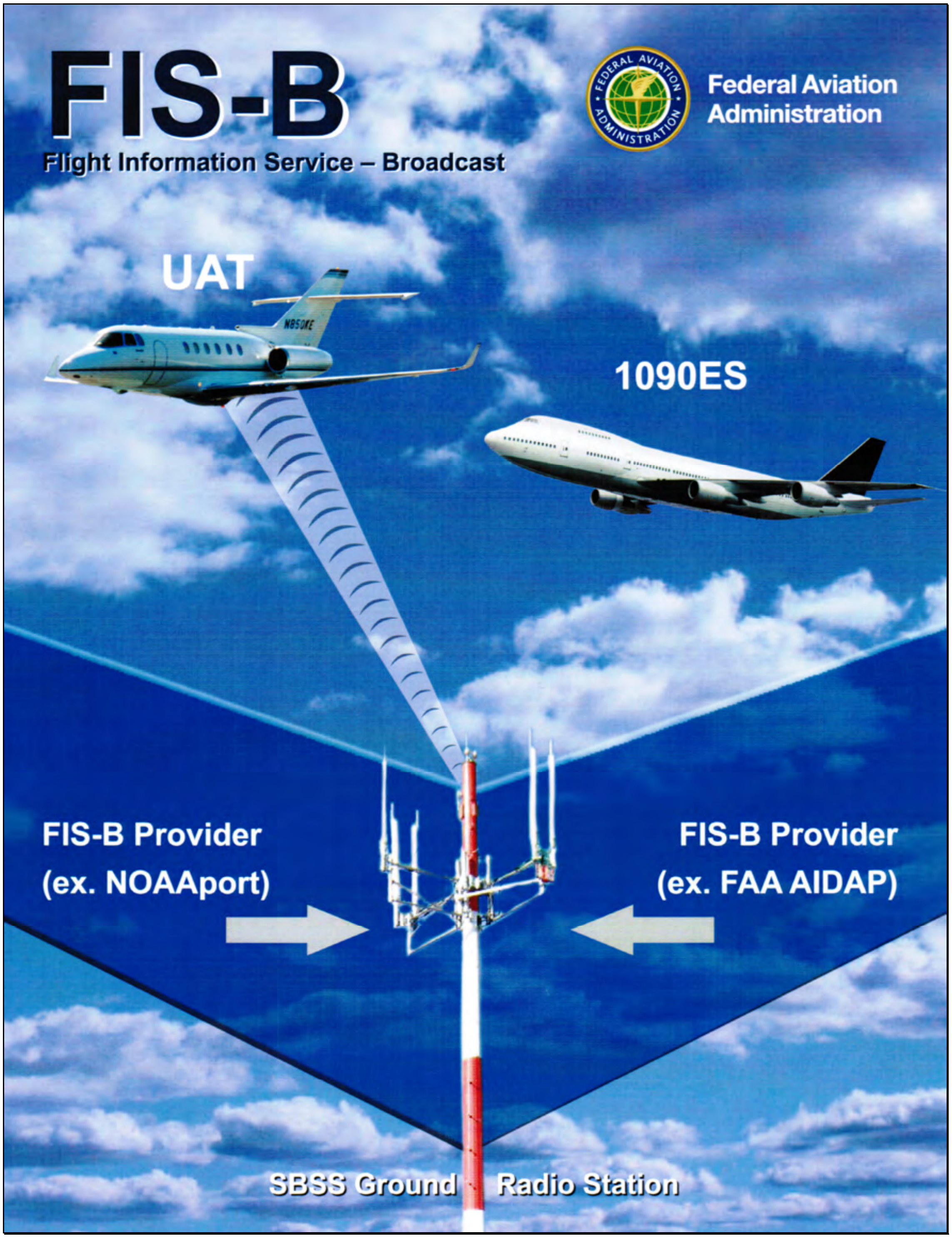
2D	Two-Dimensional
3D	Three-Dimensional
4D	Four-Dimensional
AC	Advisory Circular
ACM	Adjacent Center Metering
A/DMT	Arrival/Departure Management Tool
ADS-B	Automatic Dependent Surveillance–Broadcast
ADS-C	Automatic Dependent Surveillance–Contract
AEDT	Aviation Environmental Design Tool
AeroMACS	Aeronautical Mobile Airport Communications System
AIM	Aeronautical Information Management
AIP	Airport Improvement Program
AIRE	Atlantic Interoperability Initiative to Reduce Emissions
AMS	Acquisition Management System
ANSP	Air Navigation Service Provider
AOC	Airline Operations Center
APMT	Aviation Portfolio Management Tool
AR	Authorization Required
ARC	Aviation Rulemaking Committee
ARTCC	Air Route Traffic Control Center
ASAP	Aviation Safety Action Program
ASBU	Aviation System Block Upgrades
ASDE-X	Airport Surface Detection Equipment–Model X
ASDI	Aircraft Simulation Display to Industry
ASIAS	Aviation Safety Information Analysis and Sharing
ASPIRE	Asia and Pacific Initiative to Reduce Emissions
ASSC	Airport Surface Surveillance Capability
ATC	Air Traffic Control
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATO	Air Traffic Organization
ATPA	Automated Terminal Proximity Alert
ATSAP	Air Traffic Aviation Safety Action Program
CARTS	Common Automated Radar Terminal System
CAT	Category
CATM	Collaborative Air Traffic Management
CATMT	Collaborative Air Traffic Management Technologies
CDM	Collaborative Decision Making
CDP	Climb/Descent Procedure
CDQM	Collaborative Departure Queue Management
CDTI	Cockpit Display of Traffic Information
CHI	Computer Human Interface
CIX	Collaborative Information Exchange
CLEEN	Continuous Lower Energy, Emissions and Noise
CO2	Carbon Dioxide
CRDA	Converging Runway Display Aid
CSPO	Closely Spaced Parallel Operations

CSSD	Common Status and Structure Data
Data Comm	Data Communications
DCIS	Data Comm Integrated Services
DCL	Departure Clearance
DEMO	Demonstration
DDU	Data Distribution Unit
DME	Distance Measuring Equipment
DoD	Department of Defense
EDX	Enhanced Data Exchange
EFVS	Enhanced Flight Vision System
EMS	Environmental Management System
ERAM	En Route Automation Modernization
EVS	Enhanced Vision System
FAA	Federal Aviation Administration
FAC	System Networked Facilities
FACT	Future Airport Capacity Task
FANS	Future Air Navigation System
FBTM	Flow Based Trajectory Management
FBWTG	FAA Bulk Weather Telecommunications Gateway
FIS-B	Flight Information Services–Broadcast
FLEX	Flexibility in the Terminal Environment
FMC	Flight Management Computer
FMS	Flight Management System
FOC	Flight Operations Center
FOQA	Flight Operational Quality Assurance
FRL	Fuel Readiness Level
FY	Fiscal Year
GA	General Aviation
GBAS	Ground Based Augmentation System
GIS	Geographic Information System
GLS	Ground Based Landing System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HD	High Density Airports
HITL	Human-in-the-Loop
HRJ	Hydrotreated Renewable Jet
HUD	Head-Up Display
IARD	Investment Analysis Readiness Decision
ICAO	International Civil Aviation Organization
IDAC	Integrated Departure/Arrival Capability
IFP	Instrument Flight Procedure
ILS	Instrument Landing System
ITP	In-Trail Procedure
JPDO	Joint Planning and Development Office
JRC	Joint Resources Council
KPI	Key Performance Indicator
LED	Light-Emitting Diode
LNAV	Lateral Navigation
LPV	Localizer Performance with Vertical Guidance
MALSR	Medium-Intensity Approach Lighting System with Runway Alignment Indicator
MLAT	Multilateration
MSP	Multi-Sector Planning
NAC	NextGen Advisory Committee
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NAVAID	Navigation Aid

NCR	NAS Common Reference
NEPA	National Environmental Policy Act
NextGen	Next Generation Air Transportation System
NIEC	NextGen Integration and Evaluation Capability
NM	Nautical Mile
NNEW	NextGen Network Enabled Weather
NOTAM	Notice to Airmen
NPRM	Notice of Proposed Rulemaking
NVS	NAS Voice System
NWP	NextGen Weather Processor
OAPM	Optimization of Airspace and Procedures in the Metroplex
OCEAN21	Oceanic Automation System
OEP	Operational Evolution Partnership
OGC	Open Geospatial Consortium
OI	Operational Improvement
OPD	Optimized Profile Descent
PAPI	Precision Approach Path Indicator
PBN	Performance Based Navigation
RARM	Risk Assessment and Risk Management
RF	Radius-to-Fix
RFI	Radio Frequency Interference
RNAV	Area Navigation
RNP	Required Navigation Performance
ROTG	RNAV off the Ground
RPI	Relative Position Indicator
RTA	Required Time of Arrival
RTT	Research Transition Team
RVR	Runway Visual Range
RVSM	Reduced Vertical Separation Minimum
RWI	Reduced Weather Impact
SA	Special Authorization
SAA	Special Activity Airspace
SAS	Safety Analysis System
SATNAV	Satellite Navigation
SBAS	Satellite Based Augmentation System
SID	Standard Instrument Departure
SITS	Security Integrated Tool Set
SMS	Safety Management System
SNT	Staffed NextGen Towers
SRM	Safety Risk Management
SRMD	Safety Risk Management Document
SSA	System Safety Assessment
SSE	Safety, Security and Environment
STAR	Standard Terminal Arrival Route
STARS	Standard Terminal Automation Replacement System
STBO	Surface Trajectory Based Operations
SUA	Special Use Airspace
SURF IA Alerts	Surface Indications and
SVS	Synthetic Vision System
SWIM	System Wide Information Management
TA	Tailored Arrival
TBD	To Be Determined
TBO	Trajectory Based Operations
TBFM	Time Based Flow Management
TCAS	Traffic Alert and Collision Avoidance System
TFDM	Terminal Flight Data Manager
TFM	Traffic Flow Management
TFMS	Traffic Flow Management System
TIS-B	Traffic Information Services–Broadcast

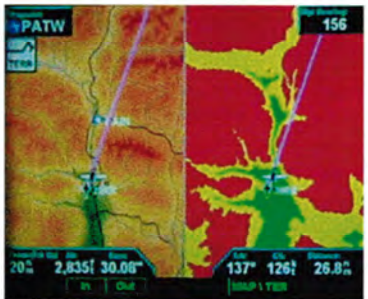
TMA	Traffic Management Advisor
TMI	Traffic Management Initiative
TOAC	Time of Arrival Control
TRACON	Terminal Radar Approach Control
TRL	Technical Readiness Level
TSO	Technical Standard Order
UAS	Unmanned Aircraft System
UAT	Universal Access Transceiver
UFPF	United Flight Planning and Filing
VDL	VHF Digital Link
VHF	Very High Frequency
VMC	Visual Metrological Conditions
VNAV	Vertical Navigation
WAAS	Wide Area Augmentation System
WAM	Wide Area Multilateration
WINS	Weather Information Network Services
WTMA	Wake Turbulence Mitigation for Arrivals
WTMA-P	Wake Turbulence Mitigation for Arrivals–Procedures
WTMD	Wake Turbulence Mitigation for Departures

FIS-B


FIS-B
Flight Information Service – Broadcast
Federal Aviation Administration
UAT
1090ES
FIS-B Provider
(ex. NOAAport)
FIS-B Provider
(ex. FAA AIDAP)
SBSS Ground Radio Station

FIS-B Service

Flight Information Service – Broadcast (FIS-B) service provides meteorological and aeronautical data to the cockpit. The SBSS control station ingests weather and aeronautical data and broadcasts generated sets of products specific to the location of a radio station. These products are broadcast only over the UAT link, so pilots have timely information of national and regional weather and aviation system changes that might impact flight.

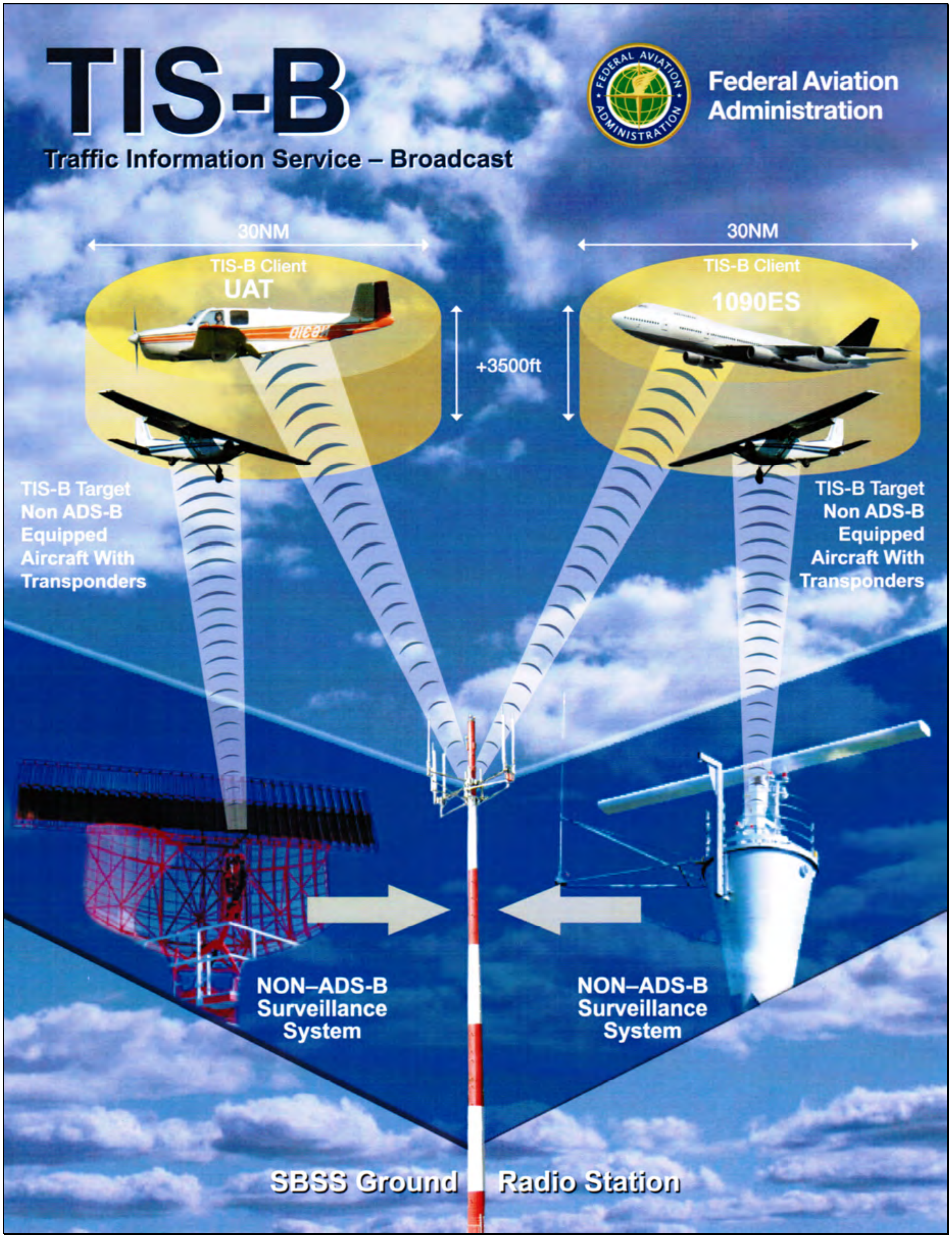


FIS-B Display

FIS-B Products

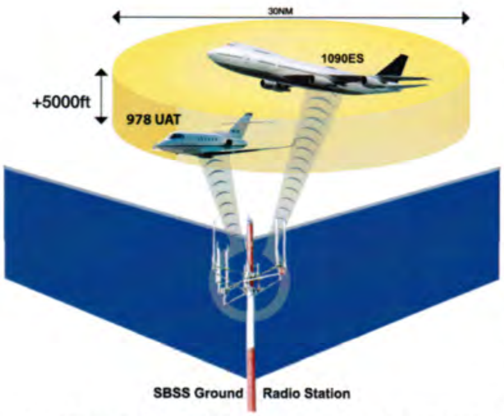
- Aviation Routine Weather Reports (METARs)
- Non-Routine Aviation Weather Reports (SPECIs)
- Terminal Area Forecasts (TAFs) and their amendments
- NEXRAD (regional and CONUS) precipitation maps
- Notice to Airmen (NOTAM) Distant and Flight Data Center
- Airmen's Meteorological Conditions (AIRMET)
- Significant Meteorological Conditions (SIGMET) and Convective SIGMET
- Status of Special Use Airspace (SUA)
- Temporary Flight Restrictions (TFRs)
- Winds and Temperatures Aloft
- Pilot Reports (PIREPS)

TIS-B


TIS-B
Traffic Information Service – Broadcast
Federal Aviation Administration
30NM
30NM
TIS-B Client
UAT
TIS-B Client
1090ES
+3500ft
TIS-B Target
Non ADS-B
Equipped
Aircraft With
Transponders
TIS-B Target
Non ADS-B
Equipped
Aircraft With
Transponders
NON–ADS-B
Surveillance
System
NON–ADS-B
Surveillance
System
SBSS Ground
Radio Station

ADS-R / TIS-B Service

ADS-R Automatic Dependent Surveillance - ReBroadcast



Cross-Linking ADS-B data for Aircraft Situational Awareness

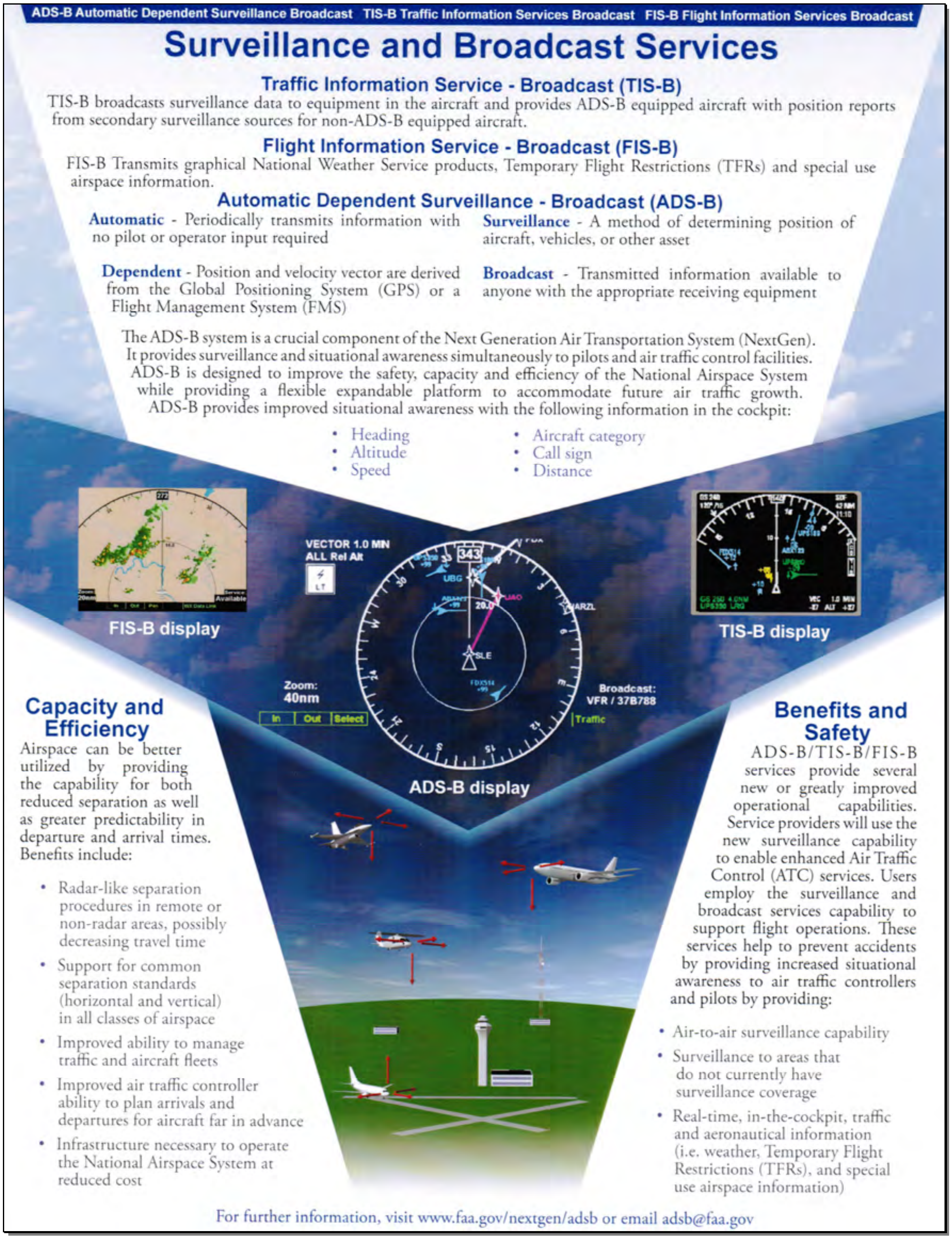
In the national airspace, there are two applicable ADS-B link technologies: 1090 Extended Squitter (1090ES) and a newer technology, Universal Access Transceiver (UAT). ADS-R is a pilot advisory service that receives data from aircraft on one link and immediately rebroadcasts it on the other link. To conserve spectrum, the service identifies aircraft broadcasting that they are ADS-B-In equipped as "client" aircraft. The traffic broadcasting on the other link within a specified radius and altitude band around each client aircraft are then rebroadcast on the client's link via ADS-R. Note that ADS-R services are only available when both aircraft are within range of any ground radio station. Since ADS-B ground stations are sited to cover current radar airspace, this means that there will be regions of airspace (typically at lower altitudes) without ADS-R coverage. Various avionics manufacturers are considering the market opportunities for ADS-B avionics with dual-link receive capability.

Traffic Information Service – Broadcast (TIS-B) is a service provided by the Surveillance and Broadcast Services System (SBSS) that provides active ADS-B users with position reports for non-ADS-B equipped aircraft that have transponders. TIS-B is a pilot advisory service for situation awareness, gathering data from U.S. ATC radars, Wide Area Multilateration (WAM) systems such as those used in Alaska / Colorado, and surface multilateration systems like ASDE-X. This non-ADS-B surveillance information is broadcast as a TIS-B service through ground radio stations to participating aircraft on both links. Like ADS-R, appropriately equipped aircraft are identified as client aircraft and non-ADS-B traffic within a specified radius and altitude band around the client aircraft are selected for TIS-B.

An aircraft or vehicle that is an active ADS-B user and is receiving TIS-B service is known as a TIS-B Client. A non-ADS-B equipped aircraft or vehicle that has its position transmitted in TIS-B reports is known as a TIS-B Target.

TIS-B Display

Surveillance & Broadcast Services


ADS-B Automatic Dependent Surveillance Broadcast   TIS-B Traffic Information Services Broadcast   FIS-B Flight Information Services Broadcast
Surveillance and Broadcast Services
Traffic Information Service - Broadcast (TIS-B)
TIS-B broadcasts surveillance data to equipment in the aircraft and provides ADS-B equipped aircraft with position reports from secondary surveillance sources for non-ADS-B equipped aircraft.
Flight Information Service - Broadcast (FIS-B)
FIS-B Transmits graphical National Weather Service products, Temporary Flight Restrictions (TFRs) and special use airspace information.
Automatic Dependent Surveillance - Broadcast (ADS-B)
Automatic - Periodically transmits information with no pilot or operator input required
Surveillance - A method of determining position of aircraft, vehicles, or other asset
Dependent - Position and velocity vector are derived from the Global Positioning System (GPS) or a Flight Management System (FMS)
Broadcast - Transmitted information available to anyone with the appropriate receiving equipment
The ADS-B system is a crucial component of the Next Generation Air Transportation System (NextGen). It provides surveillance and situational awareness simultaneously to pilots and air traffic control facilities. ADS-B is designed to improve the safety, capacity and efficiency of the National Airspace System while providing a flexible expandable platform to accommodate future air traffic growth. ADS-B provides improved situational awareness with the following information in the cockpit:
• Heading
• Altitude
• Speed
• Aircraft category
• Call sign
• Distance
FIS-B display
VECTOR 1.0 MIN
ALL Rel Alt
Zoom: 40nm
In Out Select
Broadcast: VFR / 37B788
Traffic
ADS-B display
TIS-B display
Capacity and Efficiency
Airspace can be better utilized by providing the capability for both reduced separation as well as greater predictability in departure and arrival times. Benefits include:
• Radar-like separation procedures in remote or non-radar areas, possibly decreasing travel time
• Support for common separation standards (horizontal and vertical) in all classes of airspace
• Improved ability to manage traffic and aircraft fleets
• Improved air traffic controller ability to plan arrivals and departures for aircraft far in advance
• Infrastructure necessary to operate the National Airspace System at reduced cost
Benefits and Safety
ADS-B/TIS-B/FIS-B services provide several new or greatly improved operational capabilities. Service providers will use the new surveillance capability to enable enhanced Air Traffic Control (ATC) services. Users employ the surveillance and broadcast services capability to support flight operations. These services help to prevent accidents by providing increased situational awareness to air traffic controllers and pilots by providing:
• Air-to-air surveillance capability
• Surveillance to areas that do not currently have surveillance coverage
• Real-time, in-the-cockpit, traffic and aeronautical information (i.e. weather, Temporary Flight Restrictions (TFRs), and special use airspace information)
For further information, visit www.faa.gov/nextgen/adsb or email adsb@faa.gov