PUGET SOUND AIR TRANSPORTATION COMMITTEE

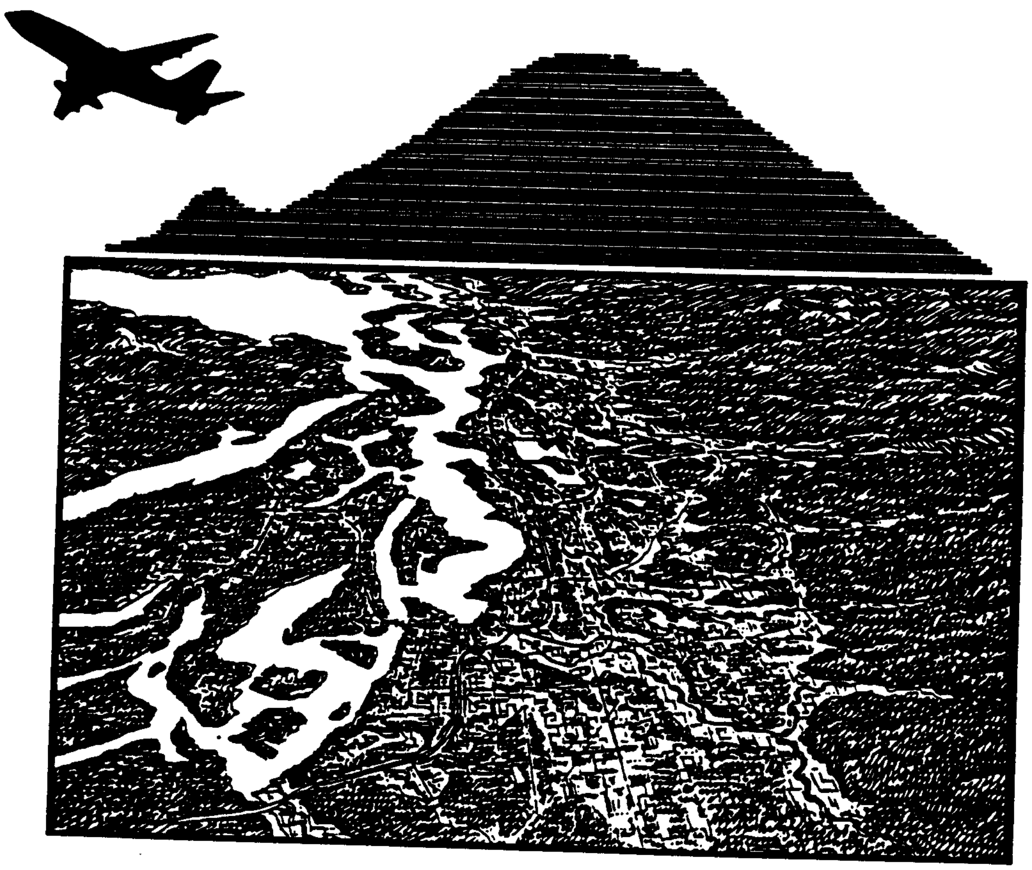
THE FLIGHT PLAN PROJECT

DRAFT FINAL REPORT

and

TECHNICAL APPENDICES

(INCLUDING DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT)



PUGET SOUND REGIONAL COUNCIL
PORT OF SEATTLE

JANUARY 1992

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ABSTRACT

REPORT TITLE:	Flight Plan Project Draft Final Report and Technical Appendices (including Draft Programmatic Environmental Impact Statement)
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FOREWORD

The Flight Plan Project is a forward-looking effort that addresses one of many growth-related issues vitally important to our region, as well as to the entire State of Washington. To ignore the role that an efficient air transportation system plays in the quality of life we now enjoy and want for the future would be irresponsible. To not recognize or attempt to minimize the social and environmental costs of maintaining such a system would also be irresponsible. At the same time, the solution that is chosen must be cost-effective and technically feasible to assure it is implemented. These are the issues and value-laden trade-offs that made the Flight Plan Project so challenging.

It is often difficult to maintain perspective when addressing an issue like air tansportation system capacity a decade before it reaches crisis proportion. However, ten years is the lead time required to decide what needs to be done and then to do it. As this document is reviewed, the region-shaping influence of the recommendations should be kept in mind. No other region in the country is as dependent on high-tech manufacturing and international trade as is the Puget Sound. The role of efficient air transportation which is convenient to our primary market areas cannot be over-emphasized when considering ecomomic benefits like the retention and creation of jobs. The ability to effectively mitigate related environmental costs is also an integral component of a healthy regional economic framework.

The people of the Puget Sound Region are recognized for our vision and innovative approaches to decision-making and problem solving. This vision, however, has always been tempered by a firm understanding of the most practical and feasible solutions available. We are also influenced by a real respect for the natural environment and appreciation of the unique and physically constrained geographical region which we inhabit. The draft Flight Plan recommendation which is described in the following text and supported by extensive technical and environmental analysis provides a balanced solution that is sensitive to a wide range of competing objectives.

The draft Flight Plan recommendation is based on a great deal of thoughtful consideration. This Draft Final Report includes a programmatic Environmental Impact Statement, which is used to assess a range of alternatives at the system planning level. This level of analysis is the first step of a multi-phased process and will be followed by more detailed analysis for each specific component of the approved system plan. Your review and comment on this document initiates a process that is very important to the future of our region. Your active participation is and will continue to be highly valued.

PUGET SOUND
AIR TRANSPORTATION
COMMITTEE

MESSAGE FROM THE CHAIR

January 7, 1992

Dear Citizen of the Puget Sound Region,

Quality air service for passengers and shippers is a prime component of both the economic vitality and quality of life we enjoy in this region. As a matter of fact, efficient and convenient commercial air service is vital to the State of Washington and the entire Pacific Northwest. As you may have heard from news reports over the last few months, our region's only commercial service airport, Seattle-Tacoma International, is quickly nearing its runway capacity.

The population growth in our region along with the increasing attractiveness of air travel means that within the next decade, Sea-Tac will be saturated in terms of the number of take-offs and landings it can handle. While the quality of air service at Sea-Tac is still quite good, without action, growing numbers of flights will lead to increased delays for travelers and shippers and a decline in our region's ability to remain a key player in domestic and international trade.

During the last two years, I have had the privilege of working with a wide range of people on the Puget Sound Air Transportation Committee (PSATC). The PSATC is comprised of citizens, environmental interests, local and state elected officials, and representatives of the airlines and the business community who were assembled to recommend a plan for the long term air carrier needs of our region. Members represented the Central Puget Sound Region Counties of King, Kitsap, Pierce, Snohomish, and Thurston. The PSATC was co-sponsored by the Puget Sound Regional Council (the region's transportation planning agency) and the Port of Seattle (operator of Sea-Tac). The study conducted by the PSATC was called the Flight Plan Project.

The PSATC began the Flight Plan Project in late 1989. Since then, forecasts of future air traffic growth were prepared and alternatives studied for meeting air travel demand through the year 2020 and beyond. Numerous experts and several consultants assisted the PSATC in collecting technical data and provided advice on how to seek a solution. After looking at a variety of system alternatives and site options and after much indepth analysis, the PSATC formulated its draft final recommendations.

The purpose of the Flight Plan Draft Final Report is to present the PSATC's draft final recommendations and to summarize the process used to develop them. Included are a set of Appendices which deal with the operational/technical, economic/financial, institutional, and environmental issues which were examined in detail in order to arrive at the draft recommendations. The Appendices are comprised of the working papers prepared by the consultants and staff during the the third phase of the project. The complete Draft Programmatic Environmental Impact Statement (DEIS) prepared as part of the study is Appendix E.

Before the recommendations are finalized, the PSATC will gather further input from interested citizens and agencies during January and February. Taking into consideration the feedback received, final recommendations will be prepared and presented for adoption and action to the governing bodies of the Puget Sound Regional Council and the Port of Seattle. It will then be up to these and other agencies to conduct further studies and to implement the recommendations.

I would like to take this opportunity to thank all of the citizens who have been involved in the Flight Plan Project and who have shared your ideas and concerns with the PSATC over the last two years. I encourage you to remain involved in this important process during the next few months and I look forward to working with you in the future.

Sincerely yours,

Robert Wallace, Chair
Puget Sound Air Transportation Committee

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DRAFT RECOMMENDATIONS

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DRAFT RECOMMENDATIONS

Introduction

After a year-and-a-half of work, at the completion of Phase II of the Flight Plan Project, the Puget Sound Air Transportation Committee (PSATC) developed a list of system alternatives and site options which were recommended for further analysis during Phase III of the Project. These alternatives and options represented a short list of the potential solutions for meeting the Puget Sound Region's air capacity needs to the year 2020 and beyond.

In Phase III, the PSATC conducted an indepth analysis of the system alternatives and site options recommended for further analysis. Data were collected for the alternatives and site options in terms of operational/technical, economic/financial, and environmental elements. Institutional factors were also examined to make sure that the alternatives could actually be implemented and to assist in the development of an action plan. At its December 4th, 1991 meeting, the PSATC used the collected information to first eliminate those alternatives and site options it considered to be unfeasible and then to develop a preferred alternative for the Puget Sound Region's future air transportation system. A list of secondary alternatives was also developed. The purpose of the secondary alternatives was to provide a set of potentially feasible solutions which could be compared with the preferred alternative in the Draft Programmatic Environmental Impact Statement.

Unfeasible Alternatives

Following is the list of alternatives which the PSATC determined would not be adequate to meet our region's future air transportation needs:

* Do Nothing and allow the region's population to grow without adequate air service

* Implement demand management at Sea-Tac and do nothing else to expand air capacity

* Force people to travel to international airports at Portland or Vancouver, B.C. with or without heavy-rail service

* Close Sea-Tac and replace it with a new international airport or regional airports

The first three alternatives listed above were deemed to be unfeasible because it was found that they would not be able to meet our region's projected demand for air travel out to the year 2020 and beyond. The last alternative above was considered unfeasible because it was found to be prohibitively expensive and to cause severe environmental impacts.

Preferred Alternative

The preferred alternative is a ed multiple airport system which calls for scheduled airline service at Paine Field in Snohomish (nty and a new dependent runway at Seattle-Tacoma International Airport. Both of these actio ould be taken concurrently and would be in place by the year 2000. It was also recommended th ite for a third commercial service airport be master planned and preserved in the southern por on of the Puget Sound Region. The third airport would be implemented sometime after the year 2010 either at McChord Air Force Base or at a new site on Fort Lewis if coordination with the military could be achieved. If military coordination is not possible, then the third airport would either be implemented in the Loveland area of Pierce County or in the Olympia/Black Lake area of Thurston County. Schematic layouts of Sea-Tac with a new dependent runway and of Paine Field can be found in Figures 1 and 2 respectively. The locations of the recommended supplemental airport sites in the south part of the region can be found in Figure 3.

The preferred alternative was chosen due to its ability to fulfill several key evaluation criteria which were based on the PSATC's Vision Statement. A list of the considerations used in choosing the preferred alternative follows:

Environmental Quality and Livability

* By the year 2000, virtually all aircraft using Sea-Tac will be classified as Stage III (the quietest type) and the number of people impacted by noise will be reduced by nearly ninety percent, even with the addition of a dependent runway.

* Airport locations within the growing urban area of the region, as opposed to in undeveloped rural areas, help to preserve open space and limit urban sprawl.

* A multiple airport system helps minimize air pollution by reducing the amount of ground travel required to reach an airport. Also, since aircraft delay is lessened with a multiple airport system, aircraft are not required to idle as long and air emissions are further reduced.

Regional Economic Vitality

* A multiple airport system strengthens the region's ability to compete for business both domestically and internationally by providing additional air capacity as it is needed.

* A multiple airport system distributes the economic benefits and the environmental costs of airport facilities throughout the region.

FIGURE 1

Sea-Tac with New Dependent* Runway

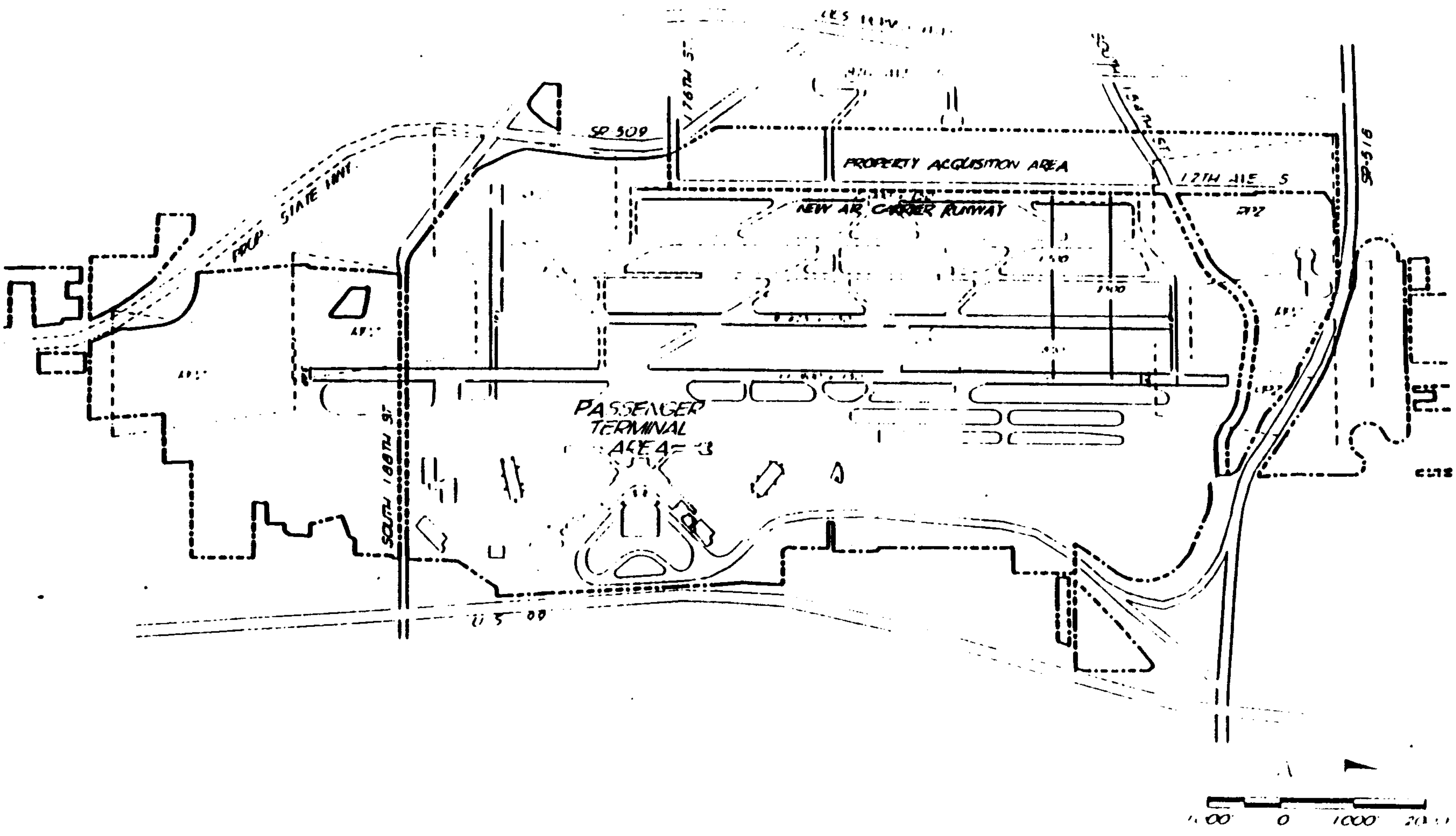


FIGURE 2

Paine Field with Existing Airfield

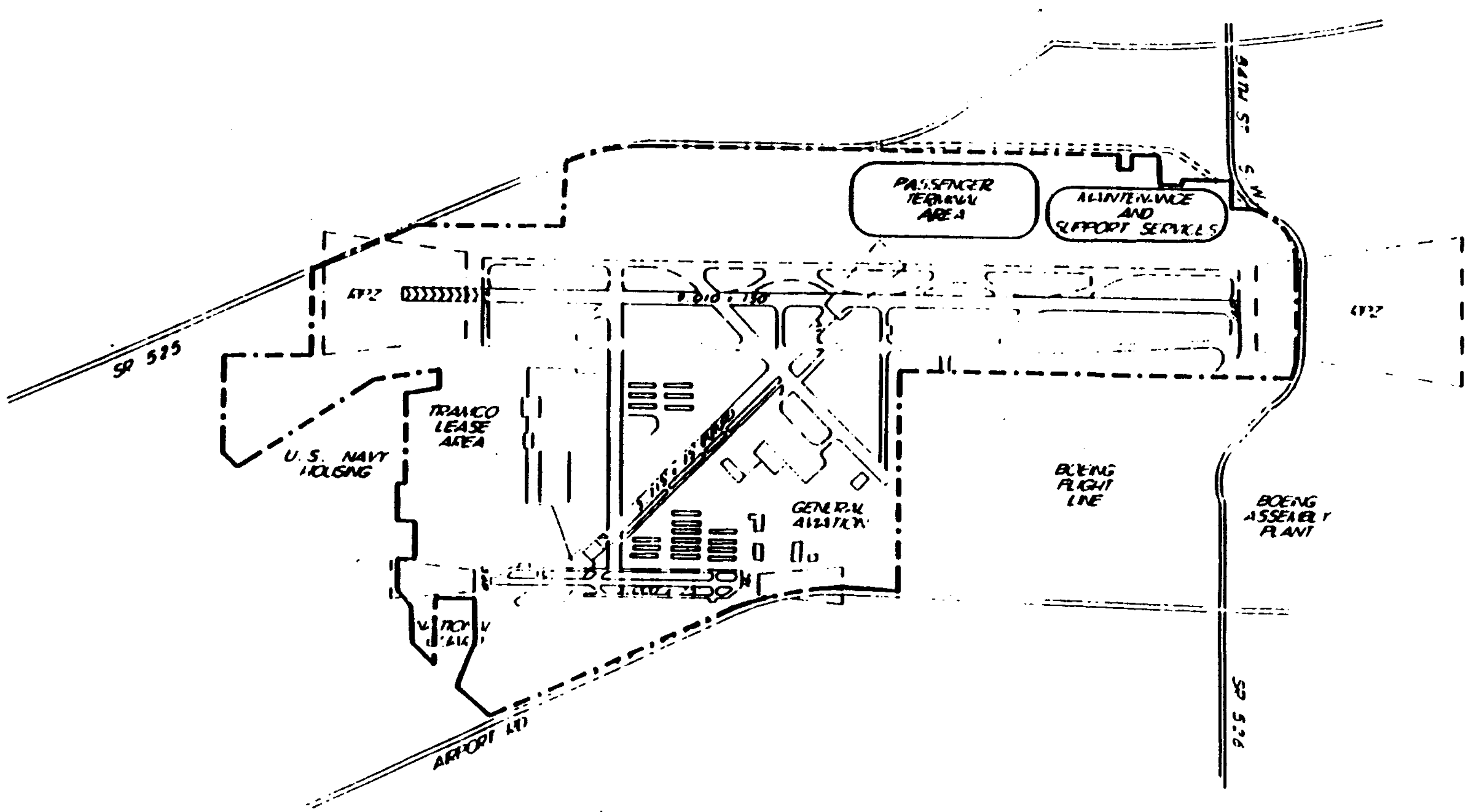
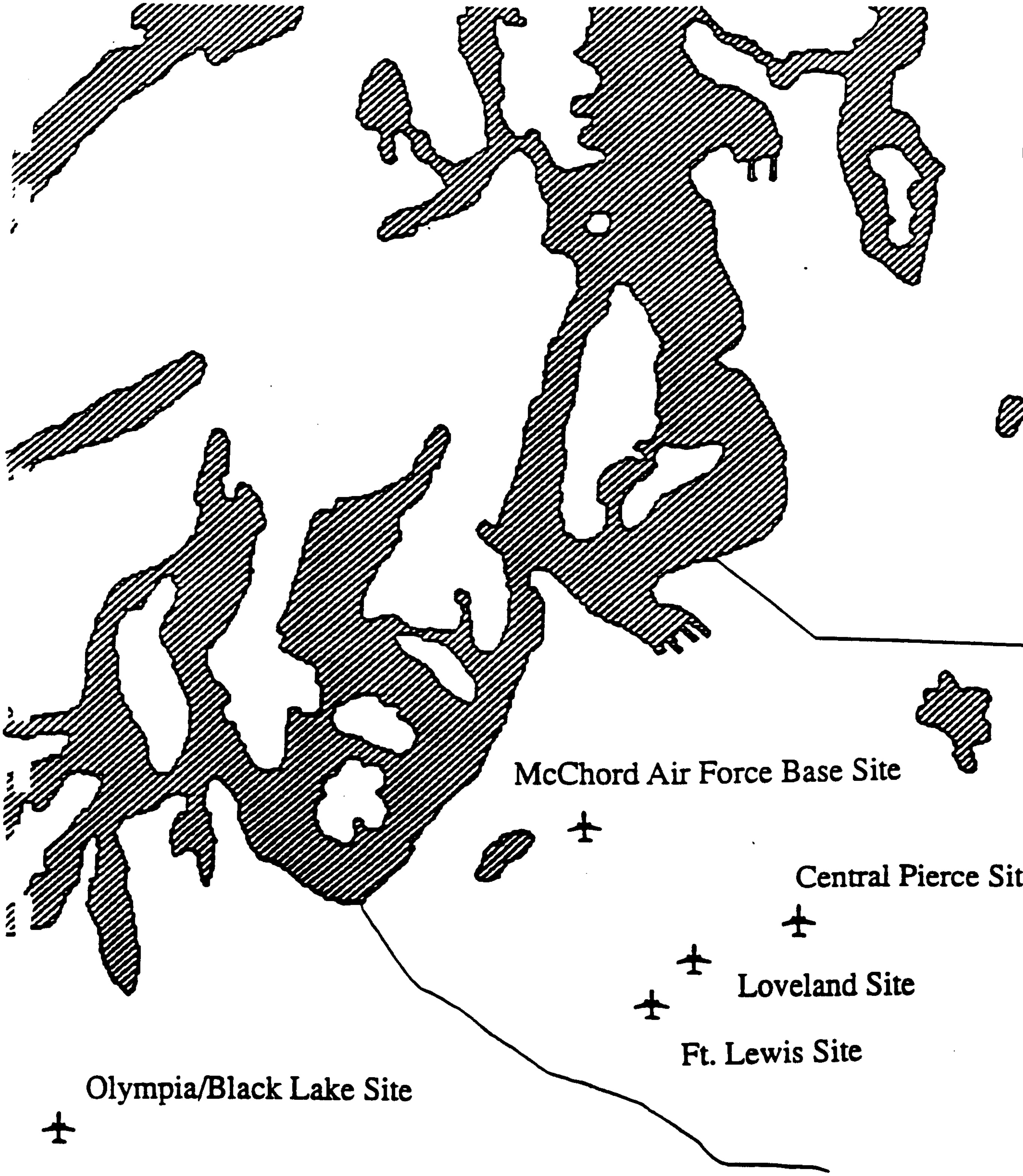


FIGURE 3

South Puget Sound Region Airport Sites



* By using existing facilities to the greatest feasible extent, the preferred alternative minimizes construction costs and lessens the possible need for tax subsidies.

Integrated Transportation System

* The existing airports and potential airport sites of the preferred alternative are in close proximity to harbors, rail lines, and the state and Interstate Highway network.

* Both Paine Field and Sea-Tac are currently being considered as stops on the region's proposed light rail transit system.

Secondary Alternatives

Alternatives in this category represent secondary solutions to our region's long term air travel needs that the PSATC found less-desirable than the preferred alternative. Each of the secondary alternatives is a variation of a multiple airport system. The list of secondary alternatives is as follows:

Alternatives without Paine Field:

* Sea-Tac with a new dependent runway and a supplemental airport at the Arlington Airport site in Snohomish County with two air carrier runways

* Sea-Tac with a new dependent runway and a supplemental airport at the Central Pierce County site with two air carrier runways

Alternative without a new dependent runway at Sea-Tac:

* Sea-Tac without a new runway and supplemental airports at Paine Field and the Central Pierce site each with one air carrier runway

Alternatives without a new dependent runway at Sea-Tac and without Paine Field:

* Sea-Tac without a new runway and a supplemental airport at the Arlington Airport site with two air carrier runways

* Sea-Tac without a new runway and supplemental airports at the Arlington Airport site and the Central Pierce site each with one air carrier runway

* Sea-Tac without a new runway and supplemental airports at the Arlington Airport and Olympia/Black Lake sites each with one air carrier runway

Finalization of Draft Recommendations

During late January and early February of 1992, eight public hearings will be held throughout the region in King, Snohomish, Pierce, Thurston, and Kitsap Counties. The purpose of the hearings is to gain citizens' and interested agencies' comments on the draft recommendations and on the Draft Programmatic Environmental Impact Statement. After considering comments received at the hearings and in writing, the PSATC will develop in March its final recommendations for the region's future air transportation system. The final recommendations will then be presented to the Puget Sound Regional Council and to the Port of Seattle for adoption and further action. These actions will include amendments to Port of Seattle and Puget Sound Regional Council plans and will call for updates to local and regional plans. Other actions necessary to implement the Final Recommendations may also be needed. An explicit action plan will be developed as part of the Final Recommendations.

Impacts and Mitigation Summary

The Draft Programmatic Environmental Impact Statement for the Flight Plan Project is found in Appendix E. Listed here for ease of reference is a summary of the environmental impacts and possible mitigation measures for the preferred and secondary alternatives. The environmental impacts summary is Figure 4 and the list of possible mitigation measures is Figure 5.

Environmental issues were one of the primary concerns addressed during the Flight Plan Project. In addition, three other categories of issues were studied. These were: operational/technical elements, economic/financial elements, and institutional elements. A summary of the data for the operational/technical and economic/financial elements can be found in Figure 9 later in the report. A discussion of institutional concerns can be found in Working Paper #10 in Appendix D.

FIGURE 4

Environmental Impacts Summary

Impacts Summary by Preferred and Secondary Alternatives							
Alternative	**Noise**	**Transportation**	**Air Quality**	**Plants & Animals**	**Earth**	**Land Use**	**Public Services & Utilities**
Preferred Alternative: Sea-Tac with Dependent Runway; Paine Field; plan for southern airport.	Total 65 Ldn population affected: 12,600 - 13,100. With runway use mitigation: 8,100 - 8,600 population affected.	Overall auto passenger mileage generally lower than other system alternatives. Daily passenger mileage: (DPM, in thousands) = 1,536 - 1,609; Annual passenger mileage: (APM, in millions) = 567-664	Lowest overall air pollutant emissions: 28.0 - 35.0 Tons CO/Day; 7.8 - 8.6 Tons NOX/Day.	Wetlands on the Paine Field and Olympia/Black Lake site could be impacted. Salmon-producing streams on the Fort Lewis and Olympia/Black Lake could be impacted. Two endangered plants and two endangered birds may be impacted on the Fort Lewis site.	Soils types at the proposed sites are appropriate for airport construction.	Compatible vicinity of Sea-Tac and Paine Field. Southern airport changes vicinity land use. Homes directly impacted: Sea-Tac = 230+; Paine Field = Several. Southern = Up to 1,060	Minor impacts to Sea-Tac and Paine Field, most facilities in place. Major impacts to southern airport options, new facilities needed.
Existing Sea-Tac; Arlington; Central Pierce County	Total 65 Ldn population affected: 7,900	Overall passenger mileage slightly higher than preferred alternative: DPM = 1,596; APM = 494 - 694	Slightly higher emissions than preferred alternative due to delays at Sea-Tac: 29.0 - 36.0 Tons CO/Day; 7.7 - 8.9 Tons NOX/Day.	No impacts.	Soils are appropriate for construction, with the exception of the Arlington site.	Compatible vicinity of Sea-Tac and Arlington. Central Pierce airport changes vicinity land use. Homes directly impacted Sea-Tac = None; Arlington = 20+; Cent. Pierce = 594+	Minor upgrading to facilities at the Sea-Tac and Arlington sites. Major upgrading to facilities at Central Pierce site.
Existing Sea-Tac; Arlington; Olympia/Black Lake.	Total 65 Ldn population affected: 7,500	Highest auto passenger mileage of three airport systems: DPM = 1,902; APM = 494 - 694	Emissions comparable to existing Sea-Tac, Arlington, and Central Pierce (above): 29.0 - 36.0 Tons CO/Day; 7.7 - 8.9 Tons NOX/Day.	Salmon-producing streams on the Olympia/Black Lake site would be impacted.	Soils are appropriate for construction, with the exception of the Arlington site.	Compatible vicinity of Sea-Tac and Arlington. Olympia/ Black Lake airport changes vicinity land use. Homes directly impacted Sea-Tac = None; Arlington = 20+; Olympia/Black Lake = [illegible]	Minor upgrading to facilities at Sea-Tac and Arlington sites. Major upgrading to facilities at Olympia/ Black Lake site.
Existing Sea-Tac; 2 Runway Arlington.	Total 65 Ldn population affected: 7,500	Comparable to other comparable 2-runway supplemental airport alternatives. DPM = 2,093; APM = 534 - 1,019	High CO emissions due to distance from major centers. 30.0 - 48.0 Tons CO/Day; 7.9 - 10.8 Tons NOX/Day	No impacts.	Soils are appropriate for construction, with the exception of the Arlington site.	Compatible with vicinity of Sea-Tac and Arlington. Homes directly impacted Sea-Tac: None; Arlington: 95	Minor upgrading to Sea-Tac and Arlington sites.
Existing Sea-Tac; Paine Field; Central Pierce County	Total 65 Ldn population affected: 7,600	Overall auto passenger mileage lower than preferred alternative: DPM = 1,354; APM = 494 - 694	Slightly higher overall emissions than preferred alternative: 29.0 - 36.0 Tons CO/Day; 7.7 - 8.9 Tons NOX/Day.	Wetlands on the Paine Field site would be impacted.	Soils are appropriate for construction.	Compatible with vicinity of Sea-Tac and Paine Field. Central Pierce airport changes land use. Homes directly impacted Sea-Tac = None; Paine Field = Several; Cent. Pierce = 594+	Minor upgrading to facilities at Sea-Tac and Paine Field. New facilities needed at Central Pierce.
Sea-Tac with Dependent Runway; 2 Runway Arlington	Total 65 Ldn population affected: 13,000	Lower overall auto passenger mileage compared to existing Sea-Tac. DPM = 1,747; APM = 604 - 732.	Overall emissions relatively high due to travel distance: 33.0 - 38.0 Tons CO/Day; 8.3 - 9.1 Tons NOX/Day	No impacts.	Soils at all sites, except Arlington, are appropriate for construction of the airport.	Compatible with vicinity of Sea-Tac and Arlington Homes directly impacted Sea-Tac = 230+; Arlington = 95	Minor impacts to Sea-Tac, most facilities in place. Upgrading of facilities required at Arlington
Sea-Tac with Dependent Runway; 2 Runway Central Pierce County.	Total 65 Ldn population affected: 13,500	Lower overall auto passenger mileage compared to existing Sea-Tac: DPM = 1,747; APM = 604 - 732.	Emissions same as Sea-Tac with Dependent Runway; 2 Runway Arlington (above): 33.0 - 38.0 Tons CO/Day; 8.3 - 9.1 Tons NOX/Day.	Three acres of wetland on the Central Pierce site would be impacted	Soils types at the proposed sites are appropriate for airport construction.	Compatible with vicinity of Sea-Tac. Central Pierce airport changes land use. Homes directly impacted: Sea-Tac = 230+; Central Pierce = [illegible]	Minor impacts to Sea-Tac, most facilities in place New facilities needed at Central Pierce site.

FIGURE 5

Possible Mitigation Measures Summary

Noise

- Preferential runway use and direction
- Flight track modifications
- Special nighttime procedures (i.e. Puget Sound departures)
- Nighttime operational restrictions
- Aircraft use restrictions (i.e. using only quieter Stage III aircraft at night)
- Noise abatement arrival and departure procedures
- Nighttime ground control measures (i.e. engine run up restriction)
- Land use compatibility enhancement and retrofit (i.e. soundproofing)

Transportation

- Development of regional light rail and high-capacity transit systems.
- Roadway improvements including addition of lanes and added capacity to regional arterials and freeways
- New regional arterials and freeways
- New or modified intersections and local street improvements in vicinity of airports.

Air Quality

- Reduction of vehicular travel associated with project.
- Improvement of mass transit facilities.
- Support and compliance with the Puget Sound Regional Council's Vision 2020 plans and programs.
- Implementation of vehicular usage reduction programs and transportation demand management programs.

Plants & Animals

Wetlands

- Protect wetlands with 25 to 300 foot buffer.
- If buffer is not feasible, prepare a mitigation plan which seeks to replace the wetland functions and values that will be impacted by the project.

Streams

- Create or enhance sufficient stream habitat in the general area.

Vegetation/Wildlife

- Revegetating the sites, after construction, would reduce the impacts to plant and animal communities.
- Avoiding areas with wetlands would serve to ensure no disturbance in valuable areas.

Earth

- Avoiding all sensitive areas with potential geologic hazards would eliminate significant impacts to earth resources.
- Modern construction practices and minimizing earth movement during rainy seasons should control most earth impacts.

Land Use

- Local comprehensive plans and zoning regulations modified and implemented in accordance with the Growth Management Act to accommodate planned airports and facilties.

Public Services and Utilities

- Local facility plans modified and implemented in accordance with the concurrency requirements of the Growth Management Act to accommodate planned airports and facilities.

PROJECT PROCESS

INTRODUCTION

Just as the highways of our metropolitan area are becoming increasingly over-crowded, so too is our region's only commercial air carrier airport, Seattle-Tacoma International Airport (Sea-Tac). As the population of the Puget Sound Region expands and as air travel becomes increasingly popular, airfield congestion at Sea-Tac will continue to worsen. Airport congestion leads to longer delays for those of us using air travel and to a general decline in the quality of airline service. In the end, this will negatively affect the Puget Sound's trade dependent economy.

As part of its ongoing transportation planning for the region, the Puget Sound Regional Council (formerly Puget Sound Council of Governments) in September of 1988 adopted the "Regional Airport System Plan" which is a part of the "Regional Transportation Plan." One of the findings of the plan was that Sea-Tac would reach its capacity sometime around the year 2000. As a result, the airport will not be able to meet the growth in air passengers that is expected through the year 2020 and beyond. In response, the plan recommended that the Puget Sound Regional Council (PSRC), in cooperation with the Port of Seattle (operator of Sea-Tac), undertake a study to define a solution and an action plan to meet our region's air travel needs to the year 2020 and beyond.

In May of 1989, the PSRC and the Port of Seattle entered into an interagency agreement which was designed to "...establish a joint planning process between the Port and the [PSRC] for developing a regional air carrier system plan for the Puget Sound Region." A major goal of the Project would be to involve interested parties, governments, and citizens from throughout the region in the planning process.

The interagency agreement created the Puget Sound Air Transportation Committee (PSATC) which was given the task of studying the precise nature and extent of the airport congestion problem and to recommend a solution to the governing bodies of the PSRC and the Port. The PSATC is a thirty-nine-member steering group made-up of citizens, local and state elected officials, representatives of the business community, and aviation and environmental interests from King, Pierce, Snohomish, Kitsap, and Thurston Counties. The air transportation system study undertaken by the PSATC was called the "Flight Plan Project."

PROJECT OVERVIEW

The Flight Plan Project was conducted in three phases.

Phase I consisted of the development of a mission statement and project objectives, a vision statement, and preliminary forecasts of regional air travel demand. These products established the character of the study effort and the scope of the commercial air transportation problem facing Puget Sound residents and those who wish to travel and do business here.

The purpose of Phase II was to develop a broad range of conceptual aviation and non-aviation system alternatives and to identify generic sites which would be used to help evaluate the system alternatives. The system alternatives and sites were assessed at a basic level to eliminate those which had significant impediments to implementation or were incompatible with the PSATC's Vision Statement. The remaining system alternatives and sites were deemed to be potentially feasible. After a series of public meetings to gather citizen's comments on the alternatives, the PSATC finalized a list of feasible alternatives for extensive analysis in Phase III.

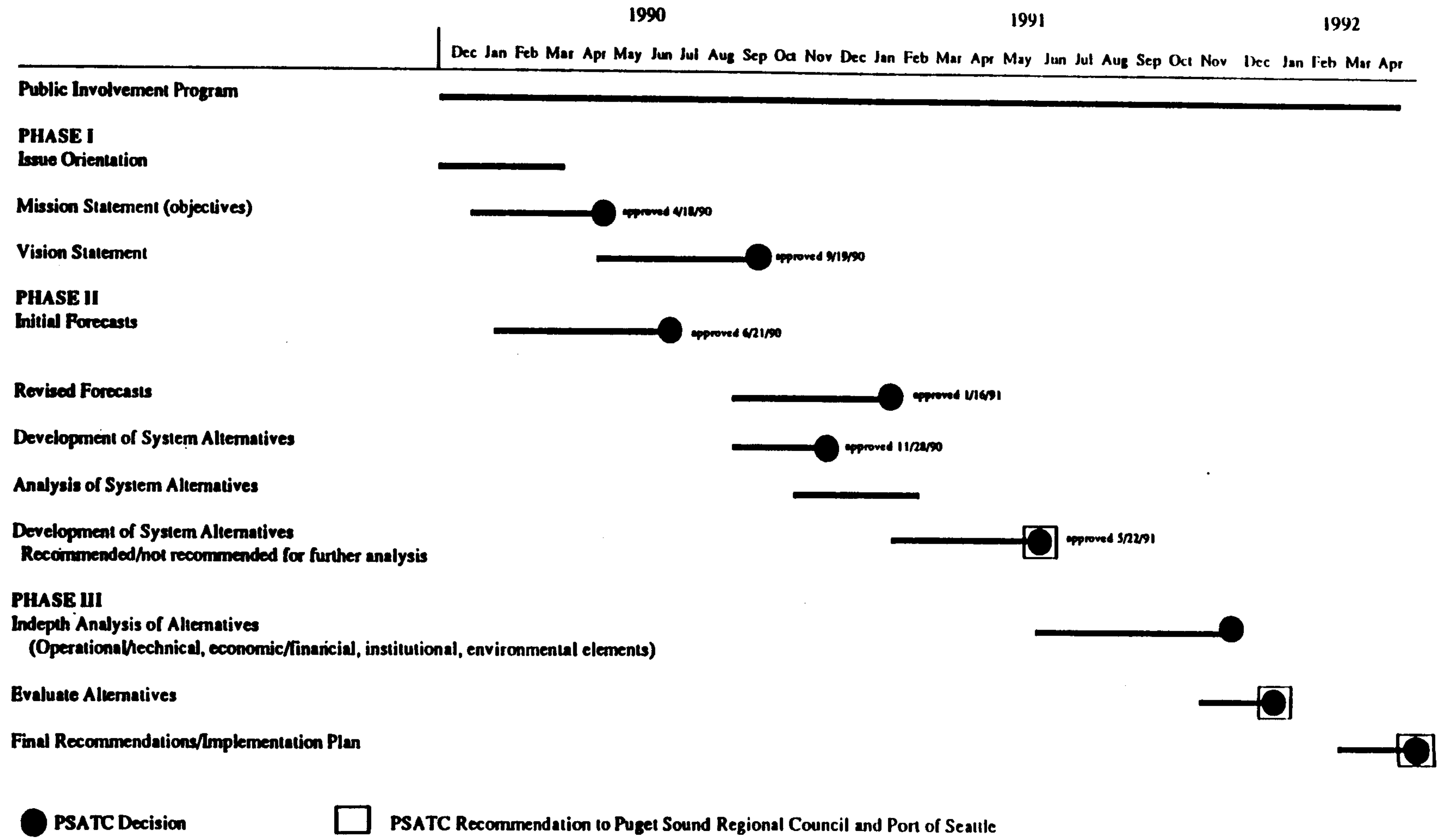
Phase III was designed to analyze and develop the remaining alternatives and options in depth and to formulate the PSATC's draft recommendations. Alternatives were studied according to operational/technical elements, economic/financial elements, institutional elements, and environmental elements.

Throughout all Phases of the Flight Plan Project, an extensive public involvement program was carried out to keep citizens informed and to encourage them to be involved in the PSATC's work. An overview of the public involvement process is presented at the end of Section Two.

Figure 6 shows the overall project schedule and includes the major tasks and milestones completed.

FIGURE 6

Flight Plan Project Schedule



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PHASE I SUMMARY

Mission Statement

The first step in the Project was for the Puget Sound Air Transportation Committee to formulate a mission statement which presented their objectives for the region's air transportation system. Based on several months of discussion, the PSATC adopted the following statement in April of 1990:

FIGURE 7

MISSION
Puget Sound Air Transportation Committee

The mission of the Puget Sound Air Transportation Committee is to strive to meet our region's commercial air transportation needs for the first half of the 21st century.

OBJECTIVES

Our air transportation system should:

* Utilize a planning process that involves all interested parties, governments, and citizens so as to seek broad public input and to ensure broad public support of our eventual recommendations.
* Be compatible with the human and natural environment and avoid adverse environmental impacts to the greatest extent possible.
* Be coordinated and integrated with all other transportation modes.
* Remain competitive nationally and internationally and meet the needs of passengers and air cargo shippers.
* Accommodate regional population and economic growth and be integrated with statewide economic and transportation plans.
* Consider and accommodate new and developing technologies.

The mission statement provided the PSATC with broad policy guidance for conducting the rest of the Flight Plan Project.

Vision Statement

Following the agreement on the mission statement, the next step was to develop a vision statement for the region's air transportation system in the year 2020. The purpose of the vision statement was for the PSATC to set general goals and to delineate what issues it felt were most important in regards to the air transportation system. It was written to guide the PSATC as it later developed and evaluated system alternatives. Essentially, the vision statement is a goal for our future air transportation system and provided a standard by which the sytem alternatives could be compared. The complete text of the vision statement can be found in Figure 8.

Initial Forecasts

In order to provide a measuring stick for the amount of demand the region's air transportation system would need to accommodate in the coming decades, the PSATC developed preliminary forecasts of air travel passengers out to the year 2020 and the aircraft operations (take-offs and landings) needed to serve them. Predictions for air cargo levels were also made. The PSATC was assisted in this effort by the aviation consulting firm of KPMG Peat Marwick.

The purpose of the initial forecasts prepared during Phase I was to determine the nature and extent of the air traffic congestion problem facing the region at Sea-Tac and to determine how much additional air travel capacity would be needed in the future. The forecasts were then revised and enhanced in Phase II.

The major findings of the forecast process, which were adopted by the PSATC in June of 1990, were that:

* 25.4 million annual airline passengers are forecast for the Puget Sound Region in the year 2000 (Sea-Tac had 16.2 million passengers per year in 1990).

* Saturation of Sea-Tac will begin when aircraft operations reach 380,000 per year - forecast to occur close to the year 2000. (Sea-Tac handled 355,000 operations in 1990).

* Hourly capacity at Sea-Tac is greatly reduced during bad weather, which occurs approximately 45 percent of the year.

* Delays at Sea-Tac in 2000 will be similar to those currently experienced at airports like Chicago's O'Hare, New York's La Guardia, and Washington, D.C.'s National.

* Airline passenger levels are growing mainly because of growth in the region's economy, population, and increase in per capita demand for flights. Most of the demand is for domestic flights.

FIGURE 8

VISION: AIR TRANSPORTATION SYSTEM 2020

This is our shared vision for the air transportation system in the year 2020.

We have an integrated air, land, and sea transportation system that will serve the region's travel needs worldwide to the year 2050 and thereafter. The transportation system enhances the livability and environmental integrity of the Pacific Northwest, is convenient and accessible to its users, promotes the economic vitality of the state, and serves as a gateway to all domestic and world markets. This transportation system is recognized worldwide as a leading model of transportation development.

THE VISION DEFINED

Environmental Quality and Livability

The air and related ground transportation system enhances the overall environmental quality and livability of the entire region, and particularly those communities surrounding transportation facilities. Specifically, it enhances a quality environment relative to:

* Noise Exposure
* Air and Water Quality
* Accessibility and Freedom of Movement
* Health and Safety of People
* Protection of Sensitive Areas

The planning and development of the air and related ground transportation system has been used as an opportunity to shape the general development pattern of the region.

Regional Economic Vitality

The air transportation system enhances and stimulates the Puget Sound Region as an economic center for the Pacific Northwest. The system serves as a major international gateway for domestic and world markets, thereby promoting the economic vitality and well-being of the State of Washington and the Pacific Northwest.

Integrated Transportation System

Air and surface transportation systems are totally integrated and support the fast, convenient, and cost-effective movement of people and goods to and from communities within Washington, and between Washington and the rest of the United States, the Pacific Rim, and the rest of the world.

The implementation of the integrated transportation system is coordinated among the affected and appropriate parties.

Existing and emerging technologies are used to the greatest extent possible in a flexible system designed to accommodate the future.

* The primary cause of Sea-Tac saturation will be caused by growth in passenger aircraft operations.

* Air cargo and international flights are a small portion of total aircraft operations. Only 3% of operations are by all-cargo flights, while overseas international flights comprise only 5% of total operations.

* No increase in all-cargo flights is expected since the growth in tonnage will be carried on larger planes or in passenger planes.

* Sea-Tac moves more Asia-Europe "sea-air" cargo than any other airport in the world. To stay competitive in the Far East-to-Europe cargo market, the region must continue to provide adequate air service facilities.

* Timely implementation of the PSATC's recommendations is needed to accommodate the region's air travel needs.

Further information on the forecasts and the methodology used can be found in the Phase I Final Report entitled "Phase I Forecasts, Flight Plan Study, Puget Sound Region" dated July 1990.

It is important to note that the future cannot be predicted with certainty. In the short term, there may be substantial variations from the forecasts. However, short-term variations are not expected to alter the long-term trends. Because of possible variations, the forecasts are best considered as activity levels at which airport capacity decisions will need to be made. In other words, the forecasts indicate what required facilities and capacity level will be needed in the future, but actual levels of demand will drive when those facilities are actually implemented.

PHASE II SUMMARY

Revised Forecasts

The initial forecasts of aircraft operations made during Phase I of the Flight Plan Project were revised in Phase II to tailor the operations forecasts to the specific trends of the Puget Sound Region. Passenger and cargo forecasts remained the same. The revised forecasts examined more closely the air travel characteristics in markets served from Sea-Tac.

The main result of the additional forecast analysis was that the number of total operations predicted was moderately lowered. For example, in the year 2020 the initial forecasts anticipated 575,000 operations per year, while the revised forecasts lowered the number of operations for the same year to 524,000. This was primarily due to the assumption that airlines serving three of Sea-Tac's key markets (Spokane, Portland, and Vancouver, B.C.) would use larger planes in the future and would therefore be able to carry more passengers for a given number of flights. The revised forecasts were used through the remainder of the Flight Plan Project in developing and analyzing air transportation system alternatives. A complete explanation of the revised forecasts can be found in Appendix J of the Phase II Final Report entitled "Phase II: Development of Alternatives," dated June 1991.

Development of System Alternatives

With forecasts indicating the nature of the airport capacity problem within the region, the next step for the PSATC was to begin to look for solutions. After hearing from several aviation experts and airport professionals from other cities, the PSATC developed a comprehensive set of system alternatives which can be classified into nine categories. The system alternatives below include both aviation-related and non-aviation-related solutions and were the PSATC's first-cut at what potential means were available for meeting the region's long term air travel needs.

System Alternatives

Base Case A: No major facility improvements at any Puget Sound airports, except for those already underway

Base Case B: Short-term capital projects and policies that may be implemented at Sea-Tac before the year 2000

Expand Sea-Tac: Full development of the existing airport site, roughly within the current boundaries

Replacement Airport: Close Sea-Tac and build a single new airport designed to meet the long-term aviation needs of the region.

Multiple Airport System: **One airport serving as the primary commercial airport for the region, with one or more smaller supplemental commercial airports.**

Remote Airport: Development of a second airport operated in tandem with Sea-Tac, with direct ground transportation connection to Sea-Tac (either a close-in airport like Boeing Field, or a distant airport like Moses Lake/Grant County). This alternative differs from a multiple airport system in that the airports would be functionally linked.

Demand Management: Pricing and/or regulatory techniques which encourage the use of larger aircraft, flights during non-peak hours, and the diversion of passengers to other travel modes.

New Technologies: New aircraft, air traffic control procedures, and other technologies which enhance airport capacity

High-Speed Ground Transportation System: Development of a high-speed ground transportation system (such as steel wheel or magnetic-levitation trains) linking major urban areas to each other and the airport, replacing a number of trips now taken by air and automobile

Screening of System Alternatives

The system alternatives selected by the PSATC represented a broad range of potential solutions to the future commercial aviation capacity problems facing the Puget Sound Region. A two-stage process was used to look at the alternatives and to eventually choose a preferred solution. The first step was a preliminary screening of the alternatives in Phase II and the second step was an indepth evaluation of the remaining alternatives during Phase III.

As a test to the technical feasibility and ability to meet the PSATC's vision, each of the alternatives was analyzed to determine if any had fatal flaws that would make its implementation impossible or impractical. A consulting team lead by Apogee Research assisted the PSATC in the analysis of the alternatives.

In order to determine the workability of any of the system alternatives, it was necessary to make sure that adequate sites would be available for each. Both existing airports and potential airport sites were examined. The sites were used to develop a range of the benefits and impacts that would be realized from each system alternative.

▒ PSATC preferred alternative per draft recommendations

One of the first tasks in this process was to inventory existing airports throughout the region to see if they could be used as sites for any of the airport-related alternatives. Fourteen airports were identified as candidates for further analysis. These were:

* Arlington Municipal Airport
* Auburn Municipal Airport
* Bellingham International
* Boeing Field (King County Airport)
* Bremerton National
* McChord Air Force Base
* Moses Lake Airport (Grant County)
* Olympia Airport
* Paine Field (Snohomish County Airport)
* Port Angeles Airport (Fairchild International)
* Renton Municipal Airport
* Seattle-Tacoma International Airport
* Skagit/Bayview Airport
* Tacoma Narrows Airport

The above sites were studied to see if they met basic acreage and facility requirements to accommodate each of the airport-related alternatives. If they did not currently have adequate facilities for any of the airport-related alternatives, they were further examined according to a set of expandability criteria to see if they could potentially be enlarged.

As a result of this initial screening, the Auburn, Port Angeles, Renton, and Tacoma airports were dropped from further analysis. It was found that the sites were too small and too constricted by urban development or topography to be used for any of the system alternatives. Although Bellingham International had promise in terms of size and existing facilities, the PSATC determined that it was too far from existing and projected population centers of the Central Puget Sound to adequately serve the region and was discarded on that basis.

A preliminary search for technically feasible sites for building new airports was also conducted. In essence, the search criteria focused on areas throughout the region which would be large enough, flat enough, and without apparent environmental roadblocks that could accommodate either a new supplemental or a new replacement airport. The search was an initial screening of potential sites only and was not a comprehensive site selection exercise. Counties searched were: Skagit, Snohomish, Kitsap, King, Pierce, Thurston, and Lewis. This effort yielded the following five "search areas:"

* Arlington/Stanwood Area (Snohomish County)
* Enumclaw/Buckley Area (King/Pierce Counties)
* Fort Lewis/Spanaway Area (Pierce County)
* Olympia/Black Lake Area (Thurston County)
* Napavine Prairie Area (Lewis County)

A search area was not a specific site, but rather a small portion of the region in which potential sites might be found. Other areas within the region were excluded from being search areas due to topography, environmental problems or severe impacts to urban areas.

Concerning potential high-speed ground transportation alignments, two corridors had been suggested in the past: 1) Vancouver, B.C. to Seattle to Portland via Sea-Tac Airport, and 2) Seattle (Sea-Tac) to Moses Lake. The PSATC chose both of these alignments for further study as potential options.

After identification of sites for each of the system alternatives was completed, the following questions were studied:

* **Airspace:** Are there conflicts with other airports or terrain?
* **Capacity:** How many aircraft operations can be accommodated (or diverted)?
* **Ground Access:** How accessible is each site option to residents of the Central Puget Sound Region?
* **Investment Requirements:** How much money would be needed for construction?
* **Economic Impact:** What are the economic implications for the region and its subareas?
* **Implementation Feasibility:** What major roadblocks might be encountered during implementation?

A three-step screening process was used to assess the system alternatives based on the answers received to the above questions. The first step was to eliminate those alternatives that were found to have serious problems in terms of the above issues. The second step was to create packages of system alternatives from those that remained. This involved combining alternatives in such a way that the resulting packages would be able to meet the air travel demand forecasts for 2020. The third step was to measure the resulting packages in terms of how well they met the PSATC's vision statement of providing adequate capacity to the year 2050.

<u>System Alternatives Recommended for Further Analysis</u>

In March of 1991, the Options Subcommittee of the Puget Sound Air Transportation Committee developed draft conclusions of what it considered to be alternatives that might be feasible or alternatives which were not feasible as a result of the screening process. After a series of public hearings in March and April of 1991 to gain public input on these conclusions, the PSATC approved the following alternatives for indepth technical/operational, economic/financial, institutional, and environmental analysis during Phase III of the Project:

* ***Multiple Airport System:*** Sea-Tac would be the region's primary commercial service airport and would either remain as is or have a commuter runway or dependent air carrier runway added. Also, the addition of one airport in the region to supplement Sea-Tac (either at an existing airport or at a new site) with one or two runways.

* ***Replacement Airport:*** Close Sea-Tac and build a new airport capable of meeting the region's long-term air travel needs.

  Packaged with the above two alternatives were Demand Management Techniques and New Technologies used to the maximum extent possible.

* Sea-Tac in conjunction with the ***maximum feasible package*** of: a) demand management techniques, b) new technologies, and c) alternate modes of transportation. This package of previous solutions would attempt to meet future demand without additional runways.

* ***Boeing Field as a Close-in Remote Airport:*** Earlier analysis of this alternative by the FAA and the consultants to the PSATC concluded that increased air traffic interaction between Sea-Tac and Boeing Field would result in unacceptable operational reliability at Boeing Field with no net capacity gain for the region. Additional analysis of the airspace situation was requested to determine if it could be resolved. If the airspace issue could be resolved, the Committee could consider this as an additional alternative warranting further study.

The PSATC found that supplemental airports under the multiple airport system alternative might be feasible at the Arlington, McChord Air Force Base, and Paine Field airports.

New supplemental airports or a new replacement airport might be built in the Arlington/Stanwood, Fort Lewis/Spanaway, and Olympia/Black Lake search areas.

System Alternatives Not Recommended for Further Analysis

The remaining system alternatives from the initial list were determined not to be feasible as "stand alone" alternatives. This means that any one of them by itself would not be able to meet the air travel demands of our region in the year 2020. However, when it was practical, these alternatives were packaged with the alternatives which were recommended for further analysis in Phase III. Alternatives in this category were:

▒ PSATC preferred alternative per draft recommendations

* All of the initial Sea-Tac alternatives (Base Case A & B, and Expand Sea-Tac) - Dropped due to inadequate capacity to meet the PSATC's Vision.

* Distant Remote Airport linked to Sea-Tac by high-speed rail (the Moses Lake option) - Dropped due to difficulty to implement, extremely high capital costs, and lack of accessibility to users.

* High-Speed Ground Transportation linking Sea-Tac to Vancouver, B.C. and Portland - Dropped due to extremely high capital costs and small incremental benefit to airport capacity. However, the PSATC encouraged and supported the study of rail by the State Air Transportation Commission and the State High-Speed Rail Commission.

* Demand Management as a stand-alone alternative - Dropped due to inadequate capacity enhancement to meet the PSATC's Vision.

* New Technologies as a stand-alone alternative - Dropped due to inadequate capacity enhancement to meet the PSATC's Vision.

For more information on both the alternatives that were recommended for further analysis and those that were not, as well as the results of the technical analysis and screening, please refer to the Phase II final report entitled "Phase II: Development of Alternatives" dated June 1991.

PHASE III SUMMARY

Refinement of System Alternatives Recommended for Further Analysis

Phase III of the Flight Plan Project was designed to develop a specific list of alternatives by refining the system alternatives and sites which were determined to be feasible or potentially feasible during Phase II. This was done by re-examining those system alternatives which were determined to be potentially feasible and by developing conceptual site layouts for each of the combinations of system alternatives/site options. Using the site layouts, the alternatives were then evaluated indepth according to a set of operational/technical, economic/financial, institutional, and environmental criteria. Based on the indepth analysis, a preferred alternative was chosen.

One of the four system alternatives carried forward for further study from Phase II of the Flight Plan Project -Boeing Field as a Close-In Remote Airport- was classified by the Puget Sound Air Transportation Committee as "potentially feasible." This meant that the PSATC thought that this alternative might be workable, but further study was needed than was provided in Phase II.

In addition, a more broadly-defined Demand Management alternative was also examined in detail in Phase III as well as a new iteration under the multiple airport system alternative which consists of a three-airport system.

Further Study of Boeing Field as a Close-In Remote

Preliminary study of Boeing Field as a Close-In Remote Airport in Phase II indicated that serious airspace conflicts with Sea-Tac would limit Boeing Field's feasibility for use as a commercial air carrier airport. However, the PSATC wanted further study of this alternative to see if it could be made to work before it was rejected. Therefore, in Phase III, a thorough examination of the Boeing Field Airspace was done in a working paper entitled "Working Paper #1 - Boeing Field Airspace Review." A copy of this paper can be found in Appendix B.

Essentially, the analysis revealed that the airspace between Boeing Field and Sea-Tac is already congested and that adding commercial flights into Boeing Field would greatly increase airborne delays in the system. Also, since the two airports are so close together, a unique air traffic control procedure has already been developed (in 1989) to safely handle traffic using them. An increase in flights into Boeing Field would eventually exceed the ability to use the procedure safely. Due to these problems, the PSATC chose to drop the Boeing Field alternative from further consideration.

Indepth Analysis of Demand Management

In Phase III, the PSATC studied the application of Demand Management techniques in detail. A panel of experts was convened to help the PSATC determine what specific methods were available and what their benefits and drawbacks would be. In addition, a working paper (Working Paper # 4) entitled "Demand Management" was prepared. Working Paper # 4 can be found in Appendix B.

The working paper explained that some forms of Demand Management are already being used at Sea-Tac and that the Flight Plan Forecasts also took into account demand management concepts such as larger-sized aircraft and higher load factors (number of seats filled on each flight). The primary conclusion reached in the analysis was that Demand Management can be used to help shape demand, but it is not designed to curtail demand. Also, Demand Management should be used as part of a comprehensive package of solutions and is most effective for buying time in the short term until additional airport capacity can be implemented. New technologies and alternate modes of transportation are part of a broad Demand Management concept that was incorporated into the "Do Nothing" alternative that is presented in the EIS.

Multiple Airport System with Three Airports

Coming out of Phase II, one of the the alternatives recommended for further analysis was a multiple airport system with Sea-Tac and one supplemental airport. Four iterations were defined under this alternative depending on whether Sea-Tac would stay as it is or would add another runway and whether the supplemental airport would have one runway or two.

At its August 15, 1991 meeting, the PSATC chose to add another series of cases under the multiple airport system alternative -Sea-Tac with two supplemental airports (a three airport system). Under this alternative, Sea-Tac would remain the primary commercial service airport and would handle all types of service (including foreign and long haul domestic flights) while the two supplemental airports would handle service to regional markets like Portland, Vancouver, B.C., and Spokane and to some major hub airports in the west like Salt Lake City, Denver, and San Francisco. One of the supplemental airports would be located in the northern part of the region and the other in the southern part. The supplemental airports could either have one or two runways each.

This iteration was added due to the PSATC's interest in planning for air travel demand not only to 2020 but also beyond. Under the concept, development of the system would be phased, with each supplemental airport being added or expanded only when demand warranted.

Development of Site Concepts

In order to evaluate the system alternatives according to specific, localized impacts, it was necessary to develop conceptual site layouts in actual locations. The Flight Plan Project looked at two types of sites: existing airports and potential sites for construction of new airports. The first type already had a specific location which could be used to test the alternatives, but for the latter type, a specific test site had to be chosen from the search areas carried-forward from Phase II.

Both types of sites served as test cases for the future noise levels, traffic impacts, site acquisition and construction costs, airspace, and economic impacts, etc. that would be encountered in implementing one of the system-level alternatives.

Sites were initially screened for fatal flaws in Phase II of the Project. For the sites that remained, the Phase III consultant prepared layouts of each of the system alternatives as they applied to each of the individual sites. Included were locations of runways, parking areas, passenger terminal, and other airport support services.

For the new airport search areas developed in Phase II, it was necessary to define a particular location within the area for the site. This was done with preliminary research and was not intended to be a thorough siting exercise. Additional comprehensive studies would need to be completed in order to choose a best site for any newly-constructed airports.

For existing airports, additional facilities were located based on the consultant's initial examination of existing facilities and surrounding development. The layout drawings for each site and alternative as well as text describing them can be found in Working Paper #6 in Appendix B.

One of the search areas recommended for use as a test case in Phase II, the Fort Lewis/Spanaway Area, was renamed the "Central Pierce County Area" in Phase III to reflect that it not only included the military land of Fort Lewis, but also the land off of the Fort to the east. This expanded definition of the search area allowed the PSATC to include sites in the southern portion of the region that would be either on or off of federal land.

The resulting list of alternatives and sites for which conceptual layouts were developed included:

Sea-Tac Airport Alternatives

* Sea-Tac with or without a new commuter runway
* Sea-Tac with or without a new dependent air carrier runway

Supplemental Airport Alternatives

* Existing Arlington Airport with runway extension
* Arlington Airport with a new runway
* Existing Paine Field
* Paine Field with a new runway
* Existing McChord Air Force Base used jointly with military
* McChord AFB with a new runway used jointly with military
* Supplemental airport at Central Pierce site with one runway
* Supplemental airport at Central Pierce site with two runways
* Supplemental airport at Olympia/Black Lake site with one runway
* Supplemental airport at Olympia/Black Lake site with two runways

Replacement Airport Alternatives

* Replacement airport at Central Pierce site with three runways
* Replacement airport at Olympia/Black Lake site with three runways
* Replacement airport at Fort Lewis site with three runways

List of Alternatives/Options

From the system alternatives carried forward from Phase II and the site concepts outlined above, a comprehensive list of the various combinations of alternatives/site options was prepared. The 34 alternatives presented in the list below were then extensively evaluated and a preferred alternative was chosen:

System Alternative	Airport Options	
Do Nothing	1	Sea-Tac without commuter R/W
	2	Sea-Tac with commuter R/W
Multiple Airport System with Two Airports	3	Alternate 1 & Arlington 1 R/W
	4	Alternate 1 & Paine 1 R/W
	5	Alternate 1 & McChord 1 R/W
	6	Alternate 1 & Central Pierce 1 R/W
	7	Alternate 1 & Olympia/Black Lake 1 R/W
	8	Alternate 1 & Arlington 2 R/W
	9	Alternate 1 & Paine 2 R/W
	10	Alternate 1 & McChord 2 R/W
	11	Alternate 1 & Central Pierce 2 R/W
	12	Alternate 1 & Olympia/Black Lake 2 R/W
	13	Sea-Tac w/ Dependent R/W & Arlington 1 R/W
	14	Sea-Tac w/ Dependent R/W & Paine 1 R/W
	15	Sea-Tac w/ Dependent R/W & McChord 1 R/W
	16	Sea-Tac w/ Dependent R/W & Cent. Pierce 1 R/W
	17	Sea-Tac w/ Dependent R/W & Oly/Blk Lake 1 R/W
	18	Sea-Tac w/ Dependent R/W & Arlington 2 R/W
	19	Sea-Tac w/ Dependent R/W & Paine 2 R/W
	20	Sea-Tac w/ Dependent R/W & McChord 2 R/W
	21	Sea-Tac w/ Dependent R/W & Cent. Pierce 2 R/W
	22	Sea-Tac w/ Dependent R/W & Oly/Blk Lake 2 R/W
Multiple Airport System with Three Airports	23	Alternate 1 & Arlington 1 R/W & C. Pierce 1 R/W
	24	Alternate 1 & Paine 1 R/W & C. Pierce 1 R/W
	25	Alternate 1 & Arling. 1 R/W & Oly/Blk Lake 1 R/W
	26	Alternate 1 & Paine 1 R/W & Oly/Blk Lake 1 R/W
	27	Alternate 13 & Central Pierce 1 R/W
	28	Alternate 14 & Central Pierce 1 R/W
	29	Alternate 13 & Olympia/Black Lake 1 R/W
	30	Alternate 14 & Olympia/Black Lake 1 R/W

▩ PSATC preferred alternative per draft recommendations (note: alternative 30 to be used only if a supplemental site cannot be acquired in the Central Pierce area)

Replacement	31	Central Pierce w/ 3 R/W
Airport	32	Olympia/Black Lake w/ 3 R/W
	33	Fort Lewis w/ 3 R/W
Do Nothing	34	Alternate 1 & Demand Management

Distribution and Satisfaction of Regional Demand

In Phase I of the Flight Plan Project, forecasts of regional air passenger demand to the year 2020 were prepared. These indicated total air passengers that would use airports in the Central Puget Sound Region. As part of the analysis of the alternatives in Phase III, market areas were defined for each of the site options and the regional demand was disaggregated to each. This was done to show what the expected number of passengers would be that would use each site and what number of aircraft operations would be needed to serve them.

Under single airport systems, the market area for the airport was defined as the entire Central Puget Sound Region. For multiple airport systems, the market area for each airport was delineated by determining which people in the region could get to that airport in less travel time than to any other airport in the system. A thorough explanation of the methodologies used to determine the market areas and passenger demand for each airport site can be found in Working Papers #3 and #5 in Appendix B. Working Paper #3 was an initial disaggregation of regional demand to smaller sub-regions and lead to the conclusion that a three-airport multiple airport system should be examined. Working Paper #5 was a more-thorough examination of individual airport market areas.

It is important to note that the market areas described above were based on year 2020 data and that the demand figures for each represents a likely eventual outcome. In the decades before 2020, the market areas for individual sites will become viable to support commercial aviation at different times. This is based on differing population bases and growth rates that exist in different parts of the region. As markets become viable from a profit point of view, airlines will begin to serve an airport with a few flights per day during peak travel times. With growth in the market, more and more flights will be added and service will improve.

Evaluation Methodology

The major portion of work done in Phase III was the preparation and application of a series of working papers which dealt with the operational/technical, economic/financial, institutional, and environmental factors which were used to evaluate the 34 alternatives/site options indepth. The working papers as they were adopted by the Puget Sound Air Transportation Committee can be found in the Appendices. The environmental working papers (# 12A, 12B & 12C) were later incorporated into the Draft Programmatic Environmental Impact Statement which is Appendix E.

The 34 alternatives/site options presented above were then evaluated indepth according to the specific methodology which is discussed in Working Paper #2 in Appendix A. The methodology was designed to evaluate the system alternatives/site options in a rigorous and consistent manner by researching a broad range of data.

Evaluation is a planning process that measures the relative conformance of alternatives to a set of common factors. Factors which can be measured or quantified are expressed in units of size, volume, population, dollars, weight, etc.. Non-measurable or qualitative factors are usually ranked according to their relative position on a rating scale that may be either weighted or not weighted.

The main focus of the evaluation was to allow for system alternatives/site options to be compared to one another rather than studied in absolute terms. This means that the relative rank of the alternatives/site options as compared to one another is more important than the absolute values obtained for any single one.

The factors which were used to evaluate the system alternatives/site options are outlined below:

Operational/Technical Elements - Appendix B

* Runway Capacity: (Working Paper #7) — Measured in aircraft operations (take-offs and landings) per year, this factor indicates the future air travel demand that can be accommodated

* Airspace: (Working Paper #7) — A ranking based on a preliminary review of the amount of interaction or conflict that would occur with planes operating to and from other airports or restrictions caused by terrain

* Accessibility: (Working Paper #9) — Measured in terms of the percentage of the region's population that can get to a given site in sixty minutes or less and total travel mileage, this factor indicates convenience and market viability

Economic/Financial Elements - Appendix C

* Capital Costs: (Working Paper #11) — Measured in dollars, this factor indicates the cost to build (including land acquisition and construction)

*	Aircraft Delay Costs: (Working Paper #11)	Measured in dollars per year, this factor indicates the costs incurred due to an airport being operated above its capacity (assuming service reductions are not imposed due to congestion). It can also be used to measure the amount of operational capacity which is available relative to the number of passengers served
*	Funding: (Working Paper #11)	A ratio of the funds which will be generated over a twenty year period and the capital improvement costs, this factor indicates financial viability
*	Economic Impacts: (Working Paper #8)	A ranking based on the level and distribution of economic benefits that would be generated for the region

Institutional Elements - Appendix D

This evaluation element can not be quantified. It involves factors such as the socio-political acceptance of the best alternative and the use of recent or potential new legislation in order to implement and operate the recommended alternative.

The institutional analysis revealed that all of the alternatives could be implemented, but instead of developing a ranking, the results of the analysis were used in the draft recommendations to help develop an action plan for implementing the preferred alternative.

It was also found that the Flight Plan Project Recommendations can become part of the Puget Sound Region's framework for meeting the guidelines of the state's Growth Management Act.

Environmental Elements - Appendix E, Draft Programmatic Environmental Impact Statement

*	Noise Impacts: (Working Paper #12A)	Measured in terms of five different criteria, most important of which is the number of people who would be exposed to a noise level of 65 Ldn or greater
*	Air Quality: (Working Paper #12B)	Measured in tons per year of Carbon Monoxide and Nitrogen Oxides emitted from both vehicles and aircraft

* Wetlands Impacts: (Working Paper #12C) — Measured in acres of wetlands affected
* Salmon Stream Impacts: (Working Paper #12C) — Measured in feet of streams affected

In addition to the above factors, the working papers examined other factors within each of the four categories (operational/technical, economic/financial, institutional, and environmental). However, the above factors were used as the best representatives for each of the elements.

Summary of Evaluation Results

Both the system-level alternatives and the individual sites were evaluated according to the operational/technical, economic/financial, institutional, and environmental factors. Data was collected at the site level and then aggregated for each of the system alternatives. The full details of the analyses can be found in the various working papers in the Appendices.

In order to present the data from the working papers in a concise format, summary tables were prepared. Data summaries at the system alternative level and by site options are presented in Figures 9 and 10 respectively. Following the data summary tables are the important points gathered from the evaluation process.

Operational/Technical Elements

Runway Capacity

The capacity analysis found that Sea-Tac as it is now would not be able to meet the region's air travel needs past the year 2000. Sea-Tac was determined to have a practical capacity of 380,000 take-offs and landings each year. Above this level, delays would begin to rise rapidly. In 1990, Sea-Tac handled 355,000 operations.

It was determined that the best long-term alternative in terms of capacity would be a three-airport system which included Sea-Tac and eventually two supplemental airports. This alternative would provide adequate capacity through the year 2020 and beyond.

FIGURE 9

System Alternatives Data Summary

SYSTEM ALTERNATIVES	OPERATIONAL/TECHNICAL		ECONOMIC/FINANCIAL			ENVIRONMENTAL		
	RUNWAY CAPACITY (1000 OPS) Working Paper 7	ACCESSIBILITY (%POPULATION WITHIN 60 MIN.) Working Paper 9	CAPITAL COSTS ($MILLIONS) Working Paper 11	DELAY COSTS ($MILLIONS) Working Paper 11	JOBS (1000) Working Paper 8	TOTAL POPULATION TO 65 LDN Working Paper 12A	AIR QUALITY (TOTAL TONS/DAY) CO Working Paper 12B	NOX Working Paper 12B
DESCRIPTION (NO. OF INSTRUMENT RWYS)								
SEA-TAC WITH DEM MGT (1)*	380	79	230	4,900	246	7,000	34 - 46	8 - 10
REPLACEMENT AIRPORT (3)	750	22-34	1,564 - 2,078	1,600	310-311	300-2,800	76 - 85	16 - 17
TWO AIRPORT SYSTEMS								
EXISTING SEA-TAC & ONE 1-RWY SUPL (2)	630	79-92	466 - 730	4,900 - 5,100	289-307	8,200	30 - 47	8 - 10
EXISTING SEA-TAC & ONE 2-RWY SUPL (3)	760-880	79-92	474 - 879	4,900	303-307	8,300	30 - 48	8 - 11
SEA-TAC + AC RW & ONE 1-RW SUPL (3)	730	79-92	788 - 1,043	2,500 - 2,900	303-304	13,500	33 - 38	8 - 9
SEA-TAC + AC RW & ONE 2-RW SUPL (4)	860-980	79-92	788 - 1,158	2,500 - 2,900	303-304	14,000	33 - 38	8 - 9
THREE AIRPORT SYSTEMS								
EXISTING SEA-TAC & TWO 1-RW SUPL (3)	880	92-96	788 - 1,028	4,400 - 4,900	305-307	7,900	29 - 36	8 - 9
SEA-TAC + AC RW & TWO 1-RW SUPL (4)	980	92-96	1,086 - 1,362	1,800 - 2,500	303-305	13,600	28 - 35	8 - 9
SEA-TAC + AC RW & TWO 2-RW SUPL (6)	1060-1480	92-96	1,320 - 1,760	1,500 - 2,100	303-305	13,600	28 - 35	8 - 9

*Does not meet projected demand.

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FIGURE 10

Site Options Data Summary

SITES	OPERATIONAL/TECHNICAL			ECONOMIC/FINANCIAL				ENVIRONMENTAL				
	RUNWAY CAPACITY (OPS) Working Paper 7	AIRSPACE (RANK) Working Paper 7	ACCESS (%POP IN 60 MIN) Working Paper 9	CAPITAL COSTS ($MILLIONS) Working Paper 11	DELAY COSTS ($MILLIONS) Working Paper 11	FUNDS/ COST (RATIO) Working Paper 11	ECONOMIC IMPACTS (RANK) Working Paper 8	Ldn65 POP YR 2000 (1000 POP) Working Paper 12A	TOTAL EMISSIONS (TONS/DAY) CO Working Paper 12B	TOTAL EMISSIONS (TONS/DAY) NOX Working Paper 12B	WETLANDS (ACRES) Working Paper 13	SALMON STREAMS (FEET) Working Paper 13
SEA-TAC												
Existing with Dem. Mgt.	380,000	2	79	230	4,000	4	2	7	46	10	0	0
New Air Carrier Runway	480,000	2	79	618	1,500 - 2,900	2 8-3 1	2	11 8-13 0	25 - 30	8 - 8	0	0
ARLINGTON												
One Runway	250,000	2	14	156 252	30 - 50	0 8-1 4	3	0 1 0 7	3	1	0	0
Two Runways	500,000	2	14	201-358	30 - 50	0.7-1 1	3	0-0 5	3	2	0	0
McCHORD AFB												
One Runway	250,000-	4	39	138-263	30 - 50	1 5	2	0 1 0 8	2	1	2	0
Two Runways	250,000	5	39	170-294	30 - 50	1.1-1.4	2	0 1 0 8	2	1	2	0
PAINE FIELD												
One Runway	250,000-	3	46	427-540	20 - 50	0 4 0 7	3	0 1 1 2	6	.1	35	0
Two Runways	500,000-	6	46	523-645	20 - 50	0.4-0 6	3	0 1-1 3	6	.1	35	0
CENTRAL PIERCE												
One Runway	250,000	4	34	319 415	30 - 50	0 7 1 0	1	0 0 5	3	1	0	0
Two Runways	500,000	6	34	542-600	20 - 50	0.4-0 6	1	0 0 5	3	1	3	0
Three Runways	750,000	2	34	2078	1,600	1 3	2	2 8	70	16	28	0
OLYMPIA/BLACK LAKE												
One Runway	250,000	1	22	314 433	30 50	0 4 0 9	2	0 0 1	11	2	0	2,000
Two Runways	500,000	1	22	364-625	30 - 50	0 4-0 7	2	0 0 1	13	3	36	7,000
Three Runways	750,000	1	22	1800	1,600	1 5	3	0 3	85	17	81	21,600
FT. LEWIS												
Three Runways	750,000	4	34	1564	1,600	1 8	2	1 3	70	16	0	4 000

Accessibility/Demand

A three-airport multiple airport system was found to best serve regional demand because it would provide the greatest number of sites from which people could get airline service.
Supplemental airport sites which are relatively close to the region's centers of population (Sea-Tac, Paine Field, McChord, Central Pierce, Fort Lewis) are expected to capture a larger market in a more reasonable time frame than those sites which are relatively more distant (Arlington and Olympia/Black Lake).

The accessibility of replacement airport sites is worse than for any other option due to the lack of suitable sites close to the region's population.

In terms of integration with other forms of transportation, Sea-Tac, Paine Field, and McChord are the best. These sites are most proximate to the Interstate 5 corridor and are accessible to rail lines, harbors, and highways. In addition, Sea-Tac and Paine are the only sites which are being considered for service by the proposed regional light rail system.

Airspace

No single metric exists which can be used to evaluate airspace issues. Rather, airspace can be classified along a continuum of workable to non-workable which is defined by the type of airspace restrictions and problems that may be encountered. As a result, the Flight Plan consultant identified the various airspace conflicts that would occur if commercial airline service were started at any of the airport sites and developed a ranking.

It is important to note that although conflicts may be present, it does not mean that the airspace cannot be made to work. The level of analysis conducted in Flight Plan did not look at specific solutions to airspace conflicts.

In general, the most constricted airspace occurs over the Pierce County sites due to interaction with current military activities at McChord Air Force Base and at Fort Lewis and due to constraints caused by Mt. Rainier and the Cascade foothills.

Economic/Financial Elements

Capital Costs

In terms of capital costs alone, the most expensive alternative is a replacement airport with the alternative of doing nothing being the least expensive.

Delay Costs

The most expensive alternatives in terms of delay costs involve doing nothing at Sea-Tac or Sea-Tac with Demand Management alone. Overall, delay can best be reduced with a replacement airport since it would be built large enough to accommodate all of the demand placed on the regional system. Other than the replacement airport, the alternate that reduces delay the most is the three-airport multiple airport system.

Delay can also be significantly reduced with a dependent runway at Sea-Tac since Sea-Tac's capacity would then be in line with the demand being placed upon it. A new dependent runway is needed at Sea-Tac to meet short-term demand that is forecast by the year 2000. However, even after 2000 when a supplemental airport would be in service, the new dependent runway will continue to be needed to meet the demand for air service at Sea-Tac since the regional market will still be focused at Sea-Tac.

Funding

In terms of overall costs (capital and delay costs), a phased three-airport multiple airport system is the least expensive because it reduces delay costs and has only moderate capital costs.

Supplemental airports may not be financially self-supporting in the short term, but some forms of funding support and/or subsidy measures may be available (potentially from Sea-Tac).

Economic Impacts

Airport activity leads to two basic types of economic impacts: 1) an increase in jobs, sales, and tax revenues and 2) maintenance and enhancement of the Puget Sound Region's strong position in national and global markets. A do nothing approach would harm the region's and the state's economy because it does not provide the high-quality air service needed to attract and retain higher-wage employers.

A phased three-airport system provides the highest total economic benefits to the region and distributes the benefits to the most communities. A three-airport system in which Sea-Tac has a new dependent runway ranks the best because it: 1) optimizes the use of existing facilities which are closest to the region's centers of population, 2) strengthens the region's ability to compete for global air-dependent commerce, and 3) preserves the best air connections to other airports throughout the State of Washington.

Environmental Elements

Noise Impacts

Noise at Sea-Tac will be significantly reduced because of a quieter aircraft fleet using the airport in the coming decade (nearly 100 per cent Stage III by 2001). Noise at Sea-Tac will be further reduced if supplemental airports are used because it will be required to handle less traffic than it otherwise would. Under a do nothing alternative at Sea-Tac, air traffic would be forced into more noise sensitive times of the day.

Using sites that currently handle jet aircraft operations minimizes the amount of people newly exposed to aircraft noise.

A multiple airport system distributes the single event noise across the region, but with a lower number of events at each site.

Total Air Emissions

The two primary sources of air pollutant emissions under all of the alternatives are cars and aircraft. Multiple airport systems with close-in supplemental airports have the greatest accessibility and therefore reduce somewhat the total amount of vehicular emissions. If a regional rail transit system is implemented, fewer vehicle trips would be generated by passengers and airport employees and emissions would be further reduced. Also, since multiple airport systems reduce the amount of aircraft delay, emissions from this source are also reduced.

Since possible replacement airports are less accessible, they increase vehicle miles traveled and the amount of vehicular emissions.

Wetlands, Salmon Streams and Other Natural Environment

Alternatives at undeveloped sites tend to have the highest natural environmental impacts related to wetlands, salmon streams and other flora and fauna habitats. Locating airports in developed areas protects rural areas and decreases the loss of open space. Sites without existing airports are also subject to the greatest land use changes if a new airport is built.

In order to facilitate the comparison of the data in the summary tables (Figures 9 & 10), letter "grades" were assigned to each alternative and site according to each of the evaluation factors. These grade sheets are presented in Figures 11 & 12.

Both the data summary tables and the grade sheets were used by the PSATC to help choose a preferred alternative and secondary alternatives for analysis in the Draft Programmatic Environmental Impact Statement.

FIGURE 11

System Alternatives Comparative Summary

SYSTEM ALTERNATIVES	OPERATIONAL/TECHNICAL		ECONOMIC/FINANCIAL			ENVIRONMENTAL	
DESCRIPTION (NO. OF INSTRUMENT RWYS)	RUNWAY CAPACITY Working Paper 7	ACCESSIBILITY Working Paper 9	CAPITAL COSTS Working Paper 11	DELAY COSTS Working Paper 11	ECONOMIC IMPACTS Working Paper 8	NOISE Working Paper 12A	AIR QUALITY Working Paper 12B
SEA-TAC WITH DEM MGT (1)*	D	B-	A	D	D	B	A
REPLACEMENT AIRPORT (3)	C	D-	D	A	D	A	D
TWO AIRPORT SYSTEMS							
EXISTING SEA-TAC & ONE 1-RWY SUPL (2)	C-	B	B+	D	C	B	B+
EXISTING SEA-TAC & ONE 2-RWY SUPL (3)	C-	B	B	D	C	B	B
SEA-TAC + AC RW & ONE 1-RW SUPL (3)	C	B	B-	C-	B	B	B-
SEA-TAC + AC RW & ONE 2-RW SUPL (4)	B	B	B-	C	B	B	B-
THREE AIRPORT SYSTEMS							
EXISTING SEA-TAC & TWO 1-RW SUPL (3)	C-	A	B-	C-	A	B-	B
SEA-TAC + AC RW & TWO 1-RW SUPL (4)	B	A	C-	B	A	B-	B
SEA-TAC + AC RW & TWO 2-RW SUPL (6)	A	A	C-	B+	A	B-	B

** Does not meet projected demand.*

FIGURE 12

Site Options Comparative Summary

SITES	OPERATIONAL/TECHNICAL			ECONOMIC/FINANCIAL				ENVIRONMENTAL	
	RUNWAY CAPACITY Working Paper 7	AIRSPACE Working Paper 7	ACCESS Working Paper 9	CAPITAL COSTS Working Paper 11	DELAY COSTS Working Paper 11	FUNDS/ COST Working Paper 11	ECONOMIC IMPACTS Working Paper 8	LdN 65 POPULATION Working Paper 12A	OTHER Working Papers 12b, 13
SEA-TAC									
Existing with Dem. Mgt.	B-	B	A	A	D	A	B	C	A-
New Air Carrier Runway	B	B	A	C	C	A	B	C-	B+
ARLINGTON									
One Runway	C	B	D	A	A	B	C	B+	A
Two Runways	B	B	D	B	A	B	C	A-	A
McCHORD AFB									
One Runway	C-	C-	B-	A	A	B	B	B+	A-
Two Runways	C	D	B-	A	A	B	B	B+	A-
PAINE FIELD									
One Runway	C	C	B	C	A	C	C	B	B+
Two Runways	B	D	B	C	A	C	C	B	B+
CENTRAL PIERCE									
One Runway	C	C-	C	B	A	B	A	A-	A
Two Runways	B-	D	C	C	A	C	A	A-	A-
Three Runways	A	B	C	D	C	B	B	C	C+
OLYMPIA/BLACK LAKE									
One Runway	C	A	C-	B	A	C	B	A	A-
Two Runways	B	A	C-	C	A	C	B	A	B
Three Runways	A	A	C-	D	C	B	C	A-	D
FT. LEWIS									
Three Runways	A	C-	C	D	C	B	B	B-	C

Public Hearings on the Draft Recommendations and Draft Programmatic EIS

During late January and early February, a series of eight public hearings will be held in King, Pierce, Snohomish, Thurston, and Kitsap Counties to gather public testimony on the draft recommendations and on the Draft Programmatic Environmental Impact Statement. After considering the comments received at the hearings and by mail, the PSATC will finalize its recommendations and a Final Programmatic EIS will be prepared. It is expected that the PSATC will present its final recommendations to the Puget Sound Regional Council and the Port of Seattle for adoption and action in April.

PUBLIC INVOLVEMENT

One of the components of the Puget Sound Air Transportation Committee's Mission Statement was to develop a recommendation that merits and attracts broad public support of the Committee's recommendations by involving citizens in the Flight Plan Project. To this end, a wide variety of means were used to keep citizens informed on what was happening with the Project and to allow them the opportunity to provide input to the Committee and to help shape the recommendations. The outreach activities of the PSATC were guided by the Public Involvement Subcommittee. An overview of each of the public involvement tools used is presented below.

Informational Outreach

Newspaper Supplement

To assist in informing citizens about the PSATC's draft recommendations and how comments can be made, a newspaper supplement will be inserted in weekday editions of fifteen papers throughout the region (including the Seattle Times, the Seattle Post Intelligencer, the Bremerton Sun, the Everett Herald, the Tacoma News Tribune, and the Olympian). The supplement will be released in mid-January and will provide background information on the Flight Plan Project and will outline the PSATC's draft recommendations as they are presented in this report. Dates and places for public hearings on the Flight Plan draft recommendations and Draft Programmatic EIS, as well as where written comments can be sent, will also be announced.

Newsletters

The PSATC produced six newsletters over the course of the Flight Plan Project which discussed major milestones of the Project, important study findings, and announced upcoming Committee meetings and other forums through which citizens could give the PSATC feedback. Newsletters were distributed to the Project's mailing list and included approximately 4300 citizens, community and business leaders, and local and state elected officials. Two additional newsletters are planned for 1992.

Slideshow

Two slideshows were prepared which discussed the nature of the air capacity problem facing the region and the alternatives being explored by the PSATC. Staff presented the slideshows to numerous civic and community groups, clubs, representatives of local and state governments, and other organizations. The slideshows were a concise and consistent way to educate and inform.

Ongoing Briefings

Flight Plan Committee members and staff met with a wide range of community groups, business leaders, the press, and representative of governments to discuss the Project. The slideshows, newsletters, and detailed Project summaries were often used to provide extensive background information.

Press Releases and Media Contact

Before each PSATC meeting, media advisories were sent to reporters and editors throughout the region. Project staff spoke regularly with area reporters to keep them abreast of the Project issues.

Press releases were issued to announce major PSATC decisions and clippings of relevant articles were distributed to all PSATC members. In addition, two media "brown bag lunches" were held, one during Phase II and one during Phase III. At the lunches, the staff provided detailed technical information to the media and answered questions.

Constituent Services

A full-time public involvement coordinator was available to respond to questions and requests for information both by phone and in writing. Several hundred citizens utilized this service.

Collection of Public Input

Public Open Houses/Scoping Meetings

During November of 1990, a series of six public meetings were held throughout the region to provide citizens with the opportunity to comment on the system alternatives and sites being considered, to suggest other alternatives, and to identify the environmental impacts that should be addressed in the Draft Programmatic EIS. The meetings were conducted in an open house format and provided citizens the opportunity to submit scoping comments for the Project's Draft Programmatic EIS. Notice of the scoping meetings and the address for scoping comments were published in the Seattle Times, the Seattle Post Intelligencer, the Tacoma News Tribune, the Everett Herald, and the Bremerton Sun.

Public Meetings

At the end of Phase II of the Flight Plan Project, the PSATC developed a draft list of alternatives that it considered might be feasible. Before a final set of alternatives was chosen for indepth analysis, the PSATC held four meetings throughout the region in March and April of 1991 to gather testimony from citizens and agencies. Over 150 people testified at the meetings and over 200 written comments and letters were received.

To provide citizens with the opportunity to comment on the PSATC's draft recommendations and on the Draft Programmatic Environmental Impact Statement, a series of eight public hearings will be held in late January and early February. Citizens may also comment in writing.

Focus Groups

Focus groups provide a format for gauging public opinion by inviting a random group of people to speak candidly on an issue. Two sets of focus groups were held for the Flight Plan Project. The first set of focus groups were held in late 1989 and the second set were held in October 1991. The purpose of the focus groups was to provide the PSATC with an indication of the public's feelings on our air transportation system and to help the PSATC be more aware of citizen's concerns.

Public Opinion Survey

Along the same goals as the focus groups, a public opinion survey on the region's air transportation system was conducted in December of 1990. The survey was conducted by phone and was designed to provide a representative sample of public opinion. The results were presented to the PSATC in January of 1991.

APPENDICES

APPENDIX A

EVALUATION METHODOLOGY

WORKING PAPER # 2

PRESENTED
JULY 25, 1991

ADOPTED
AUGUST 15, 1991

THE FLIGHT PLAN PROJECT PHASE III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

DATE: July 13, 1991

TO: Puget Sound Air Transportation Committee

FROM: P&D Aviation

SUBJECT: **WORKING PAPER NO. 2 - EVALUATION METHODOLOGY**

INTRODUCTION

This document presents the consultant's proposal of an evaluation methodology to be applied to alternative airport development plans selected and identified in Phase II of Flight Plan. Phase III will apply a more detailed evaluation of the alternative plans with the objective to identify the best plan to adopt and implement.

Evaluation is a planning process that measures the relative conformance of alternatives to a set of common factors. The factors are either those that can be measured or those that cannot. Measurable or quantifiable factors are expressed in monetary units or other measures of quantity such as size, weight, volume, etc. The non-measurable or qualitative factors are generally expressed according to a relative position on a rating scale that is either weighted or not weighted.

It is important that quantifiable evaluation factors be calculated to the same degree of accuracy for all alternatives because the methodology depends on comparative differences rather than absolute values. In the case of qualitative factors, a rating scale of 1 to 7 (based on the number of strategies) may be used to rate conformance of each strategy to the factor. Since there will be several qualitative factors, some planners prefer to place greater importance on certain factors by placing a weighting value to those factors. This approach may increase the subjectivity of a process that is already subjective.

Following this introduction section are discussions pertaining to a proposed evaluation methodology that embraces the following broad subject areas:

- Operational
- Environmental
- Economic
- Institutional
- Financial

OPERATIONAL FACTORS

Operational factors, generally, can be quantified. They have to do with comparative costs of the alternative plans with respect to operational costs of the users and the providers. Operational costs cover the expenses of the airlines, the airport sponsor, the passengers and other users of the airport and related agencies responsible for infrastructure development and air traffic control. Set out below are the significant operational factors to be considered in the evaluation process.

A. AIRCRAFT DELAY COSTS

Airlines may incur additional aircraft operating costs due to the ability (capacity) of each alternative to handle traffic and the associated delay consequences. These additional aircraft operating costs can be quantified by multiplying the delay hours (hours in addition to normal operating time) by the hourly operating cost of each aircraft subject to delay.

B. AIRLINE STATION COSTS

The cost of operating an airline station is more or less proportional to the passenger and baggage demand processed. This cost can be varied depending upon the efficiency of the station. For instance, if the same number of passengers must be processed at two stations instead of a single station (multiple airport system vs. single airport), there is a certain amount of redundancy in personnel and equipment which will increase the station cost per passengers processed. Therefore, a comparative airline station cost can be calculated for the alternative plans to be evaluated.

C. AIRPORT MANAGEMENT AND OPERATING COSTS (M&O Costs)

Airport M&O costs will vary proportionally to the extent of facilities to be maintained and operated. These can be calculated for each alternative plan evaluated.

D. GROUND TRAVEL COSTS (of Passengers)

The cost of traveling to the airport from the originating passenger's point of origin within the region can vary depending upon the location of the airport within the region. The ground travel cost has two components: the vehicle operating cost and the value of the passenger's time in the duration of the ground trips. The latter component is difficult to quantify while the vehicle operating cost is an easily calculable quantity. It is recommended that the value of the passenger's time be disregarded in the calculation of the ground travel cost factor.

E. AIR TRAFFIC CONTROL COSTS (ATC)

ATC costs involve the expenses of FAA to provide personnel and equipment to control air traffic in the region. It is obvious that ATC costs will be less if all commercial operations are conducted at a single airport. A multiple airport system is bound to increase ATC costs in terms of both personnel and equipment and can be calculated for each alternative plan evaluated.

F. SATISFACTION OF DEMAND

This operational factor is the most difficult to quantify. Most likely, it should be evaluated on a rating scale varying between yes to no. The range of the scale should be on the order of 1 to 7 where "1" is total satisfaction of demand and "7" is the worst satisfaction of demand.

G. CONCESSION COSTS

This factor involves the concession's income derived from the population (passengers, employees, visitors and vendors) that inhabit the airport. This population more or less is a stable number; however, if it is dispersed over more than one airport, then the cost to service the population by the concessionaires will increase. This can be calculated for each alternative evaluated.

H. INFRASTRUCTURE COSTS

The decision for airport facilities to serve the region well into the 21st Century will have ramifications on the costs to provide infrastructure facilities such as utilities, roads, public transit, etc., to serve the airport system. These costs may or may not be passed on to the airport sponsor, but nevertheless, the costs will vary for each alternative being evaluated and can be quantified.

I. EXPANDABILITY OPTIONS

The world won't come to an end at the end of the forecast period; therefore, an expandability factor similar to the one used in the Phase II evaluation should be considered in the operational factor evaluation. This cannot be quantified and should be rated on a rating scale varying between yes and no. The range of the scale should be on the order of 1 to 7, where "1" is excellent expandability and "7" is the worst case of expandability.

J. TIMING

This factor concerns the practicability of attaining the needed capacity to accommodate demand throughout the forecast period and beyond. This factor should consider both the short and long term needs and most likely should be evaluated on a rating scale varying between yes and no. The range of the scale should be similar to the other rating scales varying between 1 to 7, with "1" being consistent with the needs schedule and "7" being an unsatisfactory schedule.

ENVIRONMENTAL FACTORS

Since Phase III of Flight Plan includes a more detailed environmental analysis of proposed alternative airport development options, a more detailed evaluation analysis can be prepared. Evaluation factors concerning aircraft noise impacts and degradation of air and water quality, biotic communities, wetlands, floodplains and park lands can be assessed for each alternative plan evaluated. Each environmental factor will be evaluated on a rating scale varying between compliance and non-compliance. The range of the scale should be similar to the other rating systems varying between 1 to 7 with "1" being of no consequential impacts (FONSI) to "7" being severe impacts.

A. NOISE

Based upon the forecast of aircraft operations, airport noise contours should be developed for each plan using the FAA Integrated Noise Model (INM) to project the noise exposure associated with each alternative. The contours will be generated in the Day-Night Average Sound Level L_{dn} metric. The contours will delineate the various areas of noise exposure, and once defined it will be possible to identify noise sensitive land uses and populations lying within the noise zones. This traditional noise contour analysis should be supplemented by categorization of populations prior to exposure to aircraft noise and a single event analysis.

The single event analysis should include existing population with prior experience to aircraft noise, population that would be newly exposed to noise, population that would be exposed to a new type or level of aircraft operations, and population that would be exposed to an increase in noise level of 1.5 dBA or greater. Often the single event noise levels are better indicators than L_{dn} when adverse community response is likely to occur. The population exposed to single event noise levels above 80 SEL should be identified.

The major parameters to be considered in the evaluation of noise impacts are highlighted below.

1. Change in population within L_{dn} noise zones for the following population categories:
   - Total population
   - Population newly exposed to aircraft noise
   - Population that would experience a change in types of operations
   - Population that would experience an increase in noise over 1.5 dBA

2. Change in population within SEL contour levels for the following population categories:
   - Total population
   - Population newly exposed to aircraft noise
   - Population that would experience and increase in noise or operations

- New population that would experience single event levels 20 dBA over background levels

B. AIR QUALITY

Emissions will be generated and certain volumes associated with each plan due to aircraft operations, ground traffic, combustion of natural gas and the generation of electricity. The emissions generated by these sources can be quantified and compared to regional and subregional emissions to assess the potential for air quality impacts.

C. WATER QUALITY

Development of airport facilities may impact nearby rivers, streams, lakes or wetlands and the impact can vary from plan to plan. The extent of impacts associated with each plan should be assessed for comparative ranking of environmental factors.

D. WETLANDS/FLOODPLAINS

The impacts of airport development on these environmentally sensitive areas can be estimated and quantified by determining the area of wetlands for airport development and determining location of construction with respect to floodplains and the flood history of applicable water courses.

E. PARK LANDS

The impacts of airport development on these resources can also be quantified by estimating acreage required for airport development and removed from park or recreational use, and wildlife/waterfowl reservations.

ECONOMIC FACTORS

These evaluation factors can readily be quantified in terms of monetary values. Task 5B of the Phase III work program produces economic/financial analysis that will form the basis of the economic evaluation factors. These are:

A. CAPITAL COSTS

The cost to provide the needed airport capacity can be readily quantified. Order of magnitude capital costs will be calculated for each alternative plan. These will provide a common economic basis for comparison of the alternatives.

B. ECONOMIC EVALUATION

Several analyses will be undertaken with regard to each alternative plan. These are economic evaluations dealing with the positive and negative impacts of each alternative concerning job creations and revenue generation, analysis based upon other airport examples, and input-output analyses. The analyses will include direct impacts of employment, payroll expenditures of locally purchased goods and services. Indirect and induced impacts will be calculated for each alternative. This will include employment, household earnings and total output (value added). This will also include the tourist impacts including number of tourists, their expenditures and jobs created. The analysis will also address the relative "cost of doing business" and the variances in alternatives between promoting or discouraging business activity. Another consideration will be the growth inducing affects on the communities caused by the various strategies. These factors will be evaluated on a rating scale varying between 1 to 7 with "1" being of no consequential economic impacts and "7" being severe economic impacts.

INSTITUTIONAL IMPACTS

This evaluation factor cannot be quantified. It involves the socio-political acceptance of the best alternative and the potential need for new legislation in order to implement the recommended alternative. It has to be evaluated on a rating scale varying between politically acceptable, with a rating of "1", and non-acceptable with a rating of "7". In this sense, politically acceptable infers no serious public objection to the alternative and the ability to enact new legislation if necessary to implement the alternative plan.

FINANCIAL FACTORS

The factors to be considered are the capital costs, the sources of funds. and the shares of the cost to be financed as well as estimates of revenue generating ability. These factors can be quantified for each alternative to be evaluated.

EVALUATION METHODOLOGY SUMMARY

Normally, evaluation of alternatives involves a two step process. A preliminary screening is undertaken initially to eliminate all but the most feasible alternatives. This is followed by a more detailed comparative evaluation of the surviving alternatives. In the case of Flight Plan, Phase II accomplished the preliminary screening; therefore, Phase III will produce the detailed evaluation of the alternatives that survived Phase II. This detailed evaluation may be iterative to allow serious flaws to be addressed and alternative strategies to be refined and improved.

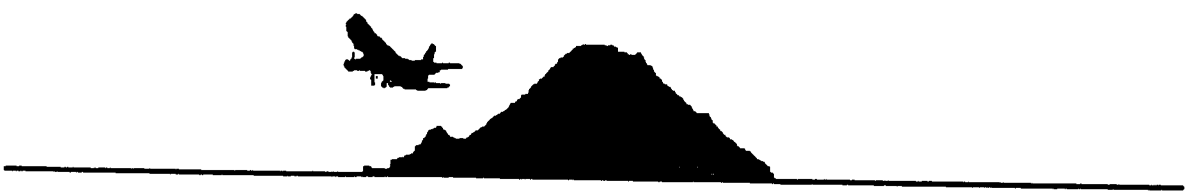
A decision must be made concerning the treatment of the qualitative factors as to whether a weighting system should be applied and if so, what are the relative weights. This may be put before the PSATC for a decision.

The results of the comparative evaluation shall be summarized in a two dimensional matrix to facilitate an understanding of the analyses and a ranking of the alternatives. A by-product of the evaluations and ranking will be an action plan for the recommended strategy. This action plan will outline future steps necessary to implement the recommendation. Included in the action plan will be a discussion of the various institutional issues needing to be addressed.

APPENDIX B

OPERATIONAL/TECHNICAL ELEMENTS

WORKING PAPERS # 1, 4, 6, 3, 5, 7, 9



WORKING PAPER #1

BOEING FIELD AIRSPACE REVIEW

PRESENTED
JULY 25, 1991

ADOPTED
AUGUST 15, 1991

THE FLIGHT PLAN PROJECT PHASE III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

DATE: July 11, 1991

TO: Puget Sound Air Transportation Committee

FROM: P&D Aviation

SUBJECT: **WORKING PAPER NO. 1 - BOEING FIELD AIRSPACE REVIEW**

SUMMARY

The use of Boeing Field as a commercial airport site is not recommended from an airspace point of view due to complexities which result from its proximity to Sea-Tac. The airspace interaction between the two facilities has resulted in development of air traffic control procedures unique to Seattle. The procedure accommodates present traffic volumes but future effectiveness under increased traffic generated by commercial flights at BFI is uncertain. Additionally, since this is a newly developed, site specific procedure, the possibility of the procedure being abandoned is greater than standard procedures commonly applied to other airports. These uncertainties create an element of risk which diminishes the attractiveness of the BFI commercial service alternative. It is further noted that additional traffic in the limited terminal airspace will increase congestion, thus resulting in increase aircraft operating costs to airlines.

INTRODUCTION

King County/Boeing Field (BFI) is located approximately 4 miles north of Sea-Tac (SEA). The proximity of the two airports combined with their non-parallel runway alignments results in air traffic interactions. The effects of these interactions have been the subject of several previous studies and it is not the intent of this paper to redocument the full extent of this work. Rather, it is the purpose of this paper to review, update and summarize previous information to determine if the airspace interaction between BFI and SEA precludes Boeing Field from being considered as a site for a supplemental regional airport. For the purposes of this analysis it is assumed this type of airport (e.g., BFI) would provide scheduled air service to Pacific Northwest, California and some national hub airport (i.e., Salt Lake City, Denver) destinations.

EXISTING INTERACTIONS

The airspace interactions pertain primarily to operations conducted during conditions when the cloud ceilings are less than 2,500 feet. These conditions necessitate the provision of mandated traffic separation and sequencing by air traffic controllers. In south traffic flows (which occur approximately 70 percent of the time) the final approach courses for arrivals to SEA and BFI converge.

Further, the instrument landing system (ILS) approach to Runway 16R at Sea-Tac crosses Boeing Field's approach path to Runway 13R. During IFR south traffic flows, this convergence causes occasional delays to Sea-Tac arrivals in the event of a missed approach at Boeing Field. Additionally, Boeing Field approaches may be delayed due to circuitous routing.

During north traffic flows in IFR conditions Boeing Field arrivals impact Sea-Tac departures. As a Boeing Field arrival nears the final approach fix, located just east of Sea-Tac, departures at SEA are held on the ground until the BFI tower reports the landing is assured or until visual separation can be provided. This reduces departure capacity at Sea-Tac (approximately 3 percent of the time).

The interaction between the airports is a result of minimum separations required by FAA for aircraft on IFR flight plans. In a radar controlled environment such as exists at Sea-Tac, aircraft not separated horizontally by at least three miles must be provided with 1,000 feet of vertical separation.

Figure 1 presents an illustration of ILS approaches to the airports in south traffic flows. A separation of three miles exists between the two approach paths at the Nolla intersection, which is the final approach fix for BFI. However, as a BFI arrival passes Nolla, the radar separation from a Sea-Tac approaching aircraft may be lost. Thus, 1,000 feet of vertical separation must then be maintained.

A. PLAN ALPHA

During certain VFR conditions, vertical separation is provided by a Boeing Field controller. During these conditions the 1,000 foot vertical separation between aircraft must be maintained and the Boeing Field tower controllers must have both aircraft in sight to provide visual separation. Generally, this is possible when ceilings are no lower than 2,500 feet. This procedure is known as "Plan Alpha".

B. NO PLAN ALPHA

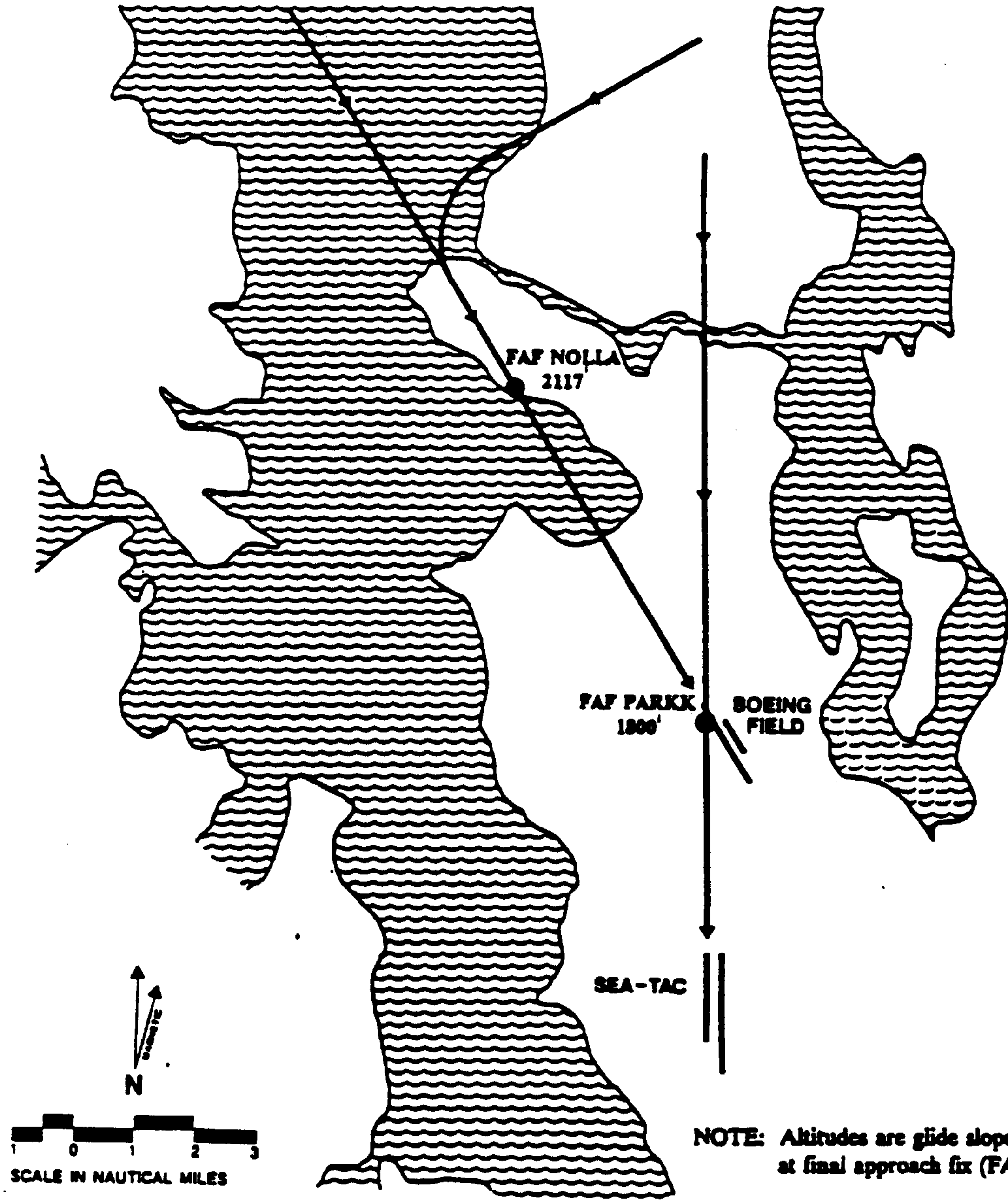
When ceilings are below 2,500 feet and separation by the Boeing tower controller is not possible, vertical separation becomes the responsibility of TRACON (Terminal Radar Approach Control). The TRACON is an FAA air traffic control facility that uses radar capabilities to provide various traffic control services (such as providing separation from other aircraft and sequencing the flow of arrivals to an airport) to aircraft arriving or departing from major air carrier airports such as SEA. The provision of vertical separation by TRACON in these certain VFR periods, in essence is the same as during actual IFR conditions. The monitoring TRACON controller can override other ATC instructions to maintain separation. During these VFR "No Plan Alpha" periods, Boeing Field arrivals are subject to increased delays as SEA arrivals have a higher priority for landing.

C. RECENT IMPROVEMENTS

Since late 1989 improved procedures have been developed which allow concurrent approaches to occur during conditions when the ceiling is below 2,500 feet. The procedures are site specific

FIGURE 1

EXISTING INSTRUMENT APPROACHES SOUTH FLOWS



NOTE: Altitudes are glide slope altitude at final approach fix (FAF).

and unique to the situation created by SEA and BFI. The vertical separation between aircraft (1,000 feet) is ensured by a TRACON controller that monitors the approaches on a radar scope. This controller position in the TRACON is unique to the Seattle approach as the sole purpose of this position is to monitor the approaches. With these procedures, approaches can be conducted simultaneously to both airports and the arrival capacity of Sea-Tac is not degraded unless a missed approach is declared at Boeing Field or the controller believes that required separation cannot be maintained. In these cases, any conflicting SEA traffic will be vectored out of the Sea-Tac approach path and resequenced in the arrival stream. This procedure eliminates traffic conflicts but results in a lost arrival slot to Sea-Tac. TRACON personnel estimate there have been approximately five missed approaches at BFI that impacted a Sea-Tac arrival since this monitored procedure has been in place. The delay incurred by affected Sea-Tac traffic will vary depending upon the volume of traffic in the terminal area but can be estimated to average 15 to 20 minutes per aircraft. The added delay allows for the aircraft to leave the approach path, return to the arrival flow and then land at SEA. Thus, based on the number of occurrences estimated by TRACON personnel, this procedure has reduced the annual delay resulting from this conflict to about 2 hours per year. The present procedure can accommodate the current, relatively moderate, volume of approaches. However, increases in approaches to both airports could result in potential loss of effectiveness due to demands on the monitoring position.

FUTURE OPERATIONS

The issue resulting from potential commercial flights at Boeing Field is not that the Sea-Tac arrival capacity is reduced since the low frequency of BFI missed approaches minimize these impacts. However, there are several important issues that must be considered when evaluating BFI as a commercial airport.

A. EFFECT OF INCREASED TRAFFIC

The first centers on the feasibility of continuing the procedure under increased traffic loads. As stated above, it has been seen from past performance that the current procedures can accommodate the present traffic volumes, however, the feasibility of accommodating higher traffic levels is uncertain. Ultimately, traffic would reach a point which would exceed the monitoring position capability.

B. FUTURE VIABILITY

The second aspect relates to the possibility of the present procedure being canceled. This could result from a mishap (such as inability to maintain the 1,000 foot separation), or a change in the FAA administration and philosophy. The present procedure was specifically developed for Seattle and obtained approvals from the highest levels of FAA, but since it is a singular, site specific approach, the possibility for elimination is greater than for traditional procedures commonly applied at other airports. While the cancellation of the procedure is not expected, the possibility will always exist. As such, developing a commercial airport system to serve the region, based on this potentially vulnerable procedure would possess risk, and jeopardize the continued viability of the BFI alternative.

If the procedure were eliminated, then operations would revert to former control methods. Under former procedures, SEA arrivals were subject to greater delays since an arrival "slot" for Sea-Tac was left open for every approach to BFI. This was done to maintain the required separation and guard against a missed approach at BFI. Since approaches could not be conducted concurrently, there was a greater impact on SEA traffic.

C. AIRSPACE CONGESTION

An additional factor that must be considered is that under the present procedures Boeing Field arrivals would be subject to delay during certain VFR conditions as a result of potentially having a lower priority than SEA arrivals. Under a scenario where a portion of Sea-Tac commercial operations are shifted to Boeing Field, these flights would incur more delays than if they remained at Sea-Tac.

More important is the fact that incremental increases in delay will occur due to additional demand placed upon the limited airspace serving the two airports. Previous simulation results indicated an incremental increase in delay of 0.05 minutes will occur for each additional flight under IFR conditions at a demand level of 382,500 annual operations. If it is assumed that Boeing Field adds 25 percent of the 1990 Sea-Tac commuter operations (approximately 36,900)[1], the contribution of the approximately 50 additional arrivals per day to average annual delay would be 0.125 minutes per operation. At Sea-Tac traffic levels of 382,500 annual operations this would result in almost 800 hours of additional delay and added annual costs to the airlines of approximately $1.3 million.[2]

D. MLS TECHNOLOGY

The focus of this analysis has been on procedural, or operational aspects, of the interaction. There are also other aspects that might be considered and one example would be the installation of a microwave landing system (MLS) at SEA. This is a new instrument landing aid which will permit curved and dog-leg instrument approaches versus the straight approach limitations of current instrument landing systems (ILS). FAA plans to ultimately transition and replace all ILS

[1]Based on 6 months (January-June 1990) data.

[2]Based on an average direct operating cost of $1,600 per hour.

with MLS, but the implementation schedule has been frequently extended. Present schedules suggest that transition to the MLS can be expected soon after the year 2000. With the installation of an MLS at Sea-Tac it would be theoretically possible to conduct simultaneous approaches to both airports by developing a curved approach procedure for SEA. Such a procedure would parallel the present final approach to BFI, then turn to the south to align with the SEA runway for final approach and landing. While this may seem like a likely solution to the present situation, there are a number of factors to consider such as the status of the MLS program, development of acceptable approach procedures and environmental concerns (it is noted that an MLS approach could increase overflights and noise over densely populated areas).

COMPARISON WITH OTHER METROPOLITAN AIRPORT SYSTEMS

To provide a broader perspective of the Boeing Field commercial use alternative, a comparison is made to other U.S. multi-commercial airport examples. The examples selected for comparison are characterized by metropolitan areas served by comparatively close commercial airports. Table 1 presents the survey data indicating runway orientation and distance of secondary airports from the primary airport.

As seen in Table 1, New York's LaGuardia and Kennedy Airports are only ten miles apart and are the closest of the commercial airports surveyed. The average distance between airports is about 23 miles. Aside from distance, ***it is important to note the runway orientations, for the most part, permit non-converging traffic flows.*** This is the major difference between Seattle and the airports surveyed. Regarding orientation, runways are designated (numbered) to indicate magnetic heading, i.e. Runway 4 is 40°, Runway 22 is 220°. This example would be a runway aligned northeast-southwest. Therefore, runways shown in Table 1 with the same, or numerically close, designation indicate similar alignments which facilitate parallel approaches. Parallel approaches promote compatible traffic flows, compared to conflicts caused by converging approaches.

TABLE 1
COMPARISON OF COMMERCIAL AIRPORT SYSTEMS IN THE U.S.

Airport	Runway Orientation	Dist. from Primary Apt.
New York		
Kennedy	4/22	N/A
	13/31	
LaGuardia	4/22	10 miles
	13/31	
Newark	4/22	20 miles
	11/29	
Los Angeles		
LAX	6(7)/24(25)	N/A
Burbank	8/26	18 miles
	15/33	
Ontario	8/26	48 miles
Orange County	1/19	36 miles
Long Beach	12/30 (primary)	17 miles
San Francisco		
SFO	10/28	N/A
	1/19	
Oakland	11/29	11 miles
	9/27	
San Jose	12/30	30 miles
Chicago		
O'Hare	14/32	N/A
	9/27	
	4/22	
Midway	4/22	17 miles
	13/31	
Miami		
Miami International	9/27	N/A
	12/30	
Fort Lauderdale	9/27	21 miles
	13/31	
Washington, D.C.		
National	18/36	N/A
	15/33	
Dulles	1/19	25 miles
	12/30	
Baltimore-Washington	15/33	32 miles
	10/28	
	4/22	
Dallas		
DFW	18/36	N/A
	13/31	
Love Field	13/31	12 miles
	18/36	

Source: P&D analysis.

Results of this survey comparison suggest multi-commercial airport systems have typically evolved to allow parallel or generally non-conflicting approaches. It can be concluded therefore, the Boeing Field alternative would be a non-standard solution to adding commercial service capacity compared to other U.S. examples.

FINDINGS AND CONCLUSIONS

The principal findings and conclusions of this review are as follows:

- In south flows during IFR and low VFR conditions (which prevail 37 percent of the time), "site specific" procedures that are unique to Seattle have been implemented which permit concurrent instrument approaches to the two airports. These have been in effect since late 1989 and have reduced the arrival capacity delays on Sea-Tac caused by this interaction. These Sea-Tac delays are infrequent and occur only during a Boeing Field missed approach. During these conditions, Boeing Field arrivals may be subject to longer, circuitous routings and thus extra delay. Sea-Tac approaches would most likely be given the most direct arrival routings.

- The present procedure accommodates the present moderate traffic volumes. Future increases in instrument approaches could overload the controller monitoring approaches and thus the future effectiveness of the procedure is uncertain.

- If Boeing Field becomes a commercial service airport, while not FAA policy but in practice BFI arrivals will still be subject to second priority status and the additional delays described above and as such it will be difficult to maintain viable schedule service.

- Impacts from the use of BFI for commercial service would not be primarily a result of the interaction of approaches with SEA, but rather from increased demand of additional commercial flights placed upon the limited terminal airspace. Additional flights would increase congestion and result in potentially significant increases in delay during conditions when the ceiling is below 2,500 feet. Moreover, the uncertainty of the existing procedures to effectively function under increased traffic volumes promotes a risky plan for accommodating demand.

- The proximity of the airports (four miles) and the converging ILS approaches in the primary traffic flow is unique to Seattle compared to multi-commercial airport systems in the U.S. In these systems, airports are separated from 10 to 48 miles. More importantly, similar runway orientations facilitate approaches which are generally compatible with the overall traffic flows. In this respect, a system comprised of SEA and BFI would result in a "non-standard" solution compared to other metropolitan areas.

- An increase in commercial flights at BFI would translate into an increase of IFR approaches and as previously stated the existing procedure may not be effective under increased traffic loads. Thus, additional IFR capacity is not achieved by use of BFI for commercial operations.
- In view of airspace interactions it is concluded that the existing procedures for concurrent approaches are unique to the conditions at Seattle. The future of the procedure is uncertain and the possibility exists that it could be canceled. Basing a commercial air service system on this procedure would be a high risk planning approach. Use of BFI as a commercial airport site is therefore not recommended.

WORKING PAPER # 4

DEMAND MANAGEMENT

PRESENTED
AUGUST 15, 1991

ADOPTED
SEPTEMBER 11, 1991

THE FLIGHT PLAN PROJECT PHASE III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

DATE: August 28, 1991

TO: Puget Sound Air Transportation Committee

FROM: P&D Aviation

SUBJECT: WORKING PAPER NO. 4 - DEMAND MANAGEMENT

EXECUTIVE SUMMARY

The term Demand Management covers a range of strategies designed to reduce congestion without building capacity improvements. This paper outlines a wide variety of possible airport demand management measures, and describes selected examples where some form of these measures have been tried.

In mid August, 1991 a panel of experts was convened to discuss the ideas set forth in this paper and the particular opportunities for demand management procedures in the Seattle region. The final conclusions and recommendations of the expert panel are summarized below.

- Develop a clear understanding of airport proprietor rights. Work within these rights and expect complex legal challenges of implementing measures which extend beyond these rights.

- Treat Transportation Demand Management (TDM) measures as one element of a comprehensive program. Acknowledge this is not a long term solution, but rather a strategy to delay and possible help finance capacity improvements which will ultimately be required.

- Evaluate TDM measures in terms of the effect on different users (e.g., airlines, airports, community, passengers, cargo). Identify the current cross subsidies within overall system and industry user groups.

Exhibit 1 presents a listing of a range of TDM measures and their estimated effects on congestion. Also summarized for each measure are jurisdictional rights, those adversely affected, and other key considerations. Lastly, the exhibit illustrates the set of measures which are recommended for application in the Flight Plan options and particularly the Maximum Demand Management option. These are indicated by a check mark and will evaluated in Phase III of the Flight Plan analysis.

A review of demand management strategies reveals that several measures are already being implemented at Sea-Tac. Specifically the Flight Plan forecasts assume the average aircraft size will increase during the planning period. Also, airlines now practice yield management which tends to increase aircraft load factors. FAA central flow control metering systems create a modified form of slots to help control congestion. General Aviation operations have already been minimized at Sea-Tac and now contribute to only about five percent of the total aircraft

operations. Lastly, a noise budget has been implemented at Sea-Tac which encourages airlines to use quieter and larger aircraft.

Additional demand management measures which are recommended by the consultant to be considered in the maximum demand management option are shown in the last column of Exhibit 1. These include the assumptions that Sea-Tac will implement some form of variable pricing of gates, terminal space, and/or landing fees to discourage use during peak hours. The maximum demand option also assumes greater control will be exerted by the airport on gate use and scheduling, and that technological advances to reduce aircraft separations and improve rail opportunities will also be implemented.

The effect of the maximum demand management alternative is difficult to precisely determine. It is generally acknowledged that none of the demand management measures can be used to increase airport capacity. The experiences gained in Boston and Minneapolis St. Paul suggest demand management measures will at best delay for a few years the need for capacity improvements. For purposes of this analysis therefore, it is assumed the maximum demand management set of measures will delay capacity improvements for five years. This means that in the year 2020 Sea-Tac with no additional airside capacity improvements can be assumed to accommodate 38 million annual passengers rather than the 32 million passengers as was assumed in the do-nothing alternative.

INTRODUCTION

A non-capital expense option for accommodating an increase in demand at an airport involves policy and administrative procedures whose objectives are to maximize the utilization of existing facilities. Instead of the typical approach of expanding facilities to handle more traffic, demand management's aim is to adjust the accommodation of traffic to fit existing airport airside and landside facilities.

The purpose of this working paper is to identify and begin to apply a range of demand management options to air transportation needs in the Puget Sound region. Specifically, this material was used as a background paper for a panel of experts assembled to help fully develop the demand management alternative carried forward from Phase II of Flight Plan. A summary of the expert panel discussion is provided at the end of this paper.

WHAT IS IT?

Demand management is intended to ease congestion by diverting some traffic to times and places where it can be handled more promptly and efficiently. Demand management can take one of three principal forms:

- Do-Nothing Approach - under which it is hoped that the congestion and delay will become so bad during peak periods that some users will decide instead for different flight times or different airports;
- Pricing Schemes - are typically applied to peak periods, such as the busy hours of the day or peak seasons of the year;
- Administrative Management - consists of regulations or rationing systems that limit use of the airport to designated airlines or types of aircraft.

The underlying objective of demand management is to close the gap of a capacity shortfall either on an interim basis until capital improvements are in place or alternatively as a substitute for further investments. Flight Plan will incorporate demand management techniques in all alternative plans to be analyzed as well as a stand-alone approach in the "do-nothing" alternative.

There were 355,000 aircraft operations performed at Sea-Tac in 1990. The demand forecast prepared for Flight Plan projected 524,000 operations in 2020. The current airside capacity of Sea-Tac has been determined to be 380,000 operations which will result in an airside capacity shortfall of 144,000 operations. It should also be noted that the Flight Plan forecasts indicated an almost tripling of passengers with only a two-thirds increase in air carrier operations.

Demand management should also focus on peak period capacities and demand during IFR conditions, since this is the current bottleneck during airside congestion.

ARE THERE SOME NON-AIRPORT EXAMPLES?

Demand management is a generic approach which has fundamentally changed traditional public works thinking. Application to the airline industry, especially following deregulation and the "open skies" approach offers a new opportunity to consider the possibility of moderating the "demand" side of a needs equation, as well as increasing the "supply" side.

In the Pacific Northwest, several familiar examples of demand management can be cited:

- the four-state Northwest Power Planning Council with its emphasis on conservation largely replacing nuclear energy (the Council was created after the WPPSS default).
- the use of conservation as a major component in the Seattle and King County solid waste programs (which have the highest recycling results in the country).
- use of volume-based water metering, and a system of parking meter fees that increases in the downtown areas.

Success in each case depends upon specifics. Leak plugging in energy use, and the relative costs of insulation versus new energy sources, are major advantages supporting new energy conservation. But in many cases, "demand management" is already underway under a different name. There may be less slack than might be assumed.

Two important perspectives to keep in mind in Flight Plan are the major assumptions already in the Phase I Demand Forecasts regarding increasing future average airplane size, and the past diversion of general aviation away from Sea-Tac. These are some of the other important details that are mentioned in the following discussion points.

HOW IS IT IMPLEMENTED?

Implementation measures depend upon the demand management measures selected. Flight Plan will identify in its final recommendations the action plan needed to achieve the measures selected. Implementation steps may include agencies other than the sponsoring PSCOG, Port of Seattle, and the FAA.

Set out below are implementation discussions for each of the three major air traffic demand management forms.

Do-Nothing Approach

This approach is often politically attractive because it does not involve a rationing process that results in some participants being dissatisfied. This approach is relatively ineffective because users tend to adjust somewhat to congestion and severely crowded conditions; therefore, they usually continue with operations at a level well over the capacity of the airport. The users most severely affected are those using smaller aircraft who are less willing to accept the costs of congestion or delay.

Pricing Schemes

Pricing schemes have been effective for diverting aircraft movements away from peak periods. The net effect of pricing schemes has been to drive away the small users (commuters and general aviation) allowing commercial users with their larger passenger volumes to replace them. Since general aviation represents a very small percent of total operations at Sea-Tac, commuter operators would be the users most impacted by a pricing scheme. Under the single airport concept, commuters would not divert to another airport because most of their passengers are making connecting flights. The airport sponsor has the authority to set landing fees subject to lease agreements in force with the airline users and also subject to grant agreements with the FAA.

Active Traffic Management

The principal objective of active traffic management is to accommodate a higher level of passenger demand by managing aircraft operations in relation to available runway capacity. There are two forms of traffic management--slot rationing and exclusion of certain categories of traffic from using the airport. These can be used singularly or in combination.

Slot rationing can be implemented either by a scheduling committee composed of airline representatives or by slot auctions where the airlines bid for slots with the slot going to the highest bidder. In either case, an hourly capacity must be established and agreed to before a slot rationing program can be implemented. The FAA has the responsibility for establishing the hourly capacity.

Currently the only U.S. Airports with slot rationing are those four designated by US DOT under its high density rule promulgated in 1973. The quotas at these airports were established by FAA based on estimated capacity of the air traffic control system and airport runways. FAA is considering lifting the rule at one of the airports because of improvements made and also because of slower growth in traffic.

Slot rationing at the high density airports initially was administered by a scheduling committee composed of representatives of the airlines and commuters operating at the airport. These committees received immunity from federal anti-trust laws and operated fairly well until deregulation in 1978. In 1985, the slot allocation system was changed to a trading system. Each carrier was allocated slots according to its usage the previous year. A pool representing 5 percent of the total number of slots was established and distributed by lottery among new entrants and existing airport users with fewer than eight slots. Slots, except those for international and essential air services, can be traded. Slots infrequently used are withdrawn. When new slots become available, they are allocated by lottery, with preference given to new entrants.

Active traffic management, based upon regulatory measures, is diametrically opposed to the "open-skies" approach inherent in deregulation. Alternatively, the concept of "Central flow control" is now the basis for managing airports (except the four high density airports) when demand for runway use exceeds capacity. Carriers can establish their own schedules, but when runway capacity at the destination airport is exceeded, the air traffic control system restrains aircraft (holding them at the originating airport gates) and then allocates them according to available runway capacity.

WHAT BENEFITS CAN BE EXPECTED?

Implementing a form of demand management will have identifiable benefits in terms of accommodation of demand. It will not add airside capacity to the airport since this may only be accomplished by expansion of airport facilities and/or the introduction of new technology.

The perceived benefits are not without associated dis-benefits, but these will be discussed in the next section.

Although no airside capacity increases will be effected through demand management, aircraft delay hours and costs can be reduced through adjustments of schedules that fill in the "valleys" of the daily distribution of traffic. The form of demand management that can be implemented by airport sponsors is the price schemes during peak traffic periods.

Technological advances, although not discussed as a demand management technique, also will help to transport more passengers at a given facility by the introduction of larger capacity aircraft.

Price schemes and the use of larger aircraft appear to be the most feasible alternatives for reducing delay. Slot rationing falls within the province of US DOT and it has not been extended to any other airports but the original high-density airports identified in 1973. Airport sponsors do not have the authority to institute a slot rationing system at their airports.

WHAT ADVERSE IMPACTS CAN BE EXPECTED?

It was stated that dis-benefits would be associated with any benefits incurred by implementation of a demand management regulation. Experience shows that demand management systems result in some dissatisfied users of airports where demand management concepts have been instituted.

In the case of Sea-Tac, the commuter carriers would be impacted by a price scheme and the use of larger aircraft may not be financially feasible. A price scheme would have to be non-discriminatory to be a legally acceptable form of demand management. Therefore, all classes of operators (airlines, commuters and general aviation) must be subjected to the same price scheme mechanism. Since general aviation represents a very small percentage of total traffic, this class of operator would be adversely impacted, but not to the same degree as the commuter carriers.

WHERE HAS IT BEEN USED?

Slot rationing has only been used at the original four high-density airports identified by US DOT in 1973. These are: John F. Kennedy and LaGuardia in New York; O'Hare in Chicago; and, Washington National Airport in D.C. Although the system has been used for almost 20 years, it is difficult to quantify the improvement in delay as a result of the slot rationing. The current level of aircraft delay under the system is known, but it would be only conjecture to quantify what the delay would have been without the slot rationing.

Price schemes have been instituted at several airports and have been tried in at least one other major airport without success. A major problem with the concept of peak-hour surcharges is how to determine the level of surcharge. Implementing a policy of differential pricing - whether based on marginal facility cost, marginal delay cost, or some purely arbitrary scheme is difficult. It is likely that a significant increase in airport user fees will raise questions of equity. There are a number of examples where airport sponsors have attempted to increase user fees and have been challenged by air carriers and general aviation. In some cases, landing fees are established in long-term lease agreements that cannot be easily changed.

Set out below are a few examples of pricing schemes that have been implemented at airports in the U.S. and Europe.

London

Active traffic management has been utilized for many years to encourage greater use of Gatwick Airport to relieve Heathrow Airport. Management techniques involve slot allocation by a schedule committee and pricing to discourage usage of airport of certain categories of traffic during peak periods.

The Gatwick experience under traffic management resulted in a 10 percent increase in runway capacity between 1981 and 1989 due mainly because of demand pressures. Gatwick is a single runway airport and has an extremely high peak hour landing fee of $10,000 which equates to $25.00 per seat for a 400 passenger B747-300.

Boston

In 1988 the Massachusetts Port Authority imposed the Program for Airport Capacity Efficiency (PACE) which called for the imposition of peak-hour pricing for smaller aircraft during the entire 24 hours. A second phase of PACE was to include peak-hour pricing for all operations. US DOT found that PACE discriminated against a class of aviation and PACE was suspended.

New York

The Port Authority of New York and New Jersey operates the three air carrier airports and a general aviation airport serving the Metropolitan New York area. In the late 1960's, the Port Authority began imposing peak-hour surcharges on general aviation to move traffic to off-peak hours. The pricing scheme was effective in reducing a segment of traffic during the peak-hour; however, this approach would not be effective at Sea-Tac, since general aviation represents a very small percent of total traffic.

California

Although capacity was not the issue, John Wayne Airport, in Orange County has invoked, in accordance with a District Court Order, airport access constraints for non-Stage III aircraft. The

Order also placed a cap of 8.4 MAP - both constraints designed to control the amount of noise over adjacent communities of the airport.

EXPERT PANEL SUMMARY

On August 15, 1991 a panel of experts was convened to discuss airport demand management techniques with the Puget Sound Air Transportation Committee (PSATC). These panelists were

- Barrie Austin, Manager of Public Affairs, Boeing Commercial Airplane Group, Seattle
- Jack Corbett, Attorney, Speigel & McDiarmid, Washington, D.C.
- Dan Kasper, Corporate Director and Head of Transportation Practice, Harbridge House, Inc., Boston
- Steve Martin, Director of Business Development, MASSPORT, Boston

Set out below are the comments of the panel. These are followed by a summary description of the demand management assumptions to be used in the Flight Plan Phase III alternatives analysis. A verbatum transcript of the panel descussion is also a part of the record and available upon request.

Goals

The success of Transportation Demand Management (TDM) methods is measured by the ability to reduce congestion while accommodating demands and minimizing negative economic consequences. The legal right of an airport proprietor to implement certain forms of TDM procedures will be judged in terms of consistency with these motives. Goals should be justified by long term forecasts which are accurate and defendable. Specific points made during the discussion are listed below.

- o TDM cannot be used to stop growth. Procedures must be used to shape growth in a manner similar to Growth Management Policies developed in the Northwest Region.
- o Overall goal should be to accommodate all passenger and cargo demand, and to shift or move it but not to eliminate it. Use TDM to modify phasing.
- o TDM should be used as an element of a comprehensive package with defendable goals.
- o TDM is most effective for "buying time". TDM will not eliminate the ultimate need for capacity improvements. Main use is to delay making capacity improvements. TDM is not an end in itself and should not be used to stop growth.

- Buying time is important when considering it takes at least 10 years to build a new airport.
- Demand management options must not be considered without full consideration of potential risk of impairing broader economic development of the area or region.
- Even if TDM is successful, results may be judged by some as unsuccessful due to negative economic impact.
- Providing air service is a competitive business. TDM in some cases is contrary to other policies of the community to stimulate economic development by encouraging or actually attracting new air service. This could widen the gap between economic growth of the Northwest Region and other more progressive communities.
- TDM must not be used injudiciously.
- Forecast believability is important to justifying improvements and use of TDM. Use of periodic passenger surveys and analysis of disaggreated demand can be helpful in this regard. Forecasts should be verified by analyzing demands by origin, destination, and passenger profile characteristics.
- Short downturns in traffic do not change overall need for capacity improvements.
- An analysis of aircraft manufacturing trends confirms future growth can be expected. A reduction in overall demand is unlikely.

Do Nothing (No expansion at Sea-Tac)

The Do Nothing option is the easiest to implement and most clearly lies within the airport proprietor's jurisdiction. Once additional facilities are developed, the proprietor may have more restricted powers in limiting use. This strategy worsens congestion, restricts growth, and can have severe economic impacts. This strategy allows demand patterns to adjust naturally to the pressures created by congestion. It can also be used to improve the justification for legally vulnerable tactics such as variable pricing until facilities are maxed out through inaction.

- "Do Nothing" is the most feasible TDM option. It is 1) politically easier and 2) legally within the airport proprietors rights.
- To take full advantage of proprietor rights, the airport operator should endeavor to resume and maintain groundside facility rights through leasing agreements. It is important for the proprietor to stay independent and transcend airline special interests.

- The airport proprietor has greater legal right to control groundside capacity. For example, control of gates can be a surrogate for controlling slots (landing rights). Further, the airport proprietor cannot be forced to build more gates.

- Facilitating development of a supplemental airport can help to avoid construction of additional facilities at primary airports.

- The pattern of airlines is to discourage building second airports. Development of supplemental airports will add additional airline cost centers. Added costs need not be a deterrent if added revenues can offset these costs. Historically, carriers don't sign up until the last minute. The community must therefore display conviction to goals and policies. Addition of supplemental airports is more acceptable to airlines when access to primary airport becomes limited due to congestion.

- Supplemental airports are difficult to justify based on connecting passenger demand since this traffic can be controlled by airlines. The airline debate over the need for the new Denver airport is a good example of this characteristic.

- The value of time (ground access plus delays) is more important to short haul passengers. Some airlines have profitably used this principal to successfully offer service from secondary airports.

- Aircraft technology changes in the foreseeable future will not change the need for additional runways, even if TDM is used to delay needs for several years.

- For technology to be effective in relieving congestion, improvements must be accepted and implemented on an industry-wide basis.

- Airlines are now practicing a form of demand management through yield management systems which attempt to maximize revenue and exert a controlling effect on load factors. Yield management systems allow more seats to be sold and attempts to maximize what people will pay. These systems attempt to maximize revenue yield and not necessarily passenger loads. Some suggest these systems can generate 10 to 15 percent more passengers. Airlines will always target for 70 percent load factors, 90 percent is unlikely since it does not maximize yield.

- Light rail as an example of a new technology, is best suited for high density markets with aging road systems such as exist in New England states.

- The economics of rail suggest the Northwest Region should not rely on this strategy. A large investment is required to make rail systems highly competitive due to right-of-way costs. Time trade-offs appear to make air alternatives more attractive in the Seattle region.

Pricing

The establishment of variable landing fees is not clearly an airport proprietor right. A good likelihood exists this could be ultimately found to be a local right, but not without considerable legal testing by the industry. Even if surcharges are implemented, the impact on airline behavior is expected to be minimal.

- o Goals of pricing schemes should be to accommodate passengers and cargo, encourage shift to larger aircraft, and to move operations to less congested airports.
- o The legal limitations of the airport proprietor are established in 1) airport/airline contracts and, 2) residual cost requirements. Residual costs are costs which exceed airport revenues and which may be used to justify landing fee increases. Discrimination can be claimed if charges are not allocated based on full cost and equity.
- o With the proper approach and justification, the chances of getting a variable pricing policy accepted by DOT is judged to be 50 percent or greater.
- o Variable pricing will be difficult to defend until actual "capacity" is reached. Pricing cannot be implemented based on a projected congestion problem.
- o In order for a pricing system to be non-discriminatory, the policy must price access, not users.
- o Airports tend to be monopolies and thus can not always serve all public interests equally. As a result, discrimination can easily occur.
- o Pricing and quotas can be interpreted as being restrictive to interstate commerce.
- o Residual cost accounting can prevent variable pricing from generating additional airport net revenues.
- o Airport pricing must be cost based to withstand legal challenges. Full cost allocation is best.
- o Using revenues generated as a result of peak hour surcharges to fund capacity improvements is most defendable policy.
- o Legal impediments exist to variable pricing.
- o Price increases have greatest effect on behavior of General Aviation and Commuters respectively. Air carriers behavior is largely inelastic to changes in landing fees since these represent only 2-4 percent of operating costs and are averaged over entire system.

- o Increases in landing fees is more defendable if justified to reduce congestion.
- o Opportunity costs can be an important argument in defense of variable pricing. Opportunity costs become important as capacity is reached. Smaller aircraft use landing and takeoff opportunities which could be more efficiently used by larger aircraft.
- o Minneapolis DOT study determined new runway construction could be delayed by six years through use of demand management techniques.
- o Minneapolis St. Paul noise surcharge has provided further evidence that variable pricing does little to effect airline behavior.
- o Nothing precludes payment by State to carriers. State subsidies could be used to guarantee essential air service but must not be discriminatory.
- o The Passenger Facility Charges (PFC's) scheduled to begin next July cannot be used as a variable surcharge. PFC's must be applied to all passengers, regardless of type of service, schedule or carrier.
- o Use of Sea-Tac surcharges or PFC's could conceivably be used for capacity improvements at other airports. Denver example however suggests this is difficult. Case history suggests it is much easier to use funds for airports within the jurisdiction of a single proprietor.
- o The closer the airport proprietor can stay to its jurisdiction, the better the chance of success. For example, pricing of aircraft push back opportunities is more defendable than airport proprietor control or pricing of airside or airspace use. Likewise, pricing the use of terminal facilities to passengers to discourage use during peak hours may also be an option.
- o Pricing policies must be geared toward areas within the jurisdiction of the airport proprietor. Using resulting funds on capacity improvements has best chance of success.
- o If a proprietor really wants to control growth, it is not necessary to wait until an airport reaches capacity. An alternative strategy is to not build additional facilities and price groundside facilities accordingly.
- o Variable pricing programs are easier to sell if they are part of a comprehensive plan to add capacity, buy time, and help reduce noise.
- o If a surcharge is not cost based, legal issues can arise.

- PACE legal findings determined 1) landing fees do not have to be based entirely on weight, 2) peak hour pricing may be found to be acceptable if it is not discriminatory and "motives are pure".

- A cost recovery system must be described to insure surcharges do not tax interstate commerce.

- When airports are subject to revenue caps, peak hour charges are negated by offpeak reductions and the airlines net financial impact is unchanged. Effect on airline behavior is thus minimized.

- If fees are devoted to expanding capacity at Sea-Tac or expanding capacity elsewhere (GA reliever or supplemental commercial airports), then the chances of making variable pricing work are much better.

Administrative Regulations

Administrative regulations are the most difficult form of demand management options for an airport proprietor to implement since they are generally beyond local jurisdictional rights and offer the greatest risk of limiting interstate commerce. These types of measures require an industry-wide agreement to change regulations.

- Legal rights are established by

  1. 1978 Airline Deregulation Act. This act gives the U.S. domestic airline industry authority to choose airline routes, rates, and services.

  2. 1958 Federal Aviation Act. This act gives the federal government authority to control airspace and air traffic.

  3. Federal Aid Sponsor Assurances. These assurances require non-discrimination between classes of carriers, non-discrimination within classes of aircraft, and require fees to stay within airport.

- Federal rights are prescribed in Federal Aviation Act and cannot be usurped by local jurisdictions without a change to federal laws.

- A unified approach involving several airport operators, as opposed to a single airport operator, can be more effective in influencing federal policy.

- The most realistic option is not to regulate airlines at the local level, but to effect their behavior.

- Changing federal regulations is a long term and very complicated process. Imposing more regulations on the airline industry is contrary to trends set by Airline Deregulation Act. In the opinion of the expert panel the airline industry could not be easily re-regulated now that deregulation as taken place.

- Airlines are supporting legislation to abolish the high density rule. DOT/FAA is not likely to add additional high density airports to system.

- There exists a reluctance at the federal level to continue and/or expand slotting due to new control techniques such as flow control metering systems. Flow control replaces airborne delays with ground holds.

Expert Panel Recommendations

The final conclusions and recommendations of the expert panel are summarized below.

- Develop a clear understanding of airport proprietor rights. Work within these rights and expect complex legal challenges of implementing measures which extend beyond these rights.

- Treat TDM measures as one element of a comprehensive program. Acknowledge this is not a long term solution, but rather a strategy to delay and possible help finance capacity improvements which will ultimately be required.

- Evaluate TDM measures in terms of the effect on different users (e.g., airlines, airports, community, passengers, cargo). Identify the current cross subsidies within overall system and industry user groups.

Consultant Recommendations

Exhibit 1 presents a listing of a range of TDM measures and their estimated effects on congestion. Also summarized for each measure are jurisdictional rights, those adversely affected, and other key considerations. Lastly, the exhibit illustrates the set of measures which are recommended for application in the Flight Plan options and particularly the Maximum Demand Management option. These are indicated by a check mark and will evaluated in Phase III of the Flight Plan analysis.

A review of demand management strategies reveals that several measures are already being implemented at Sea-Tac. Specifically the Flight Plan forecasts assume the average aircraft size will increase during the planning period. Also, airlines now practice yield management which tends to increase aircraft load factors. FAA central flow control metering systems create a modified form of slots to help control congestion. General Aviation operations have already been minimized at Sea-Tac and now contribute to only about five percent of the total aircraft operations. Lastly, a noise budget has been implemented at Sea-Tac which encourages airlines to use quieter and larger aircraft.

Additional demand management measures which are recommended by the consultant to be considered in the maximum demand management option are shown in the last column of Exhibit 1. These include the assumptions that Sea-Tac will implement some form of variable pricing of gates, terminal space, and/or landing fees to discourage use during peak hours. The maximum demand management option also assumes greater control will be exerted by the airport on gate use and scheduling, and that technological advances to reduce aircraft separations and improve rail opportunities will also be implemented.

The effect of the maximum demand management alternative is difficult to precisely determine. It is generally acknowledged that none of the demand management measures can be used to increase airport capacity. The experiences gained in Boston and Minneapolis St. Paul suggest demand management measures will at best delay for a few years the need for capacity improvements. For purposes of this analysis therefore, it is assumed the maximum demand management set of measures will delay capacity improvements for five years. This means that in the year 2020 Sea-Tac with no additional airside capacity improvements can be assumed to accommodate 38 million annual passengers rather than the 32 million passengers as was assumed in the do-nothing alternative.

Exhibit 1

Demand Management Summary

EXHIBIT I
DEMAND MANAGEMENT SUMMARY

ECHNIQUE	JURIS-DICTIONAL RIGHTS	THOSE ADVERSELY AFFECTED	KEY CONSIDERATIONS	COMPARATIVE REDUCTION IN CONGESTION	ALTERNATIVE ASSUMPTIONS: SEA-TAC	MULTI AIRPORTS	REPLACE-MENT	MAXIMUM DEMAND MGMT.
O NOTHING (NO SEA-TAC EXPANSION)								
O BUILD	PROPRIETOR	ALL USERS	MOST SEVERE ECONOMIC CONSEQUENCES EASIEST TO IMPLEMENT, INCREASES CONGESTION	NONE	✓			✓
UPPLEMENTAL AIRPORTS	PROPRIETOR	POSSIBLE AIRLINES	AVOIDS CONGESTION, IMPROVES ASSESSIBILITY	LARGE		✓		
ONTROL GATES	PROPRIETOR	AIRLINES	GREATER PROPRIETOR RIGHTS, CAN INDIRECTLY CONTROL AIRSIDE CAPACITY	MODERATE				✓
IELD MANAGEMENT	AIRLINES	PASSENGERS	CONTROLS LOAD FACTORS	SMALL	✓	✓	✓	✓
ARGER AIRCRAFT	AIRLINES	SMALLER AIRCRAFT OWNERS	NATURAL TREND, HIGH REPLACEMENT COSTS	SMALL MED	✓	✓	✓	✓
ECHNOLOGICAL ADVANCES	FEDERAL/ INDUSTRY	COST RECIPIENTS	MINIMAL IMPROVEMENTS FROM FORESEEABLE TECHNOLOGICAL ADVANCES, MUST BE IMPLEMENTED INDUSTRYWIDE	SMALL				✓
LTERNATIVE MODES	REGIONAL	AIRLINES	RAIL MOST EFFECTIVE IN HIGH DENSITY MARKETS WITH POOR ROAD SYSTEMS, LESS EFFECTIVE FOR SHORT HAUL TIME SENSITIVE TRIPS	SMALL				✓
RICING SCHEMES								
ANDING FEES	PROBABLE PROPRIETOR	SMALLER OPERATORS	LEGAL IMPEDIMENTS, GA AND COMMUTERS MOST AFFECTED, MINIMUM AFFECT ON CARRIERS	SMALL				✓
ATE FEES	PROPRIETOR	OPERATORS	GREATER PROPRIETOR RIGHTS	SMALL				✓
ERMINAL FEES	PROPRIETOR	OPERATORS/ PASSENGERS	SUBJECT TO LEASE AGREEMENTS	SMALL MED				✓
FC'S	PROPRIETOR	PASSENGERS	MUST BE APPLIED UNIVERSALLY, COULD GENERATE SUPPLEMENTAL AIRPORT FUNDS					
ADMINISTRATIVE MANAGEMENT								
SLOT RATIONING	FEDERAL	NEW ENTRANTS	FEDERAL RELUCTANCE, CONTRARY DEREGULATION TRENDS	LARGE				
QUOTAS	PROBABLE PROPRIETOR	NEW ENTRANTS	MUST NOT UNDULY LIMIT INTERSTATE COMMERCE	MODERATE				
CENTRAL FLOW CONTROL	FEDERAL	-	AIRLINES SET SCHEDULES, CONVERTS AIR DELAYS TO GROUND HOLDS	MODERATE	✓	✓	✓	✓

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BIBLIOGRAPHY

Airport Planning and Management, Alexander T. Wells, ED.D.

American Airports in the 1990's, McGraw Hill

A Strategic Plan for the Nation's Airport System, Apogee Research

Puget Sound Air Transportation Committee Flight Plan Project Phase II Development of Alternatives

Review of Traffic Management Arrangements at Sydney (Kingsford-Smith) Airport - Australian Ministry of Transport and Communications

Draft Environmental Impact Statement - Proposed Third Runway, Sydney (Kingsford-Smith) Airport - Kinhill Engineers Pty Ltd.

WORKING PAPER # 6

AIRPORT SITE CONCEPTS

PRESENTED
SEPTEMBER 11, 1991

ADOPTED
OCTOBER 16, 1991

THE FLIGHT PLAN PROJECT PHASE III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

DATE: August 28, 1991

TO: Puget Sound Air Transportation Committee

FROM: P&D Aviation

SUBJECT: **WORKING PAPER NO. 6 - AIRPORT SITE CONCEPTS**

INTRODUCTION

In this working paper, conceptual layout plans are presented for each airport site concept which will be subject to further analysis in the Flight Plan Project Phase III. These conceptual plans will be the basis for the detailed evaluation of each airport system alternative. In particular, the site concepts will be important for evaluating future aircraft noise levels, traffic impacts, site acquisition and construction costs, airspace, and economic impacts.

The concepts presented in this working paper are based on the findings of Phase II and subsequent decisions by the Flight Plan Committee. Site alternatives were identified and narrowed down in the Phase II studies. After the conclusion of Phase II, a significant modification was made to the airport system strategy developed in that phase. In Phase II, supplemental airports were classified as either "regional" or "domestic/international." After further demand allocation studies were completed in Phase III, it was concluded that all supplemental airports should be classified as regional, which would provide short-haul and medium-haul service. No long-haul or international service is envisioned for the supplemental airports through the year 2020. However, a supplemental airport could be expanded to handle long-haul and international service beyond 2020.

AIRPORT SITE ALTERNATIVES

A set of airport system alternatives has been developed in Phase III. These system alternatives determine, in part, the types of site alternatives which will be evaluated.

System Alternatives

System alternative strategies to be evaluated in Phase III consist of:

- Sea-Tac Airport alone. Under this option, improvements to Sea-Tac could range from no major improvements to the construction of a new runway and additional passenger-serving facilities. Moderate transportation demand management procedures would be included. No additional air carrier airports would be operated in the system. The Flight Plan Committee has determined that this alternative will not satisfy the long-range aviation demands of the region. However, it is included a "do nothing" alternative for the environmental impact analysis to provide a comparison with alternatives which would substantially increase the capacity of the airport system to accommodate future needs.

- Sea-Tac Airport with maximum demand management. In this option, Sea-Tac would again be the only air carrier airport. However, efforts would be undertaken to relieve airport congestion and delays by maximum application of demand management techniques.

- Sea-Tac Airport and one supplemental airport. Under this approach, Sea-Tac and one additional airport would provide air carrier service. Moderate demand management techniques would be applied. The supplemental airport could be an existing airport or a new site.

- Sea-Tac Airport with two supplemental airports. This concept envisions Sea-Tac operating in conjunction with two supplemental air carrier airports. The supplemental airports would be phased, as required. Moderate demand management techniques would be applied. The supplemental airports, either existing or new airports, would be located at the north end and the south end of the region.

- Replacement airport. In this option, Sea-Tac would be replaced by a new airport capable of providing full domestic and international service. The capacity of the new airport would be sufficient to enable it to accommodate future passenger and air cargo traffic well beyond the year 2020.

<u>Site Alternatives</u>

Within the context of the system alternatives described above, the following airport site development alternatives have been identified by the Flight Plan Committee for further evaluation. The Flight Plan evaluation process will focus on system-level considerations, rather than the selection of specific sites. This working paper presents site layout concepts to aid in the evaluation process.

- Sea-Tac Airport Alternatives:

  - Sea-Tac Airport with or without a new commuter runway
  - Sea-Tac Airport with a new dependent air carrier runway

- Supplemental Airport Alternatives

  - Existing Arlington Airport
  - Arlington Airport with a new runway
  - Existing Paine Field
  - Paine Field with a new runway
  - Joint use of existing McChord Air Force Base
  - Joint use of McChord Air Force Base with a new runway

- Additional airport at Central Pierce site with one runway
- Additional airport at Central Pierce site with two runways
- Additional airport at Olympia/Black Lake site with one runway
- Additional airport at Olympia/Black Lake site with two runways

• Replacement Airport Alternatives

- Additional airport at Central Pierce site with three runways
- Additional airport at Olympia/Black Lake site with three runways
- Additional airport at Fort Lewis site with three runways

Conceptual site layouts have been developed for each of these site alternatives, as described later in this Working Paper.

AIRPORT SITE REQUIREMENTS AND CRITERIA

Airport criteria for supplemental and replacement airports are summarized in Table 1. All new airport sites must be capable of meeting these criteria. To the extent feasible, these criteria have also been applied to existing airports fulfilling the supplemental airport role. In some cases, all supplemental airport criteria cannot be fulfilled at existing airports due to physical constraints.

Airport Role and Classification

Supplemental airports will serve commuter aircraft and narrow-body and wide-body jet aircraft in short haul and medium haul service. The largest aircraft expected to be served by the supplemental airport is the B767.

Replacement airports must accommodate all categories of aircraft, including commuter aircraft and wide-body aircraft as large as the B747. Replacement airports must serve long-haul and international traffic as well as medium-haul and short-haul.

The maximum size of aircraft served by the airport determines the aircraft approach speed category and airplane design group for the airport. These classifications effect the dimensional criteria and separation standards for the classification of airport.

Runway and Taxiway Dimensions

Supplemental airports require a runway length of 7,000 feet to accommodate maximum medium-haul destinations for narrow-body and mid-body aircraft. Replacement airports must have runway lengths of 10,000 feet, with one runway expandable to 12,000 feet.

Separation Standards

Parallel runways at supplemental airports should be separated by 3,500 feet. This separation will permit simultaneous instrument operations assuming anticipated changes to air traffic control separation standards of the Federal Aviation Administration. At replacement airports, the inboard parallel runways must be separated by 5,500 feet to allow adequate space for the passenger terminal area, vehicle parking, and roadway circulation. The third runway must be located at least 3,500 feet from one of the inboard runways. This configuration will provide for three independent instrument arrival and departure streams. (Based upon future separation standards)

Runway Protection Zones

Runway Protection Zones are clear areas located at both ends of a runway. To allow for a precision instrument approach system, the runway protection zone must be 2,500 feet in length, with an inner width of 1,000 feet and outer width of 1,750 feet. A smaller, non-precision, runway protection zone can be provided at one end of the runway at an existing airport where it is known that the precision instrument approach system would be located on the other end of the runway.

Land Area Requirements

Overall land area requirements for airport construction are 1,000 to 2,000 acres for a supplemental airport (depending upon the number of runways) and 4,600 acres for a replacement airport. These are minimum acreage requirements, and the land area required for a particular site could be greater due to specific site considerations. The passenger terminal area requires approximately 10 acres per million annual passengers. In addition, approximately 3 acres per million annual passengers should be allowed for remote/long-term vehicle parking. It is estimated that air cargo, maintenance, and airport support services will require 5 acres per million annual passengers for supplemental airports and 12 acres per million annual passengers for replacement airports.

Additional property rights should be secured to provide a noise buffer zone at each end of the runways. Property rights could be acquired through purchase of the property or acquisition of property easements. It is suggested that all property within the airport's 65 Ldn contour be controlled through purchase, easement, or zoning regulations to prohibit incompatible uses.

TABLE 1
AIRPORT CRITERIA

Item	Supplemental Airport	Replacement Airport
AIRPORT CLASSIFICATION		
Largest Aircraft Served	B-767	B-747
Aircraft Approach Speed Category	C	D
Airplane Design Group	IV	V
RUNWAY/TAXIWAY DIMENSIONS (Feet)		
Number of Runways	1 or 2	3
Runway Length	7,000	10,000
Runway Width	150	150
Taxiway Width	75	75
SEPARATION STANDARDS (Feet)		
Runway to Parallel Runway	3,500	3,500 and 5,500
Runway to Parallel Taxiway	400/600 [a]	400/600 [a]
Taxiway to Parallel Taxiway	215	267
RUNWAY PROTECTION ZONE DIMENSIONS (Feet) [b]		
Length	2,500	2,500
Inner Width	1,000	1,000
Outer Width	1,750	1,750
APPROXIMATE AREA REQUIREMENTS (Acres) (Area per Million Annual Enplaned and Deplaned Passengers)		
Passenger Terminal Area	10	10
Remote (Long Term) Parking Area	3	3
Air Cargo Maintenance and Support Services	5	12
Minimum Land Required for Airport Construction (Acres)	1,000 to 2,000 [c]	4,600

[a] Minimum requirement is 400 feet; 600 feet allows for high speed exit taxiways.
[b] For precision instrument approach.
[c] One runway: 1,000 acres; Two runways: 2,000 acres.

Source: FAA Advisory Circular 150/5300-13, Airport Design and P&D Aviation.

This land area need not be acquired in fee if an effective zoning policy can be instituted and enforced. Several states have enacted airport zoning acts that permit locally created agencies to zone lands adjacent to major airports. The zoning should prohibit incompatible land uses because of noise and development that would be a height hazard to aircraft operations.

Site Location Criteria

Criteria were established to locate new airport sites within the search areas identified in Phase II. Site search criteria are listed below:

- Land area. The site must be capable of accommodating the minimum acreage requirements including runway and runway protection zone requirements.

- Environmental. The site should not result in adverse noise impacts on surrounding land uses. Wetlands, floodlands and public parks should not be significantly affected.

- Meteorology. Runways must be oriented with prevailing winds, which are generally in a north-south direction. Weather characteristics of a region can produce local variations depending upon terrain features and other factors. Certain portions of a region may experience a higher frequency of fog, particularly during the early morning hours, while the remainder of the region is completely clear. These local conditions may not be generally known, except to the local residents; therefore, interviews should be conducted to determine if there are any abnormal local weather conditions that may adversely affect airport operations.

- Obstructions. The imaginary surfaces defined by Federal Aviation Regulations Part 77 must not have significant penetrations. These imaginary surfaces extend outward and upward from the runway ends and sides. There must be no penetrations to the airport approach surfaces, which extend from the ends of the runways. Penetrations could be caused by terrain (hills and mountains), trees, or man-made objects such as buildings or towers.

- Airspace. There are two major airspace circumstances to be considered as site search criteria. The first is the most obvious and deals with interactions with other existing airports. This can be determined from a study of ATC procedures. The second consideration is not as apparent and relates to the ability of the FAA to develop a terminal airspace structure that will support a high capacity commercial airport. This will require the establishment of navaids to guide arriving and departing aircraft at the new airport.

- Terrain. A major cost of constructing a new major airport is the expense of preparing the site for development of airside and landside facilities. The Phase II site search criteria included two limitations of elevation differentials. The site limitation was 200 feet while the airfield was restricted to a 100 foot differential.

Elevation differentials within a 5,000± acre site should be expected and a 200 foot differential is not uncommon on large grading contracts. More important than grade differential is the nature of the sub-strata. If the site contains rock under a shallow overburden, then the elevation differential is significant; however, if the site contains soils that can readily be graded using scrapers and bulldozers, then the elevation differential should not be a limitation if other criteria are met.

As for the 100 foot elevation differential for the airfield criteria, it appears this is redundant because site preparation would attain the allowable elevation differential of the airfield portion of the site. Incidentally, the 100 foot elevation differential for a 10,000 foot runway would be one percent which is the allowable effective gradient of runways.

DESCRIPTIONS OF AIRPORT SITE CONCEPTS

The locations of airport sites are shown in Figure 1. Alternative airport site concepts are discussed below. Each layout plan is a conceptual drawing showing the airfield configuration, locations of the passenger terminal area and other important airport functions, major existing airport buildings if any, the proposed airport boundary, and the major highway access. Existing airfield facilities (runways/taxiways) are in solid lines and airfield development proposed to meet criteria for alternatives are shown in broken lines. The airport property boundary shown does not include additional areas which might be subject to easements or buffer zones. Major ground contours are shown for new airport sites to provide a rough indication of the amount of earthwork required.

Seattle-Tacoma International Airport Without New Runway (Figure 2)

This concept is essentially the existing Sea-Tac Airport. Although no new runways are included under this alternative, minor improvements such as new taxiways and terminal area expansions would occur.

Seattle-Tacoma International Airport With New Commuter Runway (Figure 3)

Under this alternative, a new 5,000-foot commuter runway would be constructed on the west side of the airport. The new runway would be located entirely on the existing airfield. The west side parallel taxiway would be removed and a new runway constructed with a centerline separation of 700 feet from the existing westerly runway (Runway 16R-34L). This distance would provide for adequate separation for aircraft under simultaneous visual operations.

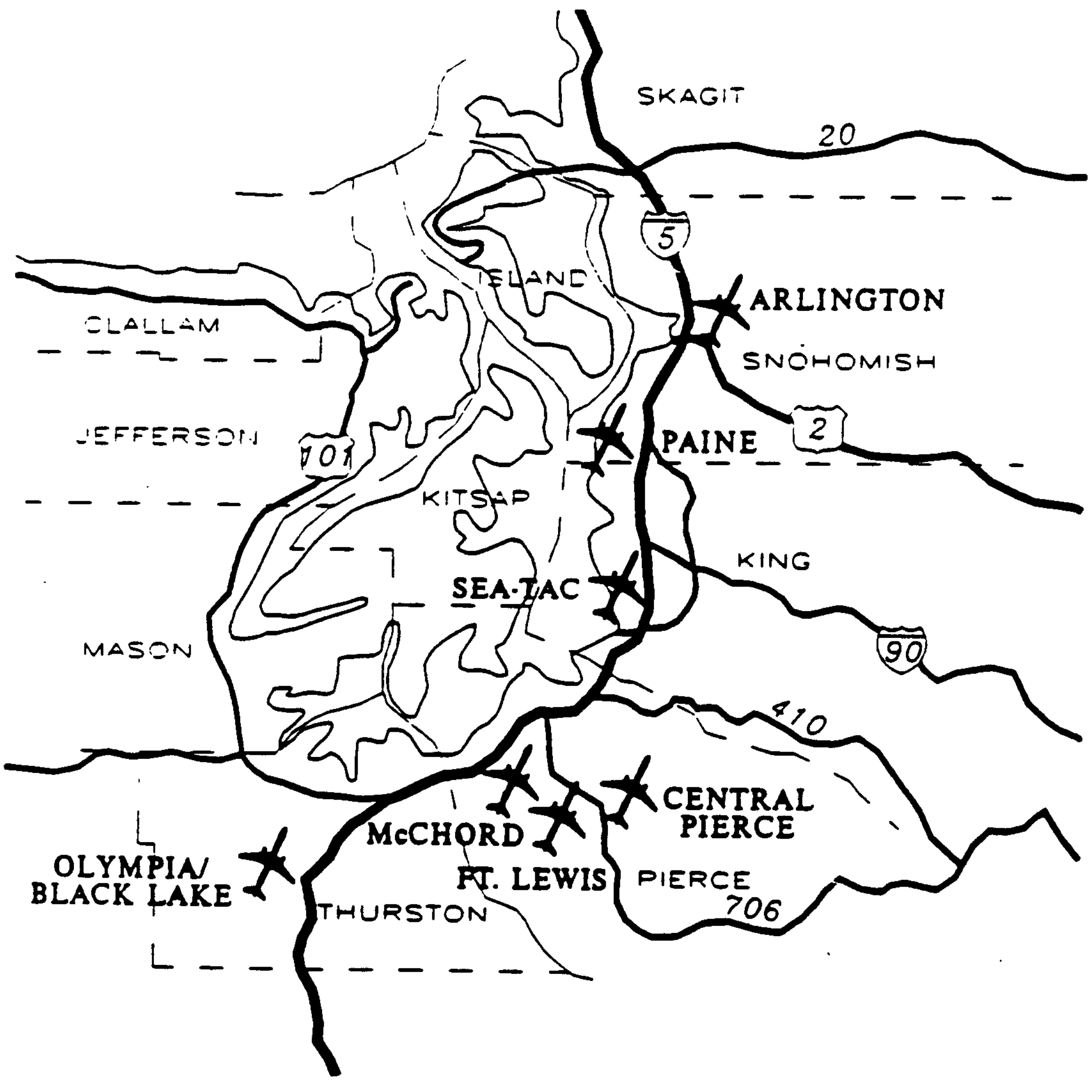
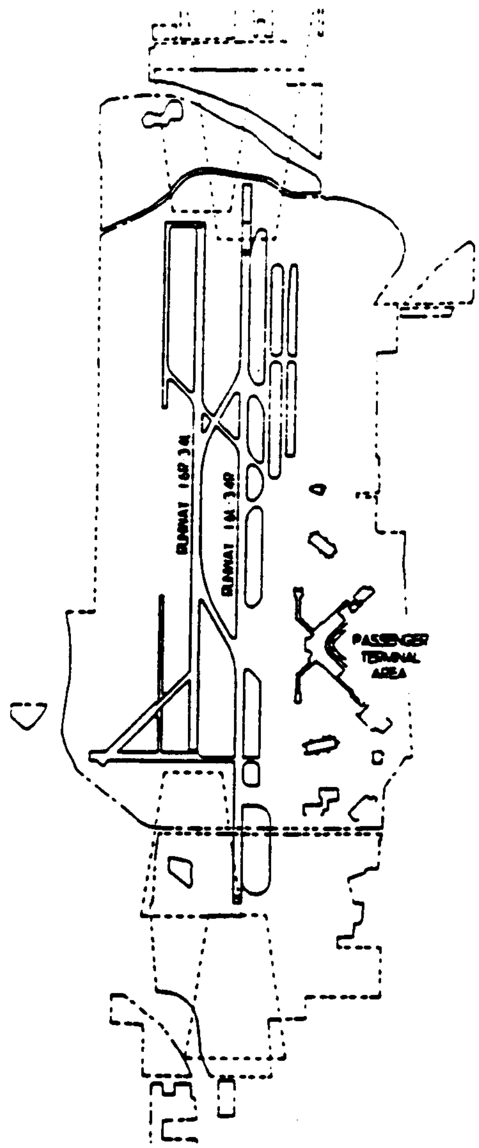
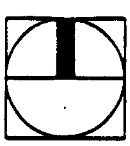


Figure 1
Airport Locations

THE FLIGHT PLAN PROJECT PHASE III

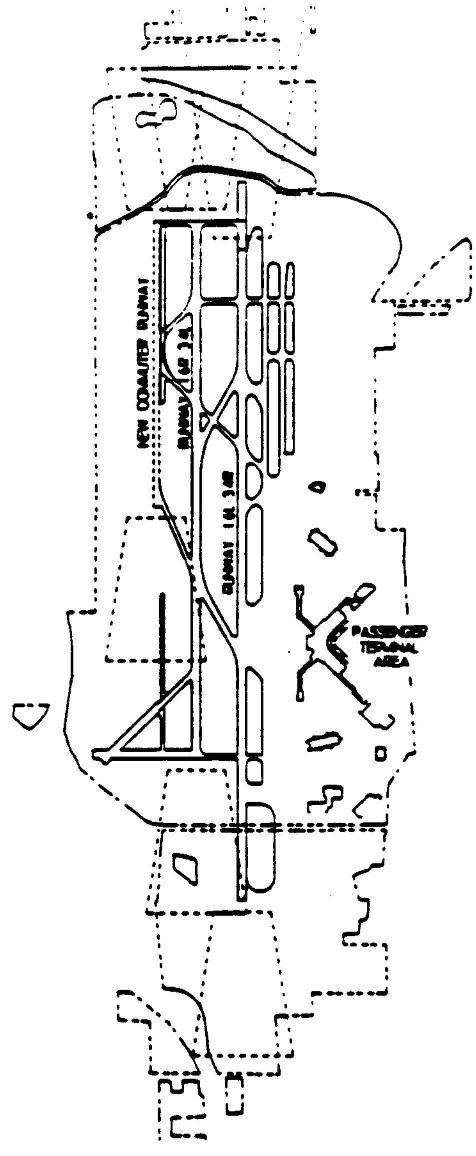
PUGET SOUND AIR TRANSPORTATION COMMITTEE

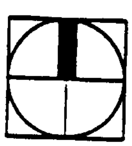




Scale 1"=3000'

Figure 2
Sea-Tac Without New Runway





Scale 1"=3000'

Figure 3
Sea-Tac With New Commuter Runway

Seattle-Tacoma International Airport With New Dependent Runway (Figure 4)

In this alternative, a new 7,000-foot runway would be constructed 2,500 feet from Runway 16L-34R. This separation distance would allow an approach on one runway and departure on the other to occur at the same time. For this alternative, additional property must be acquired between 9th and 12th Avenues South and between South 176th Street and State Route 518, to provide for construction of the new runway.

Arlington Municipal Airport With New Runway Extension (Figure 5)

Under this alternative, the north-south runway at Arlington Municipal Airport would be lengthened at the north end to a total of 7,000 feet. The general aviation area on the east side of the airport would remain. A new passenger terminal would be constructed between the two runways. Long-term parking could be provided at the west side of the airport and air cargo, maintenance, and support activities can be accommodated south of Runway 11-29. New parallel taxiways would be constructed for each runway to serve future aviation needs.

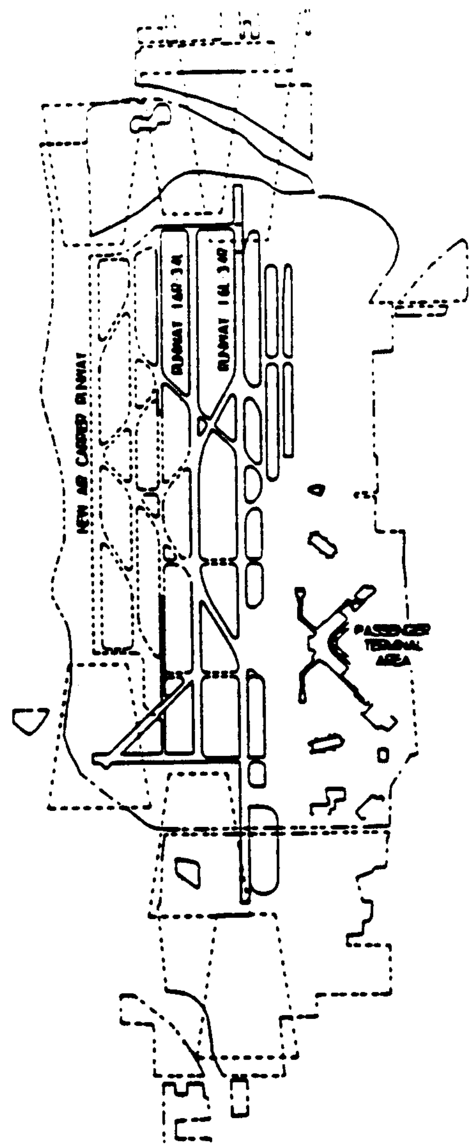
Arlington Municipal Airport With New Runway (Figure 6)

A new parallel north-south runway would be constructed west of the existing north-south runway. The new runway would be 7,000 feet long. Additionally, the present north-south runway would be extended to 7,000 feet. Additional property would be acquired on the north, east, and south sides of the airport to accommodate the required expansion. The passenger terminal would be located at midfield between the parallel runways on the east side of the airport. Air cargo and maintenance activities could be located as shown on Figure 6. Airport support functions could be accommodated at the south end of the airport.

Snohomish County Airport (Paine Field) With Existing Airfield (Figure 7)

Paine Field could be converted to a supplemental airport with no significant airfield improvements required. Activities on the east side of the airport would remain. A new passenger terminal and related air cargo and maintenance and support activities would be located on the west side of the airport. A new parallel taxiway on the west side of the primary runway would be required to provide aircraft access to the west side. The existing primary runway at Paine Field is 9,010 feet long, which is more than adequate for supplemental airport standards.

The airport management of Paine Field has pointed out that the established role of the airport allows only commuter flights due to the proximity of residential development. A change in this decision would be necessary to accommodate air carrier flights.



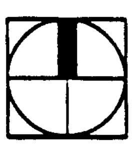

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Figure 4
Sea-Tac With New Dependent Runway

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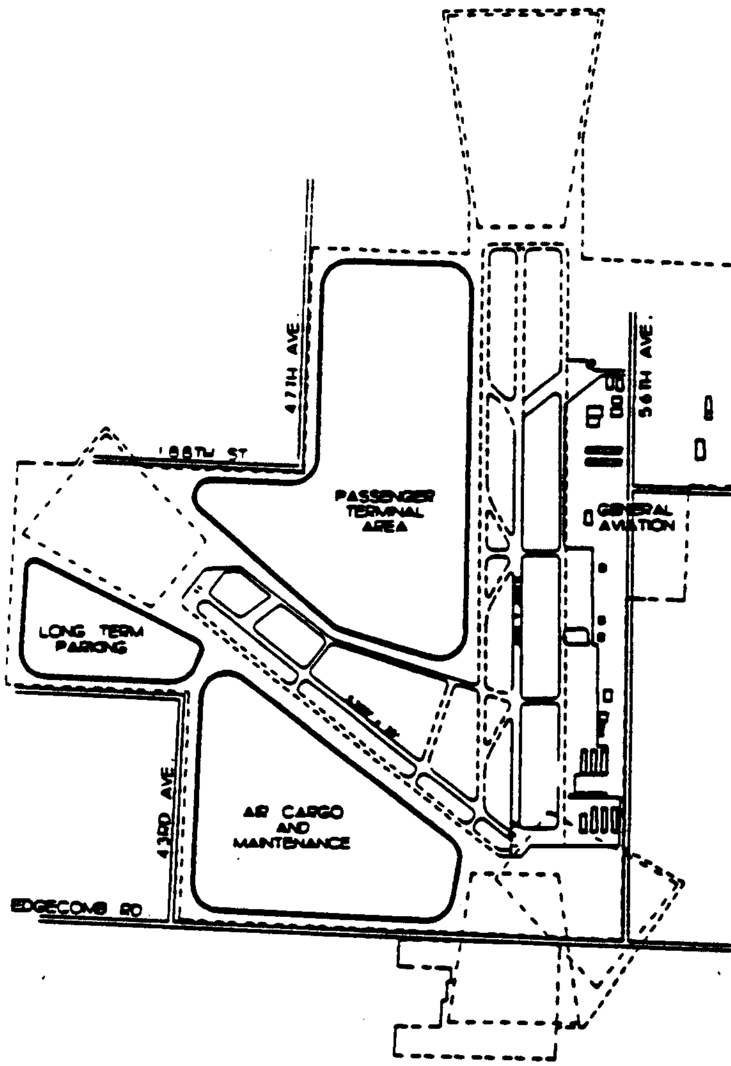

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Figure 5
Arlington Municipal Airport
With New Runway Extension

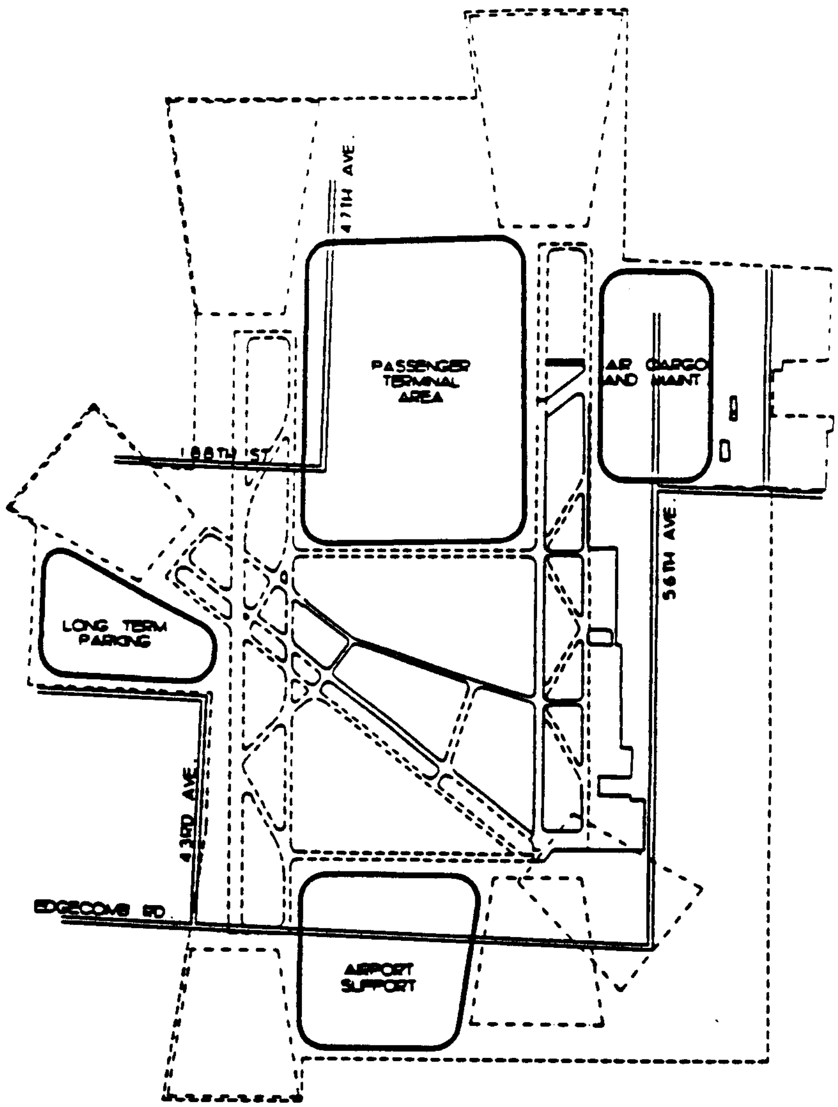

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Figure 6
Arlington Municipal Airport
With New Runway

THE FLIGHT PLAN PROJECT PHASE III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

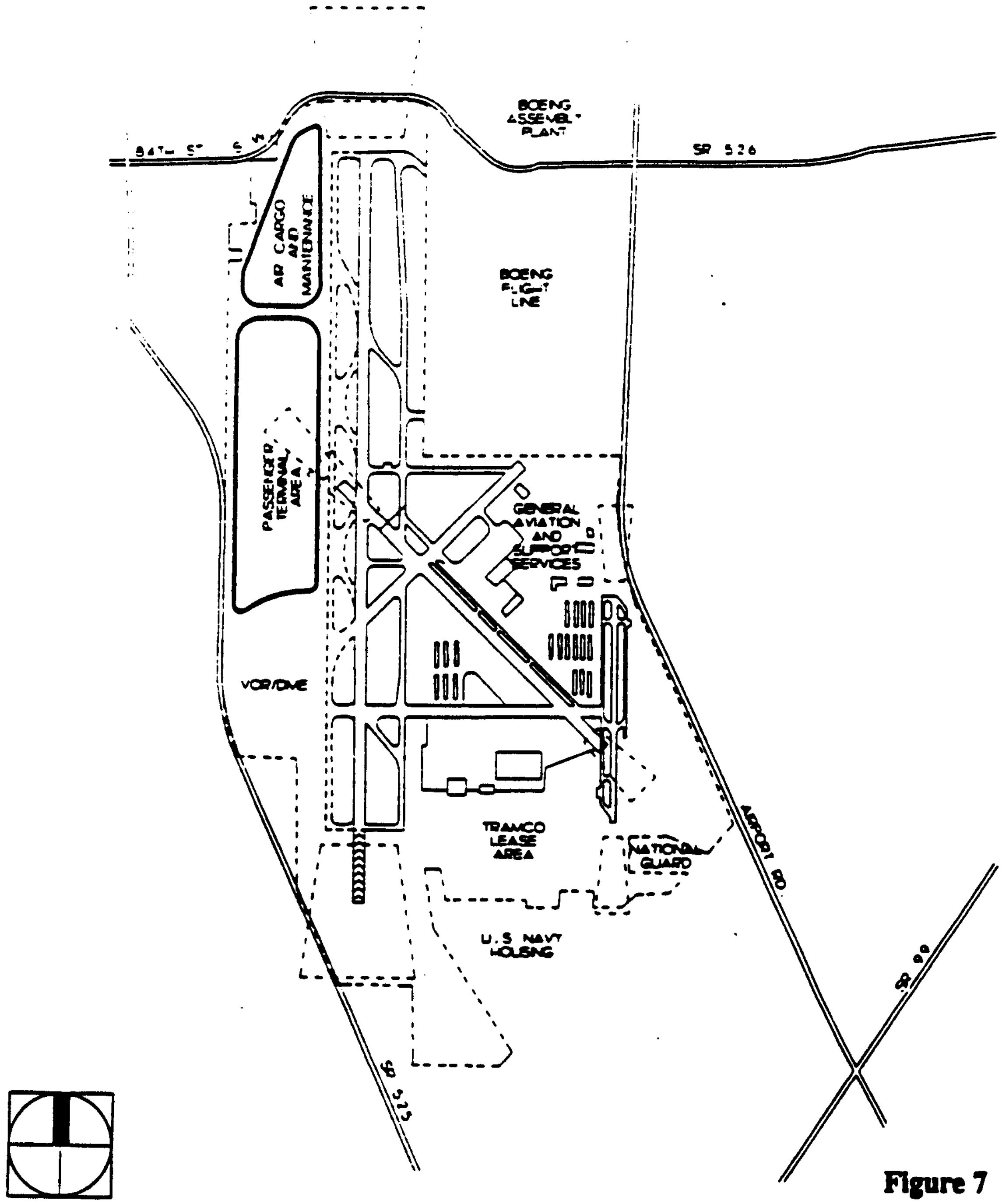

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Figure 7
Paine Field With Existing Airfield

Snohomish County Airport (Paine Field) With New Runway (Figure 8)

In this alternative, an additional north-south runway would be constructed for air carrier use east of the existing primary runway. Without relocating State Route 526 and providing for adequate runway protection zone clearance at the north end, a 5,300-foot runway can be constructed. A displaced threshold of 700 feet on the north end can be accommodated, for a total takeoff length of 6,000 feet. The new runway would be separated by 1,200 feet from the existing primary runway. The passenger terminal area would be located on the west side of the airfield. A large part of the existing general aviation area would be replaced by the new runway and air cargo and maintenance activities would be provided on the east side of the airport. The Tramco lease area on the south side of the airport would be largely undisturbed. Additional land would be acquired under this alternative at the south end of the airport for the new runway, and at the northwest corner for long-term vehicle parking.

Topography and wetlands are significant physical impediments to this alternative. The airport's west side has over two dozen identified wetlands and substantial steep slopes with SR 525 (west of the runway) 40 to 70 feet below runway elevation. The areas identified for air cargo under each alternative are generally grade accessible and free of wetlands. The south two-thirds of the new runway alternative would also involve huge amounts of fill and displacement of a large wetland. Tramco's Hangar 3 currently under development (1992 construction) would be eliminated by this alternative, and their existing Hangar 1 would exceed the 7:1 transitional surface requirements of the new runway. The new runway would displace the U.S. Army Reserve and the majority of light aircraft users at the airport as well as the support businesses. The small east ramp identified for general aviation would accommodate only three FBO's and about 150 light aircraft. The small east runway is too short for corporate aircraft use.

In the fall of 1991 a new doppler VOR will be commissioned atop the Boeing Company's paint hangar on the Boeing flight line. The southwest corner of the airport currently within the protection area for the existing VOR will then be available for development.

Joint Use of McChord Air Force Base With Existing Airfield (Figure 9)

In this concept, the passenger terminal area and air cargo, maintenance and support functions would be located on the east side of the base on existing Air Force Base property. A new parallel taxiway would be constructed on the east side of the runway to serve the civilian functions. Air Force facilities currently located in these areas include hazardous materials loading aprons. This option is based on relocating these loading areas to other locations on the base. If alternate loading areas cannot be provided, the area encompassed by the civilian activities would have to be reduced from that shown in Figure 9.

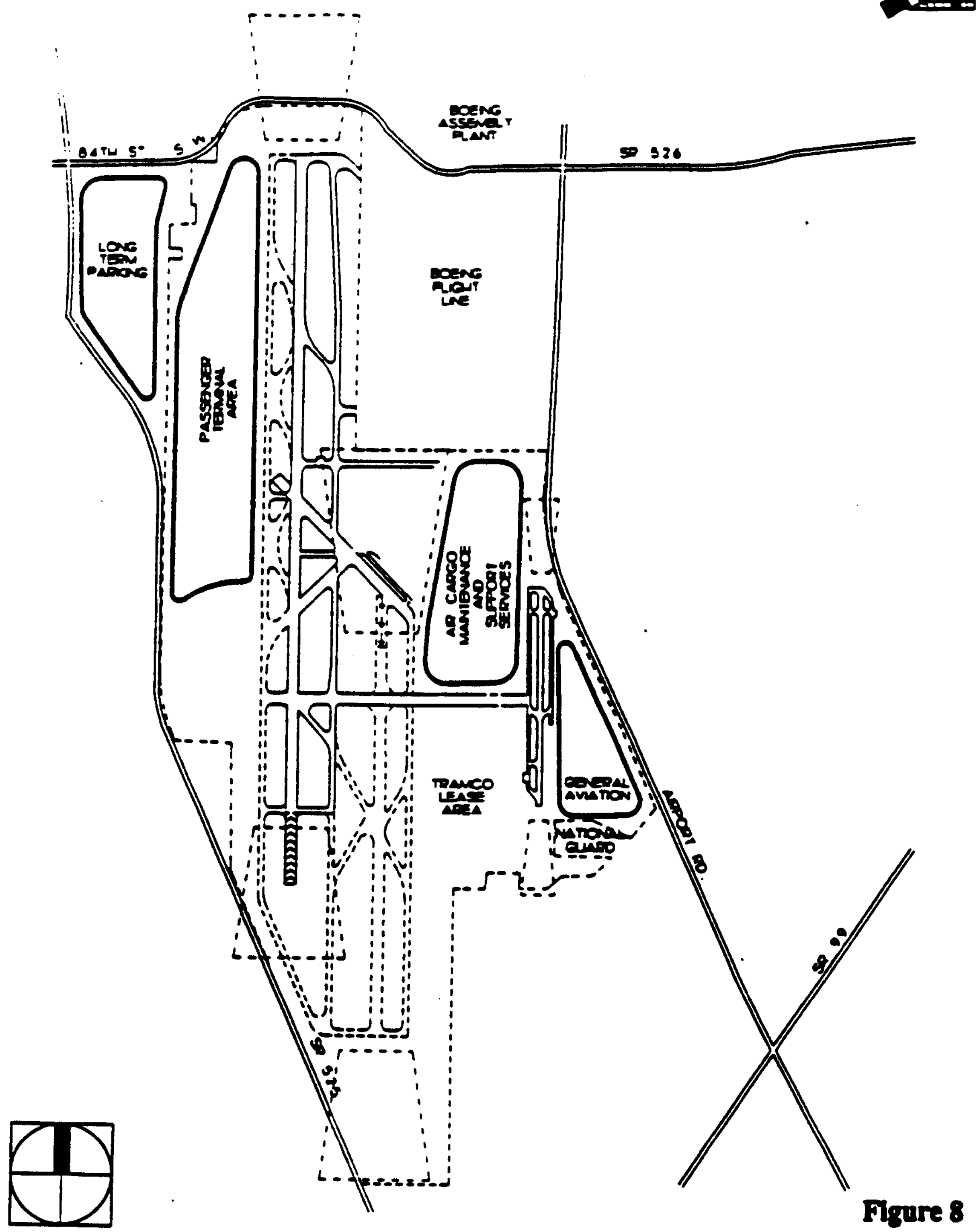

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Figure 8
Paine Field With New Runway

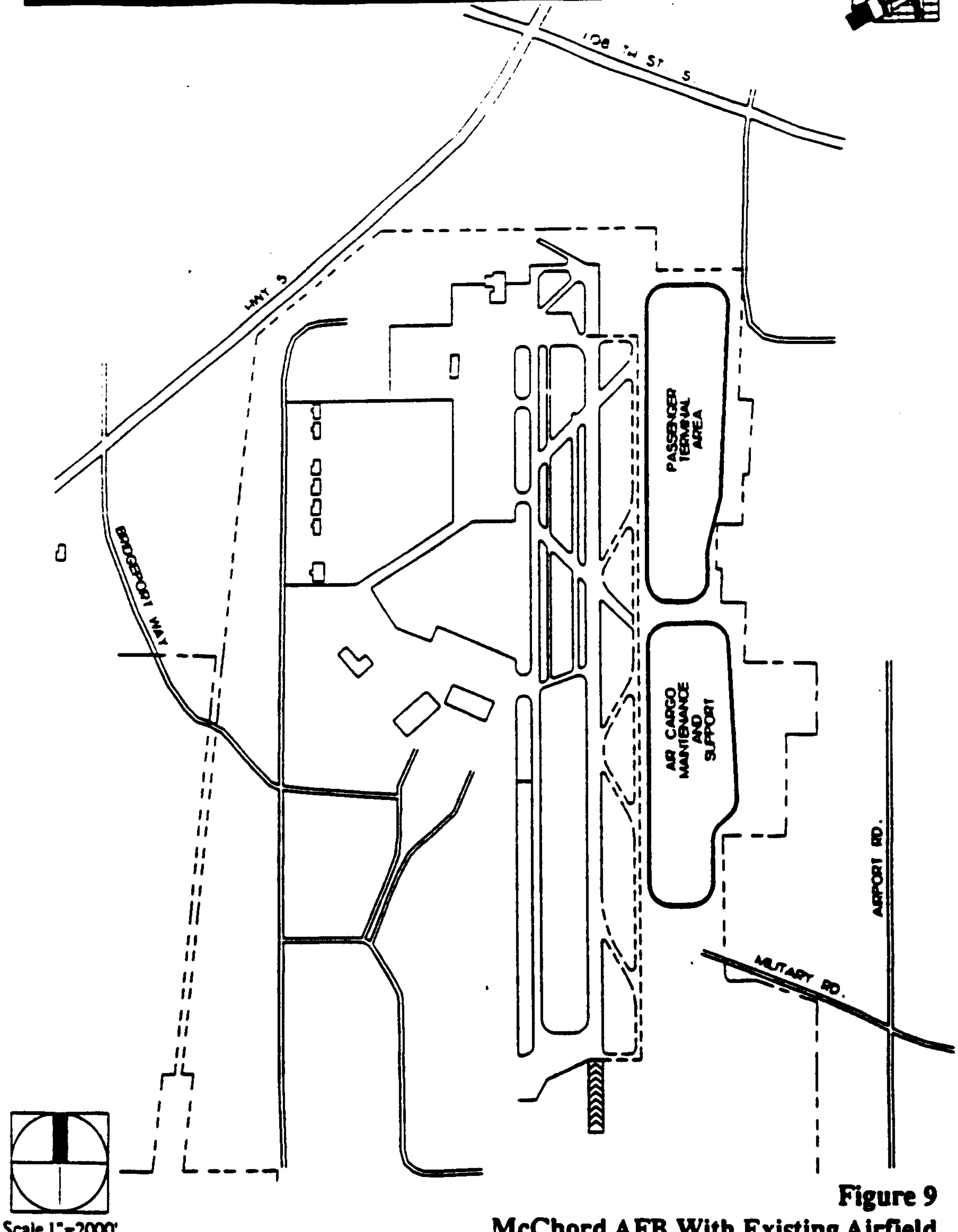

Figure 9
McChord AFB With Existing Airfield

Joint Use of McChord Air Force Base With New Runway (Figure 10)

In this concept, a new civilian runway would be constructed east of the existing runway, with a centerline separation of 700 feet. The passenger terminal area, long-term parking, and air cargo, maintenance, and support services would be located on the east side of the base on existing base property. Although this concept provides a separate runway for civilian use, the remaining area on the east side of the base is reduced.

Central Pierce One-Runway Supplemental Airport (Figure 11)

The Phase II report identified a search area in Central Pierce County called the Fort Lewis/Spanaway search area. The airport concept alternative depicted here is at the eastern edge of the identified site area and is renamed the Central Pierce site. The Central Pierce site was included in the topographic maps which identified the Fort Lewis/Spanaway search area in the Phase II analysis. A second site in the Fort Lewis/Spanaway search area, located on Fort Lewis property, is described later.

The supplemental airport configurations at this site were developed, such that they could potentially become the beginning stages of an ultimate three-runway replacement airport configuration. Therefore, the supplemental airport concepts were constrained within the bounds of the replacement airport layout. Although the layouts for supplemental airports allow them to be expanded to a replacement airport, if necessary, supplemental airports must not necessarily be expanded to replacement airports.

Under the one-runway supplemental alternative, a new runway would be constructed west of Highway 161. The runway would be 7,000 feet long with a parallel taxiway on the east side. The passenger terminal area, vehicle parking and air cargo, maintenance, and support services would be located between the runway and Highway 161. The runway could be extended to the south to a total length of 10,000 feet. The critical factor effecting runway placement was the presence of high terrain to the south. The runway location shown, when extended to 10,000 feet, will have the necessary FAR Part 77 approach surface clearance over this terrain. All three Central Pierce Site options would require the closure of Thun Field, east of Highway 161.

Central Pierce Two-Runway Supplemental Airport (Figure 12)

Under this alternative, a second 7,000-foot runway would be constructed 3,500 feet to the west of the single runway. The passenger terminal and parking area would extend along the east side of the airport between Highway 161 and the airport. Air cargo and maintenance functions can be provided between the runways on the north side. Support services can be accommodated on the south side of the airport. Both runways would be able to be extended to 10,000 feet if the airport were to be expanded to a replacement airport.

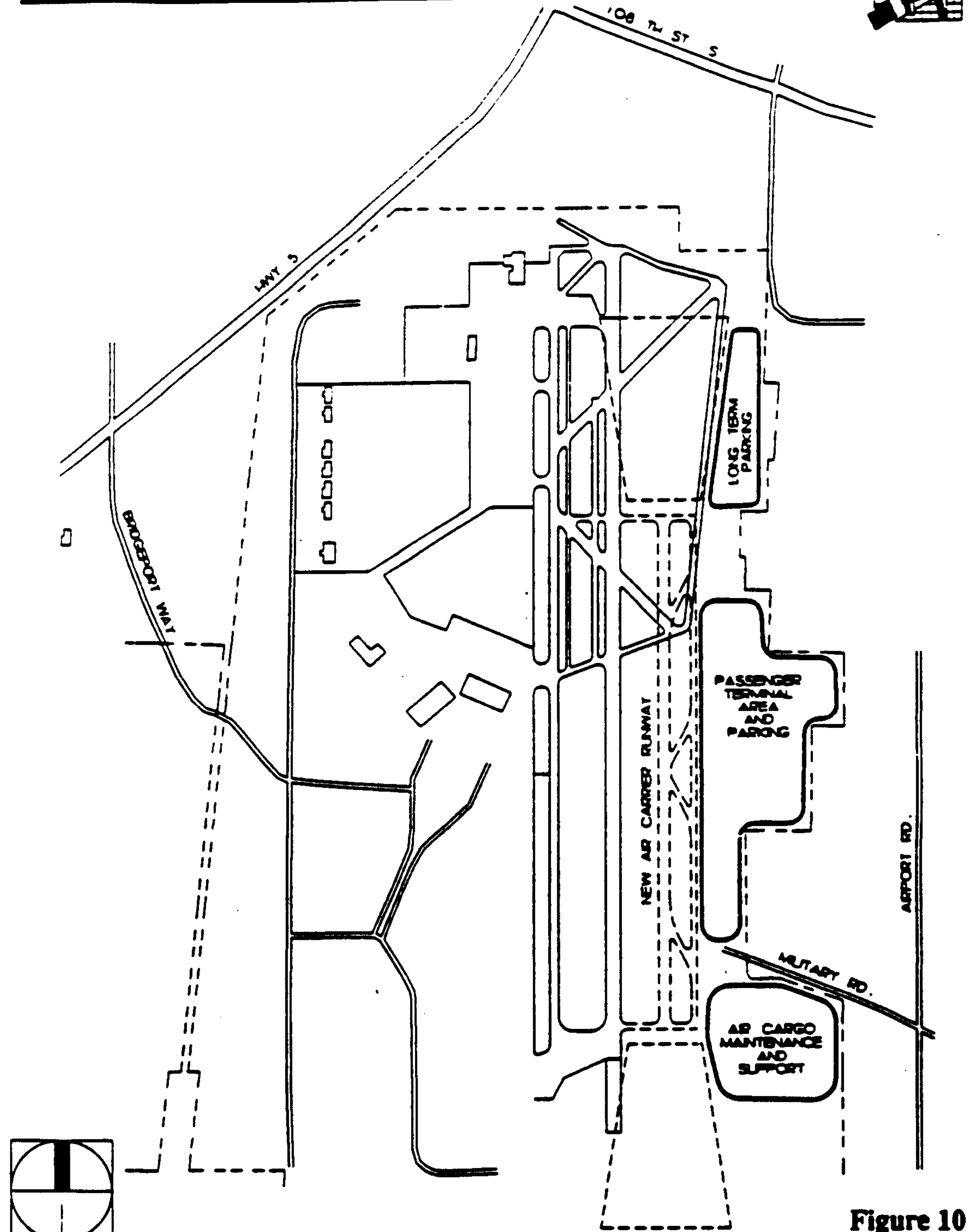

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Figure 10
McChord AFB With New Runway

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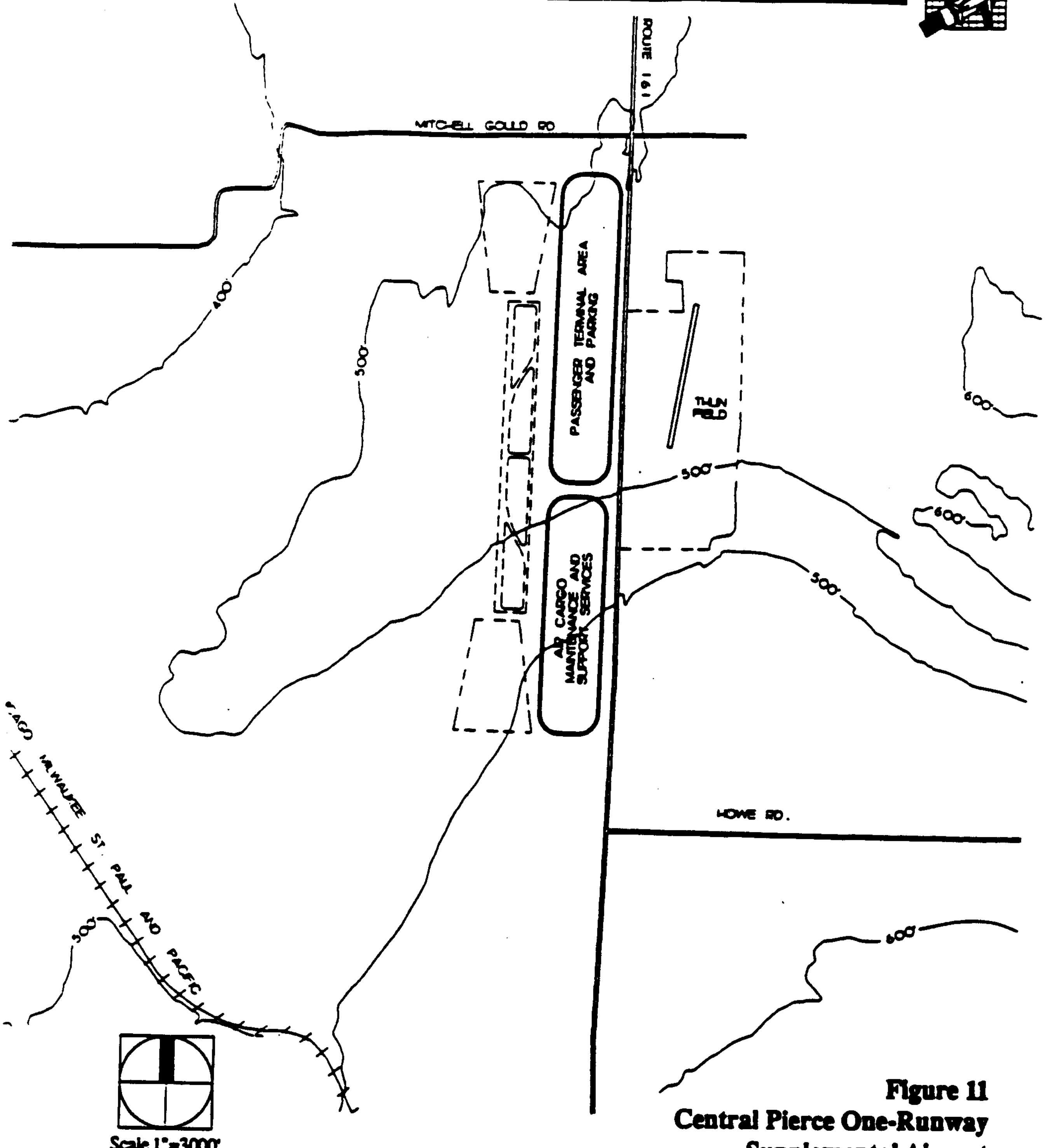

Figure 11
Central Pierce One-Runway Supplemental Airport

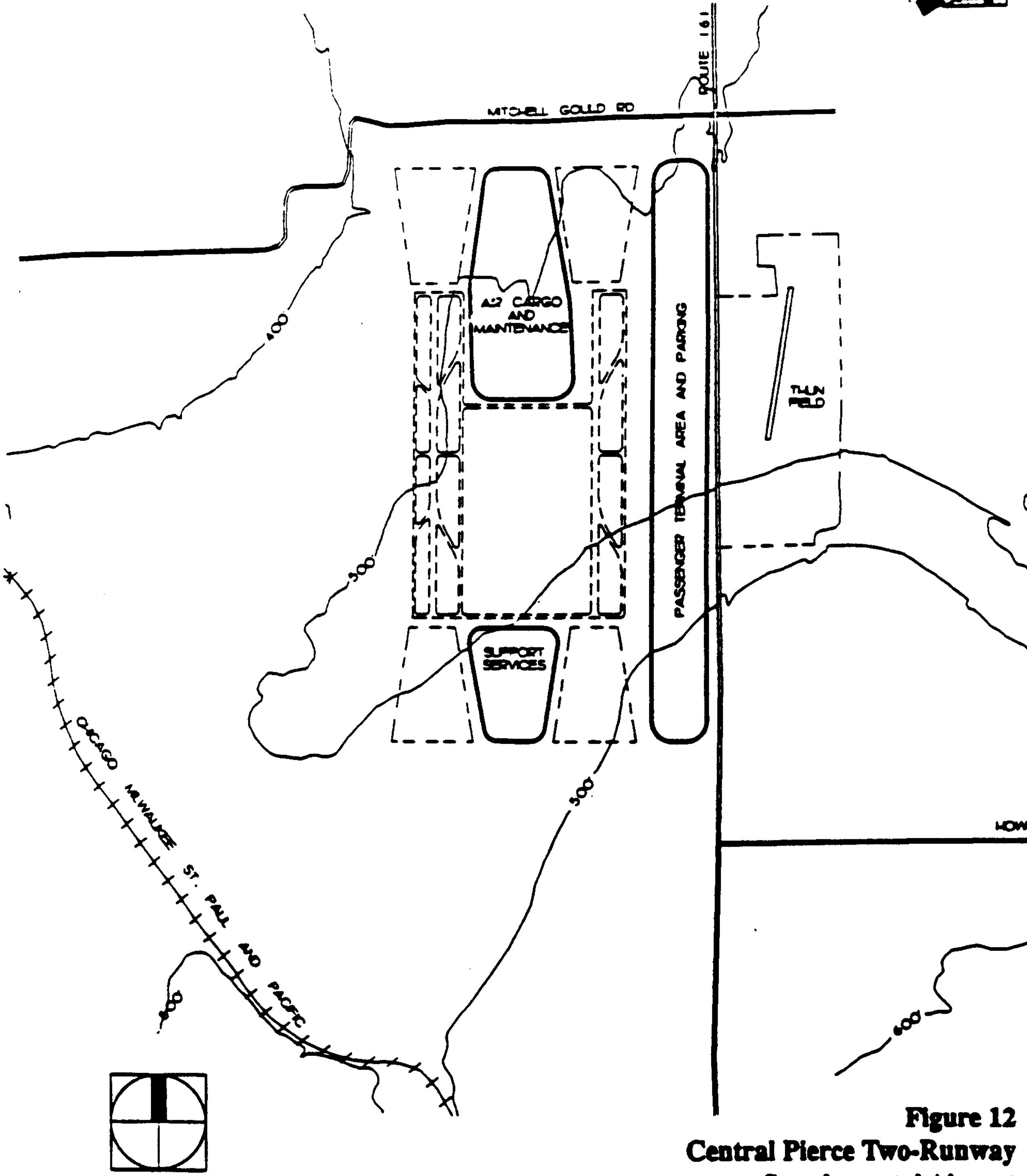

Figure 12
Central Pierce Two-Runway Supplemental Airport

Central Pierce With Replacement Airport (Figure 13)

Under this alternative, a three-runway replacement airport would be constructed on the Central Pierce site. The two easterly runways would be separated by 5,500 feet and straddle Highway 161. The passenger terminal area and related vehicle parking and circulation would be located within the area between these two runways. The easternmost runway would be capable of a 2,000-foot extension to 12,000 feet, to the north. The westerly runway would be separated from the center runway by 3,500 feet, providing for three simultaneous instrument arrival and departure streams. Additional airport activities can be accommodated on the east side of the easterly runway.

Olympia/Black Lake One-Runway Supplemental Airport (Figure 14)

As with the Central Pierce site concepts, the Olympia/Black Lake supplemental airport concepts are configured so they could potentially be beginning stages of an ultimate three-runway replacement airport. Constraints at the Olympia/Black Lake site include high terrain to the south, railroad tracks at the north and south ends of the site, and numerous creeks. The Olympia/Black Lake site is located entirely on the west side of Interstate 5 to avoid overflights over developed areas to the north.

The one-runway concept includes a 7,000-foot runway with passenger terminal and associated facilities to the east, access to the airport would be by Lathrop Road from Interstate 5. Bloom's Ditch which runs through the site would probably be rechanneled into Salmon Creek to the north. Hills directly south of the runway would have to be removed to provide adequate approach surface clearance.

Olympia/Black Lake Two-Runway Supplemental Airports (Figure 15)

The two-runway concept for Olympia/Black Lake would be similar to the two-runway concept at the Central Pierce site. However, at the Olympia/Black Lake site the westerly runway must be offset to the south to prevent relocation of Burlington Northern Railroad tracks and to avoid wetlands areas to the north. Hills at the south end of the runway must be removed for runway construction and approach surface clearance.

Both Olympia/Black Lake supplemental airport options could impact flight operations at Olympia Airport, located three miles to the northeast. Airspace conflicts could be minimized by constructing the supplemental airport runways parallel to the primary runway at Olympia Airport. However, that runway orientation would result in increased flights over existing urban areas.

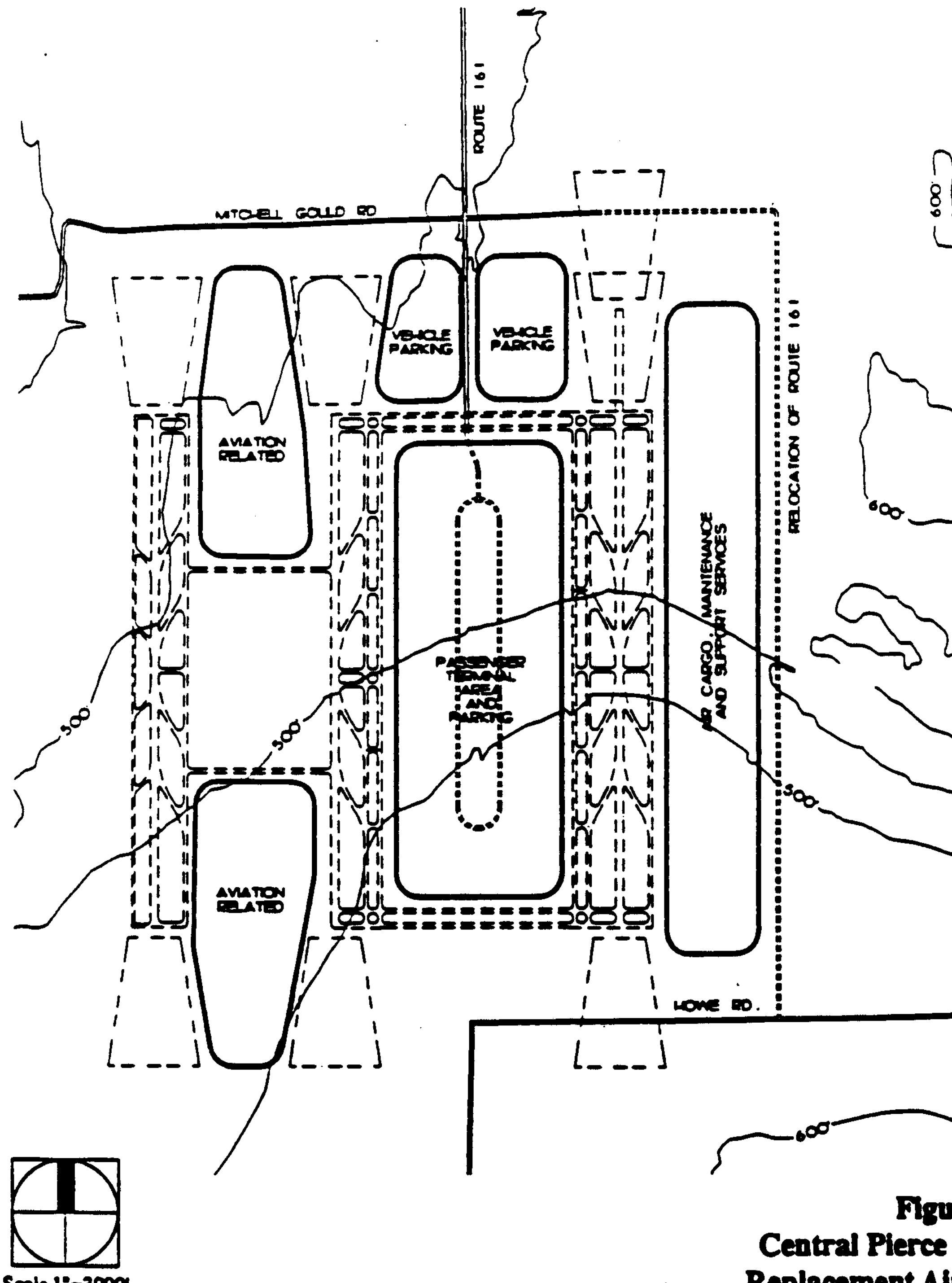

Figure 13
Central Pierce With Replacement Airport

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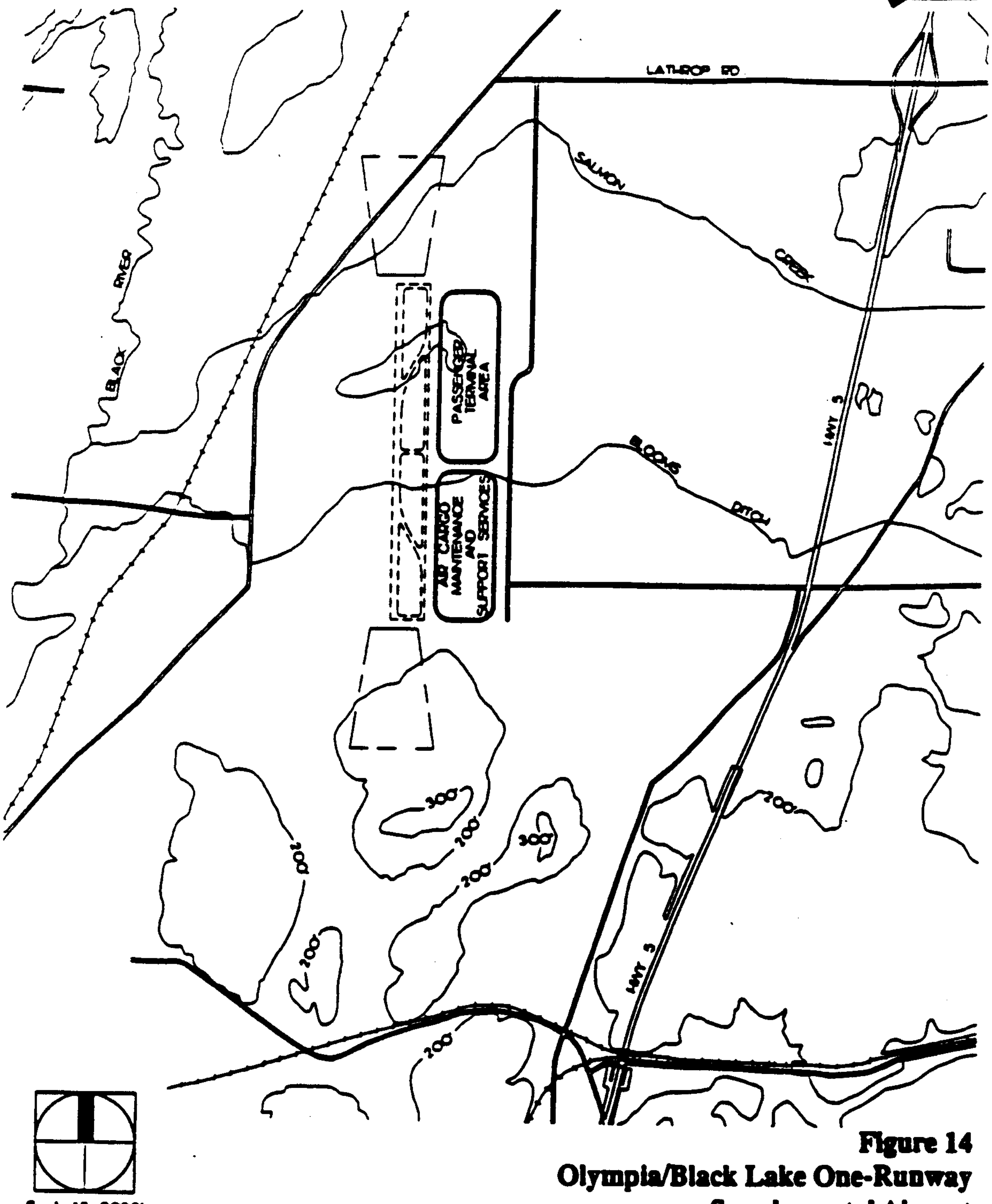

Figure 14
Olympia/Black Lake One-Runway Supplemental Airport

THE FLIGHT PLAN PROJECT PHASE III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

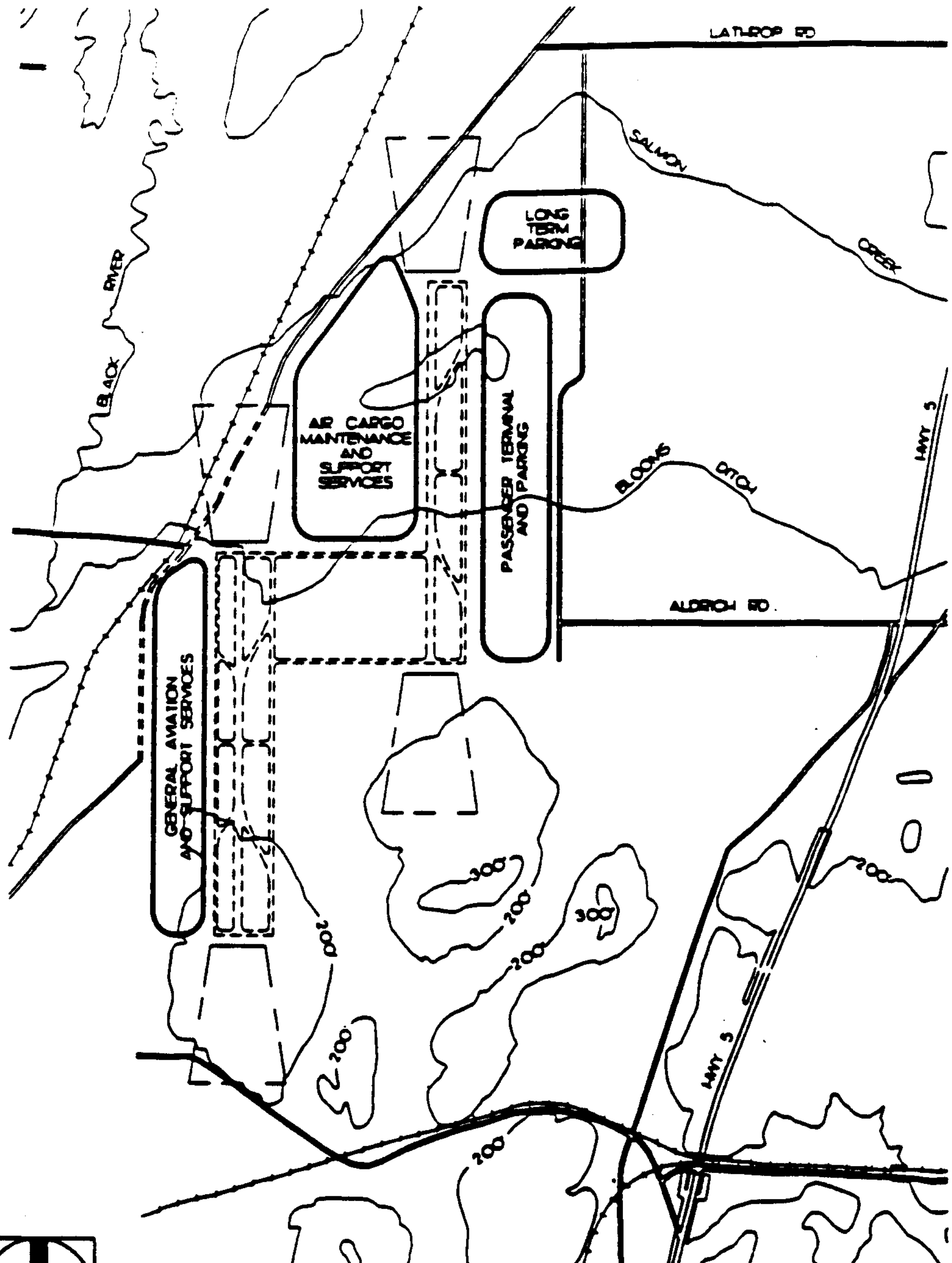

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Figure 15
Olympia/Black Lake Two-Runway Supplemental Airport

Olympia/Black Lake With Replacement Airport (Figure 16)

This alternative consists of three 10,000-foot runways on the Olympia/Black Lake site with the center runway capable of expanding to 12,000 feet. With the exception of the offset westerly runway, the configuration of this concept is similar to the replacement airport at the Central Pierce site. It is anticipated that the existing Olympia Airport would be closed under this option.

Fort Lewis Site With Replacement Airport (Figure 17)

A site in the Fort Lewis/Spanaway search area on Fort Lewis property is referred to as the Fort Lewis Site. This site is at the eastern boundary of Fort Lewis, southwest of State Highway 7 near Elk Plain. The site is in Fort Lewis Training Areas 11 and 15 and northeast of a Drop Zone in Training Area 14. Activities in these training areas would have to be relocated. However, the use of this site for an airport appears to impact Fort Lewis activities less than other suitable Fort Lewis sites. The site has no significant wetlands and would not require as extensive earthwork as other Fort Lewis sites.

SUMMARY

In this Working Paper, conceptual site layouts have been shown for all Flight Plan site alternatives. All options depicted here are feasible. New airport site layouts have been designed to avoid wetlands, railroad relocations, severe topography changes and other constraints. However, constructing new runways at existing airports are subject to constraints such as wetlands, topography, and existing development.

THE FLIGHT PLAN PROJECT PHASE III

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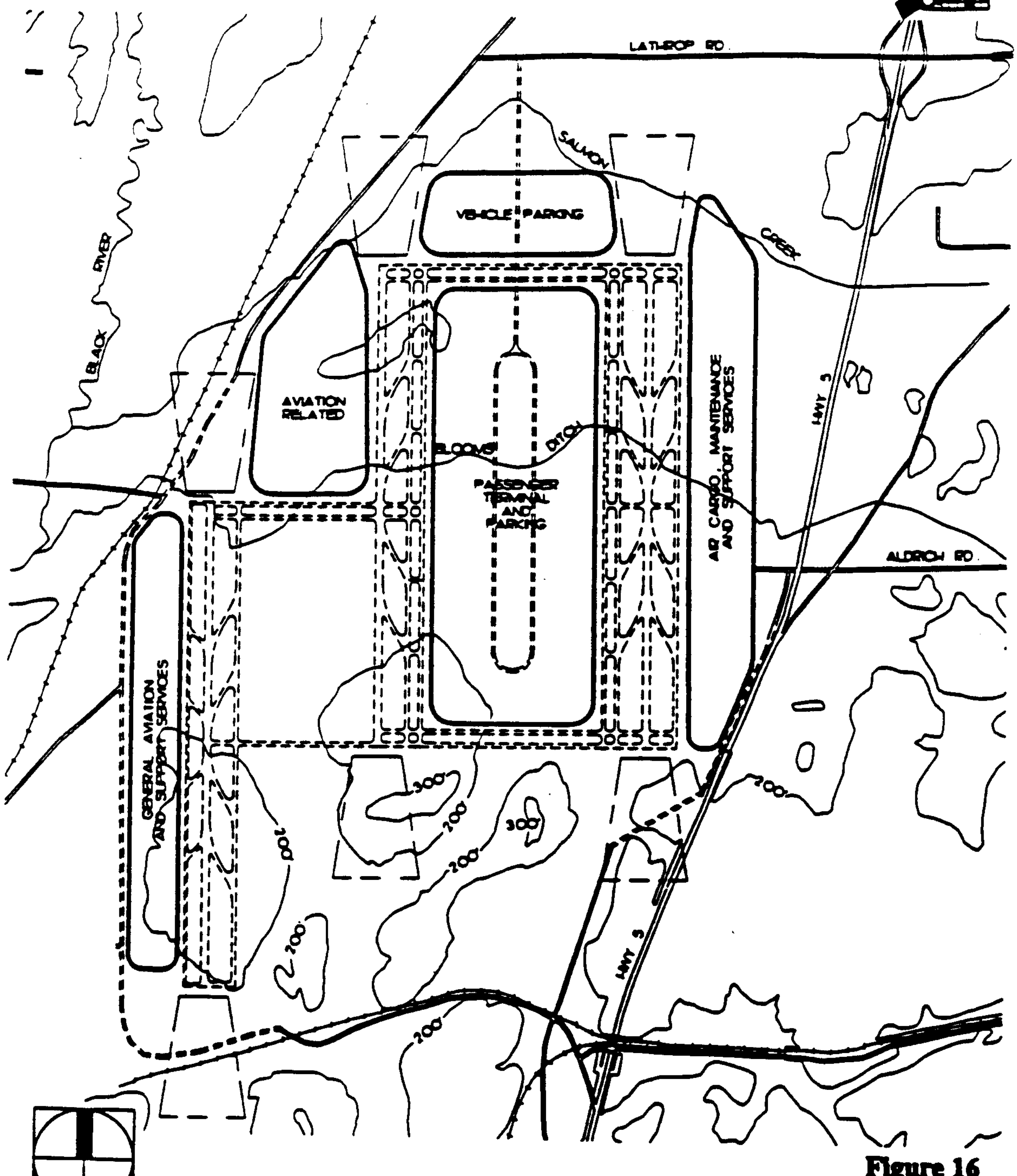

Figure 16
Olympia/Black Lake With Replacement Airport

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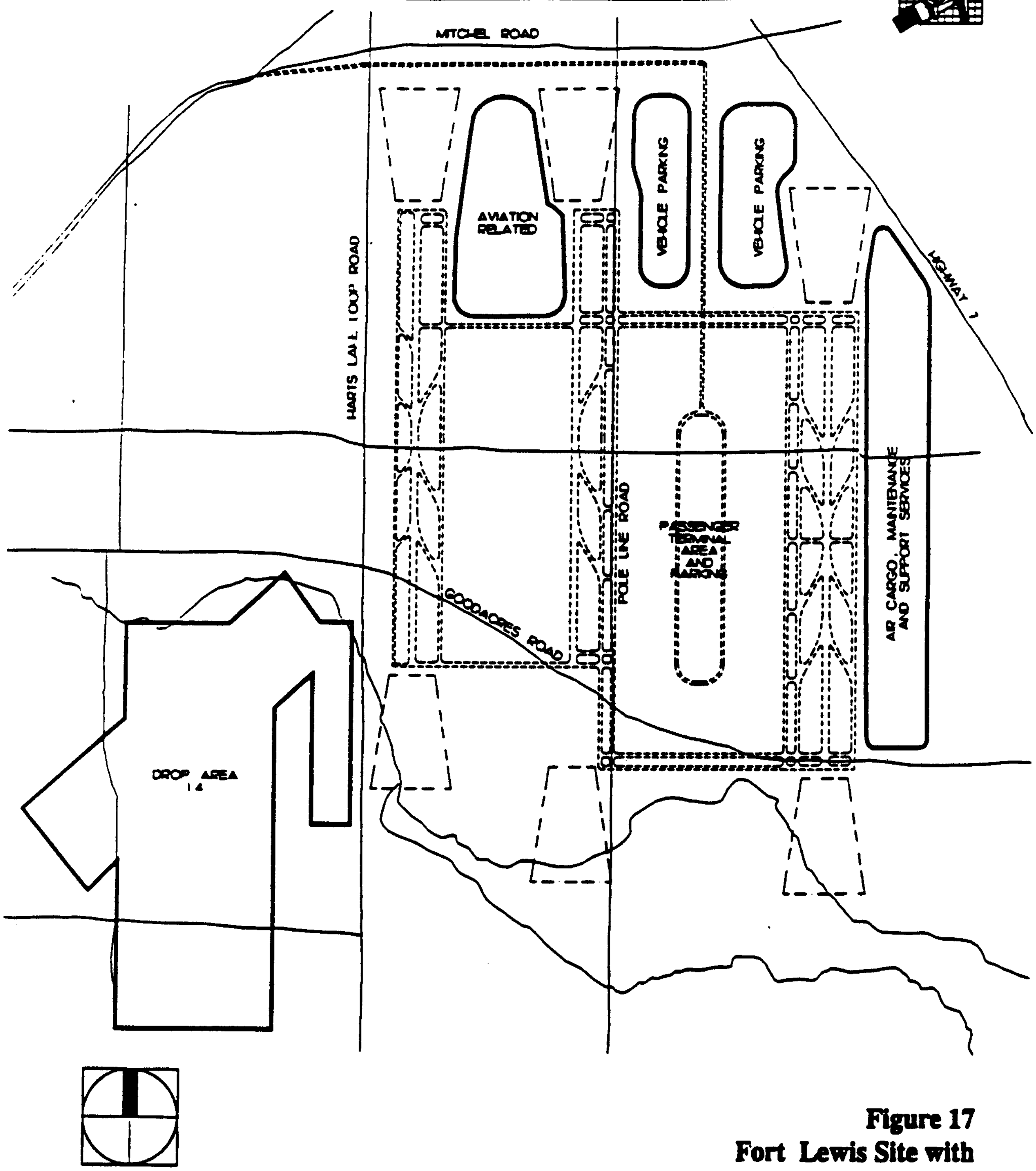

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Figure 17
Fort Lewis Site with Replacement Airport

WORKING PAPER # 3

LEVEL OF SERVICE

PRESENTED
JULY 25, 1991

ADOPTED
AUGUST 15, 1991

Due to a clerical error this number has been omitted.

THE FLIGHT PLAN PROJECT PHASE III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

DATE: July 13, 1991

TO: Puget Sound Air Transportation Committee

FROM: P&D Aviation

SUBJECT: **WORKING PAPER NO. 3 - LEVEL OF SERVICE**

INTRODUCTION

Commercial passenger forecasts for the Puget Sound region through the year 2020 were developed during Phase I of Flight Plan. These forecasts are presented as an aggregate for the entire multi-county study area and do not describe passenger origins or destinations (O&D) within the region.

Phase II of Flight Plan did not require additional passenger O&D information since the objective was to determine only which strategies should be carried forward for further analysis.

Phase III however, will conduct a comparative evaluation and ranking of airport strategies requiring a knowledge of passenger origins and destinations within the region, as well as the type of air service desired (e.g. trip length). Improved passenger O&D information will allow alternatives to be analyzed for factors such as accessibility, convenience, level-of-service desired, demand potential and demand satisfaction. It is the purpose of this document to derive this more detailed passenger forecast information.

PHASE I FORECAST SUMMARY

The Flight Plan Phase I forecast analysis determined the number of commercial passengers in the Puget Sound region would grow from 16.3 million annual passengers (MAP) in 1990 to 45 MAP in 2020. Further, it is estimated approximately one-third of these passengers are "connecting" or "through" passengers as opposed to travelers who originate or terminate their air trip at Sea-Tac. The number of locally generated O&D passengers are therefore expected to reach 30 million, a level which exceeds the current locally generated passenger counts at many multiple airport metro areas including Chicago, Los Angeles, and San Francisco.

Translating passenger growth to increases in aircraft operations reveals Sea-Tac, as it is now operated, will be unable to accommodate growth through the turn of the century without incurring substantial delays. By the year 2000, it is estimated delays will average 30 to 45 minutes in clear weather conditions and 90 minutes or more in poor weather. One of the important questions Phase III of Flight Plan must address is whether the demand for additional commercial aircraft operations can best be served at Sea-Tac or by development of new commercial airport facilities elsewhere, or both.

PASSENGER GROWTH FACTORS

The economic modeling analysis conducted during the forecast studies determined passenger growth in the Puget Sound region is most highly correlated to 1) population, 2) per capita income, and 3) airline yields. Estimates of the first two variables are available by census tracts. An aggregation of census tract passenger estimates to the county-wide level was compared to the passengers estimated by the forecast model. The differences between the forecast model and population demand estimates were found to be relatively small. This led to the conclusion that, in the Puget Sound region, population is a very good indicator of commercial passenger demand at the county-wide level. In other words, passengers per capita were found to be very similar when aggregated from the census tract to the county level. Differences among census tracts due to varying per capita incomes were averaged out when combining census tracts within counties. It can be assumed therefore that existing and future county population estimates can serve as a good indicator of passenger distributions within the region.

POPULATION DISTRIBUTION WITHIN THE REGION

Existing and future population estimates for the Puget Sound region and surrounding counties are shown in Table 1. Estimates developed by PSCOG are shown for 1990 and the year 2020. The population distribution is subdivided into three groupings defined as 1) Central - King County, 2) Northern - counties whose residents might be more conveniently located to a supplemental airport north of Sea-Tac, and 3) Southern - counties whose populations might be more conveniently located to a supplemental airport south of Sea-Tac. Within the entire eleven county region the total population is projected to increase from 3.4 million to 4.9 million in 2020. For purposes of this analysis this population and area is assumed to approximate the "market-shed" served by Sea-Tac.

In 1990, King County's share of the total market-shed population is 45 percent. In 2020 this share decreases by 2 percent to 43 percent due to more rapid population growth in the surrounding counties. The distribution of population in 2020 north and south of King County is relatively evenly distributed at 24 percent and 33 percent respectively. Snohomish and Pierce Counties dominate the northern and southern areas with 14 percent and 18 percent of the regional population.

PASSENGER DISTRIBUTION WITHIN THE REGION

Based on the findings of the PSCOG passenger correlation studies, and the population figures described above and shown in Table 1, estimates are prepared of passenger distributions within the Sea-Tac market-shed area. These estimated, shown in Table 2, are simply the 1990 and year 2020 aggregate passenger forecasts distributed to the counties according to population percentages derived in Table 1. Connecting passengers however have not been allocated to the northern or southern counties based on the reasoning that very few if any connections would occur at the supplemental airports.

TABLE 1
FLIGHT PLAN Phase III
REGIONAL POPULATION DISTRIBUTION (Thousands)

	1990	2020	1990 %	2020 %
CENTRAL COUNTY				
King	1,507	2,115	45.1%	43.1%
Subtotal	1,507	2,115	45.1%	43.1%
NORTHERN COUNTIES				
Island	60	102	1.8%	2.1%
Skagit	80	101	2.4%	2.1%
Snonomish	466	788	14.0%	16.1%
Whatcom	128	167	3.8%	3.4%
Subtotal	734	1,158	22.0%	23.6%
SOUTHERN COUNTIES				
Grays Harbor	64	66	1.9%	1.3%
Kitsap	190	295	5.7%	6.0%
Lewis	59	65	1.8%	1.3%
Mason	38	64	1.1%	1.3%
Pierce	586	869	17.6%	17.7%
Thurston	161	274	4.8%	5.6%
Subtotal	1,098	1,633	32.9%	33.3%
TOTAL	3,339	4,906	100.0%	100.0%

The type of service offered by supplemental airports will be an important consideration in determining the tendency of passengers to choose closer airports. For example, passengers planning a transcontinental trip will be more likely to accept a longer ground trip to get a better selection of airline schedules. To allow the demand projections for alternative supplemental airports to be responsive to these characteristics, the passenger distributions shown in Table 2 are further classified by short (less than 700 miles), medium (700-1100 miles), and long haul (greater than 1100 miles) air trip lengths. These estimates are derived using the aggregate city-pair statistics presented in the Flight Plan Phase I forecasting analysis. According to these data, the distribution of short, medium and long haul air trips is 22 percent, 32 percent, and 46 percent respectively. A few examples of these types of markets are listed below.

Short-haul - This includes service in markets of under 700 nonstop miles such as Bellingham, Portland, Spokane, Vancouver, Yakima, San Francisco, Oakland, and San Jose. These markets can generally be served by commuter airlines with turboprop equipment or smaller air carrier jets such as the Boeing 737.

Medium-haul - Medium-haul includes services to cities such as Los Angeles, Phoenix, Salt Lake City and Denver. Connections, of course, can be made at hubs to reach more distant final destinations.

Long-haul - Long-haul services can bypass a hub since passenger traffic in these markets can be large enough to obviate the need for passenger consolidation at the hub. Examples include San Diego, Chicago, and New York, and of course the majority of international locations.

Table 3 shows an historical distribution of the major Sea-Tac air passenger destinations using data presented in Phase I of The Flight Plan Project. The city pair O&D data is based on 1988 statistics and it should be noted that the passengers indicated represent only originating, or outbound, passengers and thus the total will be about half of the total annual passengers.

The California markets accounted for the largest share of Seattle O&D passengers with 3.1 million in CY 1987 or 31 percent of the total. Los Angeles, San Francisco and San Diego rank among Seattle's Top 10 O&D markets.

Important regional markets, including Washington State, Oregon, Idaho and Vancouver and Victoria, BC accounted for 11 percent of the total. Combined regional and California O&D passengers amounted to 42 percent of all Seattle domestic O&D passengers (including Vancouver and Victoria, BC).

TABLE 2
FLIGHT PLAN Phase III
REGIONAL PASSENGER DISTRIBUTION

	1990 Passengers (Millions)					2020 Passengers (Millions)				
	Short Haul	Medium Haul	Long Haul	Total	Regional Percentage	Short Haul	Medium Haul	Long Haul	Total	Regional Percentage
CENTRAL COUNTY										
King	2.28	3.31	4.76	10.34	63.5%	6.15	8.94	12.86	27.95	62.1%
Subtotal	2.28	3.31	4.76	10.34	63.5%	6.15	8.94	12.86	27.95	62.1%
NORTHERN COUNTIES										
Island	0.04	0.06	0.09	0.20	1.2%	0.14	0.20	0.29	0.62	1.4%
Skagit	0.06	0.08	0.12	0.26	1.6%	0.14	0.20	0.28	0.62	1.4%
Snohomish	0.33	0.48	0.70	1.52	9.3%	1.06	1.54	2.21	4.81	10.7%
Whatcom	0.09	0.13	0.19	0.42	2.6%	0.22	0.33	0.47	1.02	2.3%
Subtotal	0.53	0.76	1.10	2.39	14.6%	1.56	2.26	3.25	7.07	15.7%
SOUTHERN COUNTIES										
Grays Harbor	0.05	0.07	0.10	0.21	1.3%	0.09	0.13	0.19	0.40	0.9%
Kitsap	0.14	0.20	0.28	0.62	3.8%	0.40	0.58	0.83	1.80	4.0%
Lewis	0.04	0.06	0.09	0.19	1.2%	0.09	0.13	0.18	0.40	0.9%
Mason	0.03	0.04	0.06	0.12	0.8%	0.09	0.13	0.18	0.39	0.9%
Pierce	0.42	0.61	0.88	1.91	11.7%	1.17	1.70	2.44	5.31	11.8%
Thurston	0.12	0.17	0.24	0.52	3.2%	0.37	0.54	0.77	1.67	3.7%
Subtotal	0.79	1.14	1.64	3.57	21.9%	2.19	3.19	4.59	9.98	22.2%
TOTAL	3.59	5.22	7.50	16.30	100.0%	9.90	14.40	20.70	45.00	100.0%

Results of the passenger distribution analysis indicate that of the 45 million annual passengers projected for the year 2020, 7 million O&D passengers will be generated by the northern counties, and 10 million will be generated by the southern counties. This assumes all connecting passengers remain in King County. If it if further assumed that half of the medium haul and all of short haul passengers would select the closest commercial airport then the demand potential for a supplemental airport in the northern county sub-region is approximately 2.6 million O&D passengers and in the southern county area is 3.8 million O&D passengers.

IMPLICATIONS FOR SYSTEM ALTERNATIVES

To test the plausibility of the system alternatives being considered in Phase III, a comparison is made of the Seattle O&D passenger forecasts with other large metropolitan areas. Table 4 shows the year 2020 Sea-Tac O&D passengers compared to 1988 O&D passengers for large U.S. metropolitan areas. By the year 2020 Sea-Tac will be required to support O&D passenger volumes comparable to those now handled in Chicago, Los Angeles, and San Francisco. Each of these metropolitan areas provides multiple airport systems to meet these demands. A further examination of the metro areas served by more than one airport reveals three of the six listed are two airport systems and three are three airport systems. It should be noted Los Angeles is also a multiple airport system even though the statistics in Table 4 show passenger data for only the primary airport.

The implications of this comparison suggest the Sea-Tac projected year 2020 demands could support a two, or even three airport system. Moreover, the relatively equal distribution of demand between the north and south areas of the region also suggests a three airport system alternative which includes two supplemental airports, one north and one south of Sea-Tac, should at least be considered in the Phase III evaluations.

Passenger distributions derived earlier imply a demand of 2.6 and 3.8 million O&D passengers would exist for supplemental airports located in the northern and southern areas. Due to the geographical distribution of demand, the addition or deletion of one of these supplemental airports will affect primarily the demand at Sea-Tac and not the demand at the other supplemental airport. Thus, it can be reasoned from purely a demand standpoint, if a supplemental airport is justified north of Sea-Tac, then a supplemental airport is also justified south of Sea-Tac.

Based on this analysis, it is suggested a three airport system be added to the set of alternatives to be evaluated. The actual demand for these options will be refined further when airport concept layouts and site locations are described in greater detail. Included in the next phase of demand analysis will be: 1) the type and amount of service that would be located at each supplemental airport and 2) the service advantages and disadvantages of the multiple airport system.

FINDINGS AND CONCLUSIONS

The following summarizes the key findings and conclusions of this analysis.

- Flight Plan Phase I forecasts determined the number of O&D passengers in the Puget Sound region would grow from 10.9 MAP in 1990 to 30 MAP in 2020.
- Comparison of Sea-Tac 2020 O&D passenger projections to other metropolitan areas reveals this level of demand is now being served in other parts of the country by several two and three airport systems.
- An evaluation of factors influencing passenger demands determined that population is the best indicator of passenger distributions in the Puget Sound region.
- Using projected distributions of population and airline haul lengths, it is estimated the O&D passenger demand will be 2.6 MAP and 3.8 MAP for supplemental airports located in the northern and southern PSCOG sub-regions respectively.
- In view of these findings, it is recommended a three airport strategy be included in the Phase III alternative evaluation studies.

TABLE 3
SEATTLE'S TOP O&D CITY PAIR MARKETS

Rank	City	Passengers	Percent
1	Los Angeles	455,435	10.6%
2	San Francisco	289,265	6.7
3	New York	206,860	4.8
4	Honolulu	189,060	4.4
5	Chicago	154,225	3.6
6	Denver	147,115	3.4
7	Oakland	131,865	3.1
8	Washington, D.C.	119,700	2.8
9	San Jose	109,155	2.5
10	San Diego	108,050	2.5
11	Anchorage	106,260	2.5
12	Phoenix	104,505	2.4
13	Portland	91,909	2.1
14	Reno	91,335	2.1
15	Minneapolis/St. Paul	86,425	2.0
16	Dallas/Fort Worth	85,755	2.0
17	Orange County	84,820	2.0
18	Spokane	77,552	1.8
19	Boston	76,190	1.8
20	Ontario	71,065	1.7
21	Las Vegas	59,320	1.4
22	Atlanta	58,415	1.4
23	Detroit	58,360	1.4
24	Salt Lake City	51,841	1.2
25	Sacramento	49,753	1.2
26	Kansas City	48,535	1.1
27	Philadelphia	48,510	1.1
28	Orlando	43,745	1.0
29	Miami	42,795	1.0
30	St. Louis	39,790	0.9
31	Houston	35,075	0.8
32	Baltimore	28,125	0.7
33	Tampa	27,430	0.6
34	Juneau	24,660	0.6
35	Cleveland	23,715	0.6
36	Albuquerque	23,650	0.5
37	Tucson	23,405	0.5
38	New Orleans	23,310	0.5
39	Ketchikan	23,090	0.5
40	Hartford	21,570	0.5
41	Indianapolis	20,995	0.5
42	Pittsburgh	20,405	0.5
43	Boise	10,561	0.2
	Total-listed cities	3,393,601	83.5%
	Other cities	708,499	16.5
	GRAND TOTAL	4,302,100	100.0%

Source: The Flight Plan Project - Phase I.

TABLE 4
COMPARISON OF Sea-Tac 2020 O&D PASSENGERS TO OTHER MAJOR U.S. METROPOLITAN AREAS

City	1988 O&D Passengers (MAP)
New York (3)	45.9
Sea-Tac Year 2020 Forecast	30.0
Chicago (2)	27.3
Los Angeles	26.7
San Francisco (3)	26.5
Dallas/Fort Worth (2)	18.2
Washington, D.C. (2)	18.0
Boston	16.6
Atlanta	14.3
Houston (2)	13.5
Denver	11.9

Note: Number of multiple airports contributing to O&D passenger statistics indicated in parenthesis.

Source: U.S. Department of Transportation Origin-Destination Survey.
Flight Plan Phase 1 Forecast.

WORKING PAPER # 5

ALLOCATION OF PASSENGERS AND AIRCRAFT OPERATIONS

PRESENTED
AUGUST 15, 1991

ADOPTED
SEPTEMBER 11, 1991

THE FLIGHT PLAN PROJECT PHASE III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

DATE: August 28, 1991

TO: Puget Sound Air Transportation Committee

FROM: P&D Aviation

SUBJECT: **WORKING PAPER NO. 5 - ALLOCATION OF PASSENGERS AND AIRCRAFT OPERATIONS**

INTRODUCTION AND SUMMARY

In this Working Paper, the number of air passengers and operations in the region are allocated among airports under various alternative scenarios. Passengers and aircraft operations are first allocated on an "unconstrained" basis, without regard to the capacity constraints at Sea-Tac or other potential air carrier airport sites. For the unconstrained allocation, passengers were assigned to airports on the basis of the ground travel time to the airport and the type of service (haul length) which would be provided at the airport. In this allocation process, Sea-Tac is allocated more passengers than its capacity in the year 2020 under all scenarios.

Next, passengers and operations were allocated to airports with the consideration of the airfield capacity limit of each airport. Under this "constrained" approach, air passenger activity must be shifted from Sea-Tac to other airport sites to accommodate all future passenger demand within the region, due to the capacity constraints at Sea-Tac. The results of the constrained allocation show that no supplemental airports reach capacity although Sea-Tac would be at or near capacity in all scenarios.

UNCONSTRAINED ALLOCATION

For the unconstrained allocation, the data developed in the August 1, 1991 memorandum from the Flight Plan Staff regarding Supplemental Airport Market Areas was expanded upon. The referenced memorandum described the development of Supplemental Airport Market Areas and the level of origin and destination passenger demand allocated to each of these market areas under various two- and three-airport system scenarios. This working paper describes the allocation of airport operations under the same alternative aircraft system scenarios.

The passenger allocations included in the referenced memorandum are repeated in Table 1. As discussed in the memorandum, it is assumed that all connecting passengers (15,000,000 in the year 2020) will be accommodated at Sea-Tac. Experience at other supplemental airports indicates that there would be some connecting passengers at a new supplemental airport in the Puget Sound region. However, the number of connecting passengers at the supplemental airport would be relatively insignificant for purposes of this analysis, and is therefore not included.

The passenger estimates shown in Table 1 for each of the airport sites were used as the basis for estimating aircraft operations at the sites. The Central Pierce option shown in Table 1 includes the alternatives of using McChord Air Force Base as a supplemental airport or developing a new supplemental airport in the Central Pierce area. The methodology and results of the aircraft operations allocation is described below.

TABLE 1
UNCONSTRAINED ALLOCATION OF PASSENGERS TO AIRPORT SITES
YEAR 2020

	MID RANGE O&D PASSENGERS	UPPER RANGE OF SUPPLEMENTAL ALLOCATION			
		O&D PASSENGERS	CONNECTING PASSENGERS	TOTAL PASSENGERS	PERCENT OF TOTAL
Two-airport Systems					
Sea-Tac/Paine Field					
Sea-Tac	26.6	26.1	15.0	41.1	91.3
Paine Field	3.4	3.9	0.0	3.9	8.7
Total	30.0	30.0	15.0	45.0	100.0
Sea-Tac/Arlington					
Sea-Tac	27.8	27.5	15.0	42.5	94.4
Arlington	2.2	2.5	0.0	2.5	5.6
Total	30.0	30.0	15.0	45.0	100.0
Sea-Tac/Olympia					
Sea-Tac	28.7	28.5	15.0	43.5	96.7
Olympia	1.3	1.5	0.0	1.5	3.3
Total	30.0	30.0	15.0	45.0	100.0
Sea-Tac/Central Pierce					
Sea-Tac	26.7	26.2	15.0	41.2	91.6
Central Pierce	3.3	3.8	0.0	3.8	8.4
Total	30.0	30.0	15.0	45.0	100.0
Three-airport Systems					
Sea-Tac/Central Pierce/Paine					
Sea-Tac	23.3	22.3	15.0	37.3	82.9
Central Pierce	3.3	3.8	0.0	3.8	8.4
Paine	3.4	3.9	0.0	3.9	8.7
Total	30.0	30.0	15.0	45.0	100.0
Sea-Tac/Central Pierce/Arlington					
Sea-Tac	24.5	23.7	15.0	38.7	86.0
Central Pierce	3.3	3.8	0.0	3.8	8.4
Arlington	2.2	2.5	0.0	2.5	5.6
Total	30.0	30.0	15.0	45.0	100.0
Sea-Tac/Olympia/Paine					
Sea-Tac	25.3	24.6	15.0	39.6	88.0
Olympia	1.3	1.5	0.0	1.5	3.3
Paine	3.4	3.9	0.0	3.9	8.7
Total	30.0	30.0	15.0	45.0	100.0
Sea-Tac/Olympia/Arlington					
Sea-Tac	26.5	26.0	15.0	41.0	91.1
Olympia	1.3	1.5	0.0	1.5	3.3
Arlington	2.2	2.5	0.0	2.5	5.6
Total	30.0	30.0	15.0	45.0	100.0

Four categories of aircraft operations are considered: passenger operations, other airline operations, general aviation operations and military aircraft operations. Each of these is described below:

A. PASSENGER AIRCRAFT OPERATIONS

Passenger aircraft operations consist of air carrier and commuter/air taxi operations. The number of passenger operations were allocated according to average numbers of passengers per operation for primary and supplemental airports. The average number of passengers per operation in the region is forecast to increase from approximately 50 in 1988 to 95.7 in the year 2020. This represents an average annual growth rate of 2.0 percent over the 32-year period. This projected growth rate is consistent with the long-term historical trend in the U.S. and is also consistent with projections of the growth of average aircraft size by the FAA and aircraft manufacturers.

Typically, with primary and secondary airports serving a single market, the average number of passengers per operation is smaller at the supplemental airports. It is anticipated that this relationship would exist under a multiple-airport system in the Puget sound area. P&D Aviation analyzed the number of passengers per operation at the primary and supplemental airports in the San Francisco, Los Angeles, Houston, and Dallas/Fort Worth areas. The primary airports in these markets averaged 69 enplaned and deplaned passengers per operation in 1988. In the same year, the supplemental airports in these markets averaged 44 passengers per operation. Although the number of passengers per operation at the supplemental airports averaged only 64 percent of the primary airports, it is estimated that by the year 2020, the number of passengers per operations at the supplemental airports will be 70 percent of the primary airports. At that ratio, the number of passengers per operation at primary airports would be approximately 30 more than at supplemental airports.

The number of total passenger operations under a single-airport system was established earlier in the Flight Plan Study. The revised forecast for a single-airport option is 470,000 operations in the year 2020. It was suggested in Appendix K of the Phase II final report that the total number of operations would increase under a multiple-airport system because of increased numbers of flights to cities served by both Sea-Tac and the supplemental airport(s). P&D Aviation compared the average number of passengers per operation at single-airport and multiple-airport systems serving other markets in the U.S. and found that the number of passengers per operation for a region is essentially the same for single- and multiple-airport systems. Therefore, the number of operations were not increased for multiple-airport systems.

Passenger aircraft operations were allocated between Sea-Tac Airport and the supplemental airport(s) by maintaining the relationship that the number of passengers per operation at the supplemental airport(s) is 70 percent of the number of passengers per operation at Sea-Tac. In all scenarios, 470,000 passenger operations are allocated between the system airports (see Table 2).

B. OTHER AIRLINE OPERATIONS

Other airline operations consist primarily of cargo and charter flights. Other airline operations were previously forecast to total 30,000 in the year 2020 for a single-airport system (Table 2). This represents approximately 6.4 percent of the passenger aircraft operations. For the two- and three-airport systems it is projected that other airline operations will also be 6.4 percent of the passenger operations at each airport.

C. GENERAL AVIATION OPERATIONS

General aviation operations in the year 2020 for a single-airport system are projected to be 23,000, or approximately 5 percent of the passenger operations. It is estimated that this relationship will remain the same for Sea-Tac under the two- and three-airport systems. The number of general aviation operations at the supplemental airports was estimated to be equal to the average at Paine and Arlington (138,000 a year). As stated in Appendix K, general aviation operations account for 50 percent or more of the operations at most supplemental airports in the U.S. Today.

D. MILITARY OPERATIONS

Military operations under a single-airport system and at Sea-Tac under multiple-airport systems are estimated at 1,000 operations in the year 2020. At all supplemental airports 500 military operations are estimated for 2020.

The results of the allocation of aircraft operations to airport sites, shown in Table 2, indicate the reduction in operations expected at Sea-Tac under each of these scenarios. Under the range of two- and three-airport system alternatives examined, Sea-Tac would have between 404,900 operations (23 percent less than under a single-airport system) and 499,500 operations (5 percent less than under a single-airport system). For two-airport systems the number of operations at Sea-Tac would be 5 percent (Sea-Tac and Olympia site) to 12 percent (Sea-Tac and Paine Field) less than under a single-airport system. For three-airport systems, operations at Sea-Tac would be 12 percent to 23 percent less than under a single-airport system.

CONSTRAINED ALLOCATION

Constrained allocations were made for each of the 33 airport system alternatives. In the constrained allocation, no more passengers were allocated to an airport than its airfield could accommodate. The results of the constrained allocation process are shown in Table 3 (passengers) and Table 4 (operations).

TABLE 2
UNCONSTRAINED ALLOCATION OF AIRCRAFT OPERATIONS TO AIRPORT SITES, YEAR 2020

	AIRCRAFT OPERATIONS (THOUSANDS)					
	TOTAL	PASSENGER	OTHER AIRLINE	GENERAL AVIATION	MILITARY	MILLIONS OF PASSENGERS
Single-airport System	524.0	470.0	30.0	23.0	1.0	45.0
Two-airport Systems						
Sea-Tac/Paine Field						
Sea-Tac	461.6	413.9	26.4	20.3	1.0	41.1
Paine Field	198.2	56.1	3.6	138.0	0.5	3.9
Total	659.8	470.0	30.0	158.3	1.5	45.0
Sea-Tac/Arlington						
Sea-Tac	483.5	433.6	27.7	21.2	1.0	42.5
Arlington	177.3	36.4	2.3	138.0	0.5	2.5
Total	660.7	470.0	30.0	159.2	1.5	45.0
Sea-Tac/Olympia						
Sea-Tac	499.5	447.9	28.6	21.9	1.0	43.5
Olympia	162.0	22.1	1.4	138.0	0.5	1.5
Total	661.4	470.0	30.0	159.9	1.5	45.0
Sea-Tac/Central Pierce						
Sea-Tac	463.1	415.3	26.5	20.3	1.0	41.2
Central Pierce	196.7	54.7	3.5	138.0	0.5	3.8
Total	659.8	470.0	30.0	158.3	1.5	45.0
Three-airport Systems						
Sea-Tac/Central Pierce/Paine						
Sea-Tac	404.9	363.0	23.2	17.8	1.0	37.3
Central Pierce	194.7	52.8	3.4	138.0	0.5	3.8
Paine	196.2	54.2	3.5	138.0	0.5	3.9
Total	795.8	470.0	30.0	293.8	2.0	45.0
Sea-Tac/Central Pierce/Arlington						
Sea-Tac	425.3	381.3	24.3	18.7	1.0	38.7
Central Pierce	195.4	53.5	3.4	138.0	0.5	3.8
Arlington	175.9	35.2	2.2	138.0	0.5	2.5
Total	796.7	470.0	30.0	294.7	2.0	45.0
Sea-Tac/Olympia/Paine						
Sea-Tac	438.7	393.4	25.1	19.3	1.0	39.6
Olympia	161.1	21.3	1.4	138.0	0.5	1.5
Paine	197.4	55.3	3.5	138.0	0.5	3.9
Total	797.3	470.0	30.0	295.3	2.0	45.0
Sea-Tac/Olympia/Arlington						
Sea-Tac	460.0	412.5	26.3	20.2	1.0	41.0
Olympia	161.4	21.6	1.4	138.0	0.5	1.5
Arlington	176.7	35.9	2.3	138.0	0.5	2.5
Total	798.2	470.0	30.0	296.2	2.0	45.0

Note: Based on 100 percent of short haul and 50 percent of long haul demand allocated to supplemental airports.

TABLE 3
CONSTRAINED ALLOCATION OF PASSENGERS TO AIRPORTS

Alternate	Description	Enplaned and Deplaned Passengers											
		Year 2000 (25.4MAP)				Year 2010 (34.0 MAP)				Year 2020 (45.0 MAP)			
		Sea-Tac	North	South	Unsat.	Sea-Tac	North	South	Unsat.	Sea-Tac	North	South	Unsat.
1	Sea-Tac without Commuter R/W	23.6	0.0	0.0	1.8	28.8	0.0	0.0	5.2	32.0	0.0	0.0	13.0
2	Sea-Tac with Commuter R/W	25.4	0.0	0.0	0.0	31.4	0.0	0.0	2.6	34.9	0.0	0.0	10.1
3	Alternate 1 + Arlington 1 R/W	23.6	1.8	0.0	0.0	28.8	5.2	0.0	0.0	32.0	10.9	0.0	2.1
4	Alternate 1 + Paine 1 R/W	23.5	1.9	0.0	0.0	28.8	5.2	0.0	0.0	32.0	13.0	0.0	0.0
5	Alternate 1 + McChord 1 R/W	23.5	0.0	1.9	0.0	28.8	0.0	5.2	0.0	32.0	0.0	13.0	0.0
6	Alternate 1 + Central Pierce 1 R/W	23.5	0.0	1.9	0.0	28.8	0.0	5.2	0.0	32.0	0.0	10.9	2.1
7	Alternate 1 + Olympia/Black Lake 1 R/W	23.6	0.0	1.8	0.0	28.8	0.0	5.2	0.0	32.0	0.0	10.9	2.1
8	Alternate 1 + Arlington 2 R/W	23.6	1.8	0.0	0.0	28.8	5.2	0.0	0.0	32.0	13.0	0.0	0.0
9	Alternate 1 + Paine 2 R/W	23.5	1.9	0.0	0.0	28.8	5.2	0.0	0.0	32.0	13.0	0.0	0.0
10	Alternate 1 + McChord 2 R/W	23.5	0.0	1.9	0.0	28.8	0.0	5.2	0.0	32.0	0.0	13.0	0.0
11	Alternate 1 + Central Pierce 2 R/W	23.5	0.0	1.9	0.0	28.8	0.0	5.2	0.0	32.0	0.0	13.0	0.0
12	Alternate 1 + Olympia/Black Lake 2 R/W	23.6	0.0	1.8	0.0	28.8	0.0	5.2	0.0	32.0	0.0	13.0	0.0
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	24.2	1.2	0.0	0.0	32.4	1.6	0.0	0.0	41.8	3.2	0.0	0.0
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	23.5	1.9	0.0	0.0	31.5	2.5	0.0	0.0	41.6	3.4	0.0	0.0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	23.5	0.0	1.9	0.0	31.5	0.0	2.5	0.0	41.8	0.0	3.2	0.0
16	Sea-Tac w/Dependent R/W + Cen. Pierce 1 R/W	23.5	0.0	1.9	0.0	31.5	0.0	2.5	0.0	41.7	0.0	3.3	0.0
17	Sea-Tac w/Dependent R/W + Olym./Blt. Lake 1 R/W	24.6	0.0	0.8	0.0	33.0	0.0	1.0	0.0	41.8	0.0	3.2	0.0
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	24.2	1.2	0.0	0.0	32.4	1.6	0.0	0.0	41.8	3.2	0.0	0.0
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	23.5	1.9	0.0	0.0	31.5	2.5	0.0	0.0	41.6	3.4	0.0	0.0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	23.5	0.0	1.9	0.0	31.5	0.0	2.5	0.0	41.8	0.0	3.2	0.0
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	23.5	0.0	1.9	0.0	31.5	0.0	2.5	0.0	41.7	0.0	3.3	0.0
22	Sea-Tac w/Dependent R/W + Olym./Blt. Lake 2 R/W	24.6	0.0	0.8	0.0	33.0	0.0	1.0	0.0	41.8	0.0	3.2	0.0
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	22.3	1.2	1.9	0.0	28.8	3.1	2.1	0.0	32.0	5.9	7.1	0.0
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	21.6	1.9	1.9	0.0	28.8	2.6	2.6	0.0	32.0	6.5	6.5	0.0
25	Alternate 1 + Arlington 1 R/W + Olym./Blt. Lake 1 R	23.4	1.2	0.8	0.0	28.8	2.9	2.3	0.0	32.0	7.0	6.0	0.0
26	Alternate 1 + Paine 1 R/W + Olym./Blt. Lake 1 R/W	22.7	1.9	0.8	0.0	28.8	3.4	1.8	0.0	32.0	7.6	5.4	0.0
27	Alternate 13 + Central Pierce 1 R/W	22.3	1.2	1.9	0.0	29.9	1.6	2.5	0.0	39.5	2.2	3.3	0.0
28	Alternate 14 + Central Pierce 1 R/W	21.6	1.9	1.9	0.0	29.0	2.5	2.5	0.0	38.3	3.4	3.3	0.0
29	Alternate 13 + Olympia/Black Lake 1 R/W	23.4	1.2	0.8	0.0	31.4	1.6	1.0	0.0	41.5	2.2	1.3	0.0
30	Alternate 14 + Olympia/Black Lake 1 R/W	22.7	1.9	0.8	0.0	30.5	2.5	1.0	0.0	40.3	3.4	1.3	0.0
31	Central Pierce 3 R/W	0.0	0.0	25.4	0.0	0.0	0.0	34.0	0.0	0.0	0.0	45.0	0.0
32	Olympia/Black Lake 3 R/W	0.0	0.0	25.4	0.0	0.0	0.0	34.0	0.0	0.0	0.0	45.0	0.0
33	Alternate 1 + Demand Management	25.4	0.0	0.0	0.0	34.0	0.0	0.0	0.0	38.0	0.0	0.0	7.0

Note: Supplemental airport demand is based on mid range of unconstrained demand (i.e., accommodating 75 percent of short haul and 50 percent of long haul demand).

TABLE 4
CONSTRAINED ALLOCATION OF OPERATIONS TO AIRPORTS
YEAR 2020

Alternate	Description	Sea-Tac Acft. Opns. (2020)	Supp. 1 Acft. Opns. (2020)	Supp. 2 Acft. Opns. (2020)
1	Sea-Tac without Commuter R/W	380,000	0	0
2	Sea-Tac with Commuter R/W	410,000	0	0
3	Alternate 1 + Arlington 1 R/W	380,000	250,000	0
4	Alternate 1 + Paine 1 R/W	380,000	133,000	0
5	Alternate 1 + McChord 1 R/W	380,000	133,000	0
6	Alternate 1 + Central Pierce 1 R/W	380,000	250,000	0
7	Alternate 1 + Olympia/Black Lake 1 R/W	380,000	250,000	0
8	Alternate 1 + Arlington 2 R/W	380,000	271,000	0
9	Alternate 1 + Paine 2 R/W	380,000	133,000	0
10	Alternate 1 + McChord 2 R/W	380,000	133,000	0
11	Alternate 1 + Central Pierce 2 R/W	380,000	271,000	0
12	Alternate 1 + Olympia/Black Lake 2 R/W	380,000	271,000	0
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	480,000	170,700	0
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	477,700	34,800	0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	480,000	32,700	0
16	Sea-Tac w/Dependent R/W + Cen. Pierce 1 R/W	478,900	171,800	0
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	480,000	170,700	0
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	480,000	170,700	0
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	477,700	34,800	0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	480,000	32,700	0
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	478,900	171,800	0
22	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 2 R/W	480,000	170,700	0
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	380,000	198,400	210,600
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	380,000	66,500	204,500
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R	380,000	209,600	199,400
26	Alternate 1 + Paine 1 R/W + Olym./Blk. Lake 1 R/W	380,000	77,800	193,200
27	Alternate 13 + Central Pierce 1 R/W	453,600	160,500	171,800
28	Alternate 14 + Central Pierce 1 R/W	439,800	34,800	171,800
29	Alternate 13 + Olympia/Black Lake 1 R/W	476,600	160,500	151,300
30	Alternate 14 + Olympia/Black Lake 1 R/W	462,800	34,800	151,300
31	Central Pierce 3 R/W	0	524,000	0
32	Olympia/Black Lake 3 R/W	0	524,000	0
33	Alternate 1 + Demand Management	380,000	0	0

Note: Operations at Paine and McChord include air carrier and commuter only.
Source: P&D analysis.

A. PASSENGERS

Constrained passenger allocations were made by the Flight Plan Staff according to the methodology discussed below.

It is assumed that all of the passenger demand generated by a market area (whether Sea-Tac, supplemental or replacement) would be captured by that airport up to its capacity limit. In cases where Sea-Tac's demand was greater than its capacity, the residual passengers were assigned to the supplemental site (if one supplemental) or divided between two supplemental sites (if two supplementals), up to the capacity of the supplemental sites. Thus, under some scenarios, there would be passengers who would prefer to use Sea-Tac, but would have to drive to a more distant airport because Sea-Tac would be at capacity. Any residual passenger demand after this allocation was considered unsatisfied demand.

Passengers were allocated to supplemental airports according to their demand. The Flight Plan Staff developed a range of passenger demand for supplemental airports depending on the amount of short haul traffic assumed to be captured by the supplementals (50 percent or 100 percent). In this Working Paper, the midpoint of the range was used. As under the unconstrained allocation, it was assumed that all connecting passengers would be at Sea-Tac.

B. OPERATIONS

Aircraft operations were estimated for the year 2020 under constrained conditions for each alternative scenario (Table 4). At Sea-Tac, the number of operations would equal its annual service volume (ASV) because the airport would be at capacity. The relationship between passengers and total operations at Sea-Tac was based on the relationship indicated in Table 21 of the Phase I report.

At supplemental airports, it was estimated that commercial passenger operations would be 50 percent air carrier and 50 percent commuter. The average number of enplanements per departure were estimated to be 93 for air carrier operations and 17 for commuter operations, from Table 21 of the Phase I report. General aviation operations were estimated to be 138,000 per year (the average at Paine and Arlington). Military operations at McChord were estimated to remain at approximately 62,000 a year. If the supplemental airports are at capacity, their number of operations would equal their ASV.

The operations estimates appearing in Table 4 were used to compute airfield delays, described in Working Paper 7.

SUMMARY

If demand for air passengers in the region were allocated without regard to airport capacity, Sea-Tac would be allocated passengers in excess of its capacity under all system alternatives. Supplemental airports would be allocated at most a total of 7.7 million air passengers a year (Paine Field and Central Pierce site)

The results of the constrained passenger allocation analysis (Table 3) show that Sea-Tac alone will not be able to accommodate all passengers in the region in the year 2020. Year 2020 demand can be met with an expanded Sea-Tac and one or two supplemental airports or a replacement airport.

WORKING PAPER #7

AIRSPACE, CAPACITY AND DELAY

PRESENTED
SEPTEMBER 11, 1991

ADOPTED
OCTOBER 16, 1991

TABLE V-9
OFFICE SPACE GENERATED BY ALTERNATIVE AIRPORTS IN THE AIRPORT INFLUENCE AREA: 2020 [1]

	Projected Total Passengers		Office Sq. Ft. (000's)	
	Low	High	Low	High
Arlington	2,200,000	13,000,000	176	910
Paine	3,400,000	13,000,000	272	910
Sea-Tac	34,900,000	41,800,000	1,396	1,672
Central Pierce	3,300,000	45,000,000	264	1,800
McChord	3,200,000	13,000,000	256	910
Olympia/Black Lake	1,300,000	45,000,000	104	1,800

[1] The influence area extends approximately 1.5 to 3.0 miles around the airport.

NOTE: The forecast assumes the following:

	Airport Size		
	Small	Medium	Large
Average Square Feet of Office Space per Passenger	0.08	0.07	0.04

SOURCE: P&D Technologies.

Office Development

The amount of developed office space per passenger in the airport's area of influence was found to average 0.08 square feet at small airports, 0.07 square feet at medium sized airports, and 0.04 square feet at large airports. For the purpose of this analysis, small airports are defined as having less than 10 million annual passengers, medium sized airports have from 10 to 30 million annual passengers, and large airports are those with over 30 million annual passengers. The decreasing square foot ratio as compared to airport size indicates that as airport passenger traffic increases, new office development in the area of influence occurs at a decreasing rate.

Total annual passengers that could potentially pass through each of the alternative airports by the year 2020 range from 1.3 million passengers at Olympia/Black Lake airport, to 45 million passengers at either the Olympia/Black Lake or Central Pierce airports. Sea-Tac is the only airport that has a projection of over 30 million annual passengers in both the low and high passenger traffic scenarios.

Based on the above mentioned ratios and annual passenger projections, the amount of office development that would be expected in the area immediately surrounding each airport is shown in Table V-9. Office development ranges from a low of 104,000 potential square feet at the Olympia/Black Lake airport, to 1.8 million square feet at either the Olympia/Black Lake or Central Pierce airports. Potential office development in the Sea-Tac area of influence ranges from 1.4 to 1.7 million square feet.

Furthermore, when applied to the various airport system alternatives, this analysis indicates that Alternative 1 (Sea-Tac airport only) generates the least amount of potential office development (1.4 million square feet). Alternatives 23 to 26, on the other hand, provide the highest office development potential, with a total of 2.3 million square feet (see Table V-10). Each of these alternatives includes Sea-Tac and two other airport sites (one north of Sea-Tac and one south).

Hotel Development

A statistical analysis of the sample airport data indicates that there is a significant relationship between the number of passengers that travel through an airport and the number of hotel rooms in the corresponding airport influence area. Thus, as the number of passengers increases, so does the number of hotel rooms in the immediate area surrounding the airport. Hotel rooms increase at a slower rate, however, as compared to the number of passengers.

Table V-11 shows the projected number of hotel rooms in the influence area for both low and high annual passenger scenarios at each alternative airport. Overall, there will be

TABLE V-8
IMPACTS OF VISITOR (BUSINESS AND TOURIST) EXPENDITURES ON THE REGION: 2020
(ALTERNATE 4, 5, 8 - 32)

TOTAL PASSENGERS	45,000,000
% VISITORS	26%
TOTAL VISITORS	11,700,000

Expenditures on:	Impact		
	Jobs	Earnings (millions)	Business Revenue (millions)
Direct/Indirect Impacts			
Restaurants	58,428	$430.0	$1,544.2
Lodging	37,361	$385.9	$1,154.2
Retail	13,632	$167.2	$1,141.0
Entertainment/Sightseeing	14,822	$169.1	$550.7
Local Transportation	10,102	$150.5	$490.1
Subtotal -- Direct/Indirect	134,345	$1,302.7	$4,880.3
Induced Impacts	96,096	$1,957.5	$3,833.8
Total Impact	230,441	$3,260.2	$8,714.0

SOURCE: Martin O'Connell Associates; Seattle-King County Convention and Visitors Bureau; P&D Technologies.

TABLE V-7
IMPACTS OF VISITOR (BUSINESS AND TOURIST) EXPENDITURES
ON THE REGION: 2020
(ALTERNATE 3, 6 & 7)

TOTAL PASSENGERS	42,900,000
% VISITORS	26%
TOTAL VISITORS	11,154,000

Expenditures on:	Impact: Jobs	Impact: Earnings (millions)	Impact: Business Revenue (millions)
Direct/Indirect Impacts			
Restaurants	55,702	$409.9	$1,472.1
Lodging	35,617	$367.9	$1,100.3
Retail	12,996	$159.4	$1,087.8
Entertainment/Sightseeing	14,130	$161.2	$525.0
Local Transportation	9,630	$143.5	$467.3
Subtotal -- Direct/Indirect	128,076	$1,241.9	$4,652.5
Induced Impacts	91,612	$1,866.2	$3,654.8
Total Impact	219,687	$3,108.1	$8,307.4

SOURCE: Martin O'Connell Associates; Seattle-King County Convention and Visitors Bureau; P&D Technologies.

TABLE V-6
IMPACTS OF VISITOR (BUSINESS AND TOURIST) EXPENDITURES
ON THE REGION: 2020
(ALTERNATE 2)

TOTAL PASSENGERS	34,900,000
% VISITORS	26%
TOTAL VISITORS	9,074,000

	Impact		
Expenditures on:	Jobs	Earnings (millions)	Business Revenue (millions)
Direct/Indirect Impacts			
Restaurants	45,314	$333.5	$1,197.6
Lodging	28,976	$299.3	$895.1
Retail	10,572	$129.7	$884.9
Entertainment/Sightseeing	11,495	$131.1	$427.1
Local Transportation	7,834	$116.7	$380.1
Subtotal -- Direct/Indirect	104,192	$1,010.3	$3,784.9
Induced Impacts	74,528	$1,518.2	$2,973.3
Total Impact	178,720	$2,528.5	$6,758.2

SOURCE: Martin O'Connell Associates; Seattle-King County Convention and Visitors Bureau; P&D Technologies.

TABLE V-5
IMPACTS OF VISITOR (BUSINESS AND TOURIST) EXPENDITURES ON THE REGION: 2020
(ALTERNATE 1)

TOTAL PASSENGERS	36,500,000
% VISITORS	26%
TOTAL VISITORS	9,490,000

Expenditures on:	Impact: Jobs	Impact: Earnings (millions)	Impact: Business Revenue (millions)
Direct/Indirect Impacts			
Restaurants	47,392	$348.8	$1,252.5
Lodging	30,304	$313.0	$936.2
Retail	11,057	$135.6	$925.5
Entertainment/Sightseeing	12,022	$137.2	$446.7
Local Transportation	8,194	$122.1	$397.6
Subtotal -- Direct/Indirect	108,969	$1,056.6	$3,958.4
Induced Impacts	77,945	$1,587.8	$3,109.6
Total Impact	186,913	$2,644.4	$7,068.0

SOURCE: Martin O'Connell Associates; Seattle-King County Convention and Visitors Bureau; P&D Technologies.

there are some differences in the total impact among the alternatives which meet the projected air passenger demand, there are significantly fewer jobs, wage earnings, and business and tax revenues generated by those alternatives which do not provide sufficient capacity.

In terms of the distribution of economic impacts within the region, the major differences among the alternatives are due to the number of airports in the system. The three airport system maximizes the distribution of the impacts, while the single airport system tends to centralize the impacts in the county in which it is located.

Visitor-Related Activities

Business and tourist air travelers to the region also create substantial benefits through expenditures for lodging, entertainment, transportation, food and retail goods. Additional jobs, wage earnings and business revenues generated by business and tourist visitor expenditures for each alternative for the region as a whole are presented in Tables V-5 to V-8. As noted earlier, insufficient data were available to distribute these impacts to each county.

By the year 2020, expenditures by visitors (both business and tourist travelers) could generate between 178,700 and 230,400 more jobs, $2.5 to $3.2 billion in additional wage earnings, $6.8 to $8.7 billion in revenues to local businesses, and $13.3 to $17.1 million in local sales tax revenues due to increased earnings to local residents. In terms of total economic impacts, the major difference among the alternatives results from those options that cannot provide adequate capacity to meet the projected passenger demands and those that meet the 2020 forecast.

Development in the Airport Influence Area

An airport can attract certain types of real estate development around it. Based upon an analysis of 10 West Coast airports [1] in the United States with air passenger traffic ranging from 1.2 million to 44.4 million annual passengers, it was found that the types of land uses that had a significant relationship to passenger demand were office and hotel, and that the primary area in which such development occurred (the area of influence) extended between 1.5 and 3 miles around the airport. These findings were applied to the various alternatives as noted below.

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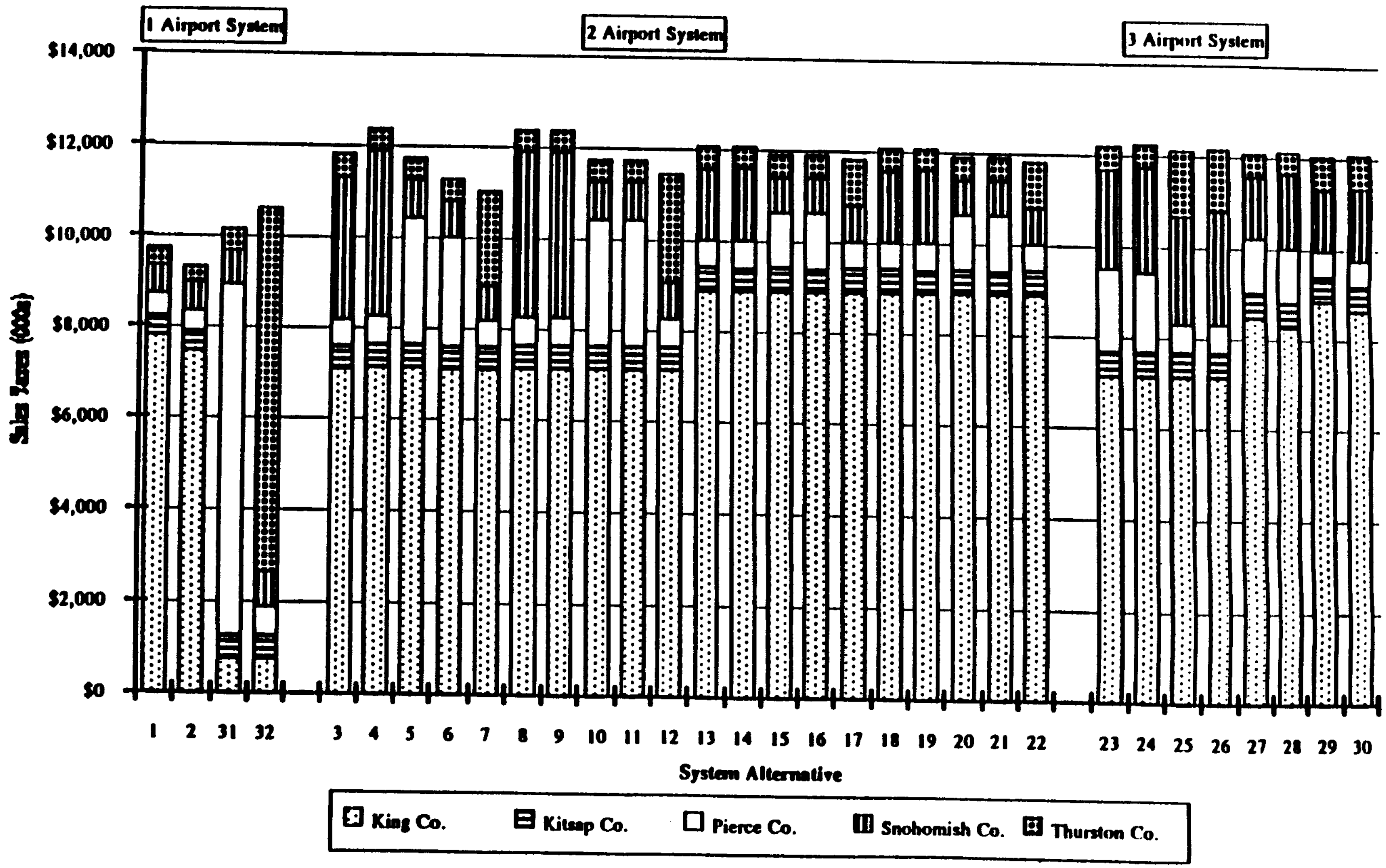
[1] The airports analyzed consisted of Burbank, John Wayne, Long Beach, Los Angeles, Oakland, Ontario, Portland, San Francisco, San Jose and Sea-Tac.

Figure V-4
Sales Tax Revenues Generated by Earnings
from Airport Activity: 2020



AR 037897

Figure V-3
Direct, Indirect and Induced Business Revenues
Generated by Airport Activity: 2020

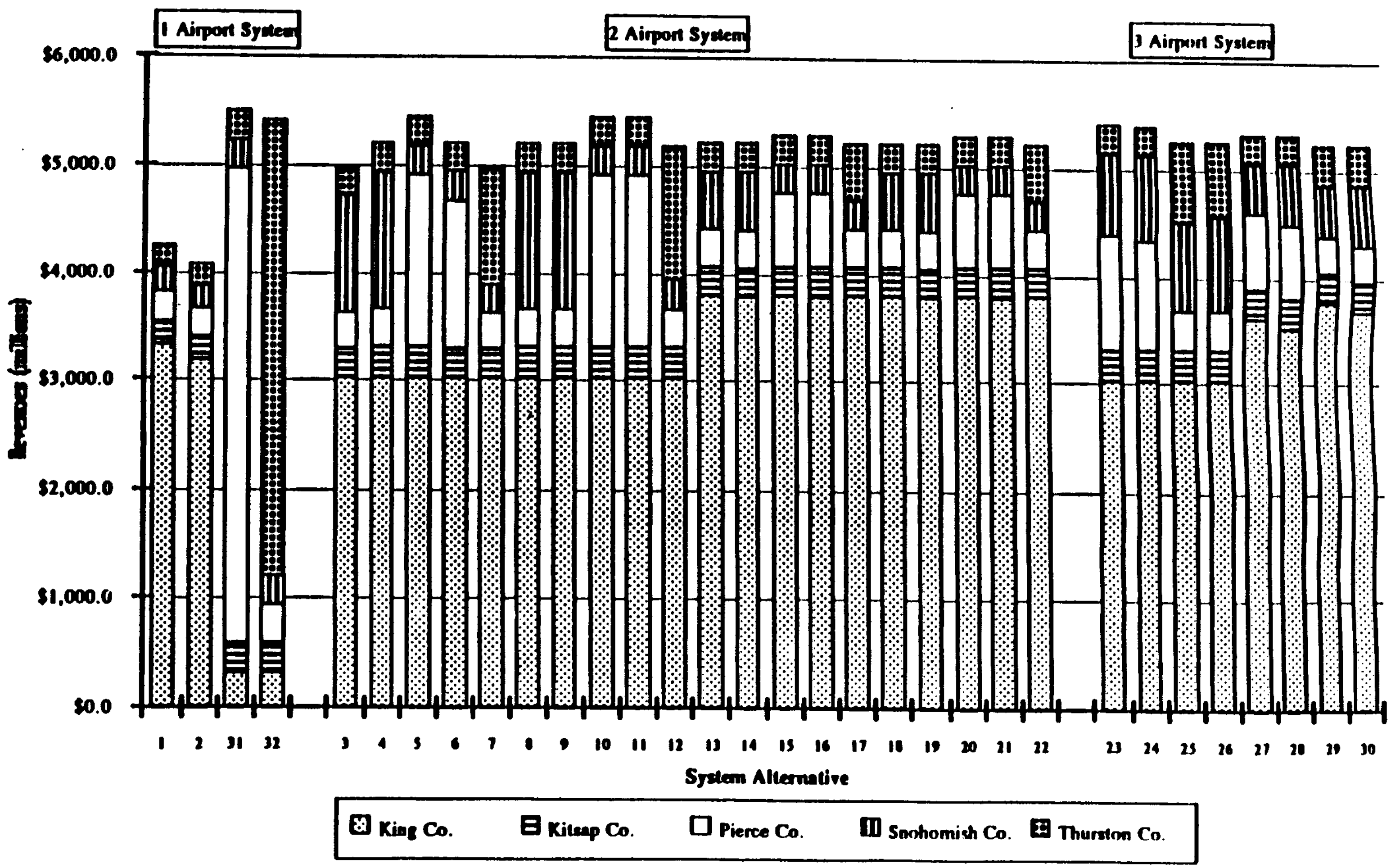


Figure V-2
Direct, Indirect and Induced Wage Earnings
Generated by Airport Activity: 2020

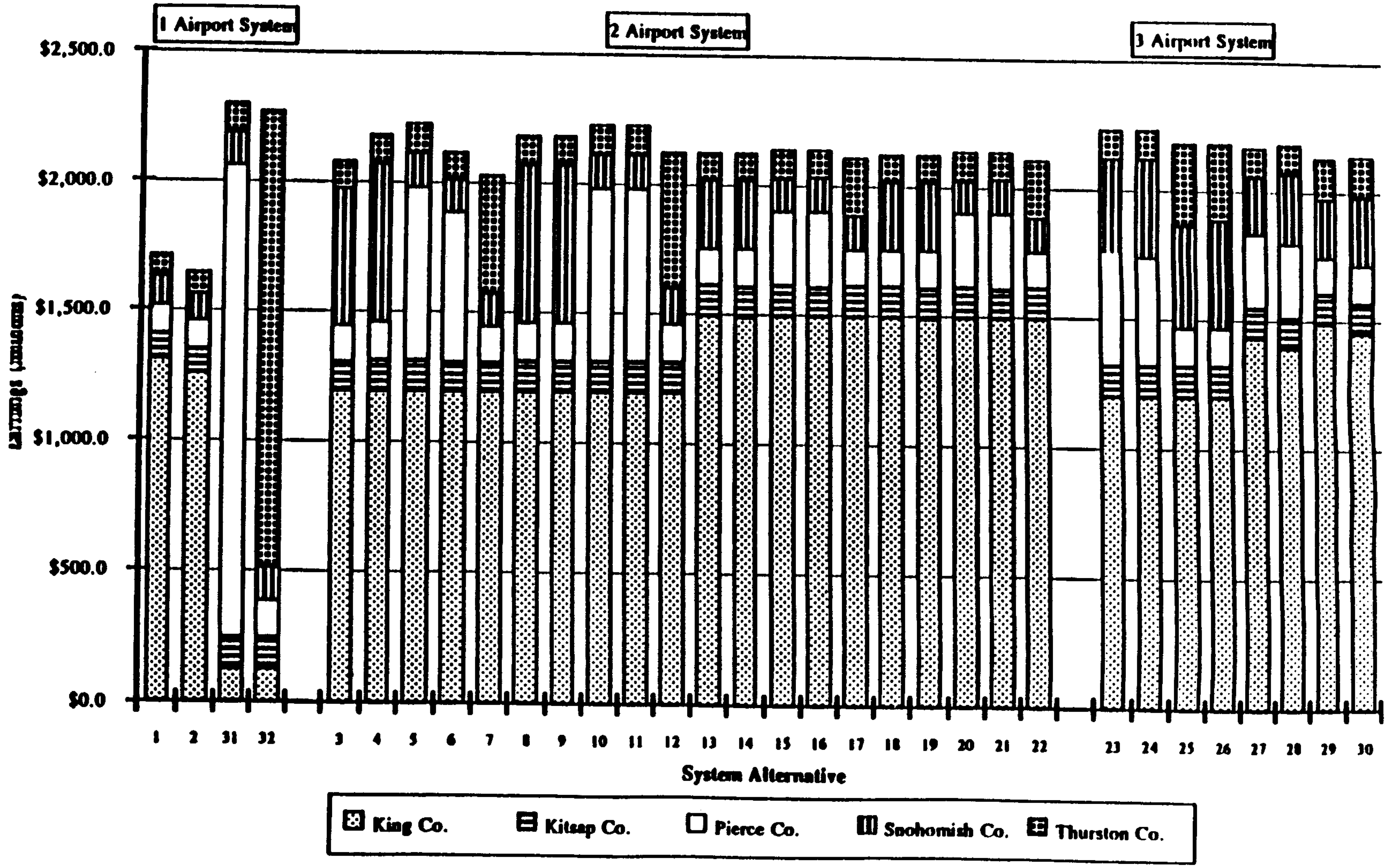


Figure V-1
Direct, Indirect and Induced Jobs
Generated by Airport Activity: 2020

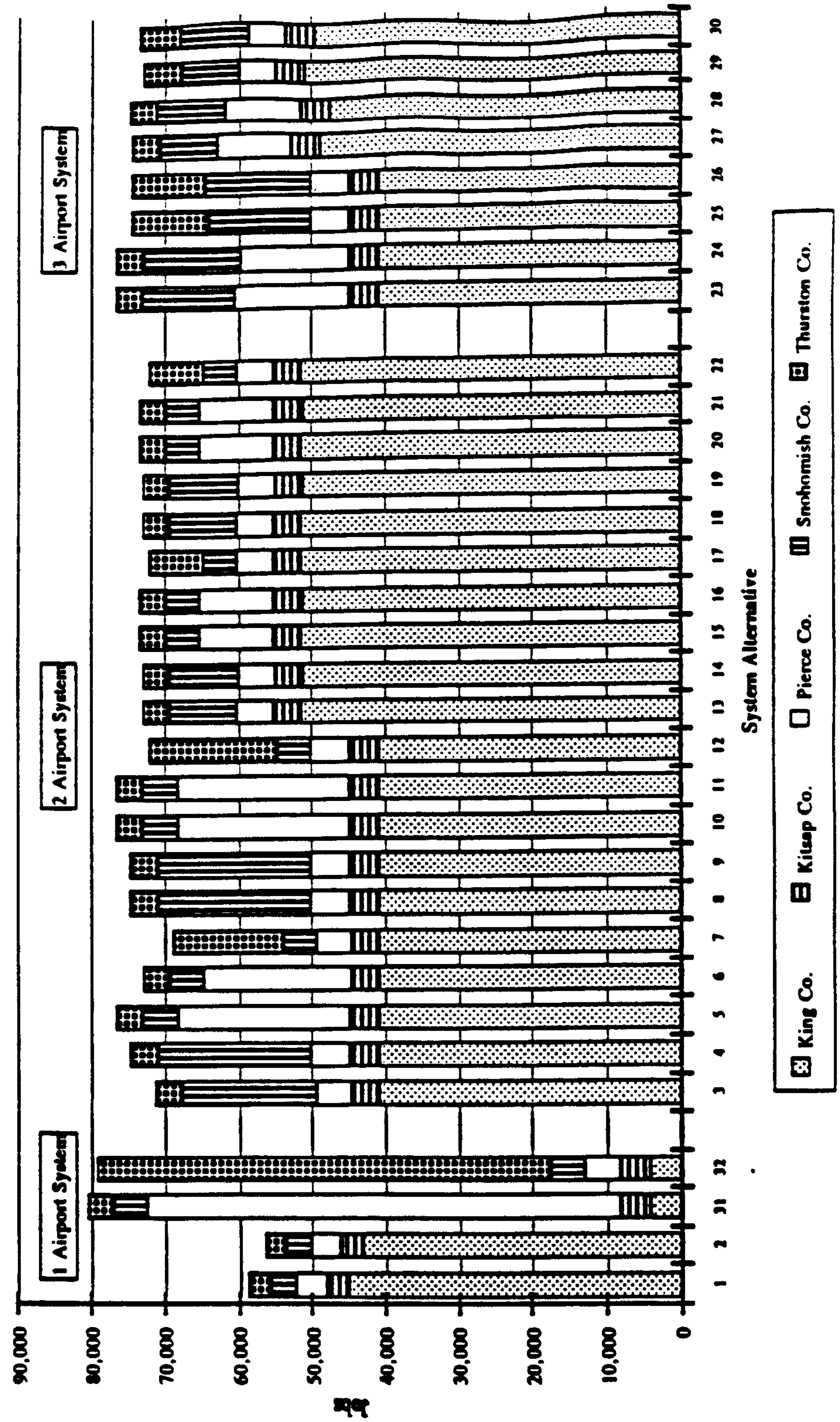


TABLE V-4
SALE TAX REVENUES GENERATED BY
AIRPORT ACTIVITY RELATED EARNINGS: 2020

Alternative	Sales Tax Revenues (000s)					
	King	Kitsap	Pierce	Snohomish	Thurston	Region
1 Airport System						
1	$7,792.7	$422.7	$488.9	$628.9	$422.7	$9,755.9
2	$7,472.6	$405.4	$468.7	$603.3	$405.4	$9,355.5
31	$748.5	$513.7	$7,652.8	$765.2	$513.7	$10,193.9
32	$748.5	$513.7	$594.7	$765.2	$8,029.4	$10,651.5
2 Airport System						
3	$7,076.9	$510.1	$590.1	$3,141.0	$510.1	$11,828.1
4	$7,113.2	$534.2	$618.7	$3,601.5	$534.2	$12,401.8
5	$7,113.2	$534.2	$2,799.3	$795.5	$534.2	$11,776.4
6	$7,076.9	$510.1	$2,441.5	$759.2	$510.1	$11,297.7
7	$7,076.9	$510.1	$590.1	$759.2	$2,110.3	$11,046.6
8	$7,113.2	$534.2	$618.7	$3,601.5	$534.2	$12,401.8
9	$7,113.2	$534.2	$618.7	$3,601.5	$534.2	$12,401.8
10	$7,113.2	$534.2	$2,799.3	$795.5	$534.2	$11,776.4
11	$7,113.2	$534.2	$2,799.3	$795.5	$534.2	$11,776.4
12	$7,113.2	$534.2	$618.7	$795.5	$2,419.7	$11,481.3
13	$8,899.4	$522.8	$605.2	$1,542.8	$522.8	$12,093.1
14	$8,863.1	$523.3	$605.6	$1,588.1	$523.3	$12,103.3
15	$8,899.4	$522.8	$1,199.5	$778.3	$522.8	$11,922.8
16	$8,881.6	$523.3	$1,216.7	$778.9	$523.3	$11,923.7
17	$8,899.4	$522.8	$605.2	$778.3	$1,036.5	$11,842.2
18	$8,899.4	$522.8	$605.2	$1,542.8	$522.8	$12,093.1
19	$8,863.1	$523.3	$605.6	$1,588.1	$523.3	$12,103.3
20	$8,899.4	$522.8	$1,199.5	$778.3	$522.8	$11,922.8
21	$8,881.6	$523.3	$1,216.7	$778.9	$523.3	$11,923.7
22	$8,899.4	$522.8	$605.2	$778.3	$1,036.5	$11,842.2
3 Airport System						
23	$7,115.0	$541.9	$1,869.0	$2,151.5	$541.9	$12,219.3
24	$7,115.0	$541.9	$1,771.1	$2,278.9	$541.9	$12,248.8
25	$7,115.0	$541.9	$627.1	$2,384.2	$1,460.1	$12,128.2
26	$7,114.4	$541.9	$627.1	$2,508.5	$1,374.1	$12,166.0
27	$8,481.7	$530.5	$1,224.3	$1,328.0	$530.5	$12,095.1
28	$8,264.6	$532.4	$1,226.8	$1,600.6	$532.4	$12,156.6
29	$8,844.7	$526.0	$608.2	$1,322.1	$748.0	$12,048.9
30	$8,626.3	$527.8	$611.1	$1,594.0	$750.8	$12,110.0

SOURCE: P&D Technologies

TABLE V-3
DIRECT, INDIRECT AND INDUCED BUSINESS REVENUE
GENERATED BY AIRPORT ACTIVITY: 2020

Alternative	Total Business Revenues (Millions) King	Kitsap	Pierce	Snohomish	Thurston	Region
1 Airport System						
1	$3,318.8	$220.9	$279.4	$221.7	$220.9	$4,261.7
2	$3,182.1	$211.8	$267.9	$212.6	$211.8	$4,086.2
31	$318.9	$268.7	$4,377.6	$269.8	$268.7	$5,503.7
32	$318.9	$268.7	$340.0	$269.8	$4,235.0	$5,432.4
2 Airport System						
3	$3,011.1	$266.5	$337.1	$1,106.1	$266.5	$4,987.3
4	$3,026.5	$279.2	$353.2	$1,268.3	$279.2	$5,206.4
5	$3,026.5	$279.2	$1,598.5	$280.2	$279.2	$5,463.6
6	$3,011.1	$266.5	$1,394.2	$267.4	$266.5	$5,205.7
7	$3,011.1	$266.5	$337.1	$267.4	$1,102.4	$4,984.5
8	$3,026.5	$279.2	$353.2	$1,268.3	$279.2	$5,206.4
9	$3,026.5	$279.2	$353.2	$1,268.3	$279.2	$5,206.4
10	$3,026.5	$279.2	$1,598.5	$280.2	$279.2	$5,463.6
11	$3,026.5	$279.2	$1,598.5	$280.2	$279.2	$5,463.6
12	$3,026.5	$279.2	$353.2	$280.2	$1,264.0	$5,203.1
13	$3,789.4	$273.4	$345.9	$543.9	$273.4	$5,226.0
14	$3,773.9	$273.6	$346.1	$559.7	$273.6	$5,226.9
15	$3,789.4	$273.4	$685.4	$274.5	$273.4	$5,296.1
16	$3,781.1	$273.5	$695.3	$274.5	$273.5	$5,297.9
17	$3,789.4	$273.4	$345.9	$274.5	$541.8	$5,225.0
18	$3,789.4	$273.4	$345.9	$543.9	$273.4	$5,226.0
19	$3,773.9	$273.6	$346.1	$559.7	$273.6	$5,226.9
20	$3,789.4	$273.4	$685.4	$274.5	$273.4	$5,296.1
21	$3,781.7	$273.5	$695.3	$274.5	$273.5	$5,298.5
22	$3,789.4	$273.4	$345.9	$274.5	$541.8	$5,225.0
3 Airport System						
23	$3,026.0	$283.1	$1,066.8	$757.4	$283.1	$5,416.4
24	$3,026.0	$283.1	$1,011.0	$802.0	$283.1	$5,405.2
25	$3,026.0	$283.1	$358.0	$839.0	$762.5	$5,268.6
26	$3,025.9	$283.1	$357.9	$882.9	$717.7	$5,267.5
27	$3,610.1	$277.0	$699.2	$468.0	$277.0	$5,331.3
28	$3,516.8	$278.3	$700.6	$563.6	$278.3	$5,337.6
29	$3,765.5	$274.8	$347.6	$465.9	$390.9	$5,244.7
30	$3,672.3	$276.0	$349.1	$561.7	$392.2	$5,251.3

SOURCE: P&D Technologies

TABLE V-2
DIRECT, INDIRECT AND INDUCED WAGE EARNINGS
GENERATED BY AIRPORT ACTIVITY: 2020

Alternative	Total Wage Earnings (Millions) King	Kitsap	Pierce	Snohomish	Thurston	Region
1 Airport System						
1	$1,309.7	$92.9	$116.4	$105.7	$92.9	$1,717.6
2	$1,255.9	$89.1	$111.6	$101.4	$89.1	$1,647.1
31	$125.8	$112.9	$1,822.1	$128.6	$112.9	$2,302.3
32	$125.8	$112.9	$141.6	$128.6	$1,764.7	$2,273.6
2 Airport System						
3	$1,189.4	$112.1	$140.5	$527.9	$112.1	$2,082.0
4	$1,195.5	$117.4	$147.3	$605.3	$117.4	$2,182.9
5	$1,195.5	$117.4	$666.5	$133.7	$117.4	$2,230.5
6	$1,189.4	$112.1	$581.3	$127.6	$112.1	$2,122.5
7	$1,189.4	$112.1	$140.5	$127.6	$463.8	$2,033.4
8	$1,195.5	$117.4	$147.3	$605.3	$117.4	$2,182.9
9	$1,195.5	$117.4	$147.3	$605.3	$117.4	$2,182.9
10	$1,195.5	$117.4	$666.5	$133.7	$117.4	$2,230.5
11	$1,195.5	$117.4	$666.5	$133.7	$117.4	$2,230.5
12	$1,195.5	$117.4	$147.3	$133.7	$531.8	$2,125.7
13	$1,495.7	$114.9	$144.1	$259.3	$114.9	$2,128.9
14	$1,489.6	$115.0	$144.2	$266.9	$115.0	$2,130.7
15	$1,495.7	$114.9	$285.6	$130.8	$114.9	$2,141.9
16	$1,492.7	$115.0	$289.7	$130.9	$115.0	$2,143.3
17	$1,495.7	$114.9	$144.1	$130.8	$227.8	$2,113.3
18	$1,495.7	$114.9	$144.1	$259.3	$114.9	$2,128.9
19	$1,489.6	$115.0	$144.2	$266.9	$115.0	$2,130.7
20	$1,495.7	$114.9	$285.6	$130.8	$114.9	$2,141.9
21	$1,492.7	$115.0	$289.7	$130.9	$115.0	$2,143.3
22	$1,495.7	$114.9	$144.1	$130.8	$227.8	$2,113.3
3 Airport System						
23	$1,195.8	$119.1	$445.0	$361.6	$119.1	$2,240.6
24	$1,195.8	$119.1	$421.7	$383.0	$119.1	$2,238.7
25	$1,195.8	$119.1	$149.3	$400.7	$320.9	$2,185.8
26	$1,195.7	$119.1	$149.3	$421.6	$302.0	$2,187.7
27	$1,425.5	$116.6	$291.5	$223.2	$116.6	$2,173.4
28	$1,389.0	$117.0	$292.1	$269.0	$117.0	$2,184.1
29	$1,486.5	$115.6	$144.8	$222.2	$164.4	$2,133.5
30	$1,449.8	$116.0	$145.5	$267.9	$165.0	$2,144.2

SOURCE: P&D Technologies

TABLE V-1
DIRECT, INDIRECT AND INDUCED JOBS
GENERATED BY AIRPORT ACTIVITY: 2020

	Total Jobs					
Alternative	King	Kitsap	Pierce	Snohomish	Thurston	Region
1 Airport System						
1	44,928	3,072	4,092	3,654	3,072	58,818
2	43,069	2,945	3,923	3,503	2,945	56,385
31	4,320	3,741	64,366	4,450	3,741	80,618
32	4,320	3,741	4,983	4,450	61,882	79,376
2 Airport System						
3	40,685	3,697	4,928	18,192	3,697	71,199
4	40,897	3,874	5,164	20,859	3,874	74,668
5	40,897	3,874	23,373	4,609	3,874	76,627
6	40,685	3,697	20,384	4,398	3,697	72,861
7	40,685	3,697	4,928	4,398	15,293	69,001
8	40,897	3,874	5,164	20,859	3,874	74,668
9	40,897	3,874	5,164	20,859	3,874	74,668
10	40,897	3,874	23,373	4,609	3,874	76,627
11	40,897	3,874	23,373	4,609	3,874	76,627
12	40,897	3,874	5,164	4,609	17,536	72,080
13	51,284	3,800	5,064	8,958	3,800	72,906
14	51,072	3,803	5,067	9,218	3,803	72,963
15	51,284	3,800	10,035	4,520	3,800	73,439
16	51,178	3,802	10,181	4,522	3,802	73,485
17	51,284	3,800	5,064	4,520	7,532	72,200
18	51,284	3,800	5,064	8,958	3,800	72,906
19	51,072	3,803	5,067	9,218	3,803	72,963
20	51,284	3,800	10,035	4,520	3,800	73,439
21	51,178	3,802	10,181	4,522	3,802	73,485
22	51,284	3,800	5,064	4,520	7,532	72,200
3 Airport System						
23	40,849	3,922	15,584	12,445	3,922	76,722
24	40,848	3,923	14,769	13,177	3,923	76,640
25	40,848	3,922	5,230	13,784	10,565	74,349
26	40,850	3,921	5,228	14,507	9,964	74,470
27	48,809	3,847	10,229	7,700	3,847	74,432
28	47,533	3,862	10,246	9,272	3,862	74,775
29	50,942	3,818	5,087	7,672	5,432	72,951
30	49,665	3,834	5,109	9,247	5,447	73,302

SOURCE: P&D Technologies

and services are purchased from outside the region. It is important, therefore, that the specific multiplier factors selected for the analysis are keyed to the regional economy. The multipliers used in this study were developed specifically for the Puget Sound Region and each county within it. These locally adjusted multipliers were obtained from the U.S. Bureau of Economic Analysis' Regional Input-Output Modeling System (RIMS II).

It is important to note that the use of "multipliers" is a traditional analytical technique that has been used in regional impact analysis for at least 30 years. This approach is commonly used in estimating the economic impact of harbors, airports, mass transit systems, and virtually any type of project that generates employment and revenue. This technique was used in a recent study of the economic impact of the Seattle Harbor and Sea-Tac Airport [1], as well as in PSRC's recently released economic and demographic forecasts for the Puget Sound Region [2].

Office development impacts are expressed in terms of additional square feet of office space to be expected within 1.5 to 3 miles around the airport at various levels of airport activity. Hotel development impacts, also within 1.5 to 3 miles around the airport, are shown in terms of additional hotel rooms and hotel sales and room tax revenues. The methodologies used in each of these analyses are contained in Appendix B of this report. The various impacts are summarized below.

Airport-Related Activities

Economic impacts (jobs, wage earnings, business revenues and local sales tax revenues) generated by airport-related activities for each alternative are presented for individual counties and the region as a whole in Tables V-1 to V-4. By the year 2020, as may be noted, the various alternatives could generate between 56,300 and 80,600 jobs, $1.6 billion to $2.3 billion in wage earnings, $4.1 billion to $5.5 billion in revenues to businesses, and $9.4 million to $12.4 million in local sales tax revenues in the region.

In terms of total economic impacts (See Figures V-1 to V-4), the major difference among the airport systems results from those alternatives that cannot provide adequate capacity to meet the projected passenger demands and those that meet the 2020 forecast. While

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[1] Martin O'Connell Associates, The Economic Impact of the Seattle Harbor and the Seattle-Tacoma International Airport, prepared for the Port of Seattle, February 1989.

[2] Puget Sound Council of Governments, STEP91: Central Puget Sound Regional Econometric Model and Regional Economic and Demographic Forecasts, 1990-2020 (Draft), no date.

- Economic impacts to the region generated by business and tourist traveler visitors to the region which arrive via air travel [1].

- Office and hotel development generated by airport activity in the immediate area surrounding the alternative airport sites.

The economic impacts are measured in terms of increased jobs, wage earnings, revenues to local businesses and local sales tax revenues. The impacts are quantified using input/output analyses which studies the interrelationships of industries in an economy.[2] The advantage of this method, which is recommended by the Federal Aviation Administration for evaluating the impact of airports on a region[3], is that it accounts for the interdependency of economic sectors within the region. Thus, it can measure the effect of a change in one economic sector (e.g., air transportation) on all economic sectors in a region.

Economic impacts are measured in terms of direct, indirect and induced effects, as follows:

- Direct impacts result from economic activities on the airport that would *not* occur if the airport was *not* there (i.e., airport employment, purchase of local goods and services, capital improvement expenditures, etc.). They also include expenditures made by business and tourist air traveler visitors that use the airport.

- Indirect impacts result from off-airport economic activities attributable to the airport (e.g., services by travel agencies, hotels, restaurants, etc). These impacts would *not* occur if the airport was not there.

- Induced impacts are the multiplier effects of the direct and indirect impacts. These include the increases in employment, wages, and revenues – in addition to the direct and indirect impacts – created by successive rounds of spending and respending. Although some of these induced impacts occur locally, some goods

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[1] Insufficient information is available to estimate the distribution of visitor expenditures by county.

[2] Input/output analysis is a commonly used technique to evaluate the impact of a change in one sector of the economy on all sectors of the economy in a region.

[3] Butler, Stewart E. and Laurence J. Kiernan, Measuring the Regional Economic Significance of Airports, U.S. Department of Transportation, Federal Aviation Administration, October, 1986.

The complex would occupy about 15,000 acres and contain two 13,000-foot runways (to handle giant air cargo aircraft and hypersonic freighters) and four taxiways. Industrial plants would be located along the taxiways, which would be anchored at their ends by global air cargo companies.

Preliminary analysis by the University of North Carolina Business School shows that were such a complex developed in North Carolina, the manufacturing facilities alone would generate a minimum of 30,000 jobs directly, with substantially greater indirect job generation through employment multipliers. At full capacity, it was estimated the complex would contribute as much as $5 billion annually to the state's economy. This does not include the economic impact on manufacturing and distribution facilities located within 3 hours driving distance of the complex which would use the air cargo facilities.

G. IMPLICATIONS FOR FUTURE AIRPORT DEVELOPMENT IN THE REGION

The Puget Sound Region is well-positioned to capitalize on the emerging aviation/industrial linkages (i.e., the projected increases in air cargo, the role of air freight in "just in time" methods and air cargo/industrial complexes, etc.). The region has an integrated sea/rail/highway system; however, there may be insufficient vacant, available land around Sea-Tac to allow development of large-scale aviation/industrial facilities. Therefore, the ability of replacement or supplemental airports to provide these facilities should be considered in evaluating the alternative sites.

THE ECONOMIC IMPACT OF ALTERNATIVES

As a result of growing environmental concern, most public discussion relative to airports, either existing or proposed, relates to noise and air pollution. In the public debate over the proper balance between air transportation technological progress and the preservation of the environment, relatively little attention is given to the powerful impact a major airport system can have on the regional and local economy. Such consideration is critical in any public investment decision.

A. . DESCRIPTION OF ECONOMIC IMPACTS

The economic impacts of the alternative airport systems were evaluated based on projected passenger demand in the year 2020 as follows:

- Economic impacts to the region and individual counties generated by airport activity.

F. GLOBAL AIR CARGO INDUSTRIAL COMPLEXES

Various public and private entities are exploring varying concepts for air cargo industrial complexes. Among those already in operation are Alliance Airport in Fort Worth, Texas, and the Intermodal complex at Huntsville, Alabama. Efforts are underway to revitalize the Kansas City International Airport, with a focus on air cargo development. Feasibility studies are underway for air cargo industrial complexes in northern Arkansas and New Hampshire, among others. In response to recent Department of Defense announcements of USAF base closings in the continental U.S., it is likely that other states and communities may also consider such complexes.

One concept of particular interest presently being studied by the State of North Carolina Air Cargo Airport Authority is that of an International transport and industrial complex. This concept, which is referred to as a Global Air Cargo Industrial Complex (GACIC) is not just an air cargo airport. Rather, it is a computer-age industrial complex in which aviation will play a pivotal distribution role. The proposed complex, which substantially extends both in scale and integrated systems technologies the successful Alliance Airport in Texas, would integrate (both spatially and operationally) JIT manufacturing systems with air freight and other transportation modes to create a functionally new type of facility.

The JIT plants will be located along the taxiways, allowing freighters to interface with them, just as railway side-spurs allow freight trains to move alongside factories for raw material delivery and loading finished product. Freight transfer would be developed so that while one feeder line is unloading components and materials from one end of the plane, another line could be loading finished product at the opposite end. Direct highway and port connections will complete the total transportation network available to the complex.

Central distribution facilities will be another key component of the complex. There will be economies of scale for efficient U.S. Customs processing and smaller load pick-up and delivery systems. Distribution centers will be connected via high-speed electronic transfer vehicles (ETVs) that will interface with airplane side and nose docks for maximum efficiency. The ETVs will operate throughout the entire industrial complex, transporting cargo pallets in a manner similar to the computerized baggage handling systems now at the largest airports. Supporting this complex will be around-the-clock communications and automated tracing and tracking systems that will allow almost instantaneous location and shipment of goods. In situations involving critical replacement parts, inventories required by international dealers or customers could be warehoused at the complex with the assurance the items would be dispatched quickly to any place in the world.

In prior economic eras, when speed of delivery and production flexibility were less crucial to competitive success, air freight was considered a luxury and limited primarily to lightweight, high value or emergency products.

Today, essentially anything that can be loaded onto a large aircraft is routinely shipped internationally by air, from automobiles and heavy machinery to live cattle. Moreover, air freight is creating new industries by being able to deliver highly perishable goods to distant markets within hours.

The next generation of freighters will be similar to the Soviet Antonov 225, the world's largest aircraft. This cargo plane can carry a payload of 250 tons for thousands of miles. Hypersonic planes now being designed will be able to carry products from the U.S. East Coast to Europe in less than two hours and to the Pacific Rim in less than three hours.

E. FUTURE TRENDS

It is not unrealistic to expect that within 20 years, advances in aviation will place U.S. businesses within three hours' delivery time of virtually any part of the world, and will provide same-day service to nearly 8 billion potential customers.

Most of the global market potential will be in the Pacific Rim, a $4 trillion market expanding at $5 billion a week. Nearly two-thirds of the world's population lives in Asia, which contains the world's fastest-growing economies. Most Asian economies are expanding at real rates two to six times the growth rates in Europe and the United States. All forecasts project U.S. trade with Asia growing much faster than with any other region of the world. Since most of the exports and imports of East Coast businesses to and from Asia are currently shipped by truck or train across the United States, West Coast businesses have a four-to-seven-day advantage in trade with Pacific Rim countries. Likewise, East Coast companies have a time advantage over West Coast firms wanting to do business in Europe. Air cargo, however, will help eliminate the time factor and all firms will have to use it to remain competitive. Further, if Japan moves into Europe in the 1990s, as it did into the United States in the 1980s, mid-point air cargo terminals, such as Sea-Tac, will play an increasingly important role in this trade.

Thus, with global sourcing and sales of products/components, JIT production and inventory systems, and speed of delivery, aviation will play a key role in the world economy. However, the ability to successfully compete in the growing world market will require an efficient aviation system with sufficient capacity and adequate facilities. State and local leaders must plan now for these and other technological advances expected in this new transportation era. One way this is currently envisioned is through the concept of a global air cargo/industrial complex.

WORKING PAPER #8

ECONOMIC IMPACTS AND STRATEGIC ECONOMIC ISSUES

PRESENTED
OCTOBER 16, 1991

ADOPTED
NOVEMBER 26, 1991

APPENDIX C

ECONOMIC\FINANCIAL ELEMENTS

WORKING PAPERS # 8, 11

4. **Data Interpretation**

The Multiple Airport System provides improved ground access for airport users, particularly during non-recurring events (not visible to the modeling process). The same weather events that influence service 45 percent of the time at Sea-Tac, also influence ground access within the 30 minute travel time perimeter. This will suggest a higher ranking for those alternatives that best address seasonal troughs in ground and air accessibility (rather than mileage or daily peaks in travel demand).

In addition, the transportation models do not include travel within each of the several hundred zones into which the region is divided or analysis purposes. The model is confined the the interzonal trips, and in this way is likely to understate actual congestion conditions as these might exist in future years.

5. **Multimodal Coordination**

HCT could help offset declining ground access to Sea-Tac during periods of peak ground congestions. Air traveler use of HCT might be encouraged through the use of remote baggage handling facilities.

6. **Direct Highway Costs**

The cost of new highway access construction varies with each airport alternative, depending upon the level of service at the new sites, and the level and proximity of existing facilities (See Working Paper No. 11). Costs are significantly higher for the Replacement sites in Central Pierce County.

7. **Preliminary Ranking** (1: best, 4: worst, on a relative scale)

Sea-Tac with Demand Management	3
Replacement	4+
Multiple Airport System (2) *	
Existing Sea-Tac plus Supplemental (1 RW)	2
Existing Sea-Tac plus Supplemental (2 RW)	2
Sea-Tac plus AC RW plus Supplemental (1 RW)	2
Sea-Tac plus AC RW plus Supplemental (2 RW)	2
Multiple Airport System (3)	
Existing Sea-Tac plus 2 Supplemental (1 RW)	1
Sea-Tac plus AC RW plus 2 Supplemental (2 RW)	1
Sea-Tac plus AC RW plus 2 Supplemental (2 RW)	1

(Note*:

Preference for a north or south site may depend upon long term growth patterns. At the time of this writing, the northern site is preferred due to present and forecasted population distribution, and access problems to Sea-Tac through Seattle from the north.)

Phase II concluded that due to accessiblity to passenger markets and redundancy of some flights, overall regional operations would increase by 16 percent over the original forecast figures (which assume one airport). This conclusion is not supported by further research in Phase III (Working Paper No. 5).

IV. HIGHLIGHTS

A summary of findings on the relationship between airport planning and other modes of transportation, and accessibility.

1. **Average Daily Travel Time**

   The north and south regions operate as independent market areas, but depend upon a constrained service at Sea-Tac in order to achieve high user levels.

2. **Annual or Daily Travel Distance**

   Commuter mileage to and from the Replacement sites is up to five times as great as to the three-airport muliple airport system alternative. Grouped together nearly midway between these two extremes are the two airport systems.

   Construction of a dependent runway at Sea-Tac diminishes miles traveled to supplemental sites, by reducing patronage of these sites.

   Given a wide range of uncertainties, it may be impossible to detect meaningful differences between the mileage requirements for the overall multiple airport systems (with Sea-Tac travel included with data on Tables 2 and 3). Specifically, a very large role is played by market cross-over passengers (from the Sea-Tac market area to supplemental airport market areas), and by that fact that these passengers are responding to airline service opportunities as well as to accessibility. These behavioral factors cannot be accounted for in origin-destination transportation models such as those housed at the Puget Sound Regional Council. **Removal of Sea-Tac constraints reduces travel to supplemental airports. It may be a matter of judgement whether this reduces overall ground travel, Sea-Tac access included.**

3. **Peak Daily Travel Time**

   The percent of regional population residing within various ground travel time contours is generally the same for average daily travel conditions and for peak congestion periods (both tested for year 2020). This modeling result is limited by model assumptions, but also reflects the regional policy that High Occupancy Vehicle (HOV) lanes and other improvements will be in place as scheduled in VISION 2020.

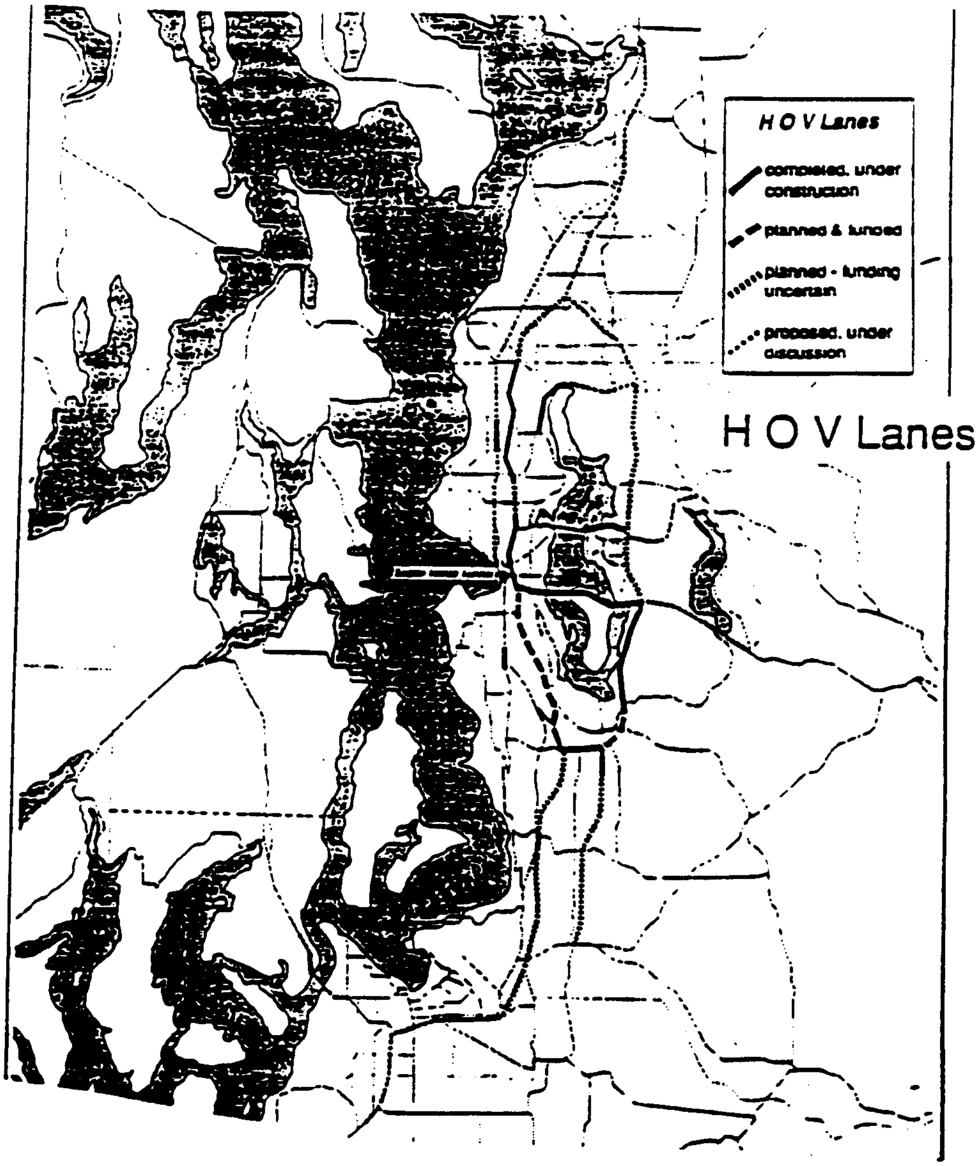

H O V Lanes
completed, under construction
planned & funded
planned - funding uncertain
proposed, under discussion
H O V Lanes

FIGURE 2

Multiple Centers
Rail

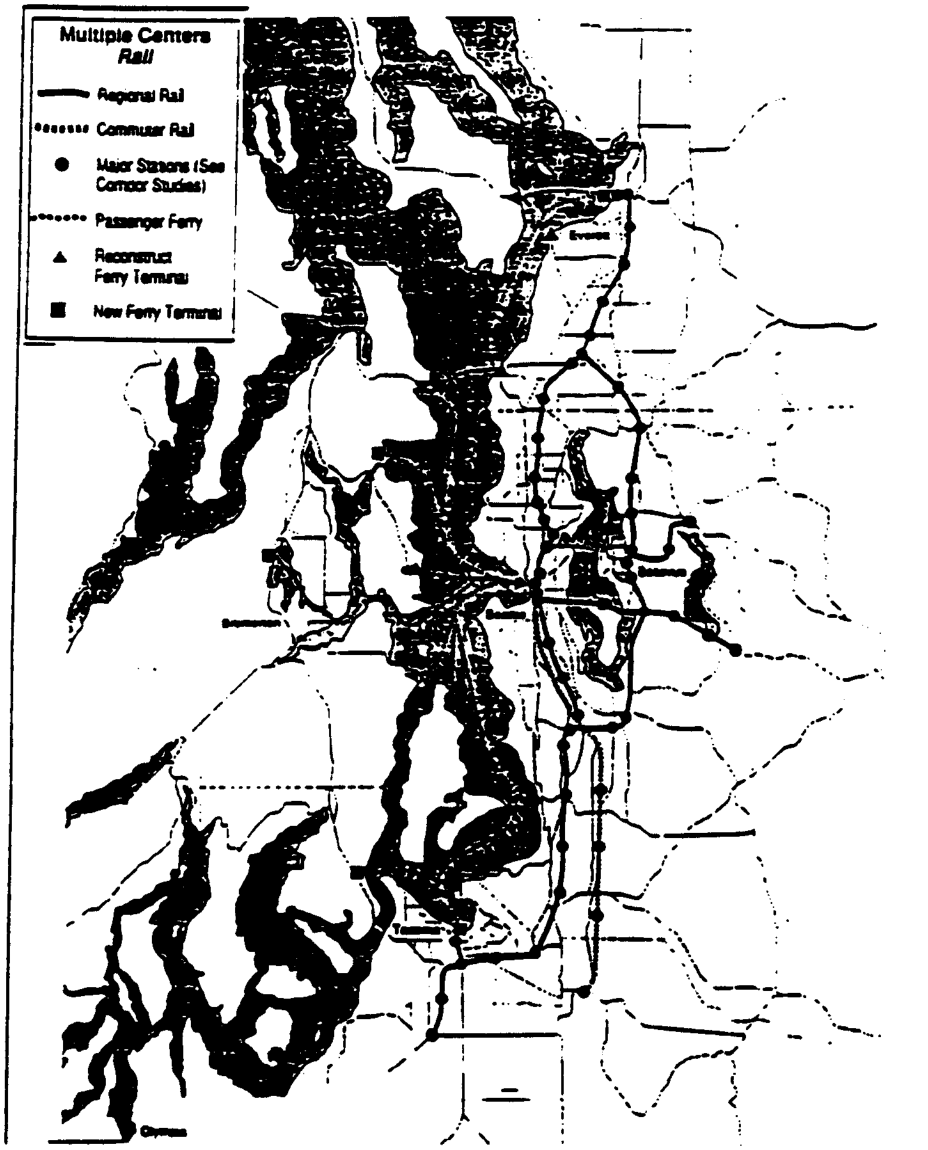


FIGURE 1

Decision Calendar

Estimated capital and operating costs for HCT through 2020 range from $8.5 billion to $12 billion. The Joint Regional Policy Committee (JRPC) is required to prepare for the ballot a plan and financing strategy. The target deadline is late 1992, and the effective statutory deadline is 1995 (four years after completion of an interagency planning agreement between the operating agencies). The ballot issue likely will include an HCT financing program as part of a broader package also including funding for other modes, such as High Occupancy Vehicle (HOV) lanes.

If the most likely rail alignment options turn out to be equally preferable, packaging of final HCT alignment commitments with future airport locations is one possibility that could improve any needed long term airport siting decision process. The preliminary rail and HOV alignments in VISION 2020 are depicted on Figures 1 and 2.

High Speed Rail

Phase II also estimated that a high speed rail system (to be distinguished from metropolitan light rail commuter facilities) could divert as many as 40,000 annual airline operations by 2020 (in the Vancouver-Seattle-Portland corridor), compared to a shortfall in total capacity of 144,000 (forecast of 524,000 operations less 380,000 existing capacity at Sea-Tac). Three fourths or more of airline passengers between Seattle, Portland and Vancouver are connecting rather than local passengers.

These claimed benefits should not be overstated or double-counted. In the future the affected smaller planes with be replaced by larger ones. Also expected is the elimination of those connecting flights whose purpose is to increase load factors for planes destined for other locations (e.g., Portland to Chicago). Many of these can expect to become overflights. For these reasons, the total operational forecast for 2020 was reduced in Phase II, from 575,000 annually to 524,000.

Following public hearings, Flight Plan decided in May 1991 to include in Phase III a full scale alternative that combined rail, new technologies, and demand management as a broad alternative to the other facility expansion alternatives. Flight Plan has since examined demand management (Working Paper No. 4: Demand Management, and expert panel) and combined the demand management package (including rail) with the Sea-Tac "no action" alternative.

Airline Routing Decisions

Of greater importance to the siting of new facilities (greater than average or peak ground travel time) is the willingness of the airlines to direct planes and new investments to sites competing with the existing airport location (Sea-Tac).

Reduced landing costs, perhaps funded in part by congestion fees at the stressed existing facility, are one possible tool discussed by the Demand Management expert panel. Experiences at other locations in the nation also give some insight into this important airline decision. For example, airlines can refuse to relocate, and in this way can establish service competing with the new location (Southwest Airlines at Love Field now competes in this way with the Dallas/Fort Worth replacement airport). In other cases, once one airline does relocate, perhaps enticed by lower landing fees, others often follow to provide competition.

Light Rail Transit

Phase II estimated that light rail transit (LRT) would not greatly improve access (measured in time) to three selected search areas (Central Pierce County, Olympia/Black Lake, Arlington) during average travel conditions. Time traveling to stations from points of origin (usually home or hotel) and time spent at stations are two important factors reducing overall average speeds (Phase II, Table 6-6). It has been assumed by Flight Plan that the any high speed rail system will link the airports as well as the business centers.

High capacity transit (HCT) is built into the time calculations in Table 1A and 1B. While the average time of HCT is comparable to that of auto, the reliability during inclimate weather is an important benefit that is not accounted for the the transportation models supporting the Tables.

High Capacity Transit

Institutions

High Capacity Transit (HCT) planning was mandated in 1990 (HCT Act of 1990 and 1991, SHB 1825 and ESHB 2151, respectively). The 1990 Act created a Joint Regional Policy Committee and empowered it to prepare and adopt a regional high capacity transportation (HCT) implementation program, including financing. These are to be consistent with the regional transportation plan (RCW 81.104.040).

Regional plans and local comprehensive plans are to address the relationship between urban growth and an effective HCT system plan and provide cooperation with transit agencies.

Regional Policy

Future airport needs and related development should be considered in the alignments of HCT corridors, the locations of transit stations, local feeder service, and the provision of remote baggage handling facilities (e.g., at the King Street Station site in Seattle for air travelers residing north of Sea-Tac).

The 1990 Regional Transportation Plan (linked to the regionally adopted VISION 2020 growth strategy) will be amended to respond to the Flight Plan results.

> "The Regional Air Carrier System Plan is being developed separately and will be amended into the Growth Strategy and Transportation Plan upon completion. Any new airport and its attendant impacts will be evaluated as part of that amendment process. The air carrier plan will reflect the results of this regional plan update in any recommendations that are made." (VISION 2020, Assumptions, Sec. 2-1, September 1990).

New long term multicounty population and economic forecasts (developed in the spring of 1991) are being interpreted to the local level through scenarios being developed by the PSRC and the local governments. The resulting scenarios will eventually support local comprehensive planning decisions (under the GMA) and then a final set of officially adopted forecasts. Local comprehensive plans looking twenty years into the future are to be completed by July 1993, pursuant to the GMA. The results of the regional travel forecasting scenarios might be available in time for use in the Final Environmental Impact Statement of Flight Plan (March 1992).

In summary, the Flight Plan accessibility analysis dovetails with analysis for HCT and local comprehensive plans, and the related VISION 2020 Regional Growth Strategy and Regional Transportation Plan.

V. RELATED PLANNING

Growth Management Act

The Institutional Analysis (Working Paper No. 10) relates Flight Plan to comprehensive land use planning required under the Growth Management Act (GMA) of 1990 (and amended in 1991).

The Act requires coordination between land use planning and transportation planning. The GMA goal is to "encourage efficient multimodal transportation systems that are based on regional priorities and coordinated with county and city comprehensive plans." Countywide and multicounty (for the King, Pierce and Snohomish County area) "growth policy plans" are required to address regional and state transportation, siting and other needs, and are required by July of 1992.

Comprehensive plans are required by July 1993. These are to be coordinated at the countywide level. Comprehensive plans are to include long range (at least six years) capital facilities elements, and the provision of services "concurrent with development".

Concurrency is defined as follows (GMA, Section 7(6)e):

> "Concurrent with the development" shall mean that improvements or strategies are in place at the time of development, or that a financial commitment is in place to complete the improvements or strategies within six years.

The Act also requires that "all transportation projects within the region that have an impact upon regional facilities or services must be consistent with the plan" (GMA, Section 55(2)). In addition the Regional Transportation Planning Organization (specificed in the GMA as the federally recognized Metropolitan Planning Organization(s), or the PSRC for this four-county region) must "Develop and adopt a Regional Transportation Plan that is consistent with county, city and town comprehensive plans and state transportation plans" (Section 55(1)b).

III. AIRPORT IMPACTS

Highway needs generated by the airport development(s) can be divided into two categories: direct impacts due to actual airport traffic, and those larger impacts that will be generated by development within a 1.5 to 3.0 mile radius of the new facilities.

Direct Impacts

Working Paper No. 11 (Capital Costs) identifies specific highway and interchange improvements likely to be needed at each potential airport site, and applies local unit costs to these needs. The improvements include widening of existing freeways, construction of new freeways or interchanges, and the widening or construction of major arterials. The incremental highway improvement cost to serve morning and evening peak hour passenger demand is calculated.

The resulting approximate costs are:

TABLE 5

Offsite Access Improvement Costs for Airport Systems

Alternative	Cost ($ millions, 1990 dollars)
Sea-Tac and Maximum Demand Management	49.0
Replacement Airport	86.0 to 186.0
Supplemental (2 and 3 airport systems)	
(New site(s))	(6.0 to 41.0)
With Sea-Tac actions	55.0 to 126.0

Secondary Impacts

Economic impacts are projected on a countywide basis in Working Paper No. 8. Associated with these job and housing activities will be transportation effects which will increase mobility to and from the airport site(s). Will residents and employees in the affected areas be able to get to work and home, and to and from the supplemental (or replacement) airport?

The Puget Sound Regional Council is working with local jurisdictions at the technical level to model these kinds of future events. Location of potential airport sites can be included in the scenarios tested prior to the adoption of local comprehensive plans in July 1993. For the present, and for use in the Flight Plan Draft Environmental Impact Statement, Flight Plan is relying upon existing sets of growth forecasts extending to the year 2010 (also in use by Metro for HCT planning) and those for VISION 2020 that generally encourage a regional pattern of 10-15 activity centers (in the King, Kitsap, Pierce, and Snohomish County areas) served by HCT combined with highway investments.

Field, and McChord and Central Pierce County, respectively. Extension of HCT into these areas would not be part of this early phase of HCT planning and implementation.

The VISION 2020 land use strategy (under refinement by local governments pursuant to the GMA) does not show HCT leading to the Central Pierce County site. As a general point, HCT might be of minimal benefit if the typical trip to the airport is from the home rather than the office or the central business district. This is clearly the case in Los Angeles, for example.

Highway improvements required for the respective sites might be as follows:

TABLE 4

Possible Flight Plan Offsite Improvements

Arlington Site:	Depending upon the service level, either enlarged capacity on 67th or on SR 530, both with an improved Freeway connection. These options assume independent improvements to 172nd (Edgecomb Road).
Paine Field:	For this option, SR 526 (the Evergreen Speedway) would be widened, and there would be a new interchange with SR 525. Independent widening of SR 525 is assumed.
McChord:	Varied improvements under these options would include widening of Interstate-5, new access from SR 512 and a revised interchange linking SR 512 and Steele Road. Independent widening of SR 512 is assumed.
Central Pierce:	Improvements would include widening of SR 161 into Puyallup, and a share in the costs of the cross-base freeway eastbound from Interstate-5, together with improvements to 176th South.
Olympia/Black Lake:	Improved interchange with Interstate-5 and access from Lathrop Road.

D. THREE-AIRPORT SYSTEMS

These are the same as for two-airport systems, except that the combinations each include one site north and one south of Sea-Tac.

4. Geographic Distribution: The northern and southern regions (relative to the central Sea-Tac International Airport site) operate independently.

The demand in either region is not affected by actions in the alternate region. The two regions are independent market areas. This factor enables the creation of Table 3.

IV. SITE ACCESS NEEDS and COSTS

Actions related to HCT and to highway improvements are summarized below. Detailed data on highway costs (summarized here) are provided in the Capital Costs analysis (Working Paper No. 11).

A. SEA-TAC "DO NOTHING", WITH MAXIMUM DEMAND MANAGEMENT

Sea-Tac International Airport is the nearest of all the sites to the Seattle Central Business District, and the one most likely to be served first by light rail transit. Remote terminal service might also improve accessibility to air travel by ensuring passenger access to High Occupancy Vehicle (HOV) lanes during peak periods of ground congestion.

Freeway improvements to Sea-Tac and along International Boulevard (Pacific Highway South) would also be required, together with improvements to SR 518 and SR 509. Also of immediate interest will be whether the HCT system stations are near the airport (e.g., Highway 99 rather than I-5).

B. REPLACEMENT AIRPORT

This Alternative does not incorporate demand management or alternative modes of transportation. Details on rail access might be appropriately addressed in later stages of HCT planning and funding. The replacement airport sites are not presently planned to receive HCT service.

In the nearer term, ground accessibility would include some widening of Interstate-5 and construction of a possible cross-base freeway aligned generally along the southwestern edge of McChord Air Force Base and connecting with 176th South. This would provide access from Interstate-5 to either of the Central Pierce County sites. An incremental portion of a total project cost could be attributed to the airport siting. An alternative route north and south to Puyallup (SR 161) is already at capacity, but would also have to be enlarged, perhaps beyond what is assumed in Table 2. It is assumed that SR 512 would be improved independently.

Access to the Olympia/Black Lake site would probably require widening of Interstate-5 together with a revised freeway interchange and an improved Lathrop Road (93rd) approach.

C. TWO-AIRPORT SYSTEMS

Sea-Tac International Airport is the most likely site to be served by light rail transit in the foreseeable future. The nearest supplemental sites north and south are Paine

Table 2

ANNUAL PASSENGER MILEAGE TO SELECTED AIRPORT SITES - 2020

ALTERNATIVE	Passenger Mileage (Annual, in millions) ALTERNATIVE SITE	SEA-TAC	TOTAL
ONE AIRPORT SYSTEM			
Sea-Tac, alone	-----	708	708
Sea-Tac with Commuter Runway	-----	775	775
Sea-Tac with Maximum Demand Management	-----	993	993
Replacement	1,847-2,096	-----	1,847-2,096
TWO AIRPORT SYSTEMS			
Existing Sea-Tac plus Supplemental Airport (1 Runway)	212-489	323-454	534-943
Existing Sea-Tac plus Supplemental Airport (2 Runways)	212-579	323-439	534-1,019
Sea-Tac plus New Air Carrier Runway plus Supplemental Airport (1 Runway)	37-112	567-620	604-732
Sea-Tac plus New Air Carrier Runway plus Supplemental Airport (2 Runways)	37-112	567-620	604-732
THREE AIRPORT SYSTEMS			
Existing Sea-Tac plus Supplemental Airports (1 Runway)	182-394	300-317	494-694
Sea-Tac plus New Air Carrier Runway plus Supplemental Airports (1 Runway)	81-88	473-582	567-664

NOTE: *Figures have been updated subsequent to PSATC adoption using new and more-refined data.*

III. NEW ANALYSIS

Airport Market Areas

Based on relative accessibility during average driving conditions, Phase III now has examined the likely marketability of supplemental airport sites (Working Paper No. 5: Allocation of Passengers and Aircraft Operations).

Analysis in support of the Working Paper (including Flight Plan Staff Memo, August 7, 1991) assumed that half of the short haul air travel trips and half of the medium haul trips would be handled at the supplemental sites. *Working Paper No. 5 also established an upper end of the range--and then used the midpoints--on the assumption that all surrounding short haul travel would be handled at the supplemental sites.* Travel to airport sites was split on the basis of relative average daily ground travel times to Sea-Tac International and to the supplemental sites. The supplemental sites were studied separately and in pairs (using two and three airport scenarios).

New Annual Ground Mileage

Table 2 indicates the number of miles of annual commute to and from the airports that would be involved under each of the four major alternatives.

Table 3 isolates the airport sites and calculates the mileage travel associated with each of these separately, under the number alternatives (left hand column). This enables comparisons of supplemental sites with each other, apart from the (variable) Sea-Tac mileage figures for the same alternatives.

It is important to note that the passenger-mile figures in Table 3 indicate two important characteristics: 1) accessibility to passengers and 2) number of passengers served. These characteristics are positively correlated and can sometimes lead to data that is difficult to interpret. For example, sites that are close to the region's centers of population require less vehicle miles per passenger to reach them than for distant sites. However, since they are closer and thus more accessible, they also generate more total passengers. The result is more passengers using a facility, but each passenger has to travel fewer miles than if they were required to go to a distant facility. Thus, for the data in Table 3, lower numbers tend to indicate greater accessibiliy, but a high number of passenger-miles may be the result of a larger number of passengers served.

Findings

1. Table 2: From a mileage perspective for new passengers (post 1990), the accessibilities of the alternatives are as shown in the right hand column (best: Sea-Tac with maximum demand management, worst: replacement airports (by a factor of 2 or 3), and moderate: the multiple airport alternatives).

2. Table 3:

   Part A: Passenger-mile figures are higher for Sea-Tac with Demand Management and Sea-Tac with a Commuter Runway since these alternatives can accommodate more passengers.

Part B: Paine Field is the most accessible site, followed by Central Pierce and McChord. Arlington and Olympia/Black Lake are both much-less accessible.

Part C: The same pattern of accessibility is observed for supplemental airports with two runways as for supplemental airports with one runway (Part B) except that the passenger-miles for McChord are lower than for Central Pierce.

Part D: Passenger-miles to the supplemental airport sites drops in comparison to previous groups of alternatives above. There is a corresponding rise in passenger-miles to Sea-Tac since with a dependent runway, it can accommodate more passengers.

Part E: Combined passenger-miles are lowest for the system including Paine Field and Central Pierce and highest for the system including the Olympia/Black Lake and Arlington sites.

Part F: Under this set of options, Sea-Tac has a dependent runway and can thus accommodate more passengers. This leads to an increase in passsenger-miles to Sea-Tac and a decrease to the supplemental sites in comparison to alternatives in Part E.

Part G: The Replacement Airport sites have vastly greater passenger-mile figures and lower overall accessibility than any other site due to their more remote locations.

Working Paper No. 5 offered these earlier and less detailed findings:

3. Overall Distribution: Unless Sea-Tac service is "constrained" (capped), passengers will continue to seek airline service at this central location.

Working Paper No. 5 developed refined distributions reflecting, in part, a cap on service available at Sea-Tac International Airport. Only when the service level at Sea-Tac is constrained in this way--and generally when the supplementals are allowed two runways--does the service level rise significantly at the potential supplemental airport sites. The range of constraint assumptions at Sea-Tac accounts for the high end of the range of service (measured in millions of annual passengers--MAP) at the outlying locations.

The range of supplemental airport use under Sea-Tac constrained conditions is illustrated by Paine Field, Arlington and McChord. The range for Paine Field is 3.9 MAP to 13 MAP, for Arlington it is 2.5 MAP to 13.0 MAP, and for Central Pierce it is 10.9 MAP with one runway, and 13.0 MAP with two runways.

Table 3

DAILY PASSENGER MILEAGE TO SELECTED AIRPORT SITES - 2020

ALT. NO.	SITE	PASSENGER MILES (in thousands) ALT. AIRPORT	SEA-TAC	TOTAL
A.	Sea-Tac Constrained			
1	Sea-Tac, alone	-----	1,941	1,941
2	Sea-Tac, commuter runway		2,122	2,122
33	Sea-Tac, demand management		2,721	2,721
B.	Sea-Tac Constrained (2 Airport Systems)			
3	Arlington	1,000	1,014	2,014
4	Paine Field	580	884	1,464
5	McChord	809	1,204	2,013
6	Central Pierce	740	1,245	1,985
7	Olympia/Black Lake	1,339	1,245	2,584
C.	Sea-Tac Constrained with 2 RWY Supplemental Airport (2 Airport Systems)			
8	Arlington	1,209	884	2,093
9	Paine Field	580	884	1,464
10	McChord	809	1,204	2,013
11	Central Pierce	908	1,204	2,112
12	Olympia/Black Lake	1,587	1,204	2,791
D.	Sea-Tac with New Dependent Runway (2 Airport Systems)			
13/18	Arlington	177	1,570	1,747
14/19	Paine Field	102	1,553	1,655
15/20	McChord	110	1,699	1,809
16/21	Central Pierce	137	1,686	1,823
17/22	Olympia/Black Lake	307	1,699	2,006
E.	Sea-Tac Constrained (3 Airport Systems)			
23	Arlington	403	869	1,596
	Central Pierce	324		
24	Paine Field	213	856	1,354
	Central Pierce	285		
25	Arlington	510	822	1,902
	Olympia/Black Lake	570		
26	Paine Field	260	845	1,610
	Olympia/Black Lake	505		
F.	Sea-Tac with New Dependent Runway (3 Airport Systems)			
27	Arlington	85	1,412	1,634
	Central Pierce	137		
28	Paine Field	102	1,297	1,536
	Central Pierce	137		
29	Arlington	85	1,594	1,818
	Olympia/Black Lake	139		
30	Paine Field	102	1,448	1,689
	Olympia/Black Lake	139		
G.	Replacement Airports			
31	Central Pierce	5,060	-----	5,060
32	Olympia/Black Lake	5,743	-----	5,743

NOTE: *Figures have been updated subsequent to PSATC adoption* foul weather affects operations at Sea-Tac 45 percent of the time, and these same events affect airport access on the ground. The ground transportation models used to generate the data summarized in Tables 1-A and 1-B do not consider weather impacts on speed or travel times.

The VISION 2020 land use assumptions (reflected in the table) include the policy that growth in population and employment will be concentrated in denser centers where acessibility to a high capacity transit system, including HOV (High Occupancy Vehicle) lanes, is greater than in 1990. A greater share of the region's population would be able to enjoy system benefits (travel time savings) when commuting, if HOV and transit are used. Greater use of airport vans (possibly in conjunction with remote airport check-in terminals) would support this possibility.

In both tables, the slightly improved condition during peak periods is due largely to one new modeling consideration. The peak period figures were done after Phase II and reflect a greater recognition (in the revised travel model) to the fact that access to outlying locations would be in the reverse flow direction, that is, in the non-congested direction of traffic.

General Trends

While these figures do not detect increasing congestion, a general statement about regional congestion was provided in the environmental impact statement for the VISION 2020 growth management strategy. Even under the preferred and adopted regional growth alternative (greater concentration and mass transit service as modelled for Flight Plan), congestion was forecasted to worsen:

- Freeway mileage with "severe congestion" (a vehicle to capacity ratio of 0.9, that is, level of service "D" or worse) was forecasted to increase from 32.4 percent to 45.2 percent of total mileage.

- For arterials, the trend was upward from 5.2 percent of mileage to 16.5 percent.

- The combined effect was a deterioration from 7.5 percent to 20.3 percent of the total mileage.

If this is true, then accessibility to central sites (such as the Sea-Tac International Airport) may generally worsen, particularly during bad weather conditions which, again, are not considered in the model results.

From Table 1-B we see that regional accessibility to replacement sites south of Sea-Tac is considerably less than for the existing Sea-Tac site. Accessibility to Olympia/Black Lake diminishes as a percent of the total population for the four-county area. (These figures for the four-county area (tables 1-A and 1-B) are not adjusted to include accessibility to the relatively small Thurston County population.)

Table 1-A

Percent of Puget Sound Region's Population Within 30, 60, and 90 Minute Driving Times of Sea-Tac and Possible Supplemental Airports

for 2020 Average Daily Traffic Conditions and (2020 a.m. Peak Period Traffic Conditions)

	30 min. or less		60 min. or less		90 min. or less	
Sea-Tac (single airport)	30%	(32%)	79%	(78%)	97%	(96%)
Sea-Tac and Other						
Arlington	34	(38)	92	(88)	100	(97)
McChord	45	(48)	82	(80)	98	(99)
Paine Field	47	(56)	92	(90)	100	(99)
Central Pierce Co.	45	(49)	83	(79-81)	98	(97-99)
Olympia/ Black Lake	33		79		97	(96)

Source: Phase II, Table 6-7, PSRC Regional Transportation Model

Table I-B indicates travel times to each of the replacement sites. Again, these data are for average daily travel conditions, and for peak conditions.

TABLE 1-B

Percentage of the Puget Sound Region's Population Within 30, 60 and 90 Minutes Driving Time of Sea-Tac and Two Potential Replacement Airport Sites

for Average 2020 Daily Driving Conditions ane (2020 a.m. Peak Period Driving Conditions)

	30 min. or less		60 min. or less		90 min. or less	
Sea-Tac	30%	(30%)	79%	(79%)	97%	(97%)
Central Pierce Co.	14	(19-21)	34	(50-53)	64	(84-85)
Olympia/ Black Lake	2	(0)	22	(0)	39	(14)

Source: Phase II, table 6-3, and PSRC Regional Transportation Model

3. **The northern supplemental airport market area and the southern supplemental airport area operate independently.** This may be reflected in future rankings of the supplemental airport options.

4. **Using annual ground mileage as the measure of accessibility**, the most accessible alternative is a three-airport multiple airport system. The least accessible is the replacement airport alternative. The two airport systems involve somewhat more annual ground mileage than does the first ranked alternative, but still about only half as much as the replacement alternative. These general findings are true for both the total population in 2020, and the new population between 1990 and 2020.

5. **Light rail transit (LRT) involves routing, timing and funding decisions which might be coordinated with airport siting actions.** That is, airport siting might be part of a larger package involving LRT priorities and timing.

6. Phase II concluded that by itself, high speed rail facilities between Portland-Seattle-Vancouver would be sufficient at best to divert only part of the increased air travel demand. (that is, up to 40,000 of the projected total 524,000 operations in year 2020).

II. PAST WORK

A. FLIGHT PLAN

The Phase II report estimated travel times from all parts of the region to the potential airport sites. The study included estimates for two-airport systems, but not the additional three-airport systems developed in Phase III. In previous work Flight Plan also has considered both light rail transit (LRT) and general accessibility (measured in travel times) in developing its alternatives, and in allocating trip demand to airport sites within the Multiple Airport System alternatives.

Accessibility

Average and Peak Period Daily Travel Times

Phase II showed the percentage of Puget Sound Region's Population within 30, 60 and 90 minute driving times of Sea-Tac and possible supplemental airports for 2020 average daily traffic conditions. Parts of this table are shown below together with new figures (in parentheses) for peak "period" (a period longer than the peak hour) driving conditions.

One major finding in Phase II is that the most noticeable differences are for an access time of less than 30 minutes. There is very little difference between sites if the 90 minute commute distance to the airport is used as the standard.

The new figures for peak periods reported here (in parentheses) are similar, but do not reflect the difficulty of arriving at the airport during the peak hour or during periods of "non-recurring" events, such as accidents or snow events. Please note that

DATE: November 6, 1991

TO: Puget Sound Air Transportation Committee

FROM: Staff: Puget Sound Regional Council

SUBJECT: **WORKING PAPER NO. 9 -- ACCESSIBILITY/INTERACTION WITH OTHER MODES**

INTRODUCTION

Accessibility to airport services varies with the travel time and distance from home or work to the airport(s). This Working Paper includes travel times during average daily traffic conditions (from Phase II), and adds new time data for the peak ground travel period, together with new mileage information. Increasing future congestion can be moderated through land use policies and the construction of new facilities, including High Occupancy Vehicle lanes.

Phase II of Flight Plan also briefly considered rail travel as (a) a possible alternative way to access the airport(s) within the region (light rail transit), and as (b) a travel mode alternative for part of the projected air carrier passenger demand (high speed rail). More broadly, the Flight Plan VISION STATEMENT supports a "totally integrated" system of air and surface transportation, with implementation coordinated among the operating agencies.

These and other points on accessibility and modal interaction are drawn together in this Working Paper. This work is supplemental to the Phase II Report ("Accessibility", pp. 76-86), and the Level of Service Report (Phase III, Working Paper No. 5) and includes the following sections: (i) Executive Summary, (ii) Previous Work, (iii), New Analysis, (iv) Sites Access Needs and Costs, (v) Related Planning, (vi) Highlights.

I. EXECUTIVE SUMMARY

1. **Ground access to the supplemental airport sites is not sufficiently attractive in itself to offset unconstrained service at Sea-Tac.** Travel distances to the supplemental sites increase as more of the Sea-Tac market area is accommodated by supplemental airports to the north and/or south.

   (note: The line between the Sea-Tac market area and each supplemental airport market area is not defined by points midway between Sea-Tac and each selected supplemental site.)

2. **Ground access may be maintained through land use and facility actions within established corridors under the regional growth strategy as this develops (VISION 2020 and continuing work under the new State Growth Management Act), and the related local planning and concurrency requirements of the GMA.** However, it is also likely that especially during peak hour traffic and poor weather conditions, travel times to the airport(s) will continue to worsen. High capacity transit and high occupancy vehicle lanes may provide more reliable access to users when these conditions occur and as regional population growth continues.

WORKING PAPER # 9

ACCESSIBILITY/INTERACTION WITH OTHER MODES

PRESENTED
OCTOBER 23, 1991

ADOPTED
NOVEMBER 26, 1991

It should be noted that included on the table is a group of alternatives that was not previously address - this being Sea-Tac with a new runway and two supplemental airports with two air carrier runways. This option would provide the greatest system capacity, relatively low delay costs, but more importantly it is the only one that would accommodate the vision forecast demand.

7. **Existing Sea-Tac Airfield and 2 Supplemental Airports Each With 1 Air Carrier Runway**

This is a three airport system but adds two runways to the system. Annual delay costs range from $235 to $241 million and all demand is satisfied. Since Sea-Tac's capacity remains low, greater demands are placed on the supplemental airports which operate at higher traffic volumes. As with other groups, Sea-Tac delay costs are the dominant component of the range of costs totalling $232 million.

8. **Existing Sea-Tac Airfield and 1 Supplemental Airport With 1 Air Carrier Runway**

This group proposes a two airport system but adds a net of one air carrier runway to the system. As such, capacity gains are less than many of the other groups, especially considering that Sea-Tac maintains status quo. Annual delays for the group range from $234-$271 million. More important though is the fact that some demand is identified as unsatisfied - up to 2 MAP in some cases.

With the exception of the first two groups, the annual delay costs are within a fairly narrow and consistent range. This is largely due to the assumed traffic allocations and the fact that Sea-Tac is assumed to operate almost always at or near capacity. Thus, the delay costs for Sea-Tac, as noted above, tend to mask the differences between alternatives. It is important to note the great affect this has on the analysis. For the second group listed above, (Sea-Tac with a new runway and two supplemental airports), the impacts of traffic being relieved from Sea-Tac are evident. Annual delay costs drop from the $230-240 million range frequently appearing in the analysis to $141 million in one case. In this case, the two supplemental airports allow for approximately 40,000 operations to be "bled" from Sea-Tac. The affect of this traffic relief on average delay is significant (a reduction from 18.8 minutes to 11.9 minutes). The reduction in average delay at Sea-Tac reduces annual delay costs from $240 million to $140 million.

Table 1 summarizes the major conclusions of the analysis in comparing all options strictly on airspace, capacity and operational considerations. In the evaluation of the options it is also critical to consider the ability to satisfy long range demand, and therefore this is included as part of the overall ranking. For each option the following is indicated: system capacity (annual operations): passenger capabilities (in MAP); the ability to meet year 2020 demand as well as the Vision planning horizon of 2050; and, the annual aircraft delay costs. A subjective ranking has been made by the consultant which considers all operational and capacity related considerations.

3. **Sea-Tac As The Only Commercial Airport Serving The Region**

This group of alternatives results in annual delay costs lower than most other groups. Annual delay costs range from $232 to $240 million. This group of alternatives represents a one airport system, and thus total system capacity is much lower than other multiple airport systems. Since fewer aircraft are accommodated the number of aircraft experiencing delays are much less than in other systems. As a result, the total delay costs are lower. However, since capacity is limited with the one airport, there is a major portion of regional demand that cannot be served unless extreme delays are accepted. As seen in Figure 2, this group of options results in the greatest amount of unsatisfied demand ranging from 7 to 13 MAP in 2020.

4. **Sea-Tac With a New Air Carrier Runway and a Supplemental Airport With 2 Air Carrier Runways**

This group of alternatives propose a two airport system that adds a total of three air carrier runways. Thus capacity is high and all demand is satisfied. The capacity (at both Sea-Tac and the supplemental) is such that the assumed allocation of demand to the supplemental airport is well below capacity, thus the average delays are correspondingly also very low. There are five plans included in this group and the annual delay costs for the year 2020 fell within a range of $232-241 million. Since most demand was allocated to Sea-Tac it is assumed to operate at capacity and thus almost all delay costs are attributable to Sea-Tac. Annual delay costs for the group could be lowered by diverting operations from the congested Sea-Tac to the supplemental airport operating at low levels of delay.

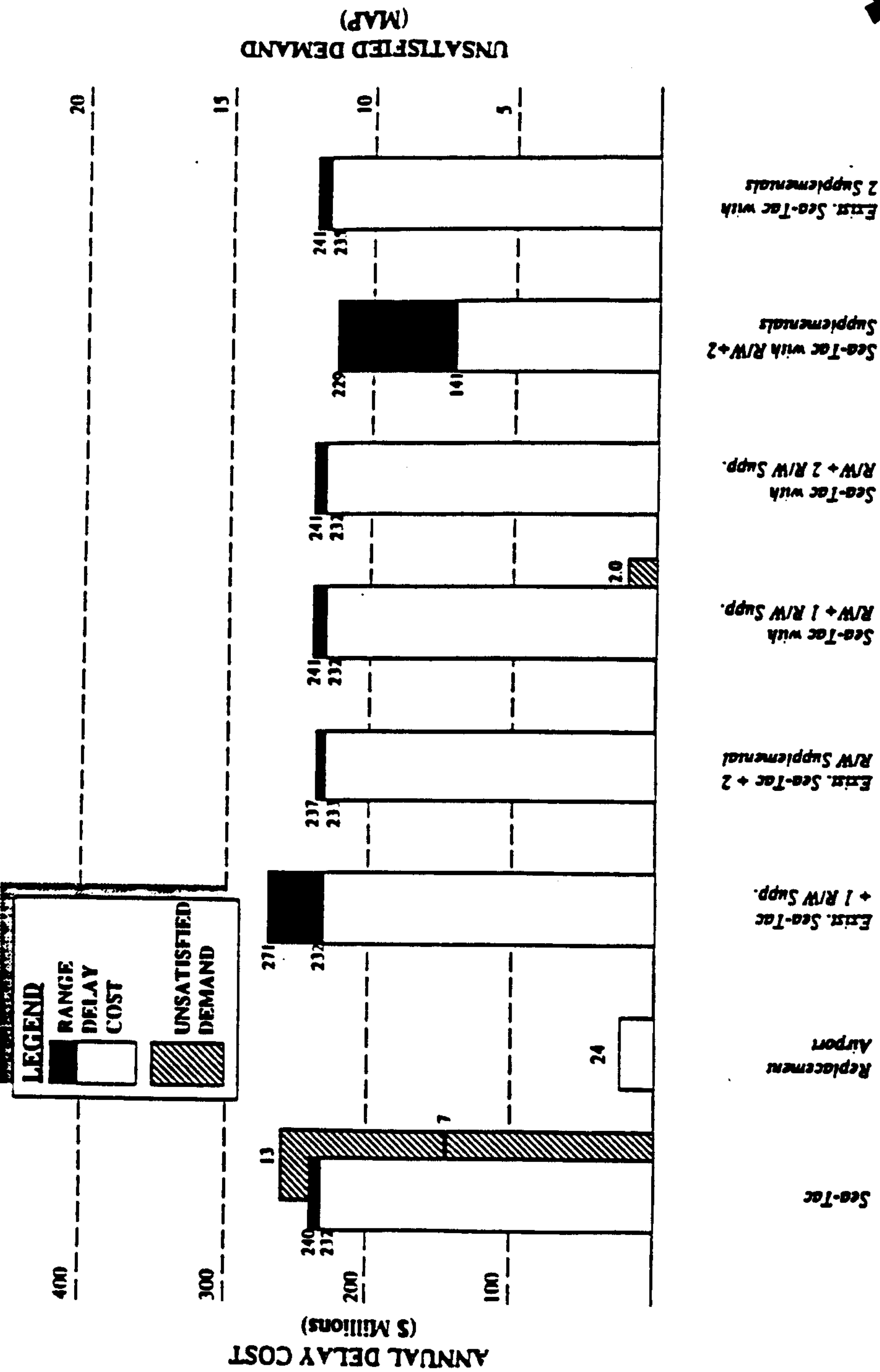
5. **Sea-Tac With a New Air Carrier Runway and 1 Supplemental Airport With 1 Air Carrier Runway**

This group proposes a two airport system that adds 2 air carrier runways to the system. Five alternatives comprise this group and annual delay costs range from $232-$241 million. The group of alternatives fully serves the year 2020 forecast passenger demand.

6. **Existing Sea-Tac Airfield and 1 Supplemental Airport With 2 Air Carrier Runways**

This group of alternatives proposes a two airport system that adds two new air carrier runways to the system. While additional capacity is provided the Sea-Tac is assumed to operate at capacity with resulting high average delays. Annual delays ranged from $233 to $237 million. (Of this Sea-Tac delays account for $232 million). Year 2020 demand is satisfied by this group.

FIGURE 2
COMPARISON OF ANNUAL DELAY COSTS - YEAR 2020



Thus for Arlington the annual capacity available for commercial use would be on the order of 62-112,000 operations. At commercial activity levels greater than these, it is expected that GA use would shift to other airports.

C. RESULTS

Annual delays, in hours, are determined by multiplying the average delay by the number of operations incurring the delay. By applying an aircraft operating cost, the annual delays can be translated into a monetary value. This was accomplished for all 33 alternatives and is contained in the appendix. This subsection summarizes the findings of the delay analysis by reporting results for the 8 major alternative groups previously described. It should be remembered that the delay costs represent an annual cost for the year 2020.

Figure 2 graphically summarizes the results and presents the annual delay costs (in most cases a range) for each major group, as well as a level of unsatisfied demand that is assumed to be associated with a group (also a range in some cases). The unsatisfied demand represents passenger demand in excess of the annual passenger levels described above for each airport. It should be noted that this demand can be met if additional delay costs are accepted. It should also be noted that the unsatisfied demand could vary due to the previously explained sensitivity to the mix of commercial aircraft. The following paragraphs explain the results shown in Figure 2 and are presented in ascending order with respect to delay costs.

1. Replacement Airport With 3 Independent Air Carrier Runways

This group produced annual delay costs significantly lower than all other alternative groups since the forecast demand is well below capacity and average delays are tolerable. Annual delay costs are estimated at $24 million. Since the airport operates below capacity, all demand is satisfied.

2. Sea-Tac With a New Air Carrier Runway and 2 Supplemental Airports Each With 1 Air Carrier Runway

This scenario adds 3 air carrier runways to the system, but at 3 locations. Annual delay costs range from $141-$229 million and all demand is satisfied. It is with this group of alternatives that the two supplemental airports start "bleeding" traffic from Sea-Tac such that significant drops in the average delays at Sea-Tac result. Thus differences in delay costs between this group and others are readily noticeable.

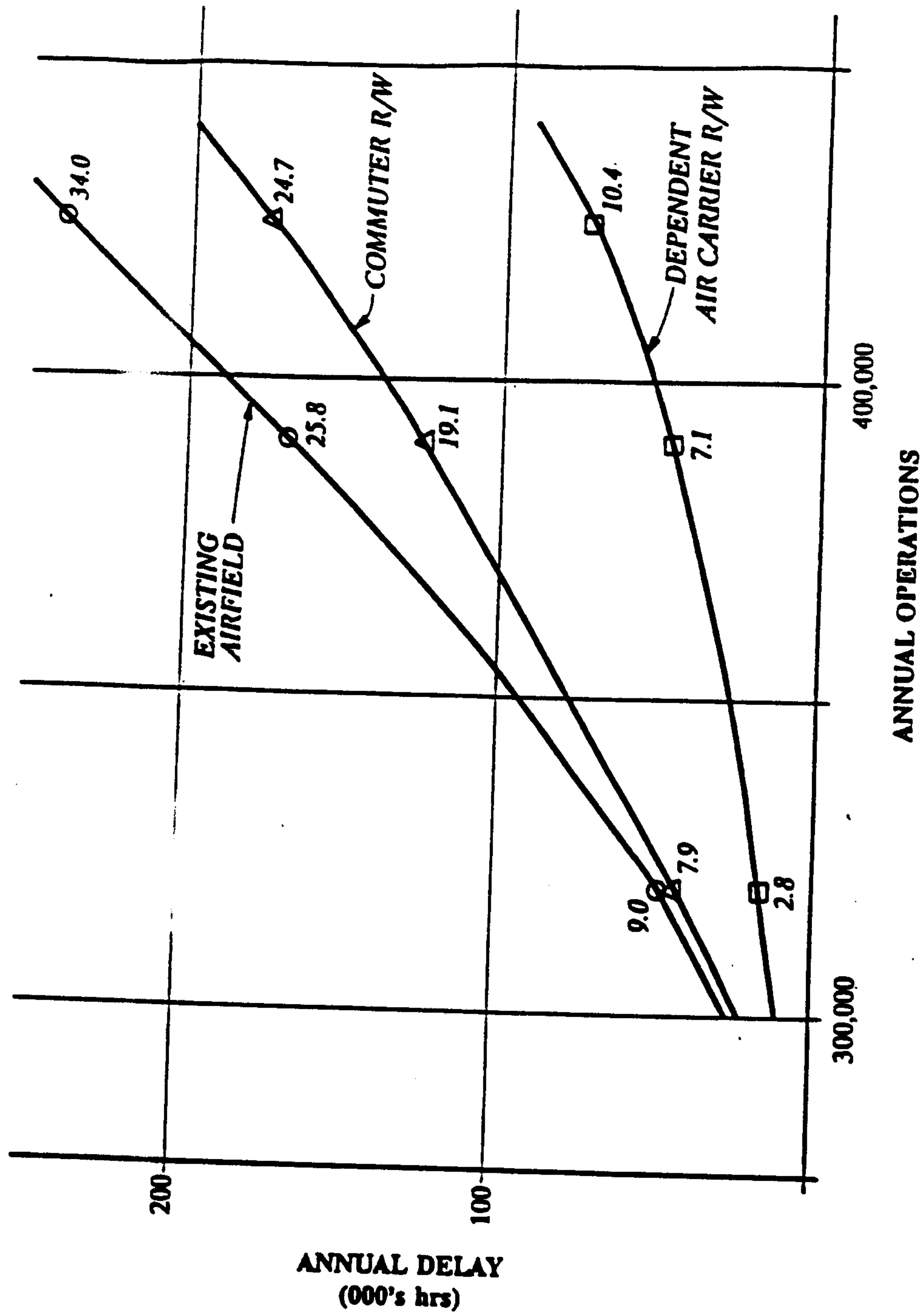
Scenario	Ann. Operations	Avg. Delay
Sea-Tac (existing runways)	380,000	22.9 min.
Sea-Tac with New Commuter R/W	410,000	22.0 min.
Sea-Tac with New Air Carrier R/W	480,000	18.8 min.

For the scenario at Sea-Tac with a new air carrier runway, the average delay shown above was extrapolated from the Task Force data presented in Figure 1. For supplemental airports, generic aircraft delay curves developed in Phase II were used to estimate average delay. This data suggested an average delay of approximately 12 minutes per operation for the supplemental airports when operating at capacity. The differences between Sea-Tac and supplemental airport average delays are explained by the following two reasons. First, at Sea-Tac the major difference between VFR and IFR capacity and relatively frequent periods of congestion during IFR is reflected in the average delay, whereas with the supplemental airports, in most cases, the difference between VFR and IFR capacities is not as great as Sea-Tac. Additionally, the Sea-Tac data is based on the detailed methodology using simulation, whereas the supplemental airport data in Phase II appears to have been developed using a generic, desk-top approach.

4. Impacts on General Aviation

The use of alternative sites considered in this analysis will impact general aviation activity differently. Some will tend to cause a displacement of GA activity from the airport while others (the new sites) will tend to attract general aviation activity. For existing airports, the assumed impacts vary due to existing airside facilities. The benefits of the existing short parallel runway at Paine Field will permit greater use of the primary runway by air carriers as the short runway will be usable only by small GA aircraft. The airport will be able to accommodate greater air carrier traffic volumes before capacity impacts GA users and causes them to relocate to other facilities. At Paine Field, the annual capacity suggests that 200-250,000 air carrier operations can be accommodated on the existing main runway (with an equivalent capacity for general aviation on the short parallel runway). Thus, it is expected that changes in the use of the airport for GA would not occur until these levels are reached and additional air carrier capacity is needed. However, at Arlington where it is assumed that both GA and commercial aircraft operate on the same runway, the capacity available for commercial use is the total runway capacity minus that portion used by general aviation (assumed in the analysis to be 138,000 annual operations).

FIGURE 1
SEA-TAC ANNUAL AIRCRAFT DELAY



Source: P&D analysis of data contained in Seattle-Tacoma International Airport Capacity Enhancement Plan.

The range for the existing Sea-Tac airfield represents the passenger levels with and without full demand management strategies. The ranges for the supplementals result from existing airfield facilities. The lower end of the range represents passenger traffic with one air carrier runway that accommodates a mix of commercial and general aviation traffic, while the upper end represents passengers accommodated by a runway used exclusively by air carriers. The latter applies to Paine Field where an existing short parallel runway is assumed to handle all GA activity at the airport and thus permit the main runway to serve primarily air carriers. The annual passengers for the supplemental regional airports are based on an assumed mix of commercial operations of 75 percent major carrier (jet) and 25 percent commuter (turboprop). Phase I assumptions for average aircraft size and enplanements per departure for the year 2020 were applied.

Regional passenger demand for the year 2020 was distributed to the various system alternatives by Flight Plan staff as described in Working Paper No. 5. Once passenger demand was assigned to each airport, the passenger demand was translated into aircraft operations for purposes of identifying average delays.

3. Average Aircraft Delay

The recently completed study performed by the Sea-Tac Airport Capacity Design Team provided an in-depth examination of delays at the airport. Through the application of the latest FAA computer technologies, the Design Team projected aircraft delays for existing facilities and an improved airfield operating at various traffic levels. Much of the data generated for Sea-Tac in this study is applicable and useful to this phase of the Flight Plan project and was used as input in this analysis.

Figure 1 highlights the study results that are most germane to this work task. The graphs shown in the figure reflect the relationship between annual aircraft delays at Sea-Tac and the number of aircraft operations for three airport scenarios - existing Sea-Tac, Sea-Tac with a new commuter runway and Sea-Tac with a new air carrier runway. As seen, annual delays increase as the number of operations increase. From these graphs it is possible to obtain an average delay for any demand level by dividing the annual delays by the demand level (annual operations) at which it is experienced. Using this approach the following average delays are obtained for the three scenarios (operating at capacity) at Sea-Tac:

The alternatives can be categorized into 8 basic groups of system concepts as follows:

- Sea-Tac as the only commercial airport serving the region. (Numbers 1, 2, 33)
- Sea-Tac without a new runway and a supplemental airport with one air carrier runway. (Numbers 3-7)
- Sea-Tac without a new runway and a supplemental airport with two air carrier runways. (Numbers 8-12)
- Sea-Tac with a new air carrier runway and a supplemental airport with one air carrier runway. (Numbers 13-17)
- Sea-Tac with a new air carrier runway and a supplemental airport with two air carrier runways. (Numbers 18-22)
- Sea-Tac without a new runway and two supplemental airports each with one air carrier runway. (Numbers 23-26)
- Sea-Tac with a new air carrier runway and two supplemental airports each with one air carrier runway. (Numbers 27-30)
- Replacement airport with three independent parallel air carrier runways. (Numbers 31, 32)

B. ANALYSIS

The purpose of this analysis was to determine delay consequences associated with each alternative plan thus providing a means of comparing how effectively they accommodate the regional demand for commercial air transportation. In order to develop these measures, certain ingredients are necessary - namely the airfield capacity of each alternative, a projection of air traffic activity (demand) for each option, and estimates of average aircraft delays that would be experienced by users at certain traffic levels.

The approach used in estimating annual delays followed these basic steps:

- Identify the annual capacity of the airfield facilities included in each alternative.
- Determine the number of annual passengers served by the respective capacities.
- Estimate air traffic activity (aircraft operations) at each airport based on the passenger volumes.
- Compare demand (annual operations) to capacity and identify average aircraft delay (in minutes) for these relationships.
- Project annual aircraft delays (in hours) by applying the average delay to annual aircraft operations.
- Translate the total annual delay into a monetary value by applying hourly direct operating costs.

15. Sea-Tac with a new dependent air carrier runway and McChord AFB with one air carrier runway. The existing runway at McChord serves as the air carrier runway.
16. Sea-Tac with a new dependent air carrier runway and the Central Pierce site with one air carrier runway.
17. Sea-Tac with a new dependent air carrier runway and the Olympia/Black Lake site with one air carrier runway.
18. Sea-Tac with a new dependent air carrier runway and Arlington Municipal Airport with two parallel air carrier runways.
19. Sea-Tac with a new dependent air carrier runway and Paine Field with two parallel air carrier runways.
20. Sea-Tac with a new dependent air carrier runway and McChord AFB with two parallel air carrier runways.
21. Sea-Tac with a new dependent air carrier runway and the Central Pierce site with two parallel air carrier runways.
22. Sea-Tac with a new dependent air carrier runway and the Olympia/Black Lake site with two parallel air carrier runways.
23. Sea-Tac without a new runway with Arlington Municipal and the Central Pierce site each with one air carrier runway.
24. Sea-Tac without a new runway with Paine Field and the Central Pierce site each with one air carrier runway.
25. Sea-Tac without a new runway with Arlington Municipal and the Olympia/Black Lake site each with one air carrier runway.
26. Sea-Tac without a new runway with Paine Field and the Olympia/Black Lake site each with one air carrier runway.
27. Sea-Tac with a new dependent air carrier runway with Arlington Municipal Airport and the Central Pierce site each with one air carrier runway.
28. Sea-Tac with a new dependent air carrier runway with Paine Field and the Central Pierce site each with one air carrier runway.
29. Sea-Tac with a new dependent air carrier runway with Arlington Municipal Airport and the Olympia/Black Lake site each with one air carrier runway.
30. Sea-Tac with a new dependent air carrier runway with Paine Field and the Olympia/Black Lake site each with one air carrier runway.
31. A replacement airport at the Central Pierce site with three parallel air carrier runways capable of supporting triple IFR approaches.
32. A replacement airport at the Olympia/Black Lake site with three parallel air carrier runways capable of supporting triple IFR approaches.
33. Sea-Tac without a new runway and full demand management.

to the existing Sea-Tac layout) are envisioned, and therefore the annual capacity would be equivalent to that indicated above for the existing Sea-Tac runways. As previously stated, the capacity of an airport may be exceeded but at the expense of increased delays.

It should be noted that the annual capacity represents an average for the airport that accounts for all operating configurations and weather occurrences. It therefore reflects periods of constrained operations during poor weather conditions.

2. **Annual Passenger Capability**

Annual passenger volumes were developed from the annual capacities through interpretation of forecast data from Phases I and II. This was undertaken to determine if regional demand is satisfied and also to determine the amount of system capacity that is utilized. The passenger levels used for projecting aircraft activity are shown below.

Airport Layout	Annual Passenger Capability
Sea-Tac (existing runways)	32-38 MAP
Sea-Tac with New Commuter R/W	34.9 MAP
Sea-Tac with New Air Carrier R/W	41.8 MAP
Supplemental Airport - One R/W	10.9-24.4 MAP
Supplemental Airport - Two R/W	31.1-37.1 MAP
Replacement Airport	64.4 MAP

It should be noted that the passenger traffic reflects levels based upon assumptions and analysis from previous phases and should not be construed as a capacity, or limit, for an airport. The above passenger capabilities are largely influenced by the number of enplanements per departure. The passenger levels would increase if the average number of enplanements per departure increases. An increase in aircraft size greater than was assumed in Phase I would promote an increase in enplanements per departure, and increase the passenger capabilities shown above. Also, as with airfield capacity, additional passengers could be accommodated but with increased delay costs.

This process produced an annual cost of aircraft delay for each alternative. It should be noted that the costs identified represent a "snapshot" at a point in time, in this case the year 2020, of the annual delay conditions. Aircraft delays would be experienced prior to 2020 but at lower levels since demand would be less. Likewise, delays after 2020 would be greater due to greater traffic volumes. It is thus important to note that it is an annual delay cost that is presented herein for the initial comparison of alternatives. The cumulative costs over the 30 year planning period would be significantly greater.

The remainder of this subsection highlights the development of the above input to the analysis. For more detail see the appendix.

1. **Annual Capacity**

Annual capacities were developed in Phase II for different Sea-Tac scenarios and for generic supplemental airfield concepts. The annual capacities used in this analysis are presented in the tabulation below.

Airport Layout	Annual Capacity
Sea-Tac (existing runways)	380,000 operations
Sea-Tac with New Commuter R/W	410,000 operations
Sea-Tac with New Air Carrier R/W	480,000 operations
Supplemental Airport - One R/W	250,000 operations
Supplemental Airport - Two R/W	500,000 operations
Replacement Airport	750,000 operations

Annual capacities for Sea-Tac are those contained in the Phase II report. The annual capacity estimates for the supplemental airports were developed by P&D based upon Phase II data, FAA guidelines, and recent capacity analyses. For the supplemental airport concepts with two air carrier runways, the runways are parallel and separated sufficiently to permit simultaneous instrument approaches and thus are capable of operating independently of one another. Thus the annual capacity of a two runway airport is twice that of a single runway airport, and the annual capacity of the replacement airport (with three independent runways) is three times that of a single runway. It should be noted that in some cases in the site analysis (Paine Field and McChord AFB), it was judged that the runway separations required for independent operations were not feasible for parallel runways. In these cases, closely spaced parallel runways (similar carriers over a period of time is considered a moderate level of delay, and average delays of 7 minutes and above are considered severe. While this analysis utilizes average delay to generate annual aircraft delay and associated costs, it can also be useful, as will be seen later, in quickly assessing the performance of an airport.

As stated previously, the focus of this working paper is on the delay consequences associated with the different alternative plans. Presented herein is a brief description of the analysis, and findings. For a more detailed treatment of the technical analysis the reader is directed to the appendix of this working paper.

A. ALTERNATIVE PLANS

A total of 33 alternatives were examined with respect to aircraft delay and are briefly described below:

1. Sea-Tac without a new runway.
2. Sea-Tac with a new commuter runway.
3. Sea-Tac without a new runway and Arlington Municipal Airport with one air carrier (7,000') runway.
4. Sea-Tac without a new runway and Paine Field with one air carrier (7,000') runway.
5. Sea-Tac without a new runway and McChord AFB with one air carrier (7,000') runway.
6. Sea-Tac without a new runway and a new airport at the Central Pierce site with one air carrier (7,000') runway.
7. Sea-Tac without a new runway and a new airport at the Olympia/Black Lake site with one air carrier (7,000') runway.
8. Sea-Tac without a new runway and Arlington Municipal Airport with two parallel air carrier (7,000') runways.
9. Sea-Tac without a new runway and Paine Field with two parallel air carrier (7,000') runways.
10. Sea-Tac without a new runway and McChord AFB with two parallel air carrier (7,000') runways.
11. Sea-Tac without a new runway and a new airport at the Central Pierce site with two parallel air carrier (7,000') runways.
12. Sea-Tac without a new runway and a new airport at the Olympia/Black Lake site with two parallel air carrier (7,000') runways.
13. Sea-Tac with a new dependent air carrier runway and Arlington Municipal Airport with one air carrier runway.
14. Sea-Tac with a new dependent air carrier runway and Paine Field with one air carrier runway. The existing primary runway at Paine serves as the air carrier runway.

CAPACITY AND DELAY ANALYSIS

In airport planning the term capacity refers to the capability of an airport, or its components, to process traffic over a period of time. In this analysis, the focus is airfield capacity which is measured by the number of aircraft operations (i.e., either a takeoff or landing) that can be accommodated within a specified period. Airfield capacity is typically estimated on an hourly or annual basis, with the hourly data most applicable for detailed analysis of a particular site, and the annual capacities being better suited for long range planning and systemwide analysis such as the Flight Plan Project. Thus the capacity measures used herein are the annual number of aircraft takeoffs and landings that can be accommodated by the airfield.

Aircraft delay is the time over and above unimpeded travel time that an aircraft must take to move from its origin to destination as a result of interference from other aircraft in the system that are competing for the use of the same facilities. Weather, airfield facilities, air traffic control procedures, and other aircraft competing for use of the same facilities (demand) all contribute to aircraft delay. In reading this working paper it is important to understand the relationship between demand, capacity and delay. As demand approaches capacity, delays will increase drastically. At low levels of demand, delays will increase in a linear fashion as demand increases. However, as demand approaches and even exceeds capacity, delays will increase exponentially. It is sometimes a difficult concept to grasp, but it is also important to note that capacity can be exceeded, but at the cost of excessive delays.

In this analysis delay is first determined on an average basis per aircraft operation and then annualized based on projected traffic. Once annual delays are determined they can be translated into a monetary value to reflect the costs to the users. Average aircraft delay can be estimated via a "desk-top approach" by comparing demand to capacity or by sophisticated computer modelling techniques. The data in this analysis was based on both approaches. The desk-top approach followed a common FAA methodology and the data generated by computer modelling was extracted from the recently completed Airport Capacity Enhancement Plan for Sea-Tac.

A few comments on average delay at this juncture are appropriate. The term average delay denotes a value for a number of aircraft within a period of time whereby one aircraft might experience only a few seconds delay and another perhaps several minutes. Years ago, an average delay of 4 minutes was determined to be an acceptable level for airport planning. At this average, the distribution of delays during an hour are such that they range from a few seconds up to but never exceeding 20 minutes. Today, the 4 minute average is still recognized in the industry as a valid measure of tolerable delay. Numerous studies of airfield capacity and delay indicate that delays will start escalating quickly at the 4 minute average. Comparing the acceptable 4 minute average to other thresholds, average delays of from 5 to 7 minutes for air

Additionally, this site is the closest to Mt. Rainier which creates operational impacts and as such aircraft would have to be routed to avoid it. In the replacement airport scenario for the site, it appears that the terminal airspace could be structured to accommodate the "cornerpost" configuration for arrivals. However, mountains could impact departures through the east airspace "gate". It is noted that Phase II analysis for the neighboring Ft. Lewis site, approximately 7 miles to the west, concluded that the site was very feasible for a replacement airport from an airspace standpoint.

The Phase II analysis also included an assessment of an airport at an Enumclaw/Buckley site. It is noted that for this site there were serious airspace concerns that resulted in elimination of the site from further consideration. These were proximity to the Cascade Mountains, the preponderance of very strong easterly winds in the area, the limited low altitude airspace available due to terrain, and obstructions to the south. At this time it appears that the concerns for the Enumclaw site do not impact the Central Pierce site to the degree such that the site would not be feasible. However, as previously mentioned, a detailed airspace study by FAA would confirm the suitability of the site for commercial operations.

E. OLYMPIA/BLACK LAKE SITE

Phase II analysis determined that the site is adequately separated from Mt. Rainier and other airports to accommodate a supplemental regional airport. However, under the replacement airport scenario for the site, it is assumed that the existing Olympia Airport would be closed.

<u>OBSTRUCTIONS</u>

Federal Aviation Regulations (FAR) Part 77, Objects Affecting Navigable Airspace, specifies a set of imaginary surfaces surrounding an airport for the purposes of protecting the airspace. If an object, natural or manmade, penetrates one of the surfaces it is an obstruction and the FAA must study and determine the impacts on air traffic. The most critical areas are the approaches to the runways, particularly in close proximity to the airport. As part of the siting analysis conducted in the development of alternative concept layouts (Working Paper No. 6), Part 77 approach surfaces prescribed for precision instrument runways were applied to all runway ends. It was found in all but one case that objects did not penetrate the approach surface within approximately 50,000 feet from a runway end. The exception to this is the Central Pierce site where it was found that about 3 acres of terrain would penetrate the approach surface from one to ten feet approximately 14,000 feet from the runway. This is not a significant violation of the obstruction standard and is not considered a fatal flaw.

- The above described vectoring impacts would not be as severe for other sites in the Arlington search area and thus an airport in the area is viable. Therefore, to measure the system-wide impacts of a north remote site, the existing airport is judged to be suitable for testing purposes.

B. PAINE FIELD

The Phase II analysis determined that use of the airport as a supplemental regional airport was feasible but would require restructuring of the TRACON airspace. It was also concluded that the airport could function well at activity levels less than 200,000 (presumably commercial aircraft) operations per year. Considering that the airport has recently served 166,000 general aviation operations but has a short parallel runway suggests that the main runway would be capable of supporting commercial aircraft activity. Therefore, airspace issues do not appear to present insurmountable roadblocks which would preclude the use of the airport in a supplemental regional role.

C. McCHORD AFB

In Phase II, McChord AFB was judged to be a very feasible site for a supplemental regional airport from an airspace perspective. The base is far enough from Sea-Tac so that compatible traffic flows could be developed to both locations. There are other, non-airspace, issues connected with the concept of joint-use of the facility that could reduce the attractiveness of this option. Issues which could potentially have negative impacts would be stipulated by the military in the formulation of the joint-use operating agreement.

D. CENTRAL PIERCE SITE

This site does not involve the use of existing airfield facilities but proposes the development of new airport facilities. As such, it is one of two locations to be tested as a replacement airport. The proposed airfield facilities would encompass the existing Pierce County - Thun Field and are approximately 8 miles east of McChord AFB. The airspace aspects of this particular site were not assessed in Phase II, however, it is immediately east of the Ft. Lewis site which was evaluated in Phase II.

Terrain to the east and west of the Puget Sound region forces air traffic in the region into a north-south corridor. Phase II analysis for the Ft. Lewis site indicated that jet traffic to and from two commercial airports in this corridor would pose problems to TRACON controllers. These same problems are applicable to the Central Pierce site, but are not considered to be insurmountable.

A. ARLINGTON MUNICIPAL AIRPORT

Phase II concluded that scheduled regional air service at the airport would not create significant airspace impacts and would be able to function within the existing airspace structure. The airport is a sufficient distance from Sea-Tac so that air traffic could be accommodated independently. It was pointed out in Phase II however that a busy regional service facility at Arlington might create potential conflicts with traffic at Paine Field and NAS Whidbey Island.

It was further pointed out that a significant level of commercial jet traffic at the airport could possibly impact operations at Sea-Tac and thus the location was not recommended as a supplemental domestic/international airport. The level of traffic implied by the domestic/international role is much greater than that for the regional role that has been designated in Phase III. Thus, it is expected that the level and nature of traffic anticipated at the airport in this analysis would not create significant airspace impacts.

In terms of longer range expansion potential, the airport would not be a suitable location for a replacement airport due to conflicts with Canadian airspace and terrain to the east (Cascade Mountains).

With respect to terrain east and north of the airport it has been noted that this would complicate the installation of a precision approach procedure from the north. The present instrument approaches for the airport consist of a localizer approach to Runway 34, and an NDB approach. Both are considered as "non-precision", since neither includes an electronic glide slope which provides the pilot with altitude guidance on descent. While obstruction protection criteria specified in FAR Part 77 for a precision instrument runway is met, it appears that the terrain east and north will impact vectoring aircraft to a final approach fix for a precision approach from the north. Stated simply, aircraft would have to descend too rapidly to be in appropriate position (at the final approach fix) to continue the approach. The descent would be too steep and is not feasible for conventional commercial aircraft. The terrain impacts a precision approach from the north (i.e., south traffic flows, which prevail approximately 70 percent of the time). A precision approach from the south can be accommodated without difficulty as the terrain is favorable in terms of obstruction standards and vectoring.

While a serious concern, this is not considered a fatal flaw for the following reasons:

- Circuitous vectoring (although undesirable) might be used as a means for implementing an approach from the north.

that the process of evaluating options could be simplified by considering a smaller number of alternatives. The final field of alternatives to be tested in this working paper totals 33 and involve airport locations at 6 sites. The objectives of analysis in this task are to:

- Review airspace circumstances with the intent of identifying potential fatal flaws that would preclude a plan from being implemented.
- Determine the airfield capacity provided by the various alternatives and estimate the delay consequences associated with the options. A ranking of alternatives can then be developed based on delay.

AIRPORT LOCATIONS

The 6 airport locations considered in this evaluation of alternatives include 4 existing airports - Sea-Tac International Airport, Arlington Municipal Airport, Paine Field, and McChord AFB. In the case of McChord AFB, it is assumed that the base would operate as a joint use facility. Two other locations, Olympia/Black Lake and Central Pierce County have been identified as potential sites for new commercial airports. In the various alternatives, Sea-Tac functions as the primary airport for the region with the other locations filling supplemental regional airport roles. This type airport would support scheduled air service to Pacific Northwest, California, and some national hub airport (i.e., Salt Lake City, Denver) destinations with a mix of turboprop and jet (B737/MD-80 class) aircraft. The only exception to these airport roles would be at the two sites for a new commercial airport. At these locations the airports could function as supplemental regional airports or the primary airport for the region. The latter would assume that a replacement airport is developed.

AIRSPACE CONSIDERATIONS

An airspace assessment of the locations involved in this analysis was conducted in Phase II of the Flight Plan Project. The purpose of the airspace review in the current task is to validate the previous conclusions with respect to specific sites in Phase III and identify conflicts that will preclude implementation of a plan. For the purposes of this working paper and the delay analysis, which is the prime focus of this paper, it was assumed that unless a fatal flaw was identified for a site, further airspace analysis would not be required. It should be noted that detailed airspace studies of recommendations that ultimately evolve from the Flight Plan Project will be conducted by FAA in the future. It should also be noted that as part of the noise analysis in later phases of this study, actual arrival and departure procedures will be developed in order to delineate flight paths. A summary of airspace findings as they relate to the Phase III analysis is presented.

TABLE 1
FLIGHT PLAN PHASE III
EVALUATION OF OPTIONS
AIRSPACE /CAPACITY OPERATIONAL CONSIDERATIONS

OPTIONS	SYSTEM CAPABILITY		DEMAND SATISFACTION		2020 AIRCRAFT DELAY COSTS ($ millions)	RANK*
	OPERATIONS (THOUSANDS)	PASSENGERS (MAP)	2020	VISION (2050)		
1 AIRPORT SYSTEM						
EXISTING SEA-TAC	380	32	71%	33%	232	11
SEA-TAC WITH NEW AC RWY	480	42	93%	43%	240	9
REPLACEMENT	750	64	143%	66%	24	4
MAXIMUM DEMAND MANAGEMENT	380	38	81%	39%	232	10
2 AIRPORT SYSTEMS						
EXISTING SEA-TAC PLUS SUPPLEMENTAL (1 RWY)	630	43-56	96%-124%	43%-57%	234-271	8
EXISTING SEA-TAC PLUS SUPPLEMENTAL (2 RWYS)	760-880	63-69	140%-153%	64%-70%	233-237	7
SEA-TAC WITH NEW AC RWY PLUS SUPPLEMENTAL (1 RWY)	730	53-66	118%-147%	54%-67%	232-241	5
SEA-TAC WITH NEW AC RWY PLUS SUPPLEMENTAL (2 RWYS)	860-900	73-79	162%-176%	74%-81%	232-241	3
3 AIRPORT SYSTEMS						
EXISTING SEA-TAC PLUS 2 SUPPLEMENTALS (1 RWY)	880	54-67	120%-149%	55%-68%	235-241	6
SEA-TAC WITH NEW AC RWY PLUS 2 SUPPLEMENTALS (1 RWY)	980	64-77	142%-171%	65%-79%	141-229	2
SEA-TAC WITH NEW AC RWY PLUS 2 SUPPLEMENTALS (2 RWYS)	1060-1480	112-114	249%-253%	114%-116%	140-165	1

* A "best to worst" subjective ranking of options based solely on airspace/capacity operational considerations.

THE FLIGHT PLAN PROJECT PHASE III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

DATE: September 3, 1991

TO: Puget Sound Air Transportation Committee

FROM: P&D Aviation

SUBJECT: WORKING PAPER NO. 7 - AIRSPACE, CAPACITY AND DELAY

EXECUTIVE SUMMARY

Table 1 on the following page summarizes the major conclusions of the airspace and capacity analysis of the Flight Plan options. For each option information is presented to summarize 1) the system capability in terms of aircraft operations and passengers, 2) the capability of the option to satisfy the projected demands, and 3) the estimated year 2020 aircraft delays which would occur. Lastly, Table 1 shows the consultant's suggested composite ranking of the options based on these considerations.

The option which receives the highest ranking (Rank 1) is the 3 airport system which includes a new air carrier runway at Sea-Tac and two air carrier runways at two supplemental airports. This option provides the greatest system capacity and is the only option which fully meets the vision demand (year 2050) requirements. It also is the most effective option in terms or relieving traffic from Sea-Tac. The second and third ranked options are the 3 and 2 airport systems with 1 and 2 runway supplementals respectively. Again, these offer greater airport system capacity and fewer aircraft delays than the other options with the exception of the replacement airport option. The replacement airport option is shown to create the least amount of aircraft delays due to the total elimination of Sea-Tac. The replacement option is not ranked first however, since it does not provide as much overall system capacity as some of the two and three airport options.

With few exceptions, the annual delay costs are within a fairly narrow and consistent range. This is largely due to the fact that Sea-Tac is assumed to operate almost always at or near capacity. Thus, the delay costs for Sea-Tac tend to mask the differences between alternatives. These differences however can become more significant when examining the cumulative effect of the airport system operations over a period of several years. The total computed aircraft annual delay costs for the year 2020 range from $24 million for the replacement airport concept to $271 million for the existing Sea-Tac option and one supplemental airport with one air carrier runway.

INTRODUCTION

The previous Working Paper No. 6 presented a total of 15 airport layout concepts for the different sites in the Puget Sound region. Various combinations of layout concepts can be formed to develop numerous alternative commercial airport systems. However, it was agreed

TABLE V-10
OFFICE AND HOTEL IMPACTS
IN THE AIRPORT INFLUENCE AREA: 2020 [1]

Alternative	Office Square Feet (000's) Sea-Tac	North [2]	South [3]	Total	Hotel Rooms Sea-Tac	North	South	Total	Hotel Room & Sales Tax Revenue Sea-Tac	North	South	Total
1 Airport System												
1	1,460			1,460	7,350			7,350	$5,841,302			$5,841,302
2	1,396			1,396	7,117			7,117	$5,656,314			$5,656,314
31			1,800	1,800			8,542	8,542			$5,393,165	$5,393,165
32			1,800	1,800			8,542	8,542			$2,359,510	$2,359,510
2 Airport System												
3	1,280	763		2,043	6,688	3,087		9,774	$5,314,781	$1,035,271		$6,350,052
4	1,280	910		2,190	6,688	3,503		10,190	$5,314,781	$1,174,864		$6,489,645
5	1,280		910	2,190	6,688		3,503	10,190	$5,314,781		$2,211,509	$7,526,289
6	1,280		763	2,043	6,688		3,087	9,774	$5,314,781		$1,948,746	$7,263,527
7	1,280		763	2,043	6,688		3,087	9,774	$5,314,781		$852,576	$6,167,357
8	1,280	910		2,190	6,688	3,503		10,190	$5,314,781	$1,174,864		$6,489,645
9	1,280	910		2,190	6,688	3,503		10,190	$5,314,781	$1,174,864		$6,489,645
10	1,280		910	2,190	6,688		3,503	10,190	$5,314,781		$2,211,509	$7,526,289
11	1,280		910	2,190	6,688		3,503	10,190	$5,314,781		$2,211,509	$7,526,289
12	1,280		910	2,190	6,688		3,503	10,190	$5,314,781		$967,535	$6,282,316
13	1,672	256		1,928	8,102	1,280		9,382	$6,438,484	$429,457		$6,867,940
14	1,664	272		1,936	8,074	1,337		9,411	$6,416,352	$448,561		$6,864,913
15	1,672		256	1,928	8,102		1,280	9,382	$6,438,484		$808,389	$7,246,872
16	1,668		264	1,932	8,088		1,309	9,397	$6,427,422		$826,446	$7,253,868
17	1,672		256	1,928	8,102		1,280	9,382	$6,438,484		$353,670	$6,792,154
18	1,672	256		1,928	8,102	1,280		9,382	$6,438,484	$429,457		$6,867,940
19	1,664	272		1,936	8,074	1,337		9,411	$6,416,352	$448,561		$6,864,913
20	1,672		256	1,928	8,102		1,280	9,382	$6,438,484		$808,389	$7,246,872
21	1,668		264	1,932	8,088		1,309	9,397	$6,427,422		$826,446	$7,253,868

TABLE V-10
OFFICE AND HOTEL IMPACTS
IN THE AIRPORT INFLUENCE AREA: 2020 [1]
(Continued)

Alternative	Office Square Feet (000's) Sea-Tac	North [2]	South [3]	Total	Hotel Rooms Sea-Tac	North	South	Total	Hotel Room & Sales Tax Revenue Sea-Tac	North	South	Total
22	1,672		256	1,928	8,102		1,280	9,382	$6,438,484		$353,670	$6,792,154
[illegible]												
23	1,280	472	568	2,320	6,688	1,987	2,269	10,943	$5,314,781	$666,306	$1,432,519	$7,413,605
24	1,280	520	520	2,320	6,688	2,130	2,130	10,947	$5,314,781	$714,283	$1,344,533	$7,373,597
25	1,280	560	480	2,320	6,688	2,246	2,011	10,944	$5,314,781	$753,315	$555,383	$6,623,479
26	1,280	608	432	2,320	6,688	2,383	1,864	10,934	$5,314,781	$799,131	$514,923	$6,628,834
27	1,580	176	264	2,020	7,779	978	1,309	10,066	$6,182,122	$328,166	$826,446	$7,336,734
28	1,532	272	264	2,068	7,609	1,337	1,309	10,255	$6,046,702	$448,561	$826,446	$7,321,709
29	1,660	176	104	1,940	8,060	978	671	9,709	$6,405,275	$328,166	$185,243	$6,918,684
30	1,612	272	104	1,988	7,892	1,337	671	9,900	$6,271,757	$448,561	$185,243	$6,905,561

[1] The influence area extends approximately 1.5 to 3.0 miles around the airport.
[2] All airport sites north of Sea-Tac: Arlington and Paine.
[3] All airport sites south of Sea-Tac: Central Pierce, McChord and Olympia/Black Lake.

SOURCE: P&D Technologies.

TABLE V-11

NUMBER OF HOTEL ROOMS AND TAX REVENUE GENERATED IN THE AIRPORT INFLUENCE AREA: 2020 [1]

AIRPORT	AREA ROOM TAX RATE	AREA SALES TAX RATE	TOTAL HOTEL TAX
ARLINGTON	0.0%	1.7%	1.7%
PAINE	0.0%	1.7%	1.7%
SEA-TAC	2.3%	1.7%	4.0%
CENTRAL PIERCE	2.0%	1.2%	3.2%
MC CHORD	2.0%	1.2%	3.2%
OLYMPIA/BLACK LAKE	0.0%	1.4%	1.4%
AVERAGE OCCUPANCY RATE (1990)		70%	
AVERAGE ROOM RATE (1990)		$77	

Airport	Projected Total Passengers		Number of Hotel Rooms		Total Hotel Tax Revenue	
	Low	High	Low	High	Low	High
Arlington	2,200,000	13,000,000	978	3,503	$328,166	$1,174,864
Paine	3,400,000	13,000,000	1,337	3,503	$448,561	$1,174,864
Sea-Tac	34,900,000	41,800,000	7,117	8,102	$5,656,314	$6,438,484
Central Pierce	3,300,000	45,000,000	1,309	8,542	$826,446	$5,393,165
McChord	3,200,000	13,000,000	1,280	3,503	$808,389	$2,211,509
Olympia/Black Lake	1,300,000	45,000,000	671	8,542	$185,243	$2,359,510

[1] The influence area extends approximately 1.5 to 3.0 miles around the airport.

SOURCE: "1990 Market Profile Report", CIC Research; Seattle-King County Convention and Visitors Bureau; Washington Department of Revenue; P&D Technologies.

sufficient demand by the year 2020 to support from 671 to 8,542 additional hotel rooms in the airport influence area.

Using a regional occupancy factor of 70 percent, an average length of stay of 4.4 days and an average nightly room rate of $77 in the year 1990 [1], P&D estimated the average annual room nights, and hotel tax revenues [2] generated each year by the projected hotel development in the airport influence areas. Potential hotel room tax revenues range from $185,000 annually at the Olympia/Black Lake airport, to $6.4 million at Sea-Tac.

As shown in Table V-10, Alternative 24 (Sea-Tac, Paine and Central Pierce airports) provides the highest level of hotel rooms and room tax revenues to the region, and Alternative 32 (Olympia/Black Lake only) provides the lowest levels.

B. SIGNIFICANCE OF IMPACTS ON REGIONAL ECONOMIC ISSUES

As noted above, the economic impacts resulting from the airport system alternatives are substantial. The degree to which they address strategic economic issues facing the region are discussed below.

Issue: Expansion of the economic base (i.e., attracting new firms, assisting existing firms to expand, identifying new outlets for exports, etc.)

- All of the alternatives will generate additional employment and expand the economic base of the region. As may be noted in Table V-12, the total number of jobs ranges from 235,100 (Alternative 2 - Sea-Tac with a new runway) to 311,100 (Alternative 31 - replacement airport at Central Pierce), an increase of between 118,500 and 194,500 jobs over existing airport-related and air passenger visitor-related jobs in 1990.

Issue: Creating more jobs with at least living-wage salaries.

- All of the alternatives will generate substantial wage earnings. As may be noted in Table V-13, these earnings range from $4.2 billion (Alternative 1) to $5.6 billion (Alternative 31), or $2.1 billion to $3.5 billion over existing airport-related and air passenger visitor-related earnings in 1990.

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[1] Average occupancy and room rate estimates are based on regional data received from the Seattle-King County Convention and Visitors Bureau.

[2] Includes hotel room tax and sales tax.

TABLE V-12
SUMMARY OF DIRECT, INDIRECT AND INDUCED JOBS
GENERATED BY AIRPORT ACTIVITY AND VISITOR EXPENDITURES: 2020

Alternative	Airport Related Direct/ Indirect	Airport Related Induced	Airport Related Total	Visitor Related Direct/ Indirect	Visitor Related Induced	Visitor Related Total	Total Direct/ Indirect	Total Induced	Total Total
Airport System [illegible]									
1	29,856	28,961	58,817	108,969	77,945	186,914	138,825	106,906	245,731
2	28,622	27,762	56,384	104,192	74,528	178,720	132,814	102,290	235,104
31	36,363	44,255	80,618	134,345	96,096	230,441	170,708	140,351	311,059
32	36,363	43,017	79,380	134,345	96,096	230,441	170,708	139,113	309,821
Airport System [illegible]									
3	35,948	35,250	71,198	128,076	91,612	219,688	164,024	126,862	290,886
4	37,674	36,996	74,670	134,345	96,096	230,441	172,019	133,092	305,111
5	37,674	38,954	76,628	134,345	96,096	230,441	172,019	135,050	307,069
6	35,948	36,912	72,860	128,076	91,612	219,688	164,024	128,524	292,548
7	35,948	33,052	69,000	128,076	91,612	219,688	164,024	124,664	288,688
8	37,674	36,996	74,670	134,345	96,096	230,441	172,019	133,092	305,111
9	37,674	36,996	74,670	134,345	96,096	230,441	172,019	133,092	305,111
10	37,674	38,954	76,628	134,345	96,096	230,441	172,019	135,050	307,069
11	37,674	38,954	76,628	134,345	96,096	230,441	172,019	135,050	307,069
12	37,674	34,407	72,081	134,345	96,096	230,441	172,019	130,503	302,522
13	36,945	35,964	72,909	134,345	96,096	230,441	171,290	132,060	303,350
14	36,970	35,994	72,964	134,345	96,096	230,441	171,315	132,090	303,405
15	36,945	36,497	73,442	134,345	96,096	230,441	171,290	132,593	303,883
16	36,957	36,528	73,485	134,345	96,096	230,441	171,302	132,624	303,926
17	36,945	35,257	72,202	134,345	96,096	230,441	171,290	131,353	302,643
18	36,945	35,964	72,909	134,345	96,096	230,441	171,290	132,060	303,350
19	36,970	35,994	72,964	134,345	96,096	230,441	171,315	132,090	303,405
20	36,945	36,497	73,442	134,345	96,096	230,441	171,290	132,593	303,883
21	36,957	36,528	73,485	134,345	96,096	230,441	171,302	132,624	303,926
22	36,945	35,257	72,202	134,345	96,096	230,441	171,290	131,353	302,643

TABLE V-12
SUMMARY OF DIRECT, INDIRECT AND INDUCED JOBS
GENERATED BY AIRPORT ACTIVITY AND VISITOR EXPENDITURES: 2020
(continued)

	Airport Related			Visitor Related			Total		
Alternative	Direct/ Indirect	Induced	Total	Direct/ Indirect	Induced	Total	Direct/ Indirect	Induced	Total
3 Airport System									
23	38,145	38,578	76,723	134,345	96,096	230,441	172,490	134,674	307,164
24	38,148	38,492	76,640	134,345	96,096	230,441	172,493	134,588	307,081
25	38,146	36,203	74,349	134,345	96,096	230,441	172,491	132,299	304,790
26	38,139	36,313	74,452	134,345	96,096	230,441	172,484	132,409	304,893
27	37,399	37,033	74,432	134,345	96,096	230,441	171,744	133,129	304,873
28	37,552	37,223	74,775	134,345	96,096	230,441	171,897	133,319	305,216
29	37,115	35,836	72,951	134,345	96,096	230,441	171,460	131,932	303,392
30	37,271	36,029	73,300	134,345	96,096	230,441	171,616	132,125	303,741

SOURCE: P&D Technologies.

TABLE V-13
SUMMARY OF REGIONAL ECONOMIC IMPACTS
GENERATED BY AIRPORT ACTIVITY AND VISITOR EXPENDITURES: 2020

Alternative	Airport Related			Visitor Related			Total		
	Jobs	Earnings (millions)	Revenue (millions)	Jobs	Earnings (millions)	Revenue (millions)	Jobs	Earnings (millions)	Revenue (millions)
1 Airport System									
1	58,818	$1,717.6	$4,261.7	186,913	$2,644.4	$7,068.0	245,731	$4,362.0	$11,329.7
2	56,385	$1,647.1	$4,086.2	178,720	$2,528.5	$6,758.2	235,105	$4,175.6	$10,844.4
31	80,618	$2,302.3	$5,503.7	230,441	$3,260.2	$8,714.0	311,059	$5,562.5	$14,217.7
32	79,376	$2,273.6	$5,432.4	230,441	$3,260.2	$8,714.0	309,817	$5,533.8	$14,146.4
2 Airport System [illegible]									
3	71,199	$2,082.0	$4,987.3	219,687	$3,108.1	$8,307.4	290,886	$5,190.1	$13,294.7
4	74,668	$2,182.9	$5,206.4	230,441	$3,260.2	$8,714.0	305,109	$5,443.1	$13,920.4
5	76,627	$2,230.5	$5,463.6	230,441	$3,260.2	$8,714.0	307,068	$5,490.7	$14,177.6
6	72,861	$2,122.5	$5,205.7	219,687	$3,108.1	$8,307.4	292,548	$5,230.6	$13,513.1
7	69,001	$2,033.4	$4,984.5	219,687	$3,108.1	$8,307.4	288,688	$5,141.5	$13,291.9
8	74,668	$2,182.9	$5,206.4	230,441	$3,260.2	$8,714.0	305,109	$5,443.1	$13,920.4
9	74,668	$2,182.9	$5,206.4	230,441	$3,260.2	$8,714.0	305,109	$5,443.1	$13,920.4
10	76,627	$2,230.5	$5,463.6	230,441	$3,260.2	$8,714.0	307,068	$5,490.7	$14,177.6
11	76,627	$2,230.5	$5,463.6	230,441	$3,260.2	$8,714.0	307,068	$5,490.7	$14,177.6
12	72,080	$2,125.7	$5,203.1	230,441	$3,260.2	$8,714.0	302,521	$5,385.9	$13,917.1
13	72,906	$2,128.9	$5,226.0	230,441	$3,260.2	$8,714.0	303,347	$5,389.1	$13,940.0
14	72,963	$2,130.7	$5,226.9	230,441	$3,260.2	$8,714.0	303,404	$5,390.9	$13,940.9
15	73,439	$2,141.9	$5,296.1	230,441	$3,260.2	$8,714.0	303,880	$5,402.1	$14,010.1
16	73,485	$2,143.3	$5,297.9	230,441	$3,260.2	$8,714.0	303,926	$5,403.5	$14,011.9
17	72,200	$2,113.3	$5,225.0	230,441	$3,260.2	$8,714.0	302,641	$5,373.5	$13,939.0
18	72,906	$2,128.9	$5,226.0	230,441	$3,260.2	$8,714.0	303,347	$5,389.1	$13,940.0
19	72,963	$2,130.7	$5,226.9	230,441	$3,260.2	$8,714.0	303,404	$5,390.9	$13,940.9
20	73,439	$2,141.9	$5,296.1	230,441	$3,260.2	$8,714.0	303,880	$5,402.1	$14,010.1
21	73,485	$2,143.3	$5,298.5	230,441	$3,260.2	$8,714.0	303,926	$5,403.5	$14,012.5
22	72,200	$2,113.3	$5,225.0	230,441	$3,260.2	$8,714.0	302,641	$5,373.5	$13,939.0

TABLE V-13
SUMMARY OF REGIONAL ECONOMIC IMPACTS
GENERATED BY AIRPORT ACTIVITY AND VISITOR EXPENDITURES: 2020
(continued)

Alternative	Airport Related Jobs	Airport Related Earnings (millions)	Airport Related Revenue (millions)	Visitor Related Jobs	Visitor Related Earnings (millions)	Visitor Related Revenue (millions)	Total Jobs	Total Earnings (millions)	Total Revenue (millions)
3 Airport System: [illegible]									
23	76,722	$2,240.6	$5,416.4	230,441	$3,260.2	$8,714.0	307,163	$5,500.8	$14,130.4
24	76,640	$2,238.7	$5,405.2	230,441	$3,260.2	$8,714.0	307,081	$5,498.9	$14,119.2
25	74,349	$2,185.8	$5,268.6	230,441	$3,260.2	$8,714.0	304,790	$5,446.0	$13,982.6
26	74,470	$2,187.7	$5,267.5	230,441	$3,260.2	$8,714.0	304,911	$5,447.9	$13,981.5
27	74,432	$2,173.4	$5,331.3	230,441	$3,260.2	$8,714.0	304,873	$5,433.6	$14,045.3
28	74,775	$2,184.1	$5,337.6	230,441	$3,260.2	$8,714.0	305,216	$5,444.3	$14,051.6
29	72,951	$2,133.5	$5,244.7	230,441	$3,260.2	$8,714.0	303,392	$5,393.7	$13,958.7
30	73,302	$2,144.2	$5,251.3	230,441	$3,260.2	$8,714.0	303,743	$5,404.4	$13,965.3

SOURCE: P&D Technologies

- The average wage per job generated by the various alternatives is approximately $17,800 per year. Due to the large number of lower paying service-oriented jobs created by visitor expenditures, this is 22 percent lower than the $22,900 average annual wage in the four-county Puget Sound Region in the first quarter of 1989.

- However, the average wage in jobs created by airport-activity is $29,200, or 28 percent higher than the regional average.

Issue: Distribution of economic growth geographically throughout the state and region

- The alternatives involving supplemental airports could generate substantial employment and earnings, and foster economic development in the counties in which they are located. As such, the development of supplemental airports could be used as an economic development or growth management tool to distribute jobs, wage earnings and business revenues within the region and bolster the economy of an area.

- The alternatives could foster major office and hotel development in the area immediately surrounding the airport. Based upon an analysis of ten airports with air passenger traffic ranging from 1.2 to 44.4 million annual passengers, it was determined that within 1.5 to 3 miles from the airport the estimated development around each of the airport sites range from 104,000 potential square feet at the Olympia/Black Lake airport, to 1.8 million square feet at either the Olympia/ Black Lake or Central Pierce airports. Furthermore, there should be sufficient demand by the year 2020 to support 671 to 8,542 hotel rooms in the influence areas of each airport alternative.

Issue: Increasing local government revenues.

- Depending on the alternative and its geographic location, the amount of additional hotel room and sales tax revenue from development in the airport influence area (1.5 to 3 mile radius) would range from $2.4 to $7.5 million annually.

- Local sales taxes generated by airport-activity and visitor-expenditure related earnings to local residents could total $22.6 to $29.5 million annually (see Table V-14).

- If Sea-Tac is abandoned for a replacement airport, the redeveloped Sea-Tac site would restore property tax revenues in King County (i.e., to the new city of Sea-Tac). However, loss of airport tenant leasehold possessory interest taxes at Sea-Tac would partially balance this gain. Conversely, if a replacement airport

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TABLE V-14
SUMMARY OF REGIONAL SALES TAX REVENUES GENERATED BY EARNINGS FROM JOBS RELATED TO AIRPORT ACTIVITY AND VISITOR EXPENDITURES: 2020

	Local Share of Sales Tax Revenues (000s)		
Alternative	Airport Related	Visitor Related	Total
1 Airport System			
1	$9,755.9	$13,883.1	$23,639.0
2	$9,355.5	$13,274.6	$22,630.1
31	$10,193.9	$17,116.1	$27,310.0
32	$10,651.5	$17,116.1	$27,767.6
2 Airport System			
3	$11,828.1	$16,317.5	$28,145.7
4	$12,401.8	$17,116.1	$29,517.8
5	$11,776.4	$17,116.1	$28,892.4
6	$11,297.7	$16,317.5	$27,615.2
7	$11,046.6	$16,317.5	$27,364.1
8	$12,401.8	$17,116.1	$29,517.8
9	$12,401.8	$17,116.1	$29,517.8
10	$11,776.4	$17,116.1	$28,892.4
11	$11,776.4	$17,116.1	$28,892.4
12	$11,481.3	$17,116.1	$28,597.3
13	$12,093.1	$17,116.1	$29,209.1
14	$12,103.3	$17,116.1	$29,219.4
15	$11,922.8	$17,116.1	$29,038.8
16	$11,923.7	$17,116.1	$29,039.7
17	$11,842.2	$17,116.1	$28,958.2
18	$12,093.1	$17,116.1	$29,209.1
19	$12,103.3	$17,116.1	$29,219.4
20	$11,922.8	$17,116.1	$29,038.8
21	$11,923.7	$17,116.1	$29,039.7
22	$11,842.2	$17,116.1	$28,958.2
3 Airport System			
23	$12,219.3	$17,116.1	$29,335.4
24	$12,248.8	$17,116.1	$29,364.9
25	$12,128.2	$17,116.1	$29,244.3
26	$12,166.0	$17,116.1	$29,282.1
27	$12,095.1	$17,116.1	$29,211.2
28	$12,156.6	$17,116.1	$29,272.7
29	$12,048.9	$17,116.1	$29,165.0
30	$12,110.0	$17,116.1	$29,226.0

SOURCE: P&D Technologies

is developed at the privately held Central Pierce site (versus the Fort Lewis site) or Olympia/Black Lake, land would be removed from the tax roles, negatively impacting property tax revenues in these areas. However, depending on the type and extent of new private development around the airport, as well as the gains from airport tenant leasehold taxes, these negative impacts would be reduced or eliminated.

Issue: **Diversification of the economy and minimizing the dependence on one major employer (e.g., the Boeing Company, which is the largest single employer and accounts for 21 percent of the employment in the Puget Sound Region).**

- The vast majority of jobs generated by the alternatives are not related to aerospace manufacturing, thus reducing the region's dependency on Boeing.

Issue: **Increasing international and domestic tourism**

- Although the alternatives do not directly promote international or domestic tourism, the ability of the alternatives to meet future air passenger demand will help facilitate tourist visits to the region.
- Depending upon the alternative system, air passenger visitors (tourists and business) to the region are expected to generate between 178,700 and 230,400 jobs, $2.5 to $3.2 billion in household earnings and $6.8 to $8.7 billion in annual business revenues for region.

Issue: **Creation of jobs in manufacturing and other industries to replace declining employment opportunities in the resource-based industries, such as mining and timber.**

- The vast majority of the jobs created by airport activity and visitor expenditures will be in non-resource-based industries.

Issue: **Increase the competitiveness of the region's businesses in the new global economy**

- The region's position in the global economy will be enhanced to the extent the alternatives are integrated with other modes of transportation in the region (i.e., sea, rail, highway) to form an efficient intermodal system.
- Due to the limited vacant, available land around Sea-Tac, development of facilities to allow the Puget Sound Region to fully capitalize on emerging aviation/industrial linkages (i.e., air freights' role in "just in time" methods and

air cargo industrial complexes, etc.) may be limited. Therefore, alternatives that replace Sea-Tac or provide supplemental airports may be needed to capitalize on these trends.

QUESTIONS FOR DISCUSSION

Following are questions beyond the scope of this analysis posed to members of expert panel:

1. What strategic economic issues other than those discussed in this paper should be considered in evaluating the alternative airport systems?

2. What are the impacts of the alternatives on these other economic issues?

3. Which alternative best supports the Puget Sound Region's growing role in the global economy? Which supports it the least?

4. What are the advantages and disadvantages other than those listed in this paper of a replacement airport vis-a-vis a multiple airport system?

5. Given the emerging trend toward air cargo/industrial complexes, should provisions be made in any of the alternatives for such facilities? If so, which alternative? What amount of air cargo should be accommodated?

6. Locating supplemental airports in various counties does, to varying degrees, serve to distribute additional employment to these areas. This additional employment, however, and additional population likely to occur, will create the need for public services, such as schools, police, fire, sewer, water and other infrastructure. Who will pay for these needed public services? Where will the funds come from?

7. If hubbing became a larger part of the Puget Sound airport system, would this be an increase in air passenger demand above the 45 MAP level?

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APPENDICES

APPENDIX A

BIBLIOGRAPHY

APPENDIX A
BIBLIOGRAPHY

Bangsberg, P. T. "Aircraft Conversion Groups Likely to Reap Benefits of Asia Cargo Boom." The Journal of Commerce. 1991 (April 19). Sec. B, p. 9.

Bluechel, Alan. "Reaping Profit from a New World Order." The Journal of State Government. 1991 (Jan/March). Vol. 64, Issue 1, pp. 18-21.

Breskin, Ira. "US Airlines Urged to Consider Expanding Use of Combi Aircraft." The Journal of Commerce. 1991 (April 1). Sec. B, p. 5.

Brown, Tom. "Trade, Traffic on I-5 Corridor Raise Vision to Global Level." Seattle Times. 1991 (June 9). Sec. E, pp. 1 and 8.

Davies, John. "Major New Runway Ruled Out for Seattle-Tacoma Airport." The Journal of Commerce. 1991.

Davies, John. "Port of Tacoma Hopes to Reap Benefits of Nearby Boeing Plant." The Journal of Commerce. 1991.

Davies, John. "Sharp Growth in Air Cargo Fleets Forecast." The Journal of Commerce. 1990 (July 30). Sec. A, p. 1.

Hamer, John C. The New Crossroads: Greater Seattle and the Global Economy. 1991 (Feb). Prepared for the Trade Development Alliance of Greater Seattle.

Kasarda, John D. "Global Air Cargo-Industrial Complexes as Development Tools." Economic Development Quarterly. 1991 (Aug). Vol. 5, No. 3, pp.187-196.

Kennedy, D. M. The New International Cities Era: The Global Activities of North American Municipal Governments. 1989. ed. E. H. Fry, L. H. Radebaugh and P. Soldatos.

Northwest Policy Center, University of Washington Graduate School of Public Affairs. Strategies of the Pacific Northwest Economic Region. 1991 (March).

Puget Sound Council of Governments. Central Puget Sound Regional Econometric Model and Regional Economic and Demographic Forecasts: 1990-2020. Technical Documentation Draft. 1991.

Puget Sound Council of Governments. Employment Estimates for Subcounty Areas: Covered Employment and Payroll, First Quarter, 1989. 1991 (June).

Redmond, Ron. "Seattle Lands a Plum: Free-trade negotiations to begin here Aug. 20." Seattle Post-Intelligence. 1991 (June 13). Sec. A, pp. 1 and 16.

"Seattle-Africa Ties Important." Editorial. Seattle Post-Intelligence. 1991 (June 27). Sec. A, p. 10.

Solomon, Mark B. "Global Service Drives Air Cargo Growth." The Journal of Commerce. 1990 (July 13). Sec. B, p. 9.

Stafford, Bill. "Where's Seattle? Trade Development Alliance of Greater Seattle will supply the answer." Seattle Post-Intelligence. 1991 (May 12).

Stier, Kenneth J. "Aviation Growth in Asia-Pacific Held Inadequate." The Journal of Commerce. 1991.

Washington State Economic Development Board. Washington Works Worldwide. 1988 (Nov). A long-term economic development strategy for Washington State.

THE FLIGHT PLAN PROJECT PHASE III

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APPENDIX B

METHODOLOGY FOR PROJECTING THE ECONOMIC IMPACT OF AVIATION ACTIVITY AND AIR PASSENGER VISITOR EXPENDITURES

P&D Aviation

A Division of P&D Technologies

APPENDIX B
METHODOLOGY FOR PROJECTING THE ECONOMIC IMPACT OF AIRPORT ACTIVITY AND AIR PASSENGER VISITOR EXPENDITURES

The economic impact generated by airport activity in the five county region [1] was estimated for three variables: jobs, wage earnings and revenue to local firms [2]. These impacts were estimated for the following categories:

- **Direct impacts.** Consequences of economic activities carried out at the airport by airlines, airport management, fixed base operators, and other tenants with direct involvement in aviation. Employing labor, purchasing locally produced goods and services, and contracting for construction and capital improvements are examples of airport activities and visitor expenditures that generate direct impacts.

- **Indirect impacts.** On and offsite economic activities that are attributable to the airport, but are not directly involved in aviation-related activities. Indirect impacts are generated by retail concessions, catering services, parking, ground transportation, etc. These enterprises, like airport businesses, employ labor, purchase locally produced goods and services, and invest in capital expansion and improvements.

- **Induced impacts.** The multiplier effects of the direct and indirect impacts. These are the increases in employment, wage earnings, and revenue over and above the direct and indirect impacts created by successive rounds of spending. For example, most of the take-home wages earned by airport employees is spent locally. Some of this spending becomes income to local individuals who provide services to airport employees. Then part of these second round incomes are also spent locally and thus become income to another set of individuals, and so on.

- **Total impacts.** The sum of direct, indirect and induced impacts.

The following methodologies were used to project the direct, indirect, induced and total impacts of airport activity and visitor expenditures in the five county study area.

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[1] The region includes the following counties: King; Kitsap; Pierce; Snohomish; and Thurston.

[2] Revenues to local firms represent expenditures for local goods and services generated by airport activity and visitor expenditures.

A. AIRPORT ACTIVITY

1. **Estimate direct and indirect employment generated by airport activity.**

Total direct employment at each airport and alternative for the year 2020 was projected on a per passenger basis using the following equation:

$$Log_{10}(\text{Direct Employment}) = 2.938 + (.929 \times Log_{10}(\text{Passengers}))$$

This equation was developed by P&D based on a statistical analysis of direct employment at 89 commercial airports in the United States which ranged in size from .004 million annual passengers (MAP) to 43.653 MAP [1].

Total indirect employment at each airport and alternative for the year 2020 was projected on a per passenger basis using the following equation:

$$\text{Indirect Employment} = 142.42 \times \text{Million Annual Passengers}$$

This equation was developed by P&D based upon the relationship of indirect employment to total passengers found in a 1989 Economic Impact Study (EIS) prepared for the Port of Seattle [2].

Total direct and indirect employment was then allocated to specific industries based on the distribution of these industries found in the above referenced Economic Impact Study prepared for the Port of Seattle.

2. **Estimate direct and indirect wage earnings generated by airport activity.**

Wage earnings were projected based upon average salary per job data from the 1989 Sea-Tac EIS. However, these data were in 1987 dollars. Thus, the salary per job data

[1] The R^2 between observed and predicted direct employment using this equation is .909. The t value is 20.123 with 87 degrees of freedom, indicating that the coefficient is statistically significant at the .005+ percent level. The F-ratio for the equation is 404.915, indicating that the equation is statistically significant at the .005+ percent level.

[2] Martin O'Connell Associates, The Economic Impact of the Seattle Harbor and The Seattle-Tacoma International Airport, prepared for the Port of Seattle, February 1989.

were increased by seven percent to estimate 1990 salaries [1]. Total wage earnings were projected using the employment projections derived above and average 1990 salaries per job.

3. **Estimate revenue generated by airport activity.**

Revenues to local firms were projected based upon revenue per job data from the 1989 Sea-Tac EIS, updated to 1990 dollars using the same inflation assumption as was applied to wage earnings. For all industries except airlines and air freight, all revenues were assumed to represent expenditures for local goods and services due to airport activity. The revenue data for airlines and air freight were reduced to account for the portion of revenue which would: (1) flow out of the region; and (2) be respent for goods and services from other industries included in the direct and indirect categories (i.e., catering, government, etc.). Total revenues were projected using the employment projections derived above and the adjusted 1990 revenues per job.

4. **Distribute direct and indirect impacts to each county in the region.**

Direct and indirect job, earning and revenue projections were then distributed to each county as follows: 75 percent of the jobs, earnings and revenues generated by a particular airport were assumed to remain in the county where the airport was located, the remaining 25 percent were divided evenly among the other counties. This formula assumes that over time, businesses serving individual airports will tend to locate near the airport, and was based upon the percentage of employees at Sea-Tac which live within King County, as found in the 1989 Sea-Tac EIS.

5. **Estimate induced impacts within each county generated by the direct and indirect impacts.**

Induced jobs, wage earnings and revenues within each county were estimated from the direct and indirect impacts using input/output multipliers obtained from the United States Bureau of Economic Analysis (BEA). The multipliers were developed specifically for each county and the region from the BEA's Regional Input-Output Modelling System (RIMS II). It should be noted that Thurston County was added to the study area late in the process and BEA was unable to generate multipliers for this county in time for use in this project. Therefore, due to similar population sizes, for all alternatives except Alternative 32 (Replacement Airport at Olympia/Black Lake), the multipliers for Kitsap County were used to estimate induced impacts in Thurston County. In the case of

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[1] This increase is based on the percent change in average salaries for Port of Seattle Aviation Division employees between 1987 and 1990.

Alternative 32, due to the magnitude of the direct and indirect job creation in the county generated by the replacement airport, the multipliers for Pierce County were considered more appropriate for estimating the induced impact in Thurston County.

6. **Estimate sales tax revenues generated by increased earnings.**

A portion of the wage earnings generated by airport activity will be respent on taxable retail goods, resulting in increased retail sales tax revenues to the region. According to the State of Washington Department of Revenue, an average of 35 percent of wage earnings are spent on taxable retail goods. This percentage was applied to direct, indirect and induced wage earnings to estimate taxable retail sales and the local tax rate was then applied to estimate sales tax revenues.

7. **Add direct, indirect and induced impacts within each county to estimate total impacts within each county and the region.**

The direct, indirect and induced impacts within each county were added to estimate total impact on jobs, wage earnings and revenues.

B. AIR PASSENGER VISITOR EXPENDITURES

1. **Estimate the percentage of air passengers which are business and tourist visitors to the region.**

The percentage of total air passengers that would be visitors to the region was estimated at 26 percent, based upon information found in the 1989 EIS for Sea-Tac.

2. **Estimate expenditures by air passenger visitors for local goods and services.**

Expenditures for local goods and services (lodging, ground transportation, retail goods, sightseeing and restaurants) was estimated on a per passenger basis using information from the 1989 EIS and the Seattle-King County Convention and Visitors Bureau.

3. **Estimate employment generated by air passenger visitor expenditures.**

Total employment generated by visitor expenditures was estimated on relationships between jobs and revenues found in the 1989 EIS.

4. **Estimate wage earnings generated by air passenger visitor expenditures.**

   Wage earnings were projected based upon average salary per job data from the 1989 Sea-Tac EIS. However, these data were in 1987 dollars. Thus, the salary per job data were increased by 7 percent to estimate 1990 salaries [1]. Total wage earnings were projected using the employment projections derived above and average 1990 salaries per job.

5. **Estimate induced impacts within the five county region generated by the visitor expenditures.**

   Induced jobs, wage earnings and revenues within the five county region were estimated from the direct impacts using input/output multipliers obtained from the United States Bureau of Economic Analysis (BEA). The BEA multipliers were developed specifically for the region from their Regional Input-Output Modelling System (RIMS II).

6. **Estimate sales tax revenues generated by increased earnings.**

   A portion of the wage earnings generated by airport activity will be respent on taxable retail goods, resulting in increased retail sales tax revenues to the region. According to the State of Washington Department of Revenue, an average of 35 percent of wage earnings are spent on taxable retail goods. This percentage was applied to direct, indirect and induced wage earnings to estimate taxable retail sales and the local tax rate was then applied to estimate sales tax revenues.

7. **Add direct and induced impacts to estimate total impacts within the region.**

   The direct and induced impacts were added to estimate total impact on jobs, wage earnings and revenues.

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[1] This increase is based on the percent change in average salaries for Port of Seattle Aviation Division employees between 1987 and 1990.

WORKING PAPER #11

CAPITAL COSTS AND FUNDING

PRESENTED
OCTOBER 23, 1991

ADOPTED
NOVEMBER 26, 1991

THE FLIGHT PLAN PROJECT PHASE III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

DATE: November 4, 1991

TO: Puget Sound Air Transportation Committee

FROM: P&D Aviation

SUBJECT: WORKING PAPER NO. 11 - CAPITAL COSTS AND FUNDING

EXECUTIVE SUMMARY

Capital Costs

Table 1 on the following page summarizes the major conclusions of the capital costs analysis of the Flight Plan options and shows the consultant's suggested composite ranking of the options based on these costs.

The option which receives the highest ranking (Rank 1) and lowest cost is existing Sea-Tac with demand management. The second and third ranked options are the existing Sea-Tac with a supplemental 1-runway airport and Sea-Tac with a supplemental 2-runway airport respectively. The replacement airport option is shown to be the most costly of all the options.

Aircraft delay Costs

The amount of airport operational capacity provided, relative to the number of passengers served, varies substantially among the options being evaluated. A comparison of property acquisition and construction costs alone does not recognize this difference. In order to account for the relative capability of each option to serve its allocated demand, aircraft delay costs were examined. Airport options with greater capacity will have lower aircraft delay costs.

In Working Paper No. 7, the alternatives were compared in terms of annual delay costs for the year 2020. In Working Paper No. 11, the cumulative delay costs for the period 2000-2020 have to be projected in order to provide a better comparison with capital costs. Table 1 summarizes the cumulative aircraft delay costs for the major option groups, together with a ranking.

Funding

The results of the financial analyses are summarized below:

- The average net operating revenue (including depreciation) is $1.2 per passenger at 9 supplemental airports surveyed. These supplemental airports varied in size from 1.5 to 12 million annual passengers (enplaned and deplaned), approximately the same range of airport size as forecasted for a supplemental airport in the Puget Sound Region between the years 2000 and 2020. The U.S. average for airports of the same size is $0.9 net operating revenue per passenger.

- Representative supplemental airports have experienced rapid growth in passenger traffic in recent years, which attests to their financial strength and the acceptability of the multiple airport system concept by air carrier airlines and their ability to operate efficiently in a multiple airport environment.

- There will be adequate funds to finance future capital improvements for all improvement alternatives at Sea-Tac.

- Adequate funds may not be available to finance improvements at existing airports used as supplemental air passenger airports or new supplemental or replacement airports, due to the large capital costs at these airports relative to the number of passengers to be served (based on the allocation of passengers described in Working Paper 5).

- Supplemental airport market areas do not generate sufficient passengers prior to 2020 to offset development costs.

- A new commuter runway or dependent air carrier runway at Sea-Tac are the only capacity improvements which generate sufficient funds to offset costs.

CAPITAL COSTS

In this working paper capital cost estimates were developed for each of the airport site concepts identified in Working Paper No. 6 plus an additional replacement airport site at Fort Lewis.

The estimates for airport construction are based on average prices derived from bid tabulations from recent construction projects in the region; FAA, WSDOT and Puget Sound Regional Council staff; and P&D Aviation staff experience with similar projects. Site preparation costs include costs of clearing and grading, drainage and erosion control, minor utility relocation and obstruction removal.

Assumptions regarding airfield pavements were based on the critical aircraft identified in Working Paper No. 6, i.e., Supplemental Airport - B-767 and Replacement Airport - B-747. All quantity calculations are based on airfield facility dimensions required by FAA AC 150/5300-13 Airport Design. Terminal area requirements are based on FAA AC 150/5360-13 Planning and Design Guidelines for Airport Terminal Facilities; FAA-RD-75-191 The Apron and Terminal Building Planning Manual; and the International Air Transport Association Airport Terminals Reference Manual.

Land acquisition costs include the estimated costs of fee simple property acquisition and easements for the amount of land required for each alternative. This includes the purchase of all land within the 65 Ldn contour for sites other than Sea-Tac. For Sea-Tac, noise remediation costs already programmed for the post year 2000 period are used. Estimated land values were based on information furnished by local professional land appraisers. Airport access

TABLE 1
FLIGHT PLAN PHASE III
EVALUATION OF OPTION COST

Alternatives and Options	Estimated Acquisition and Construction Costs ($ Millions)	Rank [a]	Estimated Aircraft Delay Costs ($ Millions)	Rank [a]
SEA-TAC AIRPORT				
Existing Sea-Tac with Demand Management*	230	1	4,900	6
REPLACEMENT AIRPORT	1,564 - 2,078	7	1,600	1
TWO AIRPORT SYSTEMS				
Existing Sea-Tac plus Supplemental (1 Runway)*	433 - 730	2	4,900 - 5,100	6
Existing Sea-Tac plus Supplemental (2 Runways)	474 - 879	3	4,900	6
Sea-Tac with new AC Runway plus Supplemental (1 Runway)	755 - 1,043	4	2,500 - 2,900	4
Sea-Tac with new AC Runway plus Supplemental (2 Runways)	786 - 1,158	4	2,500 - 2,900	4
THREE AIRPORT SYSTEMS				
Existing Sea-Tac plus 2 Supplementals (1 Runway)	788 - 1,028	4	4,400 - 4,900	5
Sea-Tac with new AC Runway plus 2 Supplementals (1 Runway)	1,086 - 1,362	5	1,800 - 2,500	3
Sea-Tac with new AC Runway plus 2 Supplementals (2 Runways)	1,320 - 1,760	6	1,500 - 2,100	2

[a] Ranking 1-9 with 1 best.

*Does not meet 2020 demand forecast.

improvement costs for each site include all off-airport roadway improvements. Estimated access improvement costs for each alternative were provided by Puget Sound Regional Council staff.

The estimated capital costs for each alternative are in 1991 dollars and are shown in Table 2. Engineering, administrative and contingency costs were estimated at 25 percent of all costs. "Engineering and administration" costs related to property acquisition include legal fees, resident relocation expenses, and administrative site acquisition costs.

Working Paper No. 6 provided conceptual drawings for each of the airport site concepts. A discussion of the improvements assumed in the cost estimates for each of the sites is presented below.

Seattle-Tacoma International Airport Without New Runway

This concept is essentially the existing Sea-Tac Airport. Although no new runways are included under this alternative, minor improvements such as new taxiway and terminal area expansions would occur. No land acquisition is assumed for this alternative.

Airport access improvements include : Widen SR 518/Airport Freeway for four and one half miles and widen I-5 for two miles. Revise SR 518 interchanges at I-5 and the SR 509 and Airport Freeway interchange with SR 518. Pacific Highway South would be widened for three miles.

Seattle-Tacoma International Airport With New Commuter Runway

Under this alternative, a new 5,000-foot commuter runway would be constructed on the west side of the present runways, approximately 1,000 feet from the western boundary of the Airport. The new runway would be located entirely on existing airport property. The west side parallel taxiway would be removed and a new runway constructed with a centerline separation of 700 feet from the existing westerly runway (Runway 16R-34L). No land acquisition is assumed for this alternative.

Airport access improvements include : Widen SR 518/Airport Freeway for four and one half miles and widen I-5 for two miles. Revise SR 518 interchanges at I-5 and the SR 509 and Airport Freeway interchange with SR 518. Pacific Highway South would be widened for three miles.

Seattle-Tacoma International Airport With New Dependent Runway

In this alternative, a new 7,000-foot runway would be constructed 2,500 feet from Runway 16L-34R. This separation distance would allow dependent instrument approaches. For

TABLE 2
FLIGHT PLAN PHASE III
CAPITAL COST ESTIMATES ($,000)

Alt	Description	Noise Impact Area Acquisition [a]	Site Acquisition	Airport Contruction	Access Contruction	Contingency Engineering Administrative	Total
1	Sea-Tac without Commuter R/W	50,000	0	45,578	49,000	36,145	180,723
2	Sea-Tac with Commuter R/W	50,000	0	74,979	49,000	43,495	217,474
3	Alternate 1 + Arlington 1 R/W	74,000	4,600	182,665	85,000	86,566	432,831
4	Alternate 1 + Paine 1 R/W	300,000	25,000	188,839	70,000	145,960	729,799
5	Alternate 1 + MCCHORD 1 R/W	62,000	19,125	191,569	82,000	88,674	443,368
6	Alternate 1 + Central Pierce 1 R/W	60,000	115,000	227,340	74,000	119,085	595,425
7	Alternate 1 + Olympia/Black Lake 1 R/W	53,300	7,500	345,249	85,000	122,762	613,811
8	Alternate 1 + Arlington 2 R/W	74,000	36,000	230,592	90,000	107,648	538,240
9	Alternate 1 + Paine 2 R/W	300,000	81,750	188,839	90,000	165,147	825,736
10	Alternate 1 + McChord 2 R/W	62,000	33,000	197,568	87,000	94,892	474,460
11	Alternate 1 + Central Pierce 2 R/W	63,500	290,000	275,794	74,000	175,824	879,118
12	Alternate 1 + Olympia/Black Lake 2 R/W	54,500	23,600	481,837	85,000	161,234	806,171
13	Sea-Tac w/dep. R/W + Arlington 1 R/W	74,000	38,800	419,639	85,000	154,360	771,799
14	Sea-Tac w/dep. R/W + Paine 1 R/W	300,000	59,200	404,977	70,000	208,544	1,042,721
15	Sea-Tac w/dep. R/W + McChord 1 R/W	62,000	53,325	406,554	82,000	150,970	754,849
16	Sea-Tac w/dep. R/W + Central Pierce 1 R/W	60,000	149,200	464,942	74,000	187,036	935,178
17	Sea-Tac w/dep. R/W + Olympia/Black Lake 1 R/W	53,300	41,700	586,518	85,000	191,630	958,148
18	Sea-Tac w/dep. R/W + Arlington 2 R/W	74,000	70,200	419,639	90,000	163,460	817,299
19	Sea-Tac w/dep. R/W + Paine 2 R/W	300,000	115,950	404,977	90,000	227,732	1,138,659
20	Sea-Tac w/dependent R/W + McChord 2 R/W	62,000	67,200	412,552	87,000	157,188	785,940
21	Sea-Tac w/dependent R/W + Central Pierce 2 R/W	63,500	324,200	464,942	74,000	231,661	1,158,303
22	Sea-Tac w/dependent R/W + Olympia/Black Lake 2 R/W	54,500	57,800	586,518	85,000	195,955	979,773
23	Alt. 1 + Arlington 1 R/W + Central Pierce 1 R/W	84,000	119,600	316,767	110,000	157,592	787,959
24	Alt. 1 + Paine 1 R/W + Central Pierce 1 R/W	310,000	140,000	254,974	95,000	199,994	999,968
25	Alt. 1 + Arlington 1 R/W + Olympia/Black Lake 1 R/W	77,300	12,100	423,432	121,000	158,483	792,415

TABLE 2
FLIGHT PLAN PHASE III
CAPITAL COST ESTIMATES ($,000)

Alt	Description	Noise Impact Area Acquisition [a]	Site Acquisition	Airport Construction	Access Construction	Contingency Engineering Administrative	Total
26	Alt. 1 + Paine 1 R/W + Olympia/Black Lake 1 R/W	303,300	32,500	380,299	106,000	205,525	1,027,624
27	Alternate 13 + Central Pierce 1 R/W	84,000	153,800	525,132	110,000	218,233	1,091,165
28	Alternate 14 + Central Pierce 1 R/W	310,000	174,200	510,470	95,000	272,418	1,362,088
29	Alternate 13 + Olympia/Black Lake 1 R/W	77,300	46,300	624,070	121,000	217,168	1,085,838
30	Alternate 14 + Olympia/Black Lake 1 R/W	303,300	66,700	609,408	106,000	271,352	1,356,760
31	Central Pierce 2 R/W	45,000	400,000	1,031,439	186,000	415,610	2,078,049
32	Olympia/Black Lake 3 R/W	15,000	34,000	1,312,414	86,000	361,854	1,809,268
33	Sea-Tac with Demand Management	50,000	0	84,689	49,000	45,922	229,611
34	Fort Lewis	30,000	48,400	1,036,690	136,000	312,773	1,563,863

[a] For Sea-Tac, this figure represents the cost of the Sea-Tac noise remediation program programmed from 2000 to 2020 ($50 million for sound attenuation in existing structures).

this alternative, additional property must be acquired between 9th and 12th Avenues South and between South 176th Street and SR 518, to provide for construction of the new runway.

Land Acquisition is estimated to total 110 acres with 230 homes.

Airport access improvements include: Widen SR 518/Airport Freeway for four and one half miles and widen I-5 for two miles. Revise SR 518 interchanges at I-5 and the SR 509 and Airport Freeway interchange with SR 518. Pacific Highway South would be widened for three miles.

<u>Arlington Municipal Airport With New Runway Extension</u>

Under this alternative, the north-south runway at Arlington Municipal Airport would be lengthened 1,670 feet at the north end to a total of 7,000 feet. The general aviation area on the east side of the airport would remain. A new passenger terminal would be constructed between the two runways. Long-term parking could be provided at the west side of the airport and air cargo, maintenance, and support activities can be accommodated south of Runway 11-29. New parallel taxiways would be constructed for each runway to serve future aviation needs.

Land Acquisition is estimated to be 100 acres with 20 homes on 60 acres and 35 acres with industrial potential.

Airport access improvements include the widening of I-5 for three miles, a new access road from I-5 (1.5 miles) and a new interchange at I-5.

<u>Arlington Municipal Airport With New Runway</u>

A new 7,000 foot long parallel north-south runway would be constructed west of the existing north-south runway. Additionally, the present north-south runway would be extended 1,670 feet to 7,000 feet. Additional property would be acquired on the north, east, and south sides of the airport to accommodate the required expansion. The passenger terminal would be located at midfield between the parallel runways on the east side of the airport. Air cargo and maintenance activities could be located at the northeast corner of the airport. Support functions could be accommodated at the south end of the airport.

Land acquisition estimated includes 360 acres on the north side of the airport which contains 70 homes and some pasture and wooded areas. Approximately 185 acres is needed on the east which is industrial land and includes Bayliner Industries at 140 acres. An additional 130 acres is needed at the southwest corner of the airport. This land is a mixture of potential commercial, industrial, a major commercial nursery and an additional 25 homes.

Airport access improvements consist of the widening of I-5 for three miles, a new access road from I-5 for 1.5 miles and a new interchange at I-5.

Snohomish County Airport (Paine Field) With Existing Airfield

Paine Field could be converted to a supplemental airport with no significant airfield improvements required. Activities on the east side of the airport would remain. A new passenger terminal and related air cargo and maintenance and support activities would be located on the west side of the airport. A new parallel taxiway on the west side of the primary runway would be required to provide aircraft access to the west side.

Land acquisition will involve approximately 140 acres on the south side of the airport. This land includes a 25 acre park and 155 acres of commercial/industrial properties of which many are improved.

Airport access improvements consist of the widening of SR 526 for three miles and a new interchange at SR 526 and SR 525 for the terminal exit.

Snohomish County Airport (Paine Field) With New Runway

In this alternative, an additional north-south runway would be constructed for air carrier use east of the existing primary runway. Without relocating SR 526 and providing for adequate runway protection zone clearance at the north end, a 5,300-foot runway can be constructed. The passenger terminal area would be located on the west side of the airfield. A large part of the existing general aviation area would be replaced by the new runway and air cargo and maintenance activities would be provided on the east side of the airport. Additional land would be acquired under this alternative at the south end of the airport for the new runway, and at the northwest corner for long-term vehicle parking.

Land acquisition will involve approximately 140 acres on the south side of the airport. This land includes a 25 acre park and 155 acres of commercial/industrial properties of which many are improved. In addition it will be necessary to acquire an additional 120 acres at the northwest corner of the airport south of Casino Road and east of Mukilteo Speedway. This will involve an additional 295 homes.

Airport access improvements consist of the widening of SR 526 for three miles and a new interchange at SR 526 and SR 525 for the terminal exit.

Joint Use of McChord Air Force Base With Existing Airfield

In this concept, the passenger terminal area and air cargo, maintenance and support functions would be located on the east side of the base on existing Air Force Base property. A new parallel taxiway would be constructed on the east side of the runway to serve the civilian functions. Air Force facilities currently located in these areas include hazardous materials loading aprons. This option is based on relocating these loading areas to other locations on the base. If alternate loading areas cannot be provided, the area encompassed by the civilian activities would have to be reduced.

Land acquisition for this alternative is entirely within the military airport boundary. A value of the land could be minimal if surplused and transferred from the government. The appraiser's recommendation was to use $1.50 per square foot for land acquired for estimating purposes. It was assumed that land would be acquired only for the landside facilities. Approximately 295 acres are needed for this purpose.

Airport access improvements will require the widening of I-5 for four miles, a new access roadway from SR 512 for one mile and a revision of the Steele/SR 512 interchange.

Joint Use of McChord Air Force Base With New Runway

In this concept, a new civilian runway would be constructed east of the existing runway, with a centerline separation of 700 feet. The passenger terminal area, long-term parking, and air cargo, maintenance, and support services would be located on the east side of the base on existing base property. Although this concept provides a separate runway for civilian use, the remaining area on the east side of the base is reduced.

Land acquisition for this alternative is again estimated only for the area required for the landside facilities and would involve approximately 505 acres.

Airport access improvements will require the widening of I-5 for four miles, a new access roadway from SR 512 for one mile and a revision of the Steele/SR 512 interchange.

Central Pierce One-Runway Supplemental Airport

Under the one-runway supplemental alternative, a new runway would be constructed west of Highway 161. The runway would be 7,000 feet long with a parallel taxiway on the east side. The passenger terminal area, vehicle parking and air cargo, maintenance, and support services would be located between the runway and Highway 161. The runway would be extended to the south to a total length of 10,000 feet. The critical factor effecting runway placement was the presence of high terrain to the south.

Land acquisition for this alternative will involve 1,140 acres of land with major housing developments including Gem Heights, commercial frontage along Meridan, major improved commercial properties, condominiums and residential land. Preliminary estimates are 594 homes, 75 acres commercial, 620 acres vacant and a 134 unit condominium complex.

Airport access improvements include the widening of I-5 for two miles, a new two mile access road connecting airport to 176th Street and a revision of the I-5 interchange.

Central Pierce Two-Runway Supplemental Airport

Under this alternative, a second 7,000-foot runway would be constructed 3,500 feet to the west of the single runway. The passenger terminal and parking area would extend along the east side of the airport between Highway 161 and the airport. Air cargo and maintenance functions can be provided between the runways on the north side. Support services can be accommodated on the south side of the airport.

Land acquisition for this alternative will involve 2,210 acres of land with major housing developments including Gem Heights, commercial frontage along Meridan, major improved commercial properties, condominiums and residential land. Preliminary estimates are 1,060 homes, 75 acres commercial, 1,230 acres vacant residential land and a 134 unit condominium complex.

Airport access improvements include the widening of I-5 for two miles, a new two mile access road connecting airport to 176th Street and a revision of the I-5 interchange.

Central Pierce With Replacement Airport

Under this alternative, a three-runway (10,000 feet each) replacement airport would be constructed on the Central Pierce site. The two easterly runways would be separated by 5,500 feet and straddle Highway 161. The passenger terminal area and related vehicle parking and circulation would be located with the area between these two runways. The easternmost runway would be capable of a 2,000-foot extension to 12,000 feet, to the north. The westerly runway would be separated from the center runway by 3,500 feet, providing for three simultaneous instrument arrival and departure streams. Additional airport activities can be accommodated on the east side of the easterly runway.

Land acquisition for this alternative will involve 4,840 acres of land with major housing developments including Gem Heights, commercial frontage along Meridan, major improved commercial properties, condominiums, residential land, a gravel pit, a transfer station and an existing airport (Thun Field, approximately 360 acres). Preliminary estimates are 1,060 homes, 75 acres commercial, 1,230 acres of vacant residential land and a 134 unit condominium complex.

Airport access improvements for this alternative include the widening of I-5 for four miles, a new interchange at I-5 and new access road connecting I-5 to airport (approximately 14 miles roadway).

Olympia/Black Lake One-Runway Supplemental Airport

This one-runway concept includes a 7,000-foot runway with passenger terminal and associated facilities to the east, access to the airport would be by Lathrop Road from Interstate 5. Bloom's Ditch which runs through the site would be rechanneled into Salmon Creek to the north. Hills directly south of the runway would be removed to provide adequate approach surface clearance.

Land acquisition for this alternative is approximately 800 acres including 50 homes and 550 acres of vacant acreage.

Airport access improvements include the widening of I-5 for two miles; a new access road from I-5 for two miles and a new interchange at I-5.

Olympia/Black Lake Two-Runway Supplemental Airport

The two-runway concept for Olympia/Black Lake would be similar to the two-runway concept at the Central Pierce site. However, at the Olympia/Black Lake site the westerly runway must be offset to the south to prevent relocation of Burlington Northern Railroad tracks and to avoid wetlands areas to the north. Hills at the south end of the runway must be removed for runway construction and approach surface clearance.

Land acquisition for this alternative will involve 1,900 acres with a total of 175 homes and 1,025 acres of vacant land.

Airport access improvements include the widening of I-5 for two miles, a new access road from I-5 for two miles and a new interchange at I-5.

Olympia/Black Lake With Replacement Airport

This alternative consists of three 10,000-foot runways on the Olympia/Black Lake site with the center runway capable of expanding to 12,000 feet. With the exception of the offset westerly runway, the configuration of this concept is similar to the replacement airport at the Central Pierce site.

Land acquisition for this alternative will involve approximately 4,020 acres, 225 homes, 2,800 vacant land and 100 acres of potential industrial land.

Airport access improvements will include the widening of I-5 for four miles with a new interchange. A new access road from I-5 to the airport (2 miles) and widen 93rd Avenue SW/ Littlerock Road for four miles.

Fort Lewis Replacement Airport Site

This alternative consists of three 10,000 foot runways on the Fort Lewis Military Reservation site in an identical configuration to the Central Pierce Replacement Airport alternative. Relocation of a major power transmission line is an additional consideration at this site along with an underground pipeline crossing the southeast corner of the land.

Land acquisition involves approximately 4,840 acres.

Airport access improvements include the widening of I-5 for 4 miles, a new interchange at I-5, and new access road connecting I-5 to the airport (9 miles).

AIRCRAFT DELAY COSTS

In Working Paper No. 7, (Airspace, Capacity and Delay), the alternatives were compared in terms of annual aircraft delay costs in the year 2020. It was pointed out that the initial comparison of costs represented a "snapshot" at a point in time of the delay consequences. It was further stated that the cumulative aircraft delay costs would be greater and the comparisons could be much different. In this working paper, an estimate of cumulative aircraft delay costs have been developed for the period 2000 to 2020 to provide an order of magnitude estimate of the cumulative delay consequences.

In this analysis, annual aircraft delay costs for each alternative for the years 2000 and 2010 were projected using the same methodology as presented in Working Paper No. 7. The approach followed these basic steps:

- Identify the annual capacity of airfield facilities in each alternative.
- Estimate aircraft operations at each airport based on the constrained allocation of passenger demand for each alternative.
- Compare demand to capacity and identify the average aircraft delay for these relationships.
- Project annual aircraft delays (in hours) by applying the average delay to annual aircraft operations.
- Translate the total delay into a monetary value by applying hourly direct operating costs.

With this, annual delay costs at three points in time were available. To estimate cumulative costs, the annual costs at the three available data points were interpolated to estimate delays for the intermediate years. Annual delay costs for each year were summed to obtain the cumulative aircraft delay costs for the alternative. Appendix A provides the annual tally of delay costs for each alternative and the cumulative costs. It should be noted that for the replacement airport scenarios it was assumed that the airport would commence operations in the year 2006, and thus for the preceding years in the analysis delay costs experience at Sea-Tac are assumed.

The results of the analysis are presented Table 3 and are also compared to the results for the year 2020 presented in Working Paper No. 7. The ranking indicated is with respect to the cumulative delay costs. The results are organized by major option groups (which consist of a number of alternatives) to simplify the presentation.

OPERATING REVENUES AND COSTS

This section and the following section describe the analyses of two additional factors important to the comparison of airport site alternatives: airport operating costs and revenues, and the financing of capital improvements. The purpose of these analyses is to provide data which characterize each of the alternatives in order to compare the desirability of alternatives from an operating revenue and financing perspective. The 33 airport system alternatives described in Working Paper 5 and an additional site at Fort Lewis are addressed. Due to the number of alternatives evaluated and the lack of specific construction program details, the financial analyses were performed on a generalized basis. The objective of the analyses is to assess the relative merits of the alternatives, rather than develop specific financial assessments of each airport.

Supplemental Airports

In this section, the operating revenues and expenditures of a supplemental airport are addressed to determine whether a new supplemental airport in the Puget Sound Region could generate sufficient operating revenues to cover its costs of operations. To address this issue, the operating revenues and expenditures of existing supplemental airports in the United States were examined. Only supplemental airports which would be similar to a supplemental airport in the Puget Sound Region were studied. Airports considered similar were in a market dominated by a single air carrier airport and served between 1.5 and 13 million total passengers (enplaned and deplaned) annually. These airports (listed in Table 3) are Chicago Midway Airport, Dallas Love Field, Houston Hobby Airport, Burbank-Glendale-Pasadena Airport, John Wayne Airport (Orange County, California), Long Beach Airport, Ontario International Airport, Ft. Lauderdale-Hollywood Airport, Oakland International Airport, and San Jose International Airport.

The net operating revenue per passenger for each of the supplemental airports surveyed is shown in Table 4. The net operating revenue per passenger varies substantially from airport to airport due, in part, to the methods of accounting and the allocation of costs between other activities operated by the airport owner (such as other airports or ports). No attempt was made to reconcile differences in accounting and financial reporting methods because of the general nature of this analysis. Net operating revenues are the difference between airport operating revenues

TABLE 3
SUMMARY OF CUMULATIVE AIRCRAFT DELAY COSTS

Option	2020 Delay Costs (millions $)	Cumulative Costs (millions $)
Sea-Tac with Demand Management	$232	$4,900
Replacement Airport	$24	$1,600
Existing Sea-Tac with 1 R/W Supplemental	$234 - $271	$4,900 - $5,100
Existing Sea-Tac with 2 R/W Supplemental	$233 - $237	$4,900
Sea-Tac with New AC R/W + 1 R/W Supplemental	$232 - $241	$2,500 - $2,900
Sea-Tac with New AC R/W + 2 R/W Supplemental	$232 - $241	$2,500 - $2,900
Existing Sea-Tac + 2 Supplementals (1 R/W)	$235 - $241	$4,400 - $4,900
Sea-Tac with New AC R/W + 2 Supplementals (1 R/W)	$141 - $229	$1,800 - $2,500
Sea-Tac with New AC R/W + 2 Supplementals (2 R/W)	$140 - $166	$1,500 - $2,100

TABLE 4
NET OPERATING REVENUES OF REPRESENTATIVE SUPPLEMENTAL AIRPORTS [a]

Primary Airport/Supplemental Airport	Net Operating Revenue [b] (millions of dollars)	Total Passengers [c] (millions)	Net Operating Revenue per Passenger (dollars)
Chicago O'Hare International Airport			
Midway	1.3	8.8	0.1
Dallas-Fort Worth International			
Love Field	4.2	5.7	0.7
Houston Intercontinental			
Hobby	11.9	8.1	1.5
Los Angeles International			
Burbank-Glendale-Pasadena	3.0	3.0	1.0
John Wayne	18.2	4.6	4.0
Long Beach	0.5	1.5	0.3
Ontario International	1.7	5.5	0.3
Miami International			
Ft. Lauderdale-Hollywood	21.9	9.1	2.4
San Francisco International			
Oakland	3.3	12.0	0.3
San Jose	11.1	6.9	1.6
Total	77.1	65.2	1.2

[a] Data are for calendar year 1990 or fiscal year ending 1990 or 1991.
[b] Includes depreciation.
[c] Enplaned and deplaned passengers.

Source: P&D Aviation Survey.

and airport operating expenditures including depreciation costs. Net operating revenues do not consider interest earned on reserves or interest and principal payments for bond indebtedness, which can be significant items compared to net operating revenues.

The net operating revenue of the supplemental airports surveyed averages approximately $1.2 per enplaned and deplaned passenger. This average was compared with the average for 29 airports throughout the United States which served the same range of passengers based on data contained in the 1989-90 Survey of Airport Rates and Charges Conducted and Compiled by the American Association of Airport Executives. The survey by the American Association of Airports Executives (AAAE) does not identify airports by name. Therefore it includes airports that are part of a system of airports as well as individual airports. From data contained in the AAAE survey, the net operating revenue per passenger for the 29 airports averaged $0.9.

Therefore, it can be concluded that supplemental airports do not face an operating revenue disadvantage over airports of the same size which are not in a multiple airport system.

Primary Airports

A survey was made to identify the operating revenues and expenditures of airports operating as a primary airport in a multiple airport system. The six primary airports which served the same markets as the supplemental airports listed in Table 4 were surveyed. These airports are: Chicago O'Hare International, Dallas Ft. Worth International, Houston Intercontinental, Los Angeles International, Miami International, and San Francisco International Airports. As seen in Table 5, the net operating revenue at these airports averages approximately $1.3 per enplaned and deplaned passenger. The average revenues per passenger are slightly higher than at supplemental airports due to the larger number of passengers served. There is also less variation among airports in the average net operating revenue per passenger compared with supplemental airports. Average revenue per passenger ranges from $0.9 at San Francisco International Airport to $1.8 at Houston Intercontinental Airport.

Seattle-Tacoma International Airport

At Seattle-Tacoma International Airport net operating revenues per passenger varied between $0.9 and $1.2 from 1986 to 1990 (Table 6). The increase between 1989 and 1990 is the result of a substantial increase in the landing fee rates in 1990 which resulted in a doubling of landing fee revenues between 1989 and 1990. Landing fee revenues were relatively stable between 1986 and 1989. Net operating revenues on the order $1.2 per passenger could be expected at Sea-Tac if landing fee rates and other rates are maintained at their current level relative to airport operating costs.

TABLE 5
NET OPERATING REVENUES OF
PRIMARY AIRPORTS [a]

Primary Airport	Net Operating Revenue [b] (millions of dollars)	Total Passengers [c] (millions)	Net Operating Revenue per Passenger (dollars)
Chicago O'Hare International Airport	75.9	60.0	1.3
Dallas-Fort Worth International	77.9	48.5	1.6
Houston Intercontinental	31.4	17.5	1.8
Los Angeles International	56.1	45.3	1.2
Miami International	[d]	[d]	[d]
San Francisco International	27.7	29.6	0.9
Total	269.0	200.9	1.3

[a] Data are for calendar year 1990 or fiscal year ending 1990 or 1991.
[b] Includes depreciation.
[c] Enplaned and deplaned passengers.
[d] Data not available.

Source: P&D Aviation Survey.

TABLE 6
NET OPERATING REVENUE PER PASSENGER AT
SEATTLE-TACOMA INTERNATIONAL AIRPORT
1986 TO 1990

Calendar Year	Net Operating Revenue [a] (millions of dollars)	Total Passengers (millions)	Net Operating Revenue per Passenger (dollars)
1986	14.4	13.6	1.1
1987	14.4	14.4	1.0
1988	13.7	14.5	0.9
1989	13.2	15.2	0.9
1990	19.5	16.2	1.2

[a] Net after allocation of depreciation expenses.

Source: Port of Seattle.

Conclusions from Operating Revenue Analyses

The following conclusions can be made from the analyses of airport operating revenues and expenditures:

- Supplemental airports of the type which could serve the Puget Sound Region have proven to be economically viable. The average net operating revenue per passenger of 10 representative supplemental airports surveyed, outside the Puget Sound area, was greater than the nation-wide average for airports serving the same number of passengers. Furthermore, supplemental airports have grown rapidly in passenger traffic in recent years, which is another indicator of their economic strength and their acceptance by the airline industry.

- Net operating revenues per passenger at Sea-Tac ($1.2 in 1990) are consistent with net operating revenues at other airports, particularly primary airports serving a multiple airport market. The net operating revenue per passenger at primary airports averages $1.3, slightly more than at Sea-Tac. However, the primary airports surveyed range in size from 17.5 to 60 million passengers, and average net operating revenue per passenger tends to increase with airport size.

FINANCIAL CAPABILITY OF ALTERNATIVES

In this section, potential sources of funding the capital improvements are discussed and airport system alternatives are evaluated according their capability to generate funds to finance the necessary capital improvements. Case studies of two major airport improvement projects are also discussed.

Funding Sources

Sources of funds for financing major capital improvement projects at airports include airport net operating revenues, passenger facility charges, FAA grants, State grants, local government sources, and private industry. The applicability of each of these sources for financing airport improvements in the Puget Sound Region is described below.

Net Operating Revenues

Historically, a primary source of funding capital improvement projects at airports has been through the airports' net operating revenues. Typically, projects are funded through accumulated revenues held in reserve accounts or through airport revenue bonds in which airport operating revenues are pledged as security for the payment of revenue bond principal and interest. As described in the preceding section, net operating revenues at supplemental airports in the range of 1.5 to 12 million annual passengers (enplaned and deplaned) averaged approximately $1.2 per

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passenger. At large primary airports a net operating revenue of $1.3 is typical. In 1990, Sea-Tac had net operating revenues of $1.2 per passenger.

Passenger Facility Charges

The Aviation Safety and Capacity Expansion Act of 1990 authorizes airports to impose a Passenger Facility Charge (PFC) of $1.00, $2.00, or $3.00 per enplaned passenger. PFC charges must be approved by the Secretary of Transportation in accordance with regulations contained in Federal Aviation Regulation, Part 158, Passenger Facility Charges, June 1991. Revenues from the PFCs are to be used to finance eligible projects at the airport in which the PFC is collected or any other airport which the agency controls. The financing of an eligible airport-related project includes making payments for debt service on revenue bonds backed by PFCs.

The applicant for PFCs must demonstrate that: (1) the amount and duration of the fee would result in revenues which do not exceed amounts necessary to finance these specific projects, and (2) each of the projects will (a) reserve or enhance capacity, safety, or security of the National Air Transportation System; (b) reduce airport noise; or (c) enhance competition between or among air carriers (for example at hubs served by a single dominant air carrier).

The PFC can be imposed on originating or connecting passengers, but no more than two PFCs can be imposed on any one-way trip. Large and medium hub airports will affectively lose 50 percent of their AIP entitlements if they impose PFCs. Large and medium hub airports are those airports enplaning 0.25 percent or more of the total U.S. annual enplanements. Based on current and projected US passenger traffic, the minimum number of total passengers (enplaned and deplaned) for medium and large hubs is estimated by P&D as follows:

Year	Lower Limit of Total Passengers for Large and Medium Hub Airports (Millions of Total Passengers)
1990	2.5
2000	3.9
2010	5.3
2020	6.7

Projects eligible for PFC funding are: (1) all AIP eligible projects, (2) projects to achieve noise compatibility, whether or not the airport has an approved FAR Part 150 noise compatibility noise program, and (3) the construction of terminal gate areas and related concourse areas, excluding concession areas.

At the time of this working paper, no airports have been approved for PFCs, although many have initiated the application process. To date, all applicants have proposed to levy $3.00 PFCs. Program durations vary from two years to thirty-three years. The City and County of Denver has proposed the largest program so far, $2.39 billion over thirty-two years. Under FAA's letter of intent for the new airport issued last year, Denver is required to imposed PFC "as soon as administratively feasible." The airport will issue a series of bonds backed by PFC revenues and airport revenues. Other applicants for PFCs include Portland, Columbus, Buffalo and Las Vegas.

FAA Airport Improvement Program (AIP)

The FAA's Aid to Airports Program provides funding for planning, construction, or rehabilitation at any public-use airport. Eligible work consists of: capital outlays for land acquisition; site preparation; construction, alteration, and repair of runways, taxiways, aircraft parking aprons, and roads within airport boundaries (except for access to areas providing revenue, such a as parking lots and aviation industrial areas); construction and installation of lighting, utilities, navigational aids, and aviation-related weather reporting equipment, safety equipment required for certification of an airport facility; security equipment required of the sponsor by the Secretary of Transportation; limited terminal development at commercial service airports; and equipment to measure runway surface tension. Grants may not be made for the construction of hangars, automobile parking facilities, buildings not related to the safety of persons in the airport, landscaping or artwork, or routine maintenance and repair.

The AIP provides two types of funds for air carrier airports: entitlement funds and discretionary funds. Entitlement funds are made available to all commercial service airports based on the following formula:

> $7.80 for each of the first 50,000 passengers enplaned each year, plus
>
> $5.20 for each of the next 50,000 passengers enplaned each year, plus
>
> $2.60 for each of the next 400,000 passengers enplaned each year, plus
>
> $0.65 for each passenger over 500,000 passengers enplaned each year, to a maximum total of $16,000,000 a year.

Discretionary funds are available on the basis of need and priority as determined by the FAA.

State of Washington

The State Aeronautics Commission Act of 1947 authorized the Commission to provide financial assistance to municipalities in support of public airport development. Specifically, the Commission was permitted to make grants or loans for planning, construction or maintenance of publicly owned or controlled airports.

In 1977 the Aeronautics Commission was dissolved and its staff became the Aeronautics Division of the new Washington State Department of Transportation. The Aeronautics Division Airport Aid/Grant Program has grown to $3 million per biennium. Funding for the program is through a tax on general aviation fuel sold in the State.

The program is geared to satisfy the planning and construction needs of general aviation in Washington State. It is one of the more active and productive in the nation, and is driven by the combined results of the Washington State Continuous Airport Systems. The main objective is to satisfy airport needs at the non-hub airports that serve as feeder airports to our state and regional air carrier airports, as well as the general aviation airports.

Although small grants (under $100,000) have been made to air carrier airports, State Aeronautics grants are not expected to be a significant source of funding for the Flight Plan airport alternatives.

Local Sources

A potential source of airport funding is general revenues from the City or County which owns and operates an airport. In recent years, however, local governments have looked for other means of financing airport operations and capital improvements because of the lack of adequate tax revenues.

Another method of airport funding is the establishment of a special purpose district such as an airport district or authority which can collect a percentage of property tax revenues within its jurisdiction. The formation of any multi-county airport jurisdiction must be approved by State legislature. The Port of Seattle has authority to operate outside of King County and therefore could operate a supplement airport in another County. However, the Port of Seattle can not collect tax revenues from another County. Presently, no tax revenues collected by the Port of Seattle are used to fund airport operations or airport capital improvements.

Private Sources

A significant source of private funding at airports is tenant provided improvements such as terminal equipment and facilities, hangar buildings, and associated aircraft ramps. In the estimated capital costs prepared for the airport alternatives, these tenant improvement costs have been excluded.

For the past several years, interest among the aviation community in the privatization of public airports has increased. The American Association of Airport Executives and the Airport Research and Development Foundation have recently undertaken a study of expanded private sector involvement in public airports, focusing on the issues of privatization and the role of private equity capital in public airports. Some recent attempts toward airport privatization, such as the proposed British American/Lockheed Air Terminal proposal to lease Albany County New York Airport, have not been successful.

A decision in August 1991 by the City of Los Angeles to investigate privatization for Los Angeles International Airport has attracted industry attention. Selling the airport to private interests is being considered because of the large amount of revenue the City of Los Angeles is asking the airport to provide the City, $100 million a year or over $2.00 per passenger.

Case Studies

Two large-scale airport improvement programs underway now are using a variety of funding sources (Table 7). Funds for the new Denver airport are largely being furnished through airport revenue bonds backed by airport operating revenues and PFCs, the sale of Stapleton Airport, and FAA discretionary funds. Four issues of revenue bonds to finance the airport will total $1.4 billion. FAA AIP discretionary funding of $330 million has been awarded for the new airport. Stapleton Airport which comprises 4,700 acres will eventually be sold and redeveloped to provide funds for the airport improvement program. The total capital cost for the new airport is expected to be $2.6 billion.

Pittsburgh International Airport has embarked on a program to relocate its passenger terminal facilities to the other side of the airport. The total cost of the program is estimated at over $700 million. Almost $500 million will be supplied through a 1988 revenue bond issue. FAA entitlement funds and discretionary funds will each contribute $67 million to the project. County and State funds together will provide over $120 million.

Costs for related access improvements at the two airports are not included. These could be as high as $200 million at Pittsburgh and $1 billion at Denver. Funds for these improvements could be provided by state and federal highway funds.

FINANCIAL CAPABILITY OF AIRPORT ALTERNATIVES

Airport alternatives were compared on the basis of their relative ability to provide funds to finance the estimated capital improvement costs. A "funds/costs ratio" was developed which provides a measure of the financial capability of the alternatives. The funds/cost ratio is

TABLE 7
SOURCES OF FUNDING FOR IMPROVEMENT PROJECTS FOR NEW DENVER AIRPORT AND PITTSBURGH INTERNATIONAL AIRPORT

Source of Funds	New Denver Airport [a] Amount (millions of dollars)	New Denver Airport [a] Percent	Pittsburgh International Airport Amount (millions of dollars)	Pittsburgh International Airport Percent
County	0	0	42	5.6
State	0	0	85	11.2
FAA Entitlement Funds	107	4.1	67	8.9
FAA Discretionary Funds	330	12.7	67	8.9
Revenue Bonds	1,400 [b]	53.8	494 [c]	65.4
Sale of Stapleton Airport and Other Sources After 1999	736	28.3	-	-
Total Cost of Project	2,600	100.0	755	100.0

[a] Sources of funds through 1999, except as noted.
[b] Backed by Airport revenues and PFCs.
[c] Backed by Airport revenues.

computed by dividing the total estimated airport funds by the total capital outlay for each airport alternative. The funds/cost ratio was also computed for the system of airports, to provide an indication of the financial capability of operating the airport under a single ownership (Table 8).

Five sources of funds were considered in this analyses. Sources of funds were estimated for the 20 year period from the year 2000 to 2020. All dollar figures are in 1991 dollars. The estimated funds were derived on the basis of the constrained allocation of passengers to airports shown in Table 9. This table appeared as Table 3 in Working Paper 5. Funds from State or Federal highway programs are not included, although these funds are not expected to be large enough to change the results of the analysis. Each source is discussed below:

- Net Operating Revenue. Airport operating revenues can fund improvement projects directly or be used to support airport revenue bonds. Net operating revenues for both primary and supplemental airports (including Sea-Tac) were estimated to average $1.2 per enplaned and deplaned passenger. This average is consistent with current experience at supplemental and primary airports as well as Sea-Tac as shown in Tables 4 through 6).

- Passenger Facilities Charges. A passenger facility charge of $3.00 per enplaned passenger is assumed to be collected at each airport from the year 2000 through 2020. Passenger facility charges were estimated under all airport alternatives except Alternatives 1, 2 and 33. PFCs were estimated without regard to the potential cost of eligible projects. Therefore the PFC funding represents a funding capability, but the PFC charges shown in Table 7 may exceed the cost of eligible improvement projects. Under multiple airport alternatives PFCs estimated for Sea-Tac could be used for a supplemental airport if controlled by a single owner-operator, such as the Port of Seattle.

  PFC legislation allows air carriers to retain 8 cents of each PFC collected after 1994. Therefore the PFC revenue allocated to each airport is estimated at $2.92 per enplaned passenger.

- FAA AIP Entitlement Funds. FAA AIP entitlement funds were allocated on the basis of the formula discussed earlier. Airport alternatives which reach or exceed the medium hub designation level, as explained earlier, will take a 50 percent reduction in entitlement funds if a PFC is collected. Therefore an airport could show a greater amount of funds from FAA entitlements than another airport that has more passengers if the smaller airport were a small hub airport and the larger airport was a medium hub airport. Estimated FAA entitlement funds were totaled for the 20-year period from the year 2000 to 2020.

TABLE 8
COMPARISON OF CAPITAL COSTS AND AVAILABLE FUNDS
TO YEAR 2020
(Millions of Dollars)

ALTERNATIVE / AIRPORT	FUNDS/ COST RATIO	TOTAL CAPITAL COST	SOURCES OF FUNDS (TO 2020)					
			TOTAL	NET OPER-ATING REVENUE	PASSENGER FACILITY CHARGES	FAA AIP ENTITLE-MENT	FAA AIP DISCRE-TIONARY	SALE OF SEA-TAC
1 Sea-Tac - No New Rwy	4.3	180.7	784.8	679.2	0.0	105.6	0.0	0.0
2 Sea-Tac - With Com Rwy	4.0	217.5	863.1	738.6	0.0	113.7	10.9	0.0
3 Sea-Tac - No New Rwy	8.9	180.7	1611.2	679.2	826.4	105.6	0.0	0.0
Arlington - 1 Rwy	1.4	252.1	352.2	138.6	168.6	44.9	0.0	0.0
Total	4.5	432.8	1963.3	817.8	995.0	150.6	0.0	0.0
4 Sea-Tac - No New Rwy	8.9	180.7	1609.8	678.6	825.6	105.5	0.0	0.0
Paine - 1 Rwy	0.7	549.1	383.3	151.8	184.7	46.8	0.0	0.0
Total	2.7	729.8	1993.1	830.4	1010.3	152.3	0.0	0.0
5 Sea-Tac - No New Rwy	8.9	180.7	1609.8	678.6	825.6	105.5	0.0	0.0
McChord - 1 Rwy	1.5	262.6	383.3	151.8	184.7	46.8	0.0	0.0
Total	4.5	443.3	1993.1	830.4	1010.3	152.3	0.0	0.0
6 Sea-Tac - No New Rwy	8.9	180.7	1609.8	678.6	825.6	105.5	0.0	0.0
Central Pierce - 1 Rwy	1.0	414.7	395.1	139.2	169.4	45.1	41.5	0.0
Total	3.4	595.4	2004.9	817.8	995.0	150.6	41.5	0.0
7 Sea-Tac - No New Rwy	8.9	180.7	1611.2	679.2	826.4	105.6	0.0	0.0
Olympia/Blk Lake - 1 Rwy	0.9	433.1	395.5	138.6	168.6	44.9	43.3	0.0
Total	3.3	613.8	2006.7	817.8	995.0	150.6	43.3	0.0
8 Sea-Tac - No New Rwy	8.9	180.7	1611.2	679.2	826.4	105.6	0.0	0.0
Arlington - 2 Rwy	1.1	357.5	399.7	151.2	184.0	46.6	17.9	0.0
Total	3.7	538.2	2010.9	830.4	1010.3	152.3	17.9	0.0
9 Sea-Tac - No New Rwy	8.9	180.7	1609.8	678.6	825.6	105.5	0.0	0.0
Paine - 2 Rwy	0.6	645.0	415.5	151.8	184.7	46.8	32.3	0.0
Total	2.5	825.7	2025.3	830.4	1010.3	152.3	32.3	0.0
10 Sea-Tac - No New Rwy	8.9	180.7	1609.8	678.6	825.6	105.5	0.0	0.0
McChord - 2 Rwy	1.4	293.7	398.0	151.8	184.7	46.8	14.7	0.0
Total	4.2	474.4	2007.7	830.4	1010.3	152.3	14.7	0.0
11 Sea-Tac - No New Rwy	8.9	180.7	1609.8	678.6	825.6	105.5	0.0	0.0
Central Pierce - 2 Rwy	0.6	698.4	453.1	151.8	184.7	46.8	69.8	0.0
Total	2.3	879.1	2062.9	830.4	1010.3	152.3	69.8	0.0

TABLE 8
COMPARISON OF CAPITAL COSTS AND AVAILABLE FUNDS
TO YEAR 2020
(Millions of Dollars)

ALTERNATIVE / AIRPORT	FUNDS/ COST RATIO	TOTAL CAPITAL COST	SOURCES OF FUNDS (TO 2020)					
			TOTAL	NET OPERATING REVENUE	PASSENGER FACILITY CHARGES	FAA AIP ENTITLEMENT	FAA AIP DISCRETIONARY	SALE OF SEA-TAC
12 Sea-Tac - No New Rwy	8.9	180.7	1611.2	679.2	826.4	105.6	0.0	0.0
Olympia/Blk Lake - 2 Rwy	0.7	625.4	444.3	151.2	184.0	46.6	62.5	0.0
Total	2.5	806.1	2055.5	830.4	1010.3	152.3	62.5	0.0
13 Sea-Tac With Dep Rwy	3.1	615.8	1890.4	784.8	954.8	119.9	30.8	0.0
Arlington - 1 Rwy	0.9	156.0	140.7	45.6	55.5	39.7	0.0	0.0
Total	2.6	771.8	2031.1	830.4	1010.3	159.6	30.8	0.0
14 Sea-Tac With Dep Rwy	3.0	615.8	1852.3	768.6	935.1	117.7	30.8	0.0
Paine - 1 Rwy	0.4	426.9	181.0	61.8	75.2	44.0	0.0	0.0
Total	2.0	1042.7	2033.3	830.4	1010.3	161.8	30.8	0.0
15 Sea-Tac With Dep Rwy	3.0	615.8	1855.1	769.8	936.6	117.9	30.8	0.0
McChord - 1 Rwy	1.3	139.0	178.0	60.6	73.7	43.7	0.0	0.0
Total	2.7	754.8	2033.1	830.4	1010.3	161.6	30.8	0.0
16 Sea-Tac With Dep Rwy	3.0	615.8	1853.7	769.2	935.9	117.8	30.8	0.0
Central Pierce - 1 Rwy	0.7	319.4	211.5	61.2	74.5	43.9	31.9	0.0
Total	2.2	935.2	2065.1	830.4	1010.3	161.7	62.7	0.0
17 Sea-Tac With Dep Rwy	3.1	615.8	1912.9	794.4	966.5	121.2	30.8	0.0
Olympia/Blk Lake - 1 Rwy	0.4	342.3	151.1	36.0	43.8	37.1	34.2	0.0
Total	2.2	958.1	2064.0	830.4	1010.3	158.3	65.0	0.0
18 Sea-Tac With Dep Rwy	3.1	615.8	1890.4	784.8	954.8	119.9	30.8	0.0
Arlington - 2 Rwy	0.7	201.5	150.8	45.6	55.5	39.7	10.1	0.0
Total	2.5	817.3	2041.2	830.4	1010.3	159.6	40.9	0.0
19 Sea-Tac With Dep Rwy	3.0	615.8	1852.3	768.6	935.1	117.7	30.8	0.0
Paine - 2 Rwy	0.4	522.8	207.2	61.8	75.2	44.0	26.1	0.0
Total	1.8	1138.6	2059.4	830.4	1010.3	161.8	56.9	0.0
20 Sea-Tac With Dep Rwy	3.0	615.8	1855.1	769.8	936.6	117.9	30.8	0.0
McChord - 2 Rwy	1.1	170.1	186.5	60.6	73.7	43.7	8.5	0.0
Total	2.6	785.9	2041.6	830.4	1010.3	161.6	39.3	0.0
21 Sea-Tac With Dep Rwy	3.0	615.8	1853.7	769.2	935.9	117.8	30.8	0.0
Central Pierce - 2 Rwy	0.4	542.5	233.8	61.2	74.5	43.9	54.3	0.0
Total	1.8	1158.3	2087.4	830.4	1010.3	161.7	85.0	0.0

TABLE 8
COMPARISON OF CAPITAL COSTS AND AVAILABLE FUNDS TO YEAR 2020
(Millions of Dollars)

ALTERNATIVE / AIRPORT	FUNDS/ COST RATIO	TOTAL CAPITAL COST	SOURCES OF FUNDS (TO 2020)					
			TOTAL	NET OPER-ATING REVENUE	PASSENGER FACILITY CHARGES	FAA AIP ENTITLE-MENT	FAA AIP DISCRE-TIONARY	SALE OF SEA-TAC
22 Sea-Tac With Dep Rwy	3.1	615.8	1912.9	794.4	966.5	121.2	30.8	0.0
Olympia/Blk Lake - 2 Rwy	0.4	364.0	153.3	36.0	43.8	37.1	36.4	0.0
Total	2.1	979.8	2066.2	830.4	1010.3	158.3	67.2	0.0
23 Sea-Tac - No New Rwy	8.8	180.7	1592.8	671.4	816.9	104.6	0.0	0.0
Arlington - 1 Rwy	0.9	237.7	225.8	79.8	97.1	48.9	0.0	0.0
Central Pierce - 1 Rwy	0.7	369.5	247.0	79.2	96.4	34.5	37.0	0.0
Total	2.6	787.9	2065.6	830.4	1010.3	187.9	37.0	0.0
24 Sea-Tac - No New Rwy	8.8	180.7	1583.0	667.2	811.8	104.0	0.0	0.0
Paine - 1 Rwy	0.5	459.5	230.3	81.6	99.3	49.4	0.0	0.0
Central Pierce - 1 Rwy	0.7	359.7	266.3	81.6	99.3	49.4	36.0	0.0
Total	2.1	999.9	2079.5	830.4	1010.3	202.8	36.0	0.0
25 Sea-Tac - No New Rwy	8.9	180.7	1608.4	678.0	824.9	105.5	0.0	0.0
Arlington - 1 Rwy	0.9	237.7	221.4	84.0	102.2	35.2	0.0	0.0
Olympia/Blk Lake - 1 Rwy	0.6	374.0	234.8	68.4	83.2	45.8	37.4	0.0
Total	2.6	792.4	2064.6	830.4	1010.3	186.5	37.4	0.0
26 Sea-Tac - No New Rwy	8.8	180.7	1598.5	673.8	819.8	104.9	0.0	0.0
Paine - 1 Rwy	0.5	485.8	254.8	97.8	119.0	38.0	0.0	0.0
Olympia/Blk Lake - 1 Rwy	0.6	361.1	209.7	58.8	71.5	43.2	36.1	0.0
Total	2.0	1027.6	2063.0	830.4	1010.3	186.1	36.1	0.0
27 Sea-Tac - With Dep Rwy	2.9	615.8	1760.5	729.6	887.7	112.5	30.8	0.0
Arlington - 1 Rwy	0.8	156.0	125.8	39.6	48.2	38.0	0.0	0.0
Central Pierce - 1 Rwy	0.7	319.4	211.5	61.2	74.5	43.9	31.9	0.0
Total	1.9	1091.2	2097.8	830.4	1010.3	194.4	62.7	0.0
28 Sea-Tac - With Dep Rwy	2.8	615.8	1708.3	707.4	860.7	109.4	30.8	0.0
Paine - 1 Rwy	0.4	426.9	181.0	61.8	75.2	44.0	0.0	0.0
Central Pierce - 1 Rwy	0.7	319.4	211.5	61.2	74.5	43.9	31.9	0.0
Total	1.5	1362.1	2100.8	830.4	1010.3	197.4	62.7	0.0
29 Sea-Tac - With Dep Rwy	3.0	615.8	1846.6	766.2	932.2	117.4	30.8	0.0
Arlington - 1 Rwy	0.8	156.0	125.8	39.6	48.2	38.0	0.0	0.0
Olympia/Blk Lake - 1 Rwy	0.4	314.0	119.9	24.6	29.9	34.0	31.4	0.0
Total	1.9	1085.8	2092.3	830.4	1010.3	189.4	62.2	0.0

TABLE 8
COMPARISON OF CAPITAL COSTS AND AVAILABLE FUNDS
TO YEAR 2020
(Millions of Dollars)

ALTERNATIVE / AIRPORT	FUNDS/ COST RATIO	TOTAL CAPITAL COST	SOURCES OF FUNDS (TO 2020): TOTAL	NET OPERATING REVENUE	PASSENGER FACILITY CHARGES	FAA AIP ENTITLEMENT	FAA AIP DISCRETIONARY	SALE OF SEA-TAC
30 Sea-Tac - With Dep Rwy	2.9	615.8	1794.4	744.0	905.2	114.4	30.8	0.0
Paine - 1 Rwy	0.4	426.9	181.0	61.8	75.2	44.0	0.0	0.0
Olympia/Blk Lake - 1 Rwy	0.4	314.0	119.9	24.6	29.9	34.0	31.4	0.0
Total	1.5	1356.7	2095.3	830.4	1010.3	192.4	62.2	0.0
31 Central Pierce - 3 Rwy	1.3	2078.0	2798.6	830.4	1010.3	126.1	207.8	624.0
32 Olympia/Blk Lake - 3 Rwy	1.5	1809.3	2771.8	830.4	1010.3	126.1	180.9	624.0
33 Sea-Tac With Dem Mgmt	4.0	229.6	908.8	788.4	0.0	120.4	0.0	0.0
34 Fort Lewis - 3 Rwy	1.8	1563.9	2747.2	830.4	1010.3	126.1	156.4	624.0

Source: P & D Aviation.

TABLE 9
CONSTRAINED ALLOCATION OF PASSENGERS TO AIRPORTS

Alternate	Description	Enplaned and Deplaned Passengers											
		Year 2000 (25.4MAP)				Year 2010 (34.0 MAP)				Year 2020 (45.0 MAP)			
		Sea-Tac	North	South	Unsat.	Sea-Tac	North	South	Unsat.	Sea-Tac	North	South	Unsat.
1	Sea-Tac without Commuter R/W	23.6	0.0	0.0	1.8	28.8	0.0	0.0	5.2	32.0	0.0	0.0	13.0
2	Sea-Tac with Commuter R/W	25.4	0.0	0.0	0.0	31.4	0.0	0.0	2.6	34.9	0.0	0.0	10.1
3	Alternate 1 + Arlington 1 R/W	23.6	1.8	0.0	0.0	28.8	5.2	0.0	0.0	32.0	10.9	0.0	2.1
4	Alternate 1 + Paine 1 R/W	23.5	1.9	0.0	0.0	28.8	5.2	0.0	0.0	32.0	13.0	0.0	0.0
5	Alternate 1 + McChord 1 R/W	23.5	0.0	1.9	0.0	28.8	0.0	5.2	0.0	32.0	0.0	13.0	0.0
6	Alternate 1 + Central Pierce 1 R/W	23.5	0.0	1.9	0.0	28.8	0.0	5.2	0.0	32.0	0.0	10.9	2.1
7	Alternate 1 + Olympia/Black Lake 1 R/W	23.6	0.0	1.8	0.0	28.8	0.0	5.2	0.0	32.0	0.0	10.9	2.1
8	Alternate 1 + Arlington 2 R/W	23.6	1.8	0.0	0.0	28.8	5.2	0.0	0.0	32.0	13.0	0.0	0.0
9	Alternate 1 + Paine 2 R/W	23.5	1.9	0.0	0.0	28.8	5.2	0.0	0.0	32.0	13.0	0.0	0.0
10	Alternate 1 + McChord 2 R/W	23.5	0.0	1.9	0.0	28.8	0.0	5.2	0.0	32.0	0.0	13.0	0.0
11	Alternate 1 + Central Pierce 2 R/W	23.5	0.0	1.9	0.0	28.8	0.0	5.2	0.0	32.0	0.0	13.0	0.0
12	Alternate 1 + Olympia/Black Lake 2 R/W	23.6	0.0	1.8	0.0	28.8	0.0	5.2	0.0	32.0	0.0	13.0	0.0
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	24.2	1.2	0.0	0.0	32.4	1.6	0.0	0.0	41.8	3.2	0.0	0.0
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	23.5	1.9	0.0	0.0	31.5	2.5	0.0	0.0	41.6	3.4	0.0	0.0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	23.5	0.0	1.9	0.0	31.5	0.0	2.5	0.0	41.8	0.0	3.2	0.0
16	Sea-Tac w/Dependent R/W + Cen. Pierce 1 R/W	23.5	0.0	1.9	0.0	31.5	0.0	2.5	0.0	41.7	0.0	3.3	0.0
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	24.6	0.0	0.8	0.0	33.0	0.0	1.0	0.0	41.8	0.0	3.2	0.0
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	24.2	1.2	0.0	0.0	32.4	1.6	0.0	0.0	41.8	3.2	0.0	0.0
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	23.5	1.9	0.0	0.0	31.5	2.5	0.0	0.0	41.6	3.4	0.0	0.0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	23.5	0.0	1.9	0.0	31.5	0.0	2.5	0.0	41.8	0.0	3.2	0.0
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	23.5	0.0	1.9	0.0	31.5	0.0	2.5	0.0	41.7	0.0	3.3	0.0
22	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 2 R/W	24.6	0.0	0.8	0.0	33.0	0.0	1.0	0.0	41.8	0.0	3.2	0.0
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	22.3	1.2	1.9	0.0	28.8	3.1	2.1	0.0	32.0	5.9	7.1	0.0
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	21.6	1.9	1.9	0.0	28.8	2.6	2.6	0.0	32.0	6.5	6.5	0.0
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R	23.4	1.2	0.8	0.0	28.8	2.9	2.3	0.0	32.0	7.0	6.0	0.0
26	Alternate 1 + Paine 1 R/W + Olym./Blk. Lake 1 R/W	22.7	1.9	0.8	0.0	28.9	3.4	1.8	0.0	32.0	7.6	5.4	0.0
27	Alternate 13 + Central Pierce 1 R/W	22.3	1.2	1.9	0.0	29.9	1.6	2.5	0.0	39.5	2.2	3.3	0.0
28	Alternate 14 + Central Pierce 1 R/W	21.6	1.9	1.9	0.0	29.0	2.5	2.5	0.0	38.3	3.4	3.3	0.0
29	Alternate 13 + Olympia/Black Lake 1 R/W	23.4	1.2	0.8	0.0	31.4	1.6	1.0	0.0	41.5	2.2	1.3	0.0
30	Alternate 14 + Olympia/Black Lake 1 R/W	22.7	1.9	0.8	0.0	30.5	2.5	1.0	0.0	40.3	3.1	1.3	0.0
31	Central Pierce 3 R/W	0.0	0.0	25.4	0.0	0.0	0.0	34.0	0.0	0.0	0.0	45.0	0.0
32	Olympia/Black Lake 3 R/W	0.0	0.0	25.4	0.0	0.0	0.0	34.0	0.0	0.0	0.0	45.0	0.0
33	Alternate 1 + Demand Management	25.4	0.0	0.0	0.0	34.0	0.0	0.0	0.0	38.0	0.0	0.0	7.0

Note: Supplemental airport demand is based on mid range of unconstrained demand (i.e., accommodating 75 percent of short haul and 50 percent of long haul demand)

- FAA AIP Discretionary Funds. Although the FAA can make no commitment on future discretionary funding the amount of discretionary funds available for alternative airport development has been estimated based on current experience. New airport alternatives are estimated to receive 10 percent of the total capital cost in FAA discretionary funding. Alternatives involving the construction of a new runway and related facilities at an existing airport are estimated to receive 5 percent of the total capital cost in FAA discretionary funding. These percentages are less than the percents allocated to the new Denver Airport (12.7 percent) and the expansion of the Pittsburgh International Airport (8.9 percent).

- Sale of Sea-Tac Airport. Under the replacement airport alternatives (Alternatives 31, 32 and 34) it is assumed that all Sea-Tac Airport property will be sold to help fund the cost of improvements at the replacement site. Sea-Tac comprises approximately 2,400 acres. The value of Sea-Tac property was estimated at its land value alone. The estimated land value is $260,000 per acre, approximately $6.00 a square foot, a total of $624,000,000 for all airport property.

The funds/cost ratio compares funds which will be collected over a 20-year period with capital improvement costs which, to a large degree, will be paid out in the initial stages of the project. Therefore, the time value of money must be considered. The financing of a new airport to serve the Puget Sound Region would probably be accomplished largely through an issue of revenue bonds which would be supported by revenues from airport operations, including PFCs. For example, a bond issue providing $100 million in capital for land acquisition and construction would require total funds (principal and interest payments) of approximately $235 million at 7.5 percent interest and equal payments over 20 years, or 2.35 times the capital provided. For the airport alternatives being considered, not all capital costs will be incurred at the outset. On the other hand, airport revenues will be relatively small in early years when passenger levels are small. Therefore, it is estimate that the funds/cost ratio must generally exceed 2.0 to 2.5 for an airport program to be financially viable, assuming most of the capital cost will be incurred at the outset of the program.

CONCLUSIONS OF FINANCIAL CAPABILITY ANALYSES

The following conclusions can be made from the analyses of the financial capability of airport alternatives (summarized in Table 8):

- Funding from PFCs could contribute one-third to one-half of the total airport funds.

- Under the alternatives with Sea-Tac alone, funds will be sufficient to finance estimated future capital expenditures.

- Capital funding could be insufficient for existing airports if converted to supplemental airports due to the large capital costs relative to the number of passengers served. For 1-runway supplementals the funds/cost ratios, based on the funds identified in Table 8, are estimated to be between 0.4 and 1.5. For 2-runway supplementals, the ratios are 0.4 to 1.4.

- Capital funding is estimated to be inadequate for new airport alternatives. New supplementals are estimated to have a funds/cost ratio of 1 or less due to their high cost and relatively low level of passengers served. New replacement airports are estimated to have funds/cost ratios from 1.3 to 1.8.

- Airport alternatives with funds/cost ratios below 2.0 to 2.5 could possibly become financially viable if additional sources of funds were obtained, such as from local sources, or if passenger levels were to increase, especially in earlier years.

- Nearly all multiple airport system alternatives would be financially feasible if: (a) funds from Sea-Tac were used to finance improvements at the other airports and (b) PFCs are collected at Sea-Tac and the supplemental airports.

- During the period analyzed (2000-2020) supplemental airports do not appear to be financially viable without subsidies from Sea-TAC.

- A new commuter runway or dependent air carrier runway at Sea-Tac are the only capacity improvements which generate sufficient funds to offset costs.

APPENDIX A

TOTAL ANNUAL DELAY COSTS FOR YEARS 2000 THROUGH 2020

APPENDIX A
TOTAL ANNUAL DELAY COSTS

Alternate	Description	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	Sea-Tac without Commuter R/W	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000
2	Sea-Tac with Commuter R/W	$225,600,000	$227,040,000	$228,480,000	$229,920,000	$231,360,000	$232,800,000	$234,240,000	$235,680,000	$237,120,000
3	Alternate 1 + Arlington 1 R/W	$233,886,730	$234,183,989	$234,481,240	$234,778,491	$235,075,743	$235,372,994	$235,670,245	$235,967,496	$236,264,748
4	Alternate 1 + Paine 1 R/W	$230,434,267	$230,606,893	$230,779,520	$230,952,147	$231,124,773	$231,297,400	$231,470,027	$231,642,653	$231,815,280
5	Alternate 1 + McChord 1 R/W	$230,434,267	$230,606,920	$230,779,573	$230,952,227	$231,124,880	$231,297,533	$231,470,187	$231,642,840	$231,815,493
6	Alternate 1 + Central Pierce 1 R/W	$232,301,850	$232,757,590	$233,213,330	$233,669,070	$234,124,810	$234,580,550	$235,036,290	$235,492,030	$235,947,770
7	Alternate 1 + Olympia/Black Lake 1 R/W	$233,886,730	$234,183,989	$234,481,240	$234,778,491	$235,075,743	$235,372,994	$235,670,245	$235,967,496	$236,264,748
8	Alternate 1 + Arlington 2 R/W	$232,919,700	$232,971,309	$233,022,918	$233,074,528	$233,126,137	$233,177,746	$233,229,355	$233,280,964	$233,332,573
9	Alternate 1 + Paine 2 R/W	$230,434,267	$230,606,893	$230,779,520	$230,952,147	$231,124,773	$231,297,400	$231,470,027	$231,642,653	$231,815,280
10	Alternate 1 + McChord 2 R/W	$230,434,267	$230,606,947	$230,779,627	$230,952,307	$231,124,987	$231,297,667	$231,470,347	$231,643,027	$231,815,707
11	Alternate 1 + Central Pierce 2 R/W	$231,327,067	$231,537,939	$231,748,812	$231,959,684	$232,170,557	$232,381,429	$232,592,302	$232,803,174	$233,014,047
12	Alternate 1 + Olympia/Black Lake 2 R/W	$232,919,700	$232,971,309	$233,022,918	$233,074,528	$233,126,137	$233,177,746	$233,229,355	$233,280,964	$233,332,573
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	$64,822,400	$68,818,410	$72,814,420	$76,810,430	$80,806,440	$84,802,450	$88,798,460	$92,794,470	$96,790,480
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	$56,034,267	$59,154,693	$62,275,120	$65,395,547	$68,515,973	$71,636,400	$74,756,827	$77,877,253	$80,997,680
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	$56,034,267	$59,154,707	$62,275,147	$65,395,587	$68,516,027	$71,636,467	$74,756,907	$77,877,347	$80,997,787
16	Sea-Tac w/Dependent R/W + Cen. Pierce 1 R/W	$56,981,600	$60,103,580	$63,225,560	$66,347,540	$69,469,520	$72,591,500	$75,713,480	$78,835,460	$81,957,440
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	$69,494,400	$74,219,710	$78,945,020	$83,670,330	$88,395,640	$93,120,950	$97,846,260	$102,571,570	$107,296,880
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	$64,411,200	$68,412,187	$72,413,173	$76,414,160	$80,415,147	$84,416,133	$88,417,120	$92,418,107	$96,419,093
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	$56,034,267	$59,158,573	$62,282,880	$65,407,187	$68,531,493	$71,655,800	$74,780,107	$77,904,413	$81,028,720
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	$56,034,267	$59,158,573	$62,282,880	$65,407,187	$68,531,493	$71,655,800	$74,780,107	$77,904,413	$81,028,720
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	$56,436,267	$59,557,733	$62,679,200	$65,800,667	$68,922,133	$72,043,600	$75,165,067	$78,286,533	$81,408,000
22	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 2 R/W	$69,196,800	$73,917,227	$78,637,653	$83,358,080	$88,078,507	$92,798,933	$97,519,360	$102,239,787	$106,960,213
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	$178,593,250	$184,224,837	$189,856,423	$195,488,010	$201,119,597	$206,751,183	$212,382,770	$218,014,357	$223,645,943
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	$142,245,317	$151,369,698	$160,494,080	$169,618,462	$178,742,843	$187,867,225	$196,991,607	$206,115,988	$215,240,370
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R	$229,380,400	$229,932,908	$230,485,415	$231,037,923	$231,590,430	$232,142,938	$232,695,445	$233,247,953	$233,800,460
26	Alternate 1 + Paine 1 R/W + Olym./Blk. Lake 1 R/W	$191,432,467	$195,616,220	$199,799,973	$203,983,727	$208,167,480	$212,351,233	$216,534,987	$220,718,740	$224,902,493
27	Alternate 13 + Central Pierce 1 R/W	$49,804,000	$52,601,990	$55,399,980	$58,197,970	$60,995,960	$63,793,950	$66,591,940	$69,389,930	$72,187,920
28	Alternate 14 + Central Pierce 1 R/W	$41,015,067	$44,618,273	$48,220,680	$51,823,087	$55,425,493	$59,027,900	$62,630,307	$66,232,713	$69,835,120
29	Alternate 13 + Olympia/Black Lake 1 R/W	$62,316,800	$64,718,120	$67,119,440	$69,520,760	$71,922,080	$74,323,400	$76,724,720	$79,126,040	$81,527,360
30	Alternate 14 + Olympia/Black Lake 1 R/W	$52,728,667	$55,534,403	$58,340,140	$61,145,877	$63,951,613	$66,757,350	$69,563,087	$72,368,823	$75,174,560
31	Central Pierce 3 R/W	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$11,374,400	$11,808,800	$12,243,200
32	Olympia/Black Lake 3 R/W	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$11,374,400	$11,808,800	$12,243,200
33	Alternate 1 + Demand Management	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000
34	Alternate 18 + Olympia Black Lake 2 R/W	$55,208,000	$58,568,833	$61,929,707	$65,290,560	$68,651,413	$72,012,267	$75,373,120	$75,373,120	$78,733,973
35	Alternate 19 + Central Pierce 2 R/W	$36,470,800	$38,472,120	$40,473,440	$42,474,760	$44,476,080	$46,477,400	$48,478,720	$50,480,040	$52,481,360

Source: P&D analysis

APPENDIX A
TOTAL ANNUAL DELAY COSTS

2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	TOTAL
$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$4,872,000,000
$238,560,000	$240,000,000	$240,000,000	$240,000,000	$240,000,000	$240,000,000	$240,000,000	$240,000,000	$240,000,000	$240,000,000	$240,000,000	$240,000,000	$4,960,000,000
$236,561,999	$236,859,250	$240,248,325	$243,637,400	$247,026,475	$250,415,550	$253,804,625	$257,193,700	$260,582,775	$263,971,850	$267,360,925	$270,750,000	$5,144,094,556
$231,987,907	$232,160,533	$232,321,813	$232,483,093	$232,644,373	$232,805,653	$232,966,933	$233,128,213	$233,289,493	$233,450,773	$233,612,053	$233,773,333	$4,874,747,131
$231,988,147	$232,160,800	$232,322,053	$232,483,307	$232,644,560	$232,805,813	$232,967,067	$233,128,320	$233,289,573	$233,450,827	$233,612,080	$233,773,333	$4,874,749,800
$236,403,510	$236,859,250	$240,248,325	$243,637,400	$247,026,475	$250,415,550	$253,804,625	$257,193,700	$260,582,775	$263,971,850	$267,360,925	$270,750,000	$5,135,377,675
$236,561,999	$236,859,250	$240,248,325	$243,637,400	$247,026,475	$250,415,550	$253,804,625	$257,193,700	$260,582,775	$263,971,850	$267,360,925	$270,750,000	$5,144,094,556
$233,384,183	$233,435,792	$233,752,913	$234,070,033	$234,387,154	$234,704,275	$235,021,396	$235,338,517	$235,655,638	$235,972,758	$236,289,879	$236,607,000	$4,916,754,767
$231,987,907	$232,160,533	$232,250,880	$232,341,227	$232,431,573	$232,521,920	$232,612,267	$232,702,613	$232,792,960	$232,883,307	$232,973,653	$233,064,000	$4,870,845,800
$231,988,187	$232,161,067	$232,251,360	$232,341,653	$232,431,947	$232,522,240	$232,612,533	$232,702,827	$232,793,120	$232,883,413	$232,973,707	$233,064,000	$4,870,851,133
$233,224,919	$233,435,792	$233,752,913	$234,070,033	$234,387,154	$234,704,275	$235,021,376	$235,338,517	$235,655,638	$235,972,758	$236,289,879	$236,607,000	$4,907,995,283
$233,384,183	$233,435,792	$233,752,913	$234,070,033	$234,387,154	$234,704,275	$235,021,376	$235,338,517	$235,655,638	$235,972,758	$236,289,879	$236,607,000	$4,916,754,767
$100,786,490	$104,782,500	$118,418,050	$132,053,600	$145,689,150	$159,324,700	$172,960,250	$186,595,800	$200,231,350	$213,866,900	$227,502,450	$241,138,000	$2,730,407,200
$84,118,107	$87,238,533	$101,719,320	$116,200,107	$130,680,893	$145,161,680	$159,642,467	$174,123,253	$188,604,040	$203,084,827	$217,565,613	$232,046,400	$2,456,829,000
$84,118,227	$87,238,667	$102,519,160	$117,799,653	$133,080,147	$148,360,640	$163,641,133	$178,921,627	$194,202,120	$209,482,613	$224,763,107	$240,043,600	$2,500,814,933
$85,079,420	$88,201,400	$103,095,793	$117,990,187	$132,884,580	$147,778,973	$162,673,367	$177,567,760	$192,462,153	$207,356,547	$222,250,940	$237,145,333	$2,499,712,133
$112,022,190	$116,747,500	$129,186,350	$141,625,600	$154,064,650	$166,503,700	$178,942,750	$191,381,800	$203,820,850	$216,259,900	$228,698,950	$241,138,000	$2,875,953,200
$100,420,080	$104,421,067	$118,035,860	$131,650,653	$145,265,447	$158,880,240	$172,495,033	$186,109,827	$199,724,620	$213,339,413	$226,954,207	$240,569,000	$2,721,601,767
$84,153,027	$87,277,333	$101,758,880	$116,240,427	$130,721,973	$145,203,520	$159,685,067	$174,166,613	$188,648,160	$203,129,707	$217,611,253	$232,092,800	$2,457,472,200
$84,153,027	$87,277,333	$102,558,320	$117,839,307	$133,120,293	$148,401,280	$163,682,267	$178,963,253	$194,244,240	$209,525,227	$224,806,213	$240,087,200	$2,501,441,400
$84,529,467	$87,650,933	$102,543,007	$117,435,280	$132,327,453	$147,219,627	$162,111,800	$177,003,973	$191,896,147	$206,788,320	$221,680,493	$236,572,667	$2,498,058,467
$111,680,640	$116,401,067	$128,817,860	$141,234,653	$153,651,447	$166,068,240	$178,485,033	$190,901,827	$203,318,620	$215,735,413	$228,152,207	$240,569,000	$2,867,722,567
$229,277,530	$234,909,117	$235,465,009	$236,020,898	$236,576,789	$237,132,680	$237,688,571	$238,244,462	$238,800,353	$239,356,243	$239,912,134	$240,468,025	$4,653,928,179
$224,364,752	$233,489,133	$233,748,047	$234,006,961	$234,265,875	$234,524,788	$234,783,702	$235,042,616	$235,301,530	$235,560,443	$235,819,357	$236,078,271	$4,415,671,065
$234,352,968	$234,905,475	$235,480,168	$236,054,862	$236,629,555	$237,204,248	$237,778,942	$238,353,635	$238,928,328	$239,503,022	$240,077,715	$240,652,408	$4,934,233,196
$229,086,247	$233,270,000	$233,491,107	$233,712,213	$233,933,320	$234,154,427	$234,375,533	$234,596,640	$234,817,747	$235,038,853	$235,259,960	$235,481,067	$4,680,724,433
$74,985,910	$77,783,900	$86,685,643	$95,587,387	$104,489,130	$113,390,873	$122,292,617	$131,194,360	$140,096,103	$148,997,847	$157,899,590	$166,801,333	$1,969,160,333
$73,437,527	$77,839,933	$83,455,113	$89,870,293	$96,285,473	$102,700,653	$109,115,833	$115,531,013	$121,946,193	$128,361,373	$134,776,553	$141,191,733	$1,772,541,133
$83,928,600	$86,330,000	$100,573,207	$114,816,413	$129,059,620	$143,302,827	$157,546,033	$171,789,240	$186,032,447	$200,275,653	$214,518,860	$228,762,067	$2,464,233,767
$77,990,297	$80,786,033	$91,662,677	$102,539,320	$113,415,963	$124,292,607	$135,169,250	$146,045,893	$156,922,537	$167,799,180	$178,675,823	$189,552,467	$2,140,406,567
$12,677,600	$13,112,000	$14,246,133	$15,380,267	$16,514,400	$17,648,533	$18,782,667	$19,916,800	$21,050,933	$22,185,067	$23,319,200	$24,453,333	$1,646,713,333
$12,677,600	$13,112,000	$14,246,133	$15,380,267	$16,514,400	$17,648,533	$18,782,667	$19,916,800	$21,050,933	$22,185,067	$23,319,200	$24,453,333	$1,646,713,333
$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$232,000,000	$4,872,000,000
$82,094,826	$88,816,533	$96,497,200	$104,177,866	$111,858,533	$119,539,200	$127,219,867	$134,900,533	$142,581,200	$150,261,867	$157,942,533	$165,623,200	$2,092,654,170
$54,482,600	$56,484,000	$64,880,587	$73,277,173	$81,673,760	$90,070,347	$98,466,934	$106,863,520	$115,260,107	$123,656,694	$132,053,280	$140,449,867	$1,537,903,667

APPENDIX D

INSTITUTIONAL ELEMENTS

WORKING PAPER # 10

INSTITUTIONAL AND IMPLEMENTATION ANALYSIS

PRESENTED
OCTOBER 23, 1991

ADOPTED
NOVEMBER 26, 1991

DATE: November 6, 1991

TO: Puget Sound Air Transportation Committee (PSATC)

FROM: Staff: Puget Sound Regional Council and Port of Seattle

SUBJECT: **WORKING PAPER NO. 10 - INSTITUTIONAL and IMPLEMENTATION ANALYSIS**

INTRODUCTION

The goal of Flight Plan Phase III is to evaluate alternative means of meeting the future air travel needs of the region, and for the advisory PSATC to develop long term recommendations to the Puget Sound Regional Council and Port of Seattle. An important part of these recommendations will address the institutional steps needed to implement the selected course of action.

The purpose of this working paper is twofold:

(1) to compare institutional capabilities and needs (particularly with regard to **siting and operational authority**) for each of the system alternatives, and

(2) To identify the steps that would be needed to implement the alternative system plans in the state of Washington.

This paper is divided into six major parts: (i) a Summary, (ii) Growth Management Elements Common to all Alternatives, (iii) Site Specific Considerations, (iv) Ways to Operate Multi-Airport Systems, (v) Implementation Steps and (vi) the Expert Panel Recommendations.

I. SUMMARY

HIGHLIGHTS

The Puget Sound Air Transportation Committee (PSATC) is advisory to the Port of Seattle (POS) and the Puget Sound Regional Council (PSRC). This joint body, created through the Interagency Agreement in 1989, involves interested parties in the development of a long term recommendation on air carrier service and facilities for the Puget Sound region. Using staff research and an expert panel, the Committee has explored ways to develop and operate each of the air transportation systems alternatives. The following is a summary of its findings:

- **The Flight Plan Project is intended by the sponsoring agencies to develop recommenations about the future of air carrier services and facilities in the Puget Sound region.** Other components of the air transportation system which are included in the 1987 Regional Airport System Plan (such as general aviation) may need to be addressed in subsequent steps, once the PSATC's recommendations are completed. While Flight Plan was not created to address general aviation needs, the possible impact of Flight Plan recommendations on general aviation should be considered by the PSATC in its transmittal to its sponsoring agencies.

- **The Flight Plan recommendations (and programmatic environmental impact statement--EIS) should lead to additional and more specific studies and decisions implementing the selected system alternative,**

- **Under current state statutes, municipal airport operators including the Port of Seattle possess the power to act outside of their respective jurisdictional boundaries; this authority can be exercised either singly or jointly.**

- **Siting of any new facilities recently has been addressed by the State Growth Management Act (GMA).** This includes significant deadlines in 1992 (countywide and multicounty policy plans), 1993 (coordinated local comprehensive plans) and 1994 (consistent local regulations). Flight Plan is not a siting study, but does examine specific likely sites in evaluating system level alternatives (no-action, replacement, two airport systems, three airport systems).

- **Airports, unlike many other public infrastructure projects, are primarily funded by private investment, either in the form of airline fees or direct user fees.** The amount of revenue generated by these fees is a function of the level of service provided to the public by these air carriers. the legvel of airline service depends on airline conclusions regarding market demand. Airports' abilities to regulate air carrier service are quite limited by federal grant assurances attached to FAA funding agreements, but do include the opportunity to regulate gates (as opposed to air traffic).

- **A number of strategic actions can be used to implement the PSATC's recommendations.** These include specific demand management actions, compliance with the state Growth Management Act with regard to siting of facilities of regional or state significance, establishment of joint operational structures under other current state law, and landbanking. **Linkages** between actions/inactions at Sea-Tac and on other sites, and with continued collaborative mechanisms to follow the completion of the Flight Plan recommendations on alternatives, and monitoring and phasing tools, should also be considered.

- The **attachment** to this Working Paper illustrates some of the linkages between Flight Plan implementation steps, the Growth Management Act requirements, and other related regional planning issues.

II. GROWTH MANAGEMENT ELEMENTS COMMON TO ALL ALTERNATIVES

Regardless of which air carrier airport system alternative is reocommended by the PSATC, the resulting implementation actions by the Puget Sound Regional Council, its member governments, and the Port of Seattle (and possibly other facility operators) will have to comply with related provisions in state and federal l legislation. This section outlines the most significant of these provisions, most of which come under the new State Growth Management Act or the authority of the Federal Aviation Administration.

Also of great importance is that fact that a multiple airport system recommendation will not be successful unless the airlines themselves concur in the routing of their planes to airports in the new market areas. **This factor weighs as heavily as all of the public sector factors addressed below in this section.** The Palmdale Airport provides a good example of a selected site which is not in use because the market potential is not sufficient to attract the airlines.

A. STATE LEGISLATION

The State Growth Management Act has created a unique and important window of opportunity for integrating regional transporation facility plans with local, county, and regional level plans and policies. Federal guidelines also support the need for statutes like the GMA to coordinate between airport planning and state and local planning (see FAA Advisory Circular AC No. 150/5050-34B, Sec. 23).

1. Local Plans

Pursuant to the GMA, cities and counties (including those that operate airports) are required to complete comprehensive plans that are consistent with countywide plans, to be completed by July 1993. Local regulations (e.g., zoning) are to be adopted in 1994 and are to be consistent with these plans.

2. Countywide Plans

The GMA, as amended (Sec. 2, 1991), requires completion of "countywide policy plans" with language on a range of factors including:

Siting	(Sec. 2 calls for "policies for siting public capital facilities of a countywide or statewide nature").
Transportation	(Sec. 2 calls for "policies for countywide transportation facilities and strategies").

Section 1 of the GMA requires that the 1993 comprehensive plans (local plans integrated at the countywide or multicounty level) provide a "process for identifying and siting essential public facilities". Listed in this category are "airports".

The statutory deadline for "county-wide policy plans" is July 1992. Coordinated countywide comprehensive plans (involving counties and cities) are to be completed by July of 1993. Earlier identification of "critical areas" in 1991 might infringe on possible airport sites; however, a balanced consideration of community needs and final action on critical areas is to be accomplished in the 1993 local adoption of the comprehensive plans.

Countywide planning structures in our region include:

King County: either the merged Metro/King County structure or a less formal coalition of Seattle, the Suburban Cities Association, and King County.

Kitsap Regional Planning Council: Interlocal agreement between the cities, county, and Indian tribes.

Pierce County: countywide coordination led by Pierce County and including joint planning between the military bases and the adjacent communities (including Pierce and Thurston Counties).

Snohomish County Tomorrow: County and city collaboration.

Thurston Regional Planning Council: Thurston County, combined with the cities and towns, Intercity Transit, Port of Olympia, School Districts, Evergreen State College and the State Capitol Committee.

By mid 1994 local land use regulations must be consistent with the coordinated land use plans adopted in July 1993. These regulations could affect the airport siting options now under consideration by Flight Plan.

Failure to influence these countywide plans within the GMA planning deadlines (1992,1993) could compromise the chances of implementing multicounty solutions to air transportation. Amendments are subject to annual review by each local jurisdiction. On the other hand, countywide plans that fail to meet the goals of the 1990 GMA are subject to appeal to one of three Governor-appointed Hearings Boards, under the 1991 GMA amendments. (One of these Boards is responsible for the four county region of King, Kitsap, Pierce and Snohomish Counties.)

3. Multicounty Planning Policy

Regional Airport System Plan

The Regional Airport System Plan (RASP) is maintained by the Puget Sound Regional Council. This is broader than Flight Plan (air carrier service) and in 1987 included recommendations regarding general aviation services. These address the need to assess the feasibility of new general aviation facilities (if existing capacity is lost in future years) and to consider the impacts on general aviation when assessing the possible expansion of Sea-Tac capacity. In addition, further analysis is recommended to either retain or to expand existing GA airport capacities, or to develop a new GA airport.

These adopted 1987 system level recommendations interact with the airspace and facility aspects of the Flight Plan alternatives, and should be addressed by the PSRC when it acts on the Flight Plan recommendations. (Flight Plan focuses on the issue of regional air carrier service, and because GA accounts for only 5 percent of total operations at Sea-Tac International, this aspect of the overall multicounty airport system (and airspace) is not fully addressed in this stage of regional decision making.)

Growth Management Act

More broadly than the RASP, the GMA also mandates that "multicounty planning policies" be developed for the metropolitan region of King, Pierce, and Snohomish Counties (all counties over 450,000 population), with the full participation of cities.

> "Multicounty planning policies shall be adopted by two or more counties, each with a population of four hundred fifty thousand or more, with contiguous urban areas and may be adopted by other counties, according to the process established under this section or other processes agreed to among the counties and cities within the affected counties throughout the multicounty region (GMA 1991, Sect. 2(7))".

This additional task might be addressed collaboratively by the three countywide organizations, acting through the Puget Sound Regional Council (PSRC) or by some other means also consistent with the GMA. To be consistent with the intent of the GMA, the PSATC's airport alternatives should be included at the multicounty level rather than subjected to separate amendment procedures later at possibly only the countywide level, or to the appeals process established in the GMA.

Also of interest is the coordination of the regional High Capacity Transit plan (timed for ballot funding issue in King County in autumn 1992) with the April 1992 PSATC recommendation. That is, long term future transit rail corridors should not bypass the leading new airport site(s) now appearing before the PSATC (Flight Plan). In addition, during Phase II, the PSATC strongly supported the related work of the State Rail Commission tp explore the feasibility of creating high-speed inter-city rail services in the State of Washington.

4. State Plans and Commissions

The GMA requires state actions to conform to local comprehensive plans (1991 Act, Sec. 4), and does clearly require the local comprehensive plans (integrated at the countywide and multicounty levels) to address airport needs. Statewide transportation issues are also under review by the State Rail Commission, and the Washington State Air Transportation Commission (WSATC).

Collaborative approaches may emerge from the complementary work of the Flight Plan (PSATC) and the WSATC. Also possible is negotiated siting, similar to what is provided for the siting of hazardous waste facilities under the 1985 State Hazardous Waste Management Act (i.e., state siting preemption, with negotiated mitigation between the vendor and the community).

As the relationship between the Flight Plan and the WSATC are sorted out, points like these are becoming more clear:

- the WSATC is based on statute rather than an Interagency Agreement (but also is directed in statute to acknowledge ongoing planning),

- the WSATC is not involved in site selection, and is broader in its statewide mandate (e.g., considering general aviation as well as air carrier needs),
- the WSATC and state are interested in the relationship between Washington State and Portland and Vancouver as part of a potential continental free trade zone and a member of the Pacific Rim.

6. Port Plans

The GMA does not specifically mention port authorities. Ports might not be specifically required to comply with local comprehensive plans. Yet, the GMA "concurrency" requirement does apply to county or city plans governing adjacent lands. Concurrency requires that permit approval be contingent upon scheduled provision of necessary public services (e.g., roads, utilities).

The Municipal Airport Act (RCW 14.08) auathorizes municipal airports to build and operate airports either "within or without the territorial limits of such municipality", and to acquire needed property through either purchase or condemnation. A direct takeover of existing airport property is not permitted without consent, although joint exercise of responsibilities (between municipalities together and/or with the state) is permitted.

Specific initial steps at the Port of Seattle would probably involve amendment of the Sea-Tac Comprehensive Plan, and if land acquisition is involved, an update to the Port's "Comprehensive Scheme".

B. FEDERAL LEGISLATION

1. Federal Aviation Administration (FAA)

All aiport actions must meet the requirements of the Aviation Safety and Noise Abatement Act of 1979, the Airport and Airways Act of 1982, and the Airport and Airway Safety and Capacity Expansion Act of 1987, the Airport Noise and Capacity Act of 1990, and/or the Federal Aviation Regulations.

The National Plan of Integrated Airport Systems (NPIAS) is a ten-year plan that is updated every two years, based on state, regional, and local airport plans. The general relationship between airport master plans and state airport systems is addressed in FAA circulars (AC Nos. 150/5070-6A and 5050-3B, respectively). The NPIAS generally governs such factors as broad criteria, airspace, Air Transportation Control (ATC) centers, navaids, and airport design standards.

It is assumed here that the state GMA will govern local and state system plans for new facilities as they are approved and then incorporated into the State Aviation System and the NPIAS. In addition, federal grant assurances signed by any airport accepting federal funds bind airport operators to provide equal access to all classes of airport users. The effect of this is that airport roles in the system plan are governed largely by airline responses to market trends and the availability of adequate physical facilities. Periodic inadequacy of facilities (e.g., instrument landing capabilities during foul weather) has recently led to the FAA Central Flow

Control program, which delays airport takeoffs to match the affected landing capacities at receiving airports.

2. **<u>Interstate Commerce Clause</u>**

Airports with capacity cannot discriminate against classes of aircraft, or exercise an "undue burden" on national and international travel once federal funds have been accepted for any projects. On the other hand, airports cannot be compelled by the federal government to expand their facilities.

3. **<u>National Environmental Policy Act (NEPA)</u>**

This Act (1969) calls for a broadly integrated consideration of the environmental consequences of proposed actions. Federal guidelines strongly encourage this assessment to begin as early as possible in the planning process. This is also true for airport projects that use federal funds.

Further, FAA is to cooperate with state and local agencies which are subject to state or local requirements comparable to NEPA (FAA Order 5050.4A, p. 76,(b)2)). Flight Plan is doing its programmatic environmental review under the State Environmental Policy Act of 1970, which except for the preamble, has identical wording to the federal statute. The EIS will be one of the several attachments to the PSATC recommendations.

4. **<u>Clean Air Act Amendments of 1990</u>**

The Federal Clean Air Act Amendments (CAAA,1990) could conceivably restrict airport siting, particularly if near term regional compliance milestones are not addressed. Specifically, under the CAAA "non-attainment" areas are subject to possible highway funding sanctions if future auto traffic significantly exceeds 1992 forecasts. This precedes completion of land use plans under the GMA. Access to outlying potential sites would be the projects most affected: Olympia/Black Lake, Arlington, Central Pierce County.

Forecasts are to appear in the updated air quality State Implementation Plan (SIP) which is to be done by state and local agencies working together (state DOT, state Ecology, regional Puget Sound Air Pollution Control Agency--PSAPCA, regional PSRC, and local elected officials).

This conformity requirement applies at all levels: plans, programs, and projects (e.g., airport access roads). Flight Plan alternatives must be recognized in forecasts of auto vehicle miles traveled (VMT's), to be included in the November 1992 update of the State Implementation Plan (SIP) for air quality. New aiport sites should not be foreclosed inadvertently by the failure to include appropriate language in regulatory plans addressing air quality. The most immediate milestone is the SIP amendment in November 1992.

III: SITE SPECIFIC CONSIDERATIONS

A goal of this institutional analysis is to help ensure that all of the different Flight Plan alternatives are capable of being implemented. As a step in this direction, unique implementation features of each alternative are identified here.

A. NO ACTION ALTERNATIVE WITH MAXIMUM DEMAND MANAGEMENT

- Port of Seattle amend Master Plan for Sea-Tac International Airport,
- Demand Management actions by Port of Seattle, other operators, the FAA, and the airlines, pursuant to Working Paper No. 4: e.g., gate pricing installed at Sea-Tac, use of generated funds to encourage and help finance improvements at expansion sites, use of larger aircraft to moderate rising trend in operations, technological advances to improve lateral separation and spacing, increasing use of Central Flow Control.
- The only site exempted from conditions of the 1990 Airport Noise and Capacity Act (because of previously negotiated Mediated Noise Agreement completed under FAR 150)

(**Example**: St. Louis Lambert Field is the example of a replacement airport effort that was reversed (by federal action). Resulting major investments--in contrast with demand management--in Lambert Field do not assure air capacity for needs beyond the year 2010.)

B. REPLACEMENT AIRPORT

- Landbanking could involve financing provided by Sea-Tac acting extraterritorially (pursuant to RCW 14.08),
- Premature disclosure of sites can result in speculation and inflated purchase prices.

  (**Example**: This was avoided in the Denver case--replacement of Stapleton--only because 80 percent of the 50 square mile site was was held by two owners.
- Central Pierce County site requires either consistency with the County Comprehensive Plan, or this together with concurrence with the United States Army if land is to be purchased from the 90,000 acre Fort Lewis site.
- Airspace conflict between Fort Lewis replacement site and McChord Air Base requires action by the FAA, in conjunction with the Air Force.

- Olympia/Black Lake site entails recommendations from the PSATC affecting jurisdictions in Thurston County not party to the 1989 POS/PSCOG Interagency Agreement initiating Flight Plan.

- Necessary closure of Thun Field or of Olympia Airport would be more likely with their consent. Airspace conflict would involve FAA, and policy issues would involve the WSATC. Possible air carrier amendments to the Regional Airport System Plan--reflecting the PSATC recommendations--would have to address the potential for reduced access to general aviation.

- State economic issue may be the long term siting decisions (Washington or other states) of the Boeing Company, combined with needed access to airport facilities (e.g., Boeing Field, Paine Field, and the Frederickson site in Central Pierce County),

- Multiple airport systems have emerged in other parts of the country, even where the intent was for a replacement airport. This highlights the need for a clear understanding of the commercial airline industry, particularly following deregulation.

  Airlines must realize new income exceeding the additional costs of serving new locations. Flight Plan makes a range of assumptions regarding the split of short haul and medium haul travel between Sea-Tac and the potential supplemental sites.

  (**Examples**: Chicago (with Midway Airport), Dallas (Dallas Fort Worth with continued use of Love Field), Washington D.C. (Dulles was to be the replacement), and Houston (with Hobby Airport). The Dulles and Houston systems are now well-coordinated largely because each system is under one operating authority.

- Use of revenues gained from conversion of present Sea-Tac International Airport site could be partially constrained by FAA, acting as a funding source for previous site investments.

(**Example**: Denver is the major example of a replacement airport. Sea-Tac International Airport is also a replacement airport, originally having been located midway between Tacoma and Seattle to supplement Boeing Field. This is comparable to the construction of the much larger Dallas/Fort Worth midway between those two cities in the early 1970's.)

C. TWO-AIRPORT ALTERNATIVES

- Port of Seattle completes Sea-Tac Master Plan to either include or exclude an air carrier runway, and to include demand management--Sea-Tac expansions may require consistency with City of SeaTac comprehensive plan, particularly with respect to "concurrency" (e.g., provision of services to any new or expanded airport site), but this and other local plans may not preclude the siting of necessary state or regional public facilities (GMA).

- Airport jurisdictions may act outside of their jurisdiction and/or jointly (RCW 14.08).
- Owners/operators update Master Plans as recommended by PSATC,
- Arlington may require consistency with Snohomish County comprehensive plan (city ownership/operation, but site unincorporated).
- Paine Field requires consistency with Snohomish County (owner/operator) comprehensive plan, and with the 1978 noise mediated agreement (Paine Field does allow "commuter" service, and due to past federal funding conditions cannot prohibit access; however, it can discourage such service),
- McChord site requires Joint Operating Agreement with the Air Force (AFR 55-20). Military review procedure begins only after submittal of a formal proposal by an eligible sponsor.
- Joint use at McChord would require completion of an environmental impact statement under NEPA (National Environmental Policy Act) rather than the state act, with the Air Force acting as the lead agency.
- Olympia/Black Lake site requires consistency with county comprehensive plan.
- Need to coordinate regional High Capacity Transit (HCT) planning with possible new outlying airport sites, over the long term.
- With regard to accessibility and quality of service, and airline route planning, see the last bullet under "replacement airport".

(**Example**: Atlanta Hartsfield Airport has been expanded as part of an aggressive "inland gateway" economic strategy, comparable to Dallas/Fort Worth and Denver. Landbanking for supplemental airports began in the 1970's (two 10,000 acre sites). A search is now underway behind the leadership of the Atlanta Regional Council to verify the correct supplemental site. The wisdom of system plans that can adjust to demands that are either higher or lower than expected is demonstrated by the recent loss of passenger traffic at Hartsfield, due to the bankruptcy of one of the two airlines using Atlanta as its hub airport. Unlike Atlanta or Denver and other hub airports, Sea-Tac draws most of its service volume from origin and destination passengers, rather than connecting passengers.)

D. THREE-AIRPORT ALTERNATIVES

- Generally the same as for Two-Airport Systems

  (**Example**: The Atlanta Regional Council (ARC) has assumed the lead over adjacent regional planning areas, by interlocal agreement, for the search for supplemental airport sites. The ARC has noticed that perhaps four supplementals can be built for the cost of a single replacement airport ($1.6 billion).)

- The danger of overbuilding increases as the number of airports increases.

  (**Example**: Tampa International/St. Petersburg/Sarasota illustrates the dangers of poor coordination (nearly all passengers use Tampa International) and the small population base of the region.)

IV. WAYS TO OPERATE AIRPORT SYSTEMS

Individual airports and airport systems can be owned and operated by a variety of entities, with or without formal agreements between each other. These entities can in some cases also build new airports, generate surplus revenues, and operate other transportation systems. These options are discussed below:

1. Independent Local Authorities

This is the current arrangement in Washington State and in the San Francisco area. San Francisco International is operated by the San Francisco Airport Commission (an appointed branch of City government). The San Jose and Oakland airports are operated by a city and a city port authority, respectively. Market forces seem to compensate for lack of airport systemwide planning, as the private airline systems compete within this particular region.

Another more complex **example** is the multiple airport "system" in the Los Angeles area. FAA supplies the system overview through airspace regulation. Included are Los Angeles International (City), Ontario (City of Los Angeles), John Wayne (Orange County), Burbank (Burbank, Glandale and Pasadena Aiport Authority), and Long Beach (City of Long Beach).

In the Puget Sound region, all of the existing airports and their operators make up a system in which, at this point, all air carrier service is being provided at one airport. As discussed above, the main factors affecting the existence of air carrier service to a community are the proximity of a strong local market for passengers and adequate physical facilities.

2. Local Authorities with Voluntary Agreements

Under Washington State legislation, this arrangement could also include the state and federal governments (RCW 14.08.200).

One modest and temporary **example** for planning purposes (not operations) is the Interagency Agreement (1989) between the Port of Seattle and the Puget Sound Regional Council. This is a planning effort and initiated the Flight Plan project. In the Boston area, Logan Field has entered into interlocal agreements with surrounding airports to provide technical assistance in the creation of service markets. This could relieve congestion at Logan Field. Dallas-Fort Worth is operated by both municipalities, through a joint Airport Board. The voting is weighted 7:4, roughly reflecting the relative populations of the two owners.

3. **Regional Authority**

This could also involve a combined effort between new countywide "airport districts" (RCW 14.08.290 and 302).

One example of a joint regional effort is the Joint Regional Policy Committee (JRPC) for high capacity transit. The JRPC is a collaborative effort between operating agencies (the transit agencies) in King, Snohomish and Pierce Counties. In 1990 the Legislature provided (SHB 1825) authority for the parties to jointly develop a plan and financing for submittal to be voters within a given deadline. The state Department of Transportation is also a member. Two years are allowed to develop an interlocal agreement, with an additional four years to complete the ballot package. Also created was a Governor-appointed "expert review panel" of national and local figures.

Another example of a regional body would be the creation of a new agency overlaying the existing authorities. This approach explains the 12-county Puget Sound Water Quality Authority (actually a state-level body) created in 1985. Members are appointed by the Governor. Amendments in 1990 now provide that the chair of the Authority shall be the Director of an existing state agency (the Department of Ecology) rather than director of the Authority staff.

4. **State Authority**

The Port Authority of New York and New Jersey is a bi-state compact based on state legislation and federal approval. The Authority operates JFK International, Newark, and LaGuardia Airports. The same arrangement could be set up within Washington State if a comparable governing board were formed. Examples of single state authorities are found in Alaska and Maryland.

Cases of federal authority can also be cited. Dulles International is owned and operated by the United States Government. Siting was influenced by federal action and the appearance of funds to purchase the present site. Dallas Fort Worth was also located during the pre-deregulation era when a strong federal presence was brought to bear, along with the coordinated efforts of the Dallas and Fort Worth business communities. The St. Louis' Lambert Field is an expansion example, selected in 1977 over the replacement alternative. This occurred at the hands of the Secretary of Transportation. Saturation is expected to occur in 2010; the Flight Plan time horizon is 2020 and beyond.

5. **Regulated Private Utility**

This would probably require new state or federal legislation. The airport(s) would be owned and operated by a private corporation and in this sense would be similar to the private airline industry. Federal or state regulations would be imposed regarding rates or facilities, or to achieve other public purposes. No examples exist in the United States although some discussions have been held with regard to the Albany, New York, airport and privatization is coming under review as a theoretically possible option for the municipally owned Los Angeles International Airport (LAX). For LAX the new options are sale to a regulated public utility, development of a governmental corporation (consisting of cities and counties), or a hybrid wherein the facilities would be rented to a consortium of governments.

6. European Hybrid Model

A quasi-private corporation is formed to operate one or more airports, and is owned by various levels of government. Daily airport operations are controlled by a working board which, in turn, is overseen by a federated board composed from each of the owner governments. (A unitary government-operated system would be the control of Washington National Airport and Dulles Airport, both operated by the U.S. Government.)

Examples of the European model are the Frankfurt Airport, Scandanavian Airlines, and the rent model used by the Port Authority of New York/New Jersey.

V. IMPLEMENTATION STEPS: TOWARD AN ACTION PLAN

Needed is an action plan to accomplish one of the four Flight Plan alternatives, combined with a decision regarding the possible Sea-Tac air carrier runway. All actions/inactions at Sea-Tac must be linked to other actions affecting other possible sites.

Section A and B, below, outline the major elements of an action strategy, and generally identify some of the major kinds of actions now required.

A. STRATEGY OUTLINE for an ACTION PLAN

If negotiations become a major feature of a collaborative implementation, general guidelines for this effort have already become apparent.

1. Comprehensiveness

Any new construction can be reduced as part of a **broader comprehensive package**, or action plan, involving demand management at the Sea-Tac site, and overall system management covering several sites,

(**Example**: Solid waste management offers instructive guidelines. Major facility siting (incinerators, landfills, transfer stations) is linked to broader efforts at waste reduction and recycling. Presented as part of an overall package, the minimized siting elements have gained public support.)

2. Total Cost Pricing

The airport system can be selected in terms of "**total cost pricing**" as is used by public utilities, whereby "costs" include environmental costs (and mitigation). The balancing of supply and demand requires a consideration of price, and this price includes non-monetary costs and in many resource areas, a consideration of scarcity.

(**Examples**: In California, consumption of water resources involves the creation of a water bank, in addition to subsidized and regulated consumption. This would be roughly equivalent to slot pricing (not to be confused with slot rationing). In the larger southwest, consumption of limited Colorado River Water involves Interstate Compacts on water use. The functional equivalent in the airline industry might be the national Central Flow Control program. In other words, "equal access" for all classes of air carriers may not mean equal unlimited access. Statutes and regulations controlling noise--e.g., the Sea-Tac noise budget--also illustrate market pricing sensitive to third parties, i.e., total cost pricing.)

(Example: Addition of a second runway at Vancouver, B.C., restricts a new second runway primarily to arrivals and Stage 3 aircraft, imposes a noise curfew, and limits reverse thrust operations), In the United States, the Aviation Safety and Noise Abatement Act of 1979 permits restrictions that do not involve an "undue burden" on interstate commerce (Sec. 104(a)2 and (b)).

3. Phasing

Phasing might include early landbanking which might be financed by congestion charges or other revenues generated at facilities nearing capacity.

(Example: The Atlanta Hartsfield Airport is nearing capacity, and beginning in the 1970's landbanked two 10,000 acre sites in the path of future urban development.)

4. Collaboration

The **membership** in collaborative implementation could include local entities, together with state (e.g., Washington State Department of Transporation) and federal entities (e.g., FAA), given the broad provisions of existing state law (RCW 14.08).

Also necessary is cooperation with the airlines to ensure that service will locate at any new airport sites.

(Example: Even with high congestion, major carriers did not locate at Stewart Airport in New York (site of a former air force base 65 miles north of New York) until American Airlines was offered as part of the agreement additional gates at JFK Airport. The PSATC demand management expert panel also suggests that revenues collected at Sea-Tac might be used to help develop alternative sites also under operational control by the entity collecting the revenues.)

Collaboration might also involve mediation to develop a package of actions including the distribution of future demand levels within a new Multiple Airport System. Mediation is not a panacea, but can work if specific minimum conditions satisfied (e.g., a willingness by all parties to participate).

(Example: Within Washington state, important mediation projects have addressed tradeoffs between water quality and forest practices (the

1987 Timber/Fish/ and Wildlife Agreement), and more recently, the allocation of water among competing interests (the experimental 1990 Statewide Chelan Agreement continues to be tested at the state and regional levels. The Noise Mediation Agreement at Sea-Tac is also an example of this approach.)

B. SOME NEEDED ACTIONS

Considering the siting and operational issues discussed in previous sections, elements of the PSATC recommended action plan should include the following elements:

1. Monitoring and Phasing of Actions

During Phase I the Demand Forecasting Subcommittee developed a critical idea relating forecasts to the recommended action package. They identified the need to identify "reasonable alternative futures" to help guide policy choices shaping the real future. The focus is on the policy thresholds, rather than the calendar of very long term forecasts. They expressed confidence in the log forecasting model up to the year 2010, and identified the need to track passenger trends between 1990 and 2010. At the same time, the full PSATC concurred in a mission statement that provides facilities in 2020 that are expandable to meet additional needs to the year 2050.

Example: This approach has been pioneered by the four-state Northwest Power Planning Council enabled by the Federal Power and Conservation Act of 1980. The Council develops a wide range of possible needs in the future, a range of tools for meeting future power needs (i.e., conservation, hydropower, co-generation, coal-fired and nuclear plants), lead times for each element of the action portfolio, and a monitoring capability to match actions to needs as these become more clear, and particularly threshold decisions points.

The PSATC might include this kind of approach as it monitors demand trends, as well as legislative windows, and the options within the air carrier "portfolio" (e.g., diminishing landbanking opportunities). The technical threshold decision points identified thusfar by Flight Plan include the inadequacy of Sea-Tac under all alternatives, and the need for three IFR runways.

2. Countywide Policy Plans and Implementation (1992-4)

The PSATC should propose specific language to be included in July 1992 in the respective "countywide policy plans" (the first GMA deadline). This language might acknowledge the Flight Plan process and recommendations to the Port of Seattle, the PSRC, airport operating agencies and regulators, and others.

Depending upon the final technical recommendations of PSATC, recommendations also should be prepared addressed to the 1993 comprehensive plans of the affected local jurisdictions. Concurrent with this might be interlocal discussions on the allocation of future travel needs and capital funds, with either Pierce, Snohomish or Thurston County airport operators, depending upon the preferred general location for either supplemental or replacement airport facilities.

Legal authorization for joint operations is provided under state law (RWC 14.08).

3. **Multicounty Policy and Implementation (1992 and 1993)**

PSATC recommendations to the PSRC should include a adoption of a multicounty air carrier transportation element, amending the 1987 Regional Airport System Plan (RASP) and linking it to the separate countywide comprehensive plans due to be completed in 1993 under the GMA. Federal funding of all surface transportation projects depends upon consistency with the regional transportation plan.

PSATC recommendations and documentation should be sufficiently focused on siting and transportation to enable their use in possible presentations before the Growth Management Hearings Boards (the GMA appeals process).

Depending upon the airspace analysis, evaluate and accommodate possible impacts/benefits for general aviation. (e.g., The 1987 RASP recommended a general aviation airport rather than supplemental airports now under consideration.) This element also should be coordinated with the WSATC and acknowledged by the PSATC.

4. **Regional Plans and Implementation (1992)**

PSATC should urge that the State Implementation Plan (SIP) for air quality and the regional High Capacity Transit (HCT) Plan, both scheduled for possible action in late 1992, accommodate the PSATC airport recommendations due in early 1992. Fedral funding of access roads to supplemental airport locations could be jeopardized if a multple airport approach (affecting air quality) is not anticipated in the SIP.

Regional plans also call for High Capacity Transit. Coordination between HCT and Flight Plan (e.g., timing and alignments) is addressed in the Accessiblity Working Paper No. 9. An HCT funding issue is planned for the ballot in November 1992 or later (statutory deadline: four years after planning began in 1991).

5. **State and Regional Partnerships (1991-4)**

Regional cooperation may depend upon specific actions at the state level. For example, the PSATC might decide whether a subsequent mediation step is needed for siting, and offer recommendations regarding possible elements of agreements, procedures and lead time requirements.

Current state law enables joint activities between operators and other entities, including state and federal agencies (e.g., the WSATC, FAA). With the WSATC, determine whether a continuing planning and implementation effort, supported in part by the FAA, now is appropriate for this state and region.

6. **Operating Agencies**

Amend local master plans (e.g., approval or rejection of an air carrier runway at Sea-Tac International Airport), or as appropriate, collaborate broadly to complete final site selection studies. This could include environmental work either with FAA as a joint participant, or with a military party as the lead agency (under the National Environmental Policy Act--the NEPA process).

Demand management at the Sea-Tac International Airport is part of all alternatives. Specific PSATC recommendations should be based upon the testimony of the expert panel, and the Working Paper No. 4, and may be part of item 4 (above).

Depending upon the alternative selected, establish a calendar for possible landbanking, and continue discussion between the Port of Seattle and King County to improve coordination of operations at Sea-Tac International and Boeing Field.

7. **Federal Government**

The FAA might be requested to work with air carriers on demand management elements, and with the state and local entities in specific ways. The National Plan for Integrated Airport Systems (NPIAS) also will require updating. The FAA should indicate the relative weight they place on Airport Layout Plans, Master Plans, the Regional Airport System Plan, and the State Airport System Plan. In other words, are FAA statutory consistency requirements comparable to those required by the Urban Mass Transit Administration and the Federal Highway Administration?

8. **Airlines**

The institutional issues involve both public and private sector aspects. The public sector institutional "map" is addressed in this paper. Equally important are relations with the airlines, and their judgments regarding the accessibility and marketability of the alternative airport systems, and demand management (Working Paper No. 4) and financing options.

The significance of market forces is found even in the underlying passenger demand forecasts (projected to be 45 million passengers in 2020). These are shaped by ticket prices and other market forces, such as the 1978 airline deregulation or the changing balance between the domestic and the global economy.

9. **Business**

Business communities have played a key role in promoting the "inland gateway" aspects of major airport expansion at Atlanta, Denver and Dallas/Fort Worth. Also, in each of these cases, the spokesman for airport development has been the mayor of the name city, since in these cases, the airport is a city airport. San Francisco and Los Angeles International Airports are also municipally owned and operated.

In Dallas/Fort Worth business support for the airport has continued, and evolved into the North Texas Trade Commission with a broadened economic development mission. (The rough counterparts in our region might be the Washington Trade Alliance, or the Greater Seattle Chamber of Commerce.)

10. Financing

In its recommendations, the PSATC should identify a financing strategy, or a process leading to such a strategy. This is addressed in Working Paper 11 (Capital Costs and Funding). A flexible siting action package (phasing and timing) is also a prudent response to market uncertainties. This idea is expanded in item 1, above.

For purposes of comparison, other major capital projects have been identified together with their costs. Access to federal funds (e.g., FAA up to 80 percent of eligible capital costs) varies. Sea-Tac International Airport is a self-funded operation based on user and vendor charges, while capital costs are covered in part by the FAA.

Illustrative Project Costs:

Flight Plan Alternatives (Working Paper No. 11)

Sea-Tac/Demand Management	**N/A**
Replacement	**$2.1 to 2.3 billion**
Multiple Airport (2)	**$0.326 to 1.2 billion**
Multiple Airport (3)	**$0.619 to 1.8 billion**

Interstate 90 Bridge in Seattle	Over $1 billion (90 % federal)
High Capacity Transit	$8.5 billion

(Estimate for capital and operating costs through the year 2020. This includes $1.4 billion for HOV--High Occupancy Vehicle lanes--in four counties. HOV lanes, if effective, are a key component of ground access to present and possible airport sites.)

Seattle Transit Tunnel	$481 million (50% grant)

(Possible light rail transit access to airport sites would utilize this facility, designed to be convertible to rail use.)

METRO Secondary Treatment	$578 million (roughly 55 percent loans and grants)

(This represents the largest recent siting issue in our region.)

Private Investments:

Value of major highrises (1989)

Gateway Tower	$195 million
Washington Mutual	$175 million
Pacific First	$200 million
Two Union Square	$177 million

(Value is greater than construction cost, e.g., cost of Gateway Tower was $105 million.)

COMPARATIVE SUMMARY

This paper has identified the implementation steps associated with each of the technical alternatives. Common insititutional elements have been identified, together with those that vary from alternative to alternative.

In Summary:

The No Action Alternative requires (a) restrictions on the Sea-Tac Airport Master Plan, combined with (b) a range of demand management actions by several parties.

The Replacement Airport Alternative requires (a) removal of Sea-Tac, combined with (b) landbanking and siting of a new facility, (c) coordination with surface transportation and land use planning under the state GMA, and (d) recognition or establishment of an operating authority, or joint authority (RCW 14.08).

The Multiple Airport System Alternatives (either one of two supplemental airports, with Sea-Tac) require (a) possible expansion of Sea-Tac, (b) land purchase or new construction and operations at existing facilities in adjacent counties, and (c) clear linkages between actions/inactions at Sea-Tac and varied actions at the other affected sites.

In addition, all alternatives require continued collaborative efforts following the completion of the Flight Plan recommendations on alternatives. The **attachment to this Working Paper is provided as an outline for the kind of recommendations that might be developed to ensure that the recommended alternative can be achieved.**

VI. EXPERT PANEL RECOMMENDATIONS

OVERVIEW

An expert panel was convened to review this working paper and to offer institutional recommendations on the Flight Plan alternatives. The panel consisted of Dick Ford (Seattle attorney and chair of the recent Washington State Growth Strategies Commission), Jim Waldo (Seattle attorney and mediator), George Howard (President, Airport Operators Council International), and Cliff Moore (Executive Director, Los Angeles Department of Airports).

Prior to the panel session, three summary discussion points derived from this Working Paper were presented:

1. The insitutional issue comes in two parts:

   (a) who might operate the selected alternative, and
   (b) the separate question of "how do we get there" (for example, siting).

2. The legal tools for accomplishing the two institutional tasks appear to exist in

   (a) RCW 14.08 (the Municipal Airports Act, which enables joint actions by operators), and
   (b) the recently passed State Growth Management Act (which for example requires action on regional siting needs).

3. The forthcoming draft recommendations of Flight Plan should include

   (a) a selected system alternative, and
   (b) a brief action plan.

   Supporting attachments will be an organized compilation of the working papers documenting the five selected decision criteria used in arriving at (a) and (b).

GUIDELINES

The Expert Panel offered guidelines that are summarized here:

1. All of the alternatives can be accomplished under current statutes, although some are easier than others.

2. The Committee should follow a two part sequence:

   (a) first select the leading **system alternative**, and

   (b) then address the various **site options** within the selected system alternative.

3. In comparing the system alternatives the Committee should:

   (a) first, apply the technical criteria (operations, environmental, economic and financing),

   (b) then, ask whether the institutional factors lower or raise the ranked alternatives, relative to each other. The second-ranked technical alternative may be superior to the first-ranked, if it is more readily accomplished. This institutional review should be recorded as part of the overall recommendation package.

   The PSATC also asked that in addition to a judgment among alternatives, the recommendation include a "roadmap" on how to implement the selected (and preserved) alternatives.

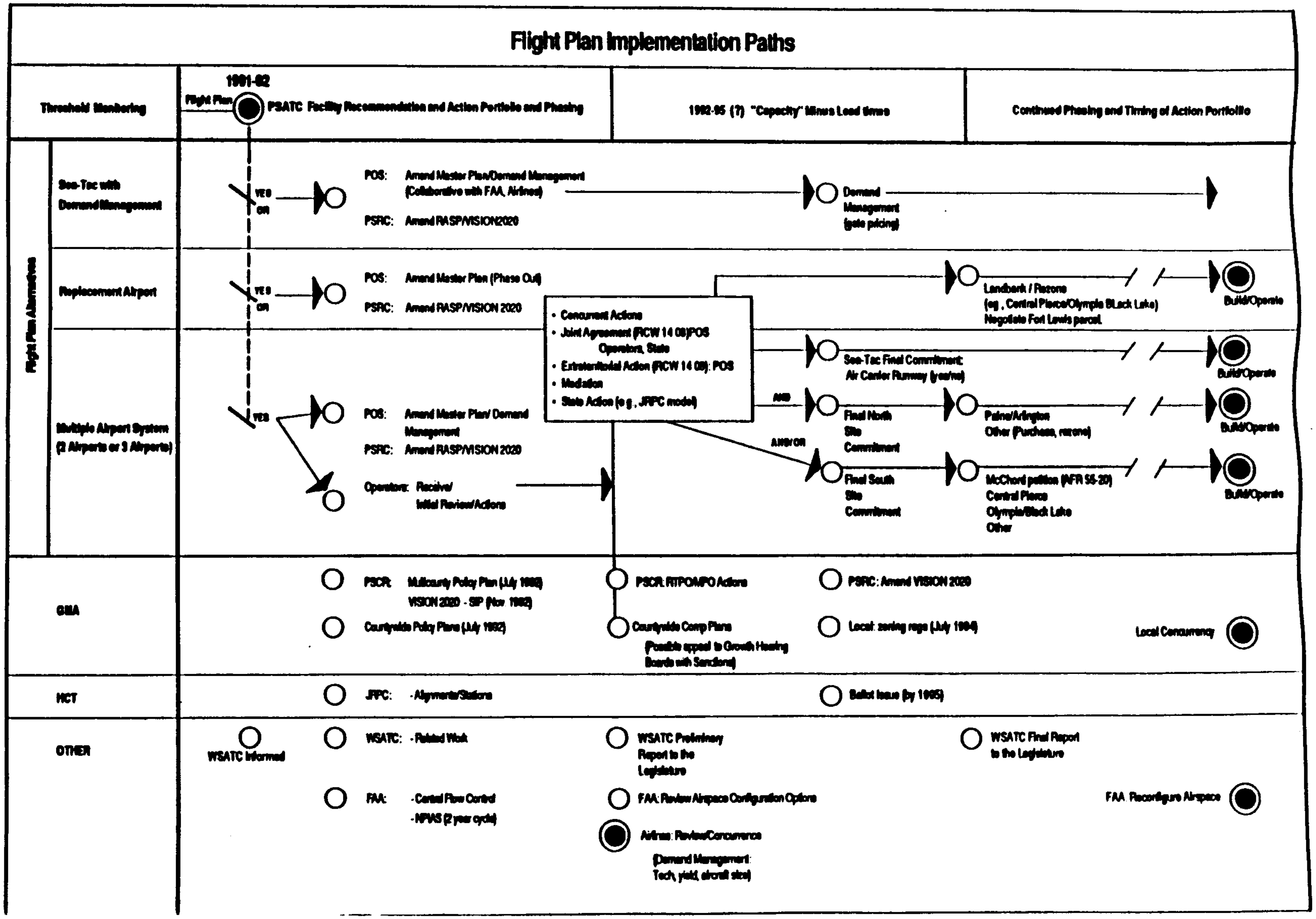
4. The recommendation should not isolate a single alternative, but should both choose an alternative and preserve other options. The public hearings can then allow comments on more than one course of action.

5. The recommendations should be addressed to the "regional planning policy" required by July 1992, under the State Growth Management Act. (The PSATC concurred with the collaborative tone of these guidelines, and the opportunity to influence both the regional and the countywide policy plans).

6. A system approach is needed, with system management:

   (a) among airports to serve capacity needs, and

   (b) between air travel and ground travel, especially regional high capacity transit.



Flight Plan Implementation Paths
Threshold Monitoring
1991-92
Flight Plan
PSATC Facility Recommendation and Action Portfolio and Phasing
1992-95 (?) "Capacity" Minus Lead time
Continued Phasing and Timing of Action Portfolio
Flight Plan Alternatives
Sea-Tac with Demand Management
YES
OR
POS: Amend Master Plan/Demand Management (Collaborative with FAA, Airlines)
PSRC: Amend RASP/VISION2020
Demand Management (gate pricing)
Replacement Airport
POS: Amend Master Plan (Phase Out)
PSRC: Amend RASP/VISION 2020
Landbank / Rezone (eg., Central Pierce/Olympia BLack Lake) Negotiate Fort Lewis parcel
Build/Operate
• Concurrent Actions
• Joint Agreement (RCW 14 08)POS Operators, State
• Extraterritorial Action (RCW 14 08): POS
• Mediation
• State Action (e g , JRPC model)
Sea-Tac Final Commitment: Air Carrier Runway (yes/no)
Multiple Airport System (2 Airports or 3 Airports)
POS: Amend Master Plan/ Demand Management
PSRC: Amend RASP/VISION 2020
Operators: Receive/ Initial Review/Actions
AND
AND/OR
Final North Site Commitment
Final South Site Commitment
Paine/Arlington Other (Purchase, rezone)
McChord petition (NFR 55-20) Central Pierce Olympia/Black Lake Other
GMA
PSCR: Multicounty Policy Plan (July 1992) VISION 2020 - SIP (Nov 1992)
Countywide Policy Plans (July 1992)
PSCR: RTPO/MPO Actions
Countywide Comp Plans (Possible appeal to Growth Hearing Boards with Sanctions)
PSRC: Amend VISION 2020
Local: zoning regs (July 1994)
Local Concurrency
HCT
JRPC: - Alignments/Stations
Ballot Issue (by 1995)
OTHER
WSATC Informed
WSATC: - Related Work
WSATC Preliminary Report to the Legislature
WSATC Final Report to the Legislature
FAA: - Central Flow Control - NPIAS (2 year cycle)
FAA: Review Airspace Configuration Options
Airlines: Review/Concurrence (Demand Management: Tech, yield, aircraft size)
FAA: Reconfigure Airspace

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APPENDIX E

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT (DEIS)

DRAFT PROGRAMMATIC EIS INCORPORATES MATERIAL FROM WORKING PAPERS # 12A, 12B, 12C

FLIGHT PLAN PROJECT FINAL REPORT

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Prepared for

PUGET SOUND REGIONAL COUNCIL
216 First Avenue South
Seattle, Washington 98104

and

PORT OF SEATTLE
Seattle-Tacoma International Airport
P.O. Box 68727
Seattle, Washington 98168

Prepared by

PARAMETRIX, INC.
13020 Northup Way
Bellevue, Washington 98005

In association with

P & D AVIATION
MESTRE GREVE ASSOCIATES

January 1992

FACT SHEET

Description

The Flight Plan Project recommends improvements to the air transportation system serving the central Puget Sound region in order to provide sufficient airport capacity through the year 2020 and beyond.

The preferred alternative includes the addition of a new dependent air carrier runway at Sea-Tac International Airport. The new runway would be located on the west side of airport property and would operate in coordination with air traffic using other runways. In addition, initiation of commercial air service at Paine Field would occur by the year 2000. To provide system capacity to the year 2050, planning would begin for a third two-runway airport to operate after the year 2010 at McChord Air Force Base or Fort Lewis Army Base, or a site just east of Fort Lewis Army Base, or in the Olympia/Black Lake area if a facility on one of the military bases cannot be achieved.

Proponent

Puget Sound Air Transportation Committee

Proposed Date for Implementation

The preferred alternative recommends that improvements to Paine Field and the addition of a new dependent runway at Sea-Tac International Airport be in service by the year 2000. Planning would begin immediately for a third two-runway airport at McChord Air Force Base, at or just east of Fort Lewis or in the Olympia Black Lake area to be in service after the year 2010.

Lead Agency

Puget Sound Regional Council (*nominal lead agency*)
Port of Seattle

Responsible Official

Mary McCumber, Puget Sound Regional Council Executive Director

Contact Person

Peter Beaulieu, Puget Sound Regional Council, Transportation Planning (206) 464-7537.
Michael Feldman, Port of Seattle, Aviation Planning Department (206) 439-7706.

Licenses Required

A variety of planning approvals would be required to implement the proposed improvements. These include, but are not limited to:

Regional Airport System Plan Amendment
Sea-Tac International Airport Master Plan Update;
Paine Field Master Plan Update;
Revisions to county and city comprehensive plans;
Joint Operating Agreement with the Air Force or Army if McChord AFB or Fort Lewis is used.
FAA approvals (Grant authorizations, etc.)

In addition, site-specific permits for each facility would be required from the jurisdictional local governments.

Authors and Principal Contributors

Parametrix, Inc. - EIS authors and environmental studies
P & D Aviation - Aviation planning
Mestre Greve and Associates - Noise and air quality
Port of Seattle - Aviation division
Puget Sound Regional Council - Transportation planning

Date of Issue of Phase I DEIS

January 7, 1992

Date Comments are Due

February 21, 1992

Send Written Comments To

Flight Plan Project
P.O. Box 68727
Seattle, Washington 98168

Utilities

Des Moines Sewer District
Puget Sound Power and Light
Rainier Vista Sewer District
Seattle City Light
Seattle Water Department
Snohomish County PUD
Tacoma City Light
Tacoma Water Department
Thurston County PUD

Federal Agencies

Bureau of Indian Affairs
Congressional Delegation
Dept. of Housing and Urban Dev.
Economic Development Administration
Environmental Protection Agency
Federal Aviation Administration
Federal Highways Administration
Fish and Wildlife Service
Urban Mass Transp. Administration
United States Air Force
United States Army
United States Army Corp of Engineers
United States Coast Guard
United States Navy

State of Washington

Department of Community Development
Department of Ecology
Department of Energy
Department of Trade and Econ. Dev.
Department of Fisheries
Department of Natural Resources
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Department of Social and Health Ser.
Department of Transportation:
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  Headquarters
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  Marine Division
Department of Employment Security
High Speed Rail Commission
Legislative Transportation Committee
Office of Archeaology and Historic Pres.
Office of the Governor
Planning, Research, and Public Trans.
Transportation Improvement Board
Utilities Transportation Commission
Department of Wildlife
WA State Air Transportation Commission

Regional Agencies

Central Puget Sound EDC
Kitsap Regional Planning Council
Metro - Environmental Division
Puget Sound Air Pollution Control Agency
Thurston Regional Planning Council
Seattle/King County EDC
Skagit Council of Governments

Draft EIS Distribution List

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Olympia Chamber of Commerce
Southwest King Co. Chamber of Comm.
Tacoma/Pierce Co. Chamber of Comm.

Others

Aircraft Noise Coalition
Kitsap Co. Assoc. of Realtors
Kitsap County EDC
Tacoma-Pierce Co. Board of Realtors
Pierce Co. Countywide Planning
  Policy Steering Committee
South King Co. EDC
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Snohomish County Tommorrow
Snohomish County EDC
Tacoma/Pierce Co. Econ. Dev. Board
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WA Transportation Policy Institute
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Tacoma Public Library
University of Puget Sound Library
University of Washington
    Suzzallo Library
    Government Documents Library
Vashon Public Library
WSDOT Library
Washington State Energy Library
Washington State Library

Cities and Towns

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City of Auburn
Town of Beaux Arts Village
City of Bellevue
City of Black Diamond
City of Bonney Lake
City of Bothell
City of Bremerton
City of Brier
City of Buckley
Town of Bucoda
Town of Carbonado
City of Carnation
Town of Clyde Hill
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City of Fife
Town of Fircrest
City of Gig Harbor
Town of Gold Bar
Town of Granite Falls
Town of Hunts Point
Town of Index
City of Issaquah
City of Kent
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City of Lacey
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City of Lake Stevens
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City of Lynnwood
City of Marysville
City of Maytown
City of Medina
City of Mercer Island
City of Mill Creek
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City of Mukilteo
City of Normandy Park
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Town of Rainier
City of Redmond
City of Renton
City of Roy
Town of Ruston
City of SeaTac
City of Seattle
Town of Skykomish
City of Snohomish
City of Snoqualmie
Town of South Prairie
City of Stanwood
Town of Steilacoom
Town of Sultan
City of Sumner
City of Tacoma
Town of Tenino
City of Tukwila
City of Tumwater
Town of Wilkeson

Cities and Towns (Continued)

City of Winslow
City of Woodway
Town of Yarrow Point
Town of Yelm

Counties

King County
Kitsap County
Pierce County
Snohomish County
Thurston County

Indian Tribes

Chehalis Tribe
Duwamish Tribe
Mukleshoot Tribe
Nisqually Tribe
Puyallup Tribe
Suquamish Tribe
Tulalip Tribe

Airport Managers

Arlington Municipal Airport
Boeing Field
Fort Lewis
McChord Air Force Base
Olympia Airport
Paine Field
Thun Field

Ports

Port of Bremerton
Port of Everett
Port of Olympia
Port of Seattle
Port of Tacoma
WA Public Ports Association

Transit Agencies

Community Transit
Everett Transit
Intercity Transit
Kitsap Transit
Metro
Pierce Transit
Snohomish County Transportation Authority (SNO-TRAN)

Time and Place of Public Hearings

Monday January 27, 1992
6pm - 10pm
Bremerton High School Auditorium
1500 13th Street
Bremerton

Tuesday January 28, 1992
6pm - 10pm
Tacoma Convention Center
Sheraton Hotel
1320 Broadway Plaza
Tacoma

Saturday February 1, 1992
12pm - 4pm
Everett Civic Auditorium
2415 Colby Avenue
Everett

Monday February 3, 1992
6pm - 10pm
Chris Knutzen Hall
Pacific Lutheran University
Corner of Garfield St. S. & Park Ave. S.
Tacoma

Wednesday February 5, 1992
6pm - 10pm
Board Room
North Thurston School District No. 3
305 Collage Street NE
Lacey

Thursday February 6, 1992
6pm - 10pm
Flag Pavilion
Seattle Center
Seattle

Wednesday February 12, 1992
6pm - 10pm
Arlington High School Auditorium
135 South French Avenue
Arlington

Thursday February 13, 1992
6pm - 10pm
Red Lion Inn, Sea-Tac
18740 Pacific Highway South
Seattle

Final Action

The Puget Sound Regional Council and Port of Seattle are expected to act on the final recommendations of the Puget Sound Air Transportation Committee in April 1992.

Type and Timing of Subsequent Environmental Review

Improvements or new facilities at any airport or site will be evaluated in project-specific environmental review by the agency responsible for the facility.

Location of EIS Background Data

Additional information on the Flight Plan Project is available at:

Port of Seattle
Aviation Planning Department
Sea-Tac International Airport

Puget Sound Regional Council
Information Center
216 First Avenue South
Seattle

Cost of This EIS Document to the Public

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1. SUMMARY

1.1 PURPOSE AND NEED

The purpose of the Flight Plan Project is to proactively plan for future air transportation demands of the central Puget Sound region through the year 2020 and beyond. The increasing popularity of air travel and growing population in the region will create a demand that will saturate the existing Sea-Tac International Airport between 1995 and 2000. Increasing demand without additional facilities will result in longer and longer delays for air travelers and ultimately will hurt the trade-oriented regional economy. Forecasts of future air travel demand have been developed in each phase of the Flight Plan Project and are summarized in section two of the Draft Final Report.

1.2 OBJECTIVES

To plan for future commercial air transportation needs, the Puget Sound Council of Governments (now the Puget Sound Regional Council, PSRC) and the Port of Seattle formed an interagency agreement in 1989 to develop a regional air carrier airport system plan. This agreement created the Puget Sound Air Transportation Committee to study the problem in detail and develop recommendations for the PSRC and Port of Seattle. The Committee is a thirty-nine member steering group comprised of citizens, local and state elected officials, members of the business community, and others with an interest in the region's future air transportation system. The work of the committee is called the Flight Plan Project.

The objectives of the Flight Plan Project are defined both by the mission and vision statements and project objectives developed during Phase I of the project and are listed in section two of the Final Report. These statements have guided the work of the Puget Sound Air Transportation Committee throughout the project and are contained in section two of the Draft Final Report.

1.3 SUMMARY

1.3.1 <u>Controversial Issues and Tradeoffs</u>

1.3.1.1 Noise

The most significant conclusion of the noise analysis is that the future noise environment for all of the system alternatives represents a significant improvement over that which exists around Sea-Tac today. The aircraft forecast to be operating in 2020 are significantly quieter and will result in reductions in both the overall Ldn (combined day and night) noise levels and the single event SEL levels. For example, the 1990 existing 65 Ldn contour for Sea-Tac covers an area of 22.1 square miles with an estimated resident population of approximately 66,000. Compare this to the worst-case scenario projected for 2020, in which the population within Sea-Tac's 65 Ldn noise contour is estimated to be less than 13,000 people. Under the preferred alternative, the 65 Ldn contour area for Sea-Tac would cover 7.1 square miles, plus an additional 0.8 square miles for the north airport at Paine Field, and the estimated total regional population exposed to the 65 Ldn noise level would be 8,100.

The noise contours generated in this study for the dependent runway at Sea-Tac consider operational mitigation measures. If measures such as restricting the runway to less noise sensitive times and for arrival traffic only are imposed, the potential noise impacts from the preferred alternative would be reduced. With restricted use of the new runway, a multiple airport system that involves a new dependent air carrier runway at Sea-Tac is more favorable from an overall noise management perspective than a multiple airport system without a new dependent runway at to Sea-Tac.

None of the secondary alternatives is significantly superior to the preferred alternative in terms of noise impacts. While these noise levels are a significant improvement over the aircraft noise levels that exist in Seattle today, it is expected that some level of adverse community response to aircraft noise would still be experienced with any of the alternatives.

1.3.1.2 Air Quality

- Aircraft departure delays and vehicular traffic congestion are the major variables in assessing air quality impacts.
- Implementation of any of the of Flight Plan alternatives will decrease overall air quality in the Central Puget Sound region.
- Under the Washington State Clean Air Act, transportation projects will have to conform clean air standards.
- Development of a Replacement Airport would have the greatest air quality emission impacts due to longer distance travel by automobiles.
- A multiple airport system will generate fewer air pollutant emissions due to shorter travel distances for automobiles. In addition, systems that use airports closer to major population centers further reduces emissions.
- Flight Plan alternatives that due not meet system capacity demand would generate the fewest air pollutant emissions.

- The preferred alternative involving Sea-Tac and Paine Field could realize additional air quality emission reductions since these sites are considered feasible locations for stations on the proposed regional light rail system.

1.3.1.3 Transportation

- Washington State Growth Management Act (GMA) requires coordination between land use planning and transportation planning.

- Regional transportation plans must be consistent with county and city comprehensive plans under GMA

- Multiple airport systems comprised of sites (or facilities) that are closer to major population centers are more accessible and overall passenger mileage will be less.

- Roadways around airport locations will need to be upgraded to meet projected traffic demand.

- Traffic congestion can be mitigated by High Capacity Transit (HCT), transportation demand management and rail.

1.3.2 Alternatives

During Phase III of the Flight Plan Project, a total of 34 airport systems which are combinations of site alternatives were evaluated. The Puget Sound Air Transportation Committee selected its preferred airport system alternative based on its ability to meet the goals and objectives included in the Flight Plan mission statement. The preferred alternative is for a multiple airport system to be developed in phases. The system includes:

- Addition of a new dependent air carrier runway to Sea-Tac International Airport to be operational by the year 2000;

- Commercial service using the existing jet runway at Paine Field with new passenger terminal and cargo handling facilities initiated by the year 2000;

- Planning and protection of development rights for a two-runway airport to operate after the year 2010 at one of the following locations:

  - Fort Lewis Army Base or McChord Air Force Base, if coordination with military activities can be achieved;
  - East of Fort Lewis Army Base, if airspace coordination can be resolved; or
  - Olympia/Black Lake area in Thurston County if no sharing with either military facility is possible.

The Puget Sound Air Transportation Committee also selected six of the 34 airport system alternatives to be evaluated as secondary alternatives in addition to the "no action" alternative required by SEPA guidelines. These six were chosen to represent the range of airport systems considered by the Committee. These secondary alternatives are highlighted in this EIS to help show the range of potential environmental impacts. The secondary alternatives are:

- Existing Sea-Tac International Airport with a 1-runway airport at Arlington and a 1-runway airport in central Pierce County (Airport System No. 23).
- Existing Sea-Tac International Airport with a 1-runway airport at Arlington and a 1-runway airport in the Olympia/Black Lake area (Airport System No. 25).
- Existing Sea-Tac International Airport with a 2-runway airport at Arlington (Airport System No. 8).
- Existing Sea-Tac International Airport with a 1-runway airport at Paine Field and a 1 runway airport in central Pierce County (Airport System No. 24).
- Sea-Tac International Airport with a new dependent air carrier runway with a 2-runway airport at Arlington (Airport System No. 18).
- Sea-Tac International Airport with a new dependent air carrier runway with a 2-runway airport in central Pierce County (Airport System No. 21).

The complete list of 34 alternatives evaluated during Phase III of the Flight Plan Project is shown in Table 2 at the end of Chapter 2.

1.3.3 Impacts and Mitigation

1.3.3.1 Impacts Matrix

The impacts of the preferred and secondary alternatives by environmental subject are summarized in Table 1.

Table 1. Impacts Summary Matrix for Preferred and Secondary Alternatives.

Alternative	Noise	Transportation	Air Quality	Plants & Animals	Earth	Land Use	Public Services & Utilities
Preferred Alternative: Sea-Tac with Dependent Runway; Paine Field; plan for southern airport.	Total 65 Ldn population affected: 12,600 - 13,100. With runway use mitigation: 8,100 - 8,600 population affected.	Overall auto passenger mileage generally lower than other system alternatives: Daily passenger mileage: (DPM, in thousands) = 1,536 - 1,689; Annual passenger mileage: (APM, in millions) = 567-664.	Lowest overall air pollutant emissions: 28.0 - 35.0 Tons CO/Day; 7.8 - 8.6 Tons NOX/Day.	Wetlands on the Paine Field and Olympia/ Black Lake site could be impacted. Salmon-producing streams on the Fort Lewis and Olympia/ Black Lake could be impacted. Two endangered plants and two endangered birds may be impacted on the Fort Lewis site.	Soils types at the proposed sites are appropriate for airport construction.	Compatible vicinity of Sea-Tac and Paine Field. Southern airport changes vicinity land use. Homes directly impacted: Sea-Tac = 230+; Paine Field = Several; Southern = Up to 1,060.	Minor impacts to Sea-Tac and Paine Field, most facilities in place. Major impacts to southern airport options, new facilities needed.
Existing Sea-Tac; Arlington; Central Pierce County.	Total 65 Ldn population affected: 7,900.	Overall passenger mileage slightly higher than preferred alternative: DPM = 1,596; APM = 494 - 694.	Slightly higher emissions than preferred alternative due to delays at Sea-Tac: 29.0 - 36.0 Tons CO/Day; 7.7 - 8.9 Tons NOX/Day.	No impacts.	Soils are appropriate for construction, with the exception of the Arlington site.	Compatible vicinity of Sea-Tac and Arlington. Central Pierce airport changes vicinity land use. Homes directly impacted: Sea-Tac = None; Arlington = 20+; Cent. Pierce = 594+.	Minor upgrading to facilities at the Sea-Tac and Arlington sites. Major upgrading to facilities at Central Pierce site.
Existing Sea-Tac; Arlington; Olympia/ Black Lake.	Total 65 Ldn population affected: 7,500.	Highest auto passenger mileage of three airport systems: DPM = 1,902; APM = 494 - 694.	Emissions comparable to existing Sea-Tac, Arlington, and Central Pierce (above): 29.0 - 36.0 Tons CO/Day; 7.7 - 8.9 Tons NOX/Day.	Salmon-producing stream on the Olympia/Black Lake site would be impacted.	Soils are appropriate for construction, with the exception of the Arlington site.	Compatible vicinity of Sea-Tac and Arlington. Olympia/ Black Lake airport changes vicinity land use. Homes directly impacted: Sea-Tac = None; Arlington = 20+; Olympia/Black Lake = 50+.	Minor upgrading to facilities at Sea-Tac and Arlington sites. Major upgrading to facilities at Olympia/ Black Lake site.

Table 1. Impacts summary matrix for preferred and secondary alternatives (continued).

Alternative	Noise	Transportation	Air Quality	Plants & Animals	Earth	Land Use	Public Services & Utilities
Existing Sea-Tac; 2 Runway Arlington.	Total 65 Ldn population affected: 7,500.	Comparable to other comparable 2-runway supplemental airport alternatives: DPM = 2,093; APM = 534 - 1,019.	High CO emissions due to distance from major centers: 30.0 - 48.0 Tons CO/Day; 7.9 - 10.8 Tons NOX/Day.	No impacts.	Soils are appropriate for construction, with the exception of the Arlington site.	Compatible with vicinity of Sea-Tac and Arlington. Homes directly impacted: Sea-Tac: None; Arlington: 95.	Minor upgrading to Sea-Tac and Arlington sites.
Existing Sea-Tac; Paine Field; Central Pierce County.	Total 65 Ldn population affected: 7,600.	Overall auto passenger mileage lower than preferred alternative: DPM = 1,354; APM = 494 - 694.	Slightly higher overall emissions than preferred alternative: 29.0 - 36.0 Tons CO/Day; 7.7 - 8.9 Tons NOX/Day.	Wetlands on the Paine Field site would be impacted.	Soils are appropriate for construction.	Compatible with vicinity of Sea-Tac and Paine Field. Central Pierce airport changes land use. Homes directly impacted: Sea-Tac = None; Paine Field = Several; Cent. Pierce = 594+.	Minor upgrading to facilities at Sea-Tac and Paine Field. New facilities needed at Central Pierce.
Sea-Tac with Dependent Runway; 2 Runway Arlington.	Total 65 Ldn population affected: 13,000.	Lower overall auto passenger mileage compared to existing Sea-Tac: DPM = 1,747; APM = 604 - 732.	Overall emissions relatively high due to travel distance: 33.0 - 38.0 Tons CO/Day; 8.3 - 9.1 Tons NOX/Day.	No impacts.	Soils at all sites, except Arlington, are appropriate for construction of the airport.	Compatible with vicinity of Sea-Tac and Arlington. Homes directly impacted: Sea-Tac = 230+; Arlington = 95.	Minor impacts to Sea-Tac, most facilities in place. Upgrading of facilities required at Arlington.
Sea-Tac with Dependent Runway; 2 Runway Central Pierce County.	Total 65 Ldn population affected: 13,500.	Lower overall auto passenger mileage compared to existing Sea-Tac: DPM = 1,747; APM = 604 - 732.	Emissions same as Sea-Tac with Dependent Runway; 2 Runway Arlington (above): 33.0 - 38.0 Tons CO/Day; 8.3 - 9.1 Tons NOX/Day.	Three acres of wetland on the Central Pierce site would be impacted.	Soils types at the proposed sites are appropriate for airport construction.	Compatible with vicinity of Sea-Tac, Central Pierce airport changes land use. Homes directly impacted: Sea-Tac = 230+; Central Pierce = 1,060+.	Minor impacts to Sea-Tac, most facilities in place. New facilities needed at Central Pierce site.

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1.3.2.2 Mitigation Measures

This section summarizes the types of mitigation measures that can be applied to reduce the impacts of using both existing and new airport facilities. Specific mitigation for airport locations is contained in the text of the DEIS.

Noise

- Preferential runway use and direction.
- Flight track modifications.
- Special nighttime procedures (i.e. Puget Sound departures).
- Nighttime operational restrictions.
- Aircraft use restrictions (i.e. using only quieter Stage III aircraft at night).
- Noise abatement arrival and departure procedures.
- Nighttime ground control measures (i.e. engine run up restriction).
- Land use compatibility enhancement and retrofit (i.e. soundproofing).

Transportation

- Development of regional light rail and high-capacity transit systems.
- Roadway improvements including addition of lanes and added capacity to regional arterials and freeways.
- New regional arterials and freeways.
- New or modified intersections and local street improvements in vicinity of airports.

Air Quality

- Reduction of vehicular travel associated with project.
- Improvement of mass transit facilities.
- Support and compliance with the Puget Sound Regional Council's Vision 2020 plans and programs.

- Implementation of vehicular usage reduction programs and transportation demand management programs.

Plants & Animals

Wetlands

- Protect wetlands with 25-to 300-foot buffer.
- If buffer is not feasible, prepare a mitigation plan which seeks to replace the wetland functions and values that will be impacted by the project.

Streams

- Create or enhance sufficient stream habitat in the general area.

Vegetation/Wildlife

- Revegetating the sites, after construction, would reduce the impacts to plant and animal communities.
- Avoiding areas with wetlands would serve to ensure no disturbance in valuable areas.

Earth

- Avoiding all sensitive areas with potential geologic hazards would eliminate significant impacts to earth resources.
- Modern construction practices and minimizing earth movement during rainy seasons should control most earth impacts.

Land Use

- Local comprehensive plans and zoning regulations modified and implemented in accordance with the Growth Management Act to accommodate planned airports and facilities.

Public Services and Utilities

- Local facility plans modified and implemented in accordance with the concurrency requirements of the Growth Management Act to accommodate planned airports and facilities.

2. FLIGHT PLAN ALTERNATIVES

The alternatives considered by the Flight Plan Project are the result of three phases of the study by the Puget Sound Air Transportation Committee. During Phase I, the project mission, vision, and objectives were developed together with preliminary forecasts of future air travel demand. This established the scope and nature of the problem facing the region. In Phase II, these forecasts were refined and finalized and a wide range of both aviation and non-aviation transportation alternatives were developed, together with generic site areas used to evaluate their viability. The system alternatives best able to meet the Flight Plan mission and objectives were recommended for more detailed further study. Phase III has studied the recommended airport system alternatives' operational, economic, environmental, and institutional characteristics and produced the draft recommendations presented here. The next step will be for the Committee to receive and respond to public comments through the EIS process and prepare its final recommendations to the Puget Sound Regional Council and the Port of Seattle. The entire Flight Plan process is described in more detail in section two of the Draft Final Report.

2.1 PREFERRED ALTERNATIVE

The Puget Sound Air Transportation Committee selected its preferred airport system alternative based on its ability to meet the goals and objectives included in the Flight Plan mission statement. In the planning process, a total of 34 airport system and site alternatives were evaluated (see Table 2). Key factors in the selection of the preferred alternative were its ability to:

- Minimize negative environmental effects and preserve sensitive areas
- Optimize long-range system capacity and economic benefits
- Provide earliest possible relief of capacity pressures and delays at Sea-Tac International Airport
- Minimize airport system delays.

The preferred alternative is for a multiple airport system to be developed in phases. The system includes:

- Addition of a new dependent air carrier runway to Sea-Tac International Airport to be operational by the year 2000.
- Commercial air carrier service using the existing jet runway at Paine Field with new passenger terminal and cargo handling facilities initiated by the year 2000.

- Planning and protection of development rights for a two-runway airport to operate after 2010 at one of the following locations:

  - Fort Lewis Army Base or McChord Air Force Base, if coordination with military activities can be achieved
  - East of Fort Lewis Army Base, if airspace coordination can be resolved
  - Olympia/Black Lake area in Thurston County if no sharing with either military facility is possible.

The new dependent runway at Sea-Tac would be located on existing airport property to minimize impacts. For this reason, the new runway will not be separated by enough distance from the existing runways to operate independently. During poor weather conditions, the new runway is far enough away from two arrival streams to be handled, although the aircraft must be staggered and not land simultaneously. The dependent runway allows the airport to operate at almost the same capacity during the 45% of the time when bad weather occurs as it does during good weather. This runway would be operation in the year 2000.

The layouts and facilities for each of the airport sites included in the preferred alternative are described in Working Paper No.'s 6 and 11. The preferred alternative is essentially Airport System No. 28 or 30, depending on which southern airport location is eventually developed.

2.2 SECONDARY ALTERNATIVES

The Puget Sound Air Transportation Committee also selected six of the 34 airport system alternatives to be evaluated as secondary alternatives. The six alternatives were chosen to represent the range of airport systems considered by the Committee, and all six would satisfy the forecasted demand for air travel. These secondary alternatives are highlighted in this EIS to help show the range of potential environmental impacts. The secondary alternatives are:

- Existing Sea-Tac International Airport with a 1-runway airport at Arlington and a 1-runway airport in central Pierce County (Airport System No. 23)

- Existing Sea-Tac International Airport with a 1-runway airport at Arlington and a 1-runway airport in the Olympia/Black Lake area (Airport System No. 25)

- Existing Sea-Tac International Airport with a 2-runway airport at Arlington (Airport System No. 8)

- Existing Sea-Tac International Airport with a 1-runway airport at Paine Field and a 1 runway airport in central Pierce County (Airport System No. 24)

- Sea-Tac International Airport with a new dependent air carrier runway with a 2-runway airport at Arlington (Airport System No. 18)

- Sea-Tac International Airport with a new dependent air carrier runway with a 2-runway airport in central Pierce County (Airport System No. 21)

The layouts and facilities for each of the airport sites included in the secondary alternatives are described in Working Paper Nos. 6 and 11.

2.3 OTHER ALTERNATIVES EVALUATED

The Puget Sound Air Transportation Committee evaluated 34 different airport systems during the Phase III study. The alternatives were based on one, two, or three airport systems, with each system including different combinations of potential airport sites. All of these alternatives were evaluated in the working papers presented to the Committee during the Phase III study. Table 2 lists all airport alternatives evaluated. This EIS includes all of the airport system alternatives to present the full range of options and environmental effects.

2.4 ALTERNATIVES CONSIDERED AND REJECTED

As a result of the Phase I, Phase II, and Phase III studies, the Puget Sound Air Transportation Committee decided to remove several alternatives initially recommended for study in Phase III from its draft recommendation.

2.4.1 No Action

Not adding capacity to the region's air transportation service would not fulfill the vision, mission, and goals adopted by the Committee to guide the Flight Plan process. Allowing the region's population to grow without providing adequate air service would result in Sea-Tac Airport's capacity being greatly exceeded and cause extreme delays for air travelers. To do nothing also results in additional noise, air quality, and surface transportation congestion impacts. By the year 2020, unsatisfied demand would range from 7 to 13 million annual passengers. This would also have severe direct and indirect economic impacts for the region, jeopardizing both its vitality and its ability to compete both nationally and internationally.

Although the no-action alternative has been eliminated from consideration by the Committee as a viable choice for the region's future, it has been included in this EIS to meet SEPA requirements and provide a comparison with other airport system alternatives. No action includes a package of demand management techniques, new technologies, and potential use of other modes.

Table 2. Phase III Airport Systems.

1. Sea-Tac without a new runway.
2. Sea-Tac with a new runway.
3. Sea-Tac without a new runway and Arlington Municipal Airport with one air carrier (7,000') runway.
4. Sea-Tac without a new runway and Paine Field with one air carrier (7,000') runway.
5. Sea-Tac without a new runway and McChord AFB with one air carrier (7,000') runway.
6. Sea-Tac without a new runway and a new airport at the Central Pierce site with one air carrier (7,000') runway.
7. Sea-Tac without a new runway and a new airport at the Olympia/Black Lake site with one air carrier (7,000') runway.
8. Sea-Tac without a new runway and Arlington Municipal Airport with two parallel air carrier (7,000') runways.[2]
9. Sea-Tac without a new runway and Paine Field with two parallel air carrier (7,000') runways.
10. Sea-Tac without a new runway and McChord AFB with two parallel air carrier (7,000') runways.
11. Sea-Tac without a new runway and a new airport at the Central Pierce site with two parallel air carrier (7,000') runways.
12. Sea-Tac without a new runway and a new airport at the Olympia/Black Lake site with two parallel air carrier (7,000') runways.
13. Sea-Tac with a new dependent air carrier runway and Arlington Municipal Airport with one air carrier runway.
14. Sea-Tac with a new dependent air carrier runway and Paine Field with one air carrier runway. The existing primary runway at Paine serves as the air carrier runway.
15. Sea-Tac with a new dependent air carrier runway and McChord AFB with one air carrier runway. The existing runway at McChord serves as the air carrier runway.
16. Sea-Tac with a new dependent air carrier runway and the Central Pierce site with one air carrier runway.
17. Sea-Tac with a new dependent air carrier runway and the Olympia/Black Lake site with one air carrier runway.
18. Sea-Tac with a new dependent air carrier runway and Arlington Municipal Airport with two parallel air carrier runways.[2]
19. Sea-Tac with a new dependent air carrier runway and Paine Field with two parallel air carrier runways.
20. Sea-Tac with a new dependent air carrier runway and McChord AFB with two parallel air carrier runways.
21. Sea-Tac with a new dependent air carrier runway and the Central Pierce site with two parallel air carrier runways.[2]
22. Sea-Tac with a new dependent air carrier runway and the Olympia/Black Lake site with two parallel air carrier runways.
23. Sea-Tac without a new runway with Arlington Municipal and the Central Pierce site each with one air carrier runway.[2]
24. Sea-Tac without a new runway with Paine Field and the Central Pierce site each with one air carrier runway.[2]
25. Sea-Tac without a new runway with Arlington Municipal and the Olympia/Black Lake site each with one air carrier runway.[2]
26. Sea-Tac without a new runway with Paine field and the Olympia/Black Lake site each with one air carrier runway.
27. Sea-Tac with a new dependent air carrier runway with Arlington Municipal Airport and the Central Pierce site each with one air carrier runway.
28. Sea-Tac with a new dependent air carrier runway with Paine Field and the Central Pierce site each with one air carrier runway.[1]
29. Sea-Tac with a new dependent air carrier runway with Arlington Municipal Airport and the Olympia/Black Lake site each with one air carrier runway.
30. Sea-Tac with a new dependent air carrier runway with Paine Field and the Olympia/Black Lake site each with one air carrier runway.[1]
31. A replacement airport at the Central Pierce site with three parallel air carrier runways.
32. A replacement airport at the Olympia/Black Lake site with three parallel air carrier runways.
33. A replacement airport at Fort Lewis with three parallel air carrier runways.
34. Sea-Tac without a new runway and full demand management.

---

(1) Preferred alternative
(2) Secondary alternatives

2.4.2 Replacement Airport

Phase III studied building three runway airports on either Fort Lewis or at the Olympia/Black Lake location to replace Sea-Tac Airport. In addition, the Phase II study evaluated a replacement airport at Moses Lake, connected with the Puget Sound region by high-speed rail. For several reasons, all of these alternatives were found to be infeasible by the Committee. Replacement airports in the Puget Sound area were substantially more expensive than other alternatives and had substantially greater environmental impacts on air quality, transportation, plants and animals, land use, and public services. A replacement airport would, however, concentrate noise impacts, so relatively fewer persons would be subjected to more noise than under other alternatives if appropriate zoning and land use planning practices are employed. Further, closure of Sea-Tac Airport would have severe economic impacts on the surrounding communities. Replacement airport systems considered in the Phase III studies have been included here to present the full range of information received by the Committee.

The Committee rejected the idea of developing a remote airport at Moses Lake linked to the Puget Sound area by high-speed rail due to the very high cost of the system, inaccessibility to most users, and the uncertainties about how it could be implemented.

2.4.3 Sea-Tac with Demand Management Only

Demand management involves a variety of techniques to modify how passengers use air transportation. Demand management is popularly thought of as a means for getting the greatest benefit out of an airport facility without adding new runways. Essentially, it is a means of easing airport congestion by encouraging passengers to travel during non-peak times and/or to places where they can be most efficiently handled. It can also mean flying planes at higher occupancy levels or using larger aircraft to carry more people per flight. Demand management techniques can include allowing congestion to induce passengers to travel during off-peak periods, applying higher prices for peak-period travel, and using administrative or regulatory limits on amount of travel allowed.

Phase III included a detailed examination of demand management techniques and their potential benefits to the future airport system. The results of this study are described in Working Paper No. 4, contained above in Appendix B. In summary, some forms of demand management are already in place at Sea-Tac and are included in the forecasts of future passenger volumes. Essentially, future aircraft fleets are assumed to have a higher proportion of large aircraft carrying more passengers per operation. Demand management cannot be effectively used to reduce the demand for flights, but it can be useful in helping shape demand. As a result, the Committee decided to have all alternatives include the maximum use of demand management techniques so that all airport facilities are used as efficiently as possible.

2.4.4 Rail or Ground Transportation to Portland or Vancouver

During the Phase II study, there was considerable interest in developing a high-speed rail system between Portland, Oregon and Vancouver, British Columbia as a means of reducing the demand for air travel. The alternative was dropped as a substitute for additional airport capacity because it was found to only have a small effect on the demand for air travel and to have very high capital costs. However, the Committee encourages and supports the study of rail by the State Air Transportation Commission and the State High-Speed Rail Commission.

2.5 AIRPORT SITES EVALUATED IN PHASE III

To evaluate the operational characteristics and potential impacts of the one, two, or three airport systems considered in Phase III, it was necessary to develop conceptual site layouts in actual locations. Both existing airports and locations where no airport now exists where used. The areas where no airport is now present were carried forward from the Phase II study, with conceptual layouts prepared based on maps and other published information. At existing airports, additional facilities were located based on current facilities and surrounding activities. All layouts are preliminary and have been used only as a means of comparing the airport system and site alternatives. Extensive site-specific analysis will be required before any facility is developed. Site layout drawings and descriptions of each site are contained in Working Paper No. 6, pages 7-12.

The following alternative airport sites were evaluated in Phase III:

Sea-Tac Airport
- Sea-Tac with or without a commuter runway
- Sea-Tac with or without a new dependent air carrier runway

Supplemental Airport Alternatives
- Existing Arlington Airport with runway extension
- Arlington Airport with a new runway
- Existing Paine Field
- Paine Field with a new runway
- Existing McChord Air Force Base used jointly with military
- McChord Air Force Base with new runway use jointly with military
- Supplemental airport at Central Pierce with one runway
- Supplemental airport at Central Pierce with two runways
- Supplemental airport at Olympia/Black Lake with one runway
- Supplemental airport at Olympia/Black Lake with two runways

Replacement Airport Alternatives

Replacement airport at Central Pierce with three runways
Replacement airport at Olympia/Black Lake with three runways
Replacement airport at Fort Lewis site with three runways

3. AFFECTED ENVIRONMENT, SIGNIFICANT IMPACTS, MITIGATION MEASURES, AND UNAVOIDABLE ADVERSE IMPACTS

3.1 NOISE

Introduction

The potential noise impacts associated with each of the airport system alternatives under consideration have been analyzed and compared with the projected future population surrounding Sea-Tac and all the other airport sites. This section summarizes the significant findings of *Working Paper No. 12A - Noise Assessment Study* by Mestre Greve Associates/ P&D Aviation, which is reproduced as Appendix 1 of this EIS and incorporated by reference. Appendix 1 contains more detailed information on the noise study, including background information on the descriptions of noise, noise metrics, assessment guidelines, aircraft operational assumptions, and the noise contours and population exposure results.

To effectively evaluate and explain potential noise impacts well into the future, this study utilizes methods and criteria that consider noise impacts in a larger area around the airport sites than is usual for traditional airport noise studies. The methods and data assumptions were uncomplicated and capable of treating all system alternatives as equitably as possible. The study utilized standard industry-wide methods of computer modeling and noise assessment analysis such as the 65 Ldn noise level contour. Supplemental noise assessment criteria were also included so that the potential noise impacts could be more thoroughly evaluated. The analysis identified the population that would be exposed to a less significant level of aircraft noise (55 Ldn) and to a level of single-event noise (80 SEL). Populations that would be newly exposed to noise at both the 55 and 65 Ldn levels were also evaluated.

The total population contained within the projected noise level contours was estimated for each of the various airport alternatives. The noise contours are based on operational assumptions for the year 2020. For comparative reasons, the population analysis is based on population projections for the year 2000 under the assumption that protective zoning and land use planning practices would be employed around the selected airport site(s) would go into effect by that date.

3.1.1 Affected Environment

The description, analysis, and reporting of community sound levels from aircraft must be sensitive to the complexity of human response to sound and the myriad sound-rating scales and metrics that have been developed for describing acoustic effects. For example, community noise is generally not constant, but varies with time. Therefore, some type of statistical metric is necessary to mathematically express a varying noise level that can be correlated to community response. As a result of the intricacies of describing noise, several noise metrics have been developed to account for noise characteristics such as loudness, duration, time of day, and cumulative effects of multiple noise events.

Certain types of noise, particularly continuous exposure to high volumes, is known to have several adverse affects on health and to cause disruption in human activities. Aircraft noise is intermittent with each event rising to a peak level and rapidly diminishing. The identified adverse effects of community airport noise on people include communication interference, sleep interference, annoyance and various physiological responses. Many factors influence how a sound is perceived and whether or not it is considered annoying to the listener. This includes not only physical characteristics of the sound but also secondary influences such as sociological and external factors. A more detailed discussion of factors that describe human response to sound in terms of both acoustic and non-acoustic factors, and the rating scales developed to account for human response are presented in Working Paper 12A (see Appendix 1). Based upon the identified effects of noise and the factors that influence annoyance, noise metrics have been established to help protect the public health and safety by gauging the potential for disruption of certain human activities.

Noise Assessment Metrics

Different types of noise level measurements were used to describe the noise environment at each of the alternative sites. It was desirable to employ nationally accepted metrics that would best predict the potential community response to aircraft noise in the neighborhoods surrounding the airport sites and which would be defensible in their application to the aircraft noise issues in the Puget Sound area.

Ldn Noise Metric. The cumulative noise metric, Day Night Noise Level (Ldn), was the primary noise metric selected to assess the noise impacts from aircraft operations. The Ldn metric is useful because it combines the loudness of each aircraft overflight, the duration of these events, the total number of overflights and the time of day these events occur into one single-number rating scale. The Ldn scale is specified by most government agencies, including the FAA and the EPA, for the assessment of the noise impacts around airports.

Extensive research using the Ldn index has been conducted on human responses to different levels of aircraft noise. Community noise standards are derived from tradeoffs between the impacts expressed in community response surveys and economic considerations for achieving these levels. Examples of the results of these surveys, expressed in terms of community reaction versus Ldn noise level, are presented in Working Paper 12A (see Exhibit 12-1 in Appendix 1). These interpretations of noise response are derived from case histories involving aircraft noise problems at civilian and military airports and the resultant community response.

The 55 Ldn noise level can be used as an indicator for when impacts from aircraft noise will likely begin to occur. The EPA has identified 55 Ldn as the noise level desirable for

Single-family rural and semi-rural residential development can be found south of the option. The area east and northeast of the option near Loveland, Fredrickson, and South Spanaway, is rapidly growing with new and proposed residential developments.

3.6.1.3 Induced Land Use

In developing a regional airport system, the opportunity is present to plan for the resulting increased levels of activity and related land uses. Comprehensive plans and zoning regulations can (and under the Growth Management Act must) be revised to accommodate new or expanded airport facilities. These regulatory mechanisms can control the type, location, density, and character of land use around a new or expanded airport to meet both local and regional needs. Hence, the estimates given here for induced land use represent only one possible scenario for future development based on the projection of office space and hotel rooms given in Working Paper No. 8, Table V-10. These estimates are based on (a) a forecasted level of air passenger volumes in 2020 (total of 45 million annual passengers, with travel at Sea-Tac "constrained" as described in Working Paper No. 5, Level of Service), and (b) a set of assumptions these airport passenger volumes to land use demands and densities for all alternatives. The preferred alternative has less induced land use impact at Paine since the amount of passenger activity ois lower. In practice, the level of passenger volumes might be achieved on a date other than 2020, and comprehensive plans and zoning regulations will uniquely direct the pattern of land use around any airport.

Studies by P & D Aviation of airports on the west coast find the area directly influenced by an airport ranges from 1.5 to 3 miles from the facility. These studies also find a direct association between airport passenger volumes and office space and hotel rooms in the influence area (see Working Paper No. 8). To estimate induced land use activity, projected office space and hotel rooms have been used to develop acreage estimates by type of activity. The acreage estimates are based in part on a detailed study of existing land use surrounding Sea-Tac airport prepared as part of the FAA Part 150 Noise Contour Study. This study found that of the developed area centered on Sea-Tac approximately 3 miles wide and 16 miles long, 75% was residential, 10% office, 8% manufacturing, and 1% hotels and motels. Because this area is substantially larger than the expected airport influence area, this information was not directly used to estimate induced land use.

Three types of land use are estimated; office, light industrial, and hotel. Retail and other commercial activities are included within each of these categories, but are not calculated separately. Because of concerns with noise, new residential use is expected to be controlled near the airport and is not directly estimated as an induced land use activity within the influence area. However, as an employment center, an airport would be expected to create demand for some residential use in the general area.

main north-south thoroughfare linking Tacoma and Mt. Rainier National Park. State Route 512 serves as the area's major east-west link connecting Lakewood.

In general, the vicinity lies in a growth sector of Pierce County. For example, Spanaway is now experiencing suburbanization and residential development in a southeasterly direction. Development in Parkland is limited to filling in the skipped-over land parcels and more intensive developments along Pacific Avenue.

Olympia/Black Lake

Location. The options are located a few miles southeast of Tumwater and are generally bounded by Interstate 5 on the east, Little Rock Road on the west, Lathrop Road on the north and Aldrich Road on the south. Most of the layout is undeveloped farmland and forested land. There a few scattered residences on the area particularly along 104th and 107th Avenue Southwest. Blooms Ditch, Allen Creek and Salmon Creek flow across the site, primarily from east to west.

Location Vicinity. The option vicinity can be characterized by rural residential development with scattered commercial, home businesses, agricultural, and manufacturing uses. Similar to the layout, the vicinity is primarily undeveloped, forested land.

Southeast of the option, near Scott Lake, is a moderately dense residential development. Further east is Millersyvania State Park. A few miles northeast of the site is the Olympia Municipal Airport.

Fort Lewis

Location. Most of the option falls within the southeastern boundary of the Fort Lewis Military Reservation just south and east of the community of Elk Plain. Part of the option falls outside of the military reservation, south of Elk Plain in unincorporated Pierce County. The layout encompasses training areas 11, 14, and 15 on the military reservation. These areas are considered heavy-use areas by the military, particularly area 14 which includes the Thirteenth Division Prairie used for mechanized battalion and tank battalion operations. Rural and semi-rural residential best describes that part of the layout in unincorporated Pierce County. An underground pipeline and overhead power transmission line also traverses the layout.

Location Vicinity. Other military training areas including areas 8, 9, 10, 12, and 13; these are located north, northwest, and west of the layout. These are also considered heavy training areas by the military. Significant marshlands can also be found west of the layout.

The vicinity becomes more densely developed to the north and northwest. The Meridian Street corridor, a few miles east of the option is the largest and densest concentration of commercial uses in the area.

A major residential development, Rainier Terrace, is in its first stages of development on 1,467 acre site approximately 2 miles south of the proposed airport location. At completion, this planned community will accommodate 3,225 single-family residences and 585 to 975 multi-family residences. A manufacturing and business park will be part of the development.

The Hidden Valley Landfill is within the area of the replacement airport option. The facility is significant because FAA regulations generally prohibit landfills within 10,000 feet of a major airport. The owner of the landfill has proposed an expansion that would allow operations to continue through 1997 or beyond. Partial approval could be granted to allow operation through 1993. Without expansion, the landfill will probably close in 1992.

The Hidden Valley Landfill is especially important for development of a replacement airport at this location. Previously disposed waste would probably have to be removed, with the developing authority becoming responsible for its safe disposal at a potentially substantial cost.

McChord Air Force Base

Location. These alternatives are situated on the existing McChord Air Force Base. The new runway option would utilize the eastern portion of the base, east of the main runway. This area includes a fire training area and lies within the clear zone for hazardous cargo loading and unloading areas.

Location Vicinity. The vicinity can be generally characterized as suburban with the density and facilities to be considered an urban center. The area includes a portion of the Lakewood Community in unincorporated Pierce County, South Tacoma, McChord Air Force Base and Fort Lewis Military Reservation, and the Parkland-Spanaway area east of the Air Force base. Pacific Lutheran University is located just east of the base.

Growth in many communities around the base has seen the subdivision of many large properties and extensive redevelopment and expansion of commercial centers. Increasing multiple-family construction has caused a shift in housing development away from single-family, owner-occupied residential development.

Most commercial development is located along a strip on Pacific Avenue with major concentration points at 112th Street, 136th street, Military Road, and 176th Street. The area is bisected by two major transportation corridors. Pacific Avenue, or State Route 7, is the family residential on moderate-sized lots. A few master-planned communities in the study area include Harbor Pointe west of the airport, and Kennilworth Hills north of the airport in Southwest Everett. Other major concentrations of new, single-family residential units are located south of Mukilteo in the vicinity of 84th Street Southwest and the Mukilteo Speedway, the Lake Serene area, and along Holly Drive between 112th and 100th Streets Southwest. Mobile homes and multiple-family units are scattered throughout the study area.

Other major land uses include industrial, commercial, recreational/open space activities and are more concentrated within the study area. Industrial uses adjoin the Boeing 747 Assembly Plant and can also be found along the Mukilteo speedway as part of the Harbour Pointe master-planned community. Another area of significant industrial use is along Highway 99.

Retail and commercial land use in the area is limited mainly to the Highway 99 corridor, a few small centers at major intersections, and two major centers at Mukilteo and Alderwood Mall. There is a considerable amount of park and recreational space in the Paine Field area.

Land uses contiguous to, and in the vicinity of, the airport are varied. To the north of the airport property are industrial uses; to the west and south land use is primarily residential; to the west is also residential with mixed open space and park land.

Central Pierce

Location. The option is located a few miles east of the Fort Lewis Military reservation in the vicinity of the 152nd Street East/Highway 161 intersection. Depending on the alternative, the layout would encompass a large residential subdivision and park-and-ride west of Highway 161, the Paul Bunyan Rifle and Sportsmans Club, several residences along Highway 161, and Thun Field, a small recreational air field located on the east side of Highway 161. Hidden Valley landfill is located east of SR 161 south of Thun Field and is within the area for the replacement airport option.

Location Vicinity. Land use in the vicinity of this alternative is characterized by rural, semi-rural, and suburban residential development with scattered commercial, home businesses, agricultural, and manufacturing uses. Much of the area is developed with housing tracts. In general, like much of Central Pierce County, the vicinity is an area in transition from rural or semi-rural to medium-density residential, commercial, and industrial.

Residential development predominates in the area directly north and northeast of the option. A surface gravel operation is located off 94th Avenue East near its intersection with 152nd Street East. Scattered single-family residences occur south of the option along Highway 161. Further south is the community of Graham.

areas. Trailer park developments are prominent in the southeastern portion of the study area west of 28th Avenue South.

Arlington

Location. This alternative is situated on the existing Arlington Municipal Airport. The proposed layouts also include some agricultural land south of 172nd Street NE just south of the airport boundary. The airport is located in the southwest portion of the Arlington City Limits. The Airport provides general aviation activities such as recreational flying, pilot training, charter and air taxi services, and corporate operations. The airport currently contains approximately 1,160 acres.

Location Vicinity. Land use in the Arlington area varies from commercial activities, in Arlington's city center, to more mixed land uses around the city center particularly in the airport vicinity. The overall character, at present, may be described as agricultural and rural-residential.

Land uses contiguous to the airport consist of agricultural, residential, and industrial uses. The south and northwest portions of the airport are dominated by agricultural uses. Undeveloped property can be found on all sides. The highest concentration of residential development is found .25 mile from the airport's southwest boundary. Other residential developments include Prospect Point north of the airport and Shoultes Green Acres south of the airport. Both of these developments are located just west of the extended centerline of the north-south runway.

Industrial land use is the dominant land use east of the airport. Boat building, logging and cement/concrete products are the major uses within this industrial area. A 40-acre industrial park occupies the airport's northwest corner. The closest commercial uses are located .75 mile to the west at Smokey Point.

Paine Field

Location. Most of the proposed facility layouts are situated on existing Paine Field Airport property located in Snohomish County just south of the Everett City Limits. Under the new runway option, some of the airport could extend into residential properties near 121st SW. Besides the main runway and terminal, the Paine Field Airport also includes U.S. Navy Housing and National Guard facilities. Activities on the airport include major aircraft maintenance facilities operated by TRAMCO, which could be partially displaced by development of a new runway.

Location Vicinity. The study area around the Paine Field option includes part of the City of Mukilteo, southwest Everett, northwest Lynnwood and Edmonds as well as the Paine Field community. Land use in the area is mixed urban uses, with predominantly single-comprehensive plans include a process for identifying and siting of essential public facilities. This process is now being reviewed by cities and counties and should be in place by July 1, 1992.

Regional airports are associated with major activities centers and meet the transportation and economic needs of the area. Intermodal transportation facilities are necessary and integrated in regional transportation plans to insure effective and efficient community development. The area serviced by a regional facility involves many communities and agencies; therefore, community concerns and impacts need to be evaluated and incorporated into regional plans.

The proposed expansion of existing airport facilities would be subject to review by several governmental agencies. Since each jurisdiction has its own regulations, land use standards vary as do the respective jurisdictional zoning codes. The rules and regulations governing this project would establish where precedence prevails and cooperation is needed for approval of the project (See Working Paper No. 10).

For this study, each jurisdiction was contacted and provided comprehensive plans and zoning maps. The maps were reviewed for existing conditions. GMA policies were used as a basis for land use analysis.

3.6.1.2 Existing Conditions

Sea-Tac

Location. These alternatives are situated on Sea-Tac International Airport property. Each runway alternative considered for the Sea-Tac option would utilize airport property west of Runway 34L and east of 12th Avenue South. This portion of the airport is currently undeveloped, except for the Weyerhauser corporate aviation facility.

Location Vicinity. Sea-Tac International Airport is surrounded by the four municipalities of Sea-Tac, Normandy Park, Des Moines, and Tukwila, and the communities of Burien and Angle Lake. Sea-Tac is located roughly in the center of these communities, and has fostered the development of industrial areas to the north and southwest. Airport-related commercial development along SR 99 dominates the east and southeast portions of the area.

Land uses around Sea-Tac reflect the general range of land uses expected in an urban environment, such as commercial, industrial, and residential development. Land immediately to the north and south of the airport, however, is mainly open space as a result of the acquisitions under the Port of Seattle's Noise Acquisition Program. Natural areas with steep topography, creeks, and small lakes can also be found around the airport. Tub Lake and Lake Reba, both tributaries of Miller Creek, are located to the north and Des Moines Creek is located to the south. Further from the airport are single-family and multi-family residential

3.5.3 Mitigation Measures

Avoiding all sensitive areas with potential geologic hazards would eliminate significant impacts to earth resources. Modern construction practices and minimizing earth movement during rainy seasons should control most earth impacts.

3.5.4 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts to earth resources would be expected.

3.6 LAND USE

This programmatic EIS evaluates the environmental consequences of different airport system alternatives at a generalized level, without detailed evaluation of individual sites or specific impacts. The purpose of the environmental analysis at this stage is to provide a comparative evaluation of the alternative airport systems. After an airport system plan is chosen, much more detailed studies will be conducted to fully evaluate all environmental impacts of each system component.

3.6.1 Affected Evironment

3.6.1.1 Significant Issues

Adjacent land uses should be compatible and are regulated by local jurisdictions using local, regional, state, and federal guidelines, policies, and regulations. The recent passage of the Washington State GMA (in March 1990) and RSHB 1025, commonly known as GMA II, one year later has provided significant guidance to planning policies. However, it did not address all of the necessary procedures and processes to implement those policies. Working Paper No. 10 discusses institutional and jurisdictional issues and relationships.

GMA I and GMA II affect the region's future air carrier system. Each jurisdiction required to plan under this legislation must adopt five-element comprehensive plans, and all five elements are to be consistent with each other. Local plans must also be consistent with regional plans. The five elements to be included are Land Use, Transportation, Capital Facilities, Utilities, and Housing. Significant issues will be the level of service for roads each municipality must adopt by July 1, 1993, the concurrency requirement for new construction, and the remediation required to improve existing roads to meet those standards. Both regional and county-wide comprehensive plans must be adopted by July 1, 1993.

Internal and external consistency would be difficult to accomplish if municipalities did not consider and adopt the GMA policies into their existing planning process. Therefore, the assumption is made that GMA policies would apply to this project. GMA II requires that

Replacement airports would require the largest quantities of fill materials. The Supplemental airport option would require significantly less.

All soil surfaces are subject to natural forces of chemical physical weathering that result in erosion. The susceptibility to erosion is dependent on the physical characteristics of the soil, vegetative cover, topography (slope), and the intensity and duration of storms. Stormwater runoff is the greatest single factor affecting erosion in the Puget Sound Region. Removal of the vegetative cover increases the erosion rate. Erosion would be minimal on most locations due primarily to the low gradient.

Grading and excavations would be required to varying degrees on each of the options available. Fill, excavation, and site grading would change the local topography. Preliminary estimates on the amount of fill required for the various alternatives are listed in Table 13 below:

Table 13. Grading and Excavation Quantities.

Sea-Tac (new runway)	13,682,000 yd^3
Arlington with runway extension	100 acres light grading
New runway	500 acres light grading
Paine Field with existing airport	400,000 yd^3
New runway	750,000 yd^3
Central Pierce replacement airport	36,000,000 yd^3
Two-runway airport	17,000,000 yd^3
One-runway airport	9,120,000 yd^3
McChord with existing airfield	745 acres light grading
New runway	800 acres light grading
Olympia/Black Lake replacement airport	32,160,000 yd^3
Two-runway airport	19,280,000 yd^3
One-runway airport	6,400,000 yd^3
Fort Lewis replacement airport	36,000,000 yd^3

3.5.2.4 No-Action

If improvements to the existing airport system do not take place, earth resources in the Puget Sound region would not be significantly affected. Areas that would have been considered for airport development would be available for other projects.

3.5.2.2 Secondary Alternatives

Alternative No. 23 would not have any impacts on the Sea-Tac site, since a new runway would not be built. The Central Pierce site soils also belong to the Alderwood-Everett Association. In addition, construction of a replacement airport at this location would require removing and disposing of material contained in the Hidden Valley Landfill. On the other hand, soils at the Arlington location belong to the Norma-Lynnwood-Custer association and would be more difficult to develop. The Arlington airport is located on the Tulalip Sole Source Aquifers as designated by the EPA. See Section 3.5.2.1 for discussion of the review process. Approximately 100 acres of land would be graded in order to extend the runway at the Arlington site.

The impacts of Alternative No. 25 would be similar to those described above for No. 23 with the exception of one runway at Olympia/Black Lake replacing the Central Pierce option. Since No. 23 provides one runway, only 6,400,000 cubic yards of fill would be moved on the Olympia/Black Lake site.

If one runway was extended and another built at the Arlington site, as would be done under Alternative No. 8, a total of 500 acres of land would need to be graded. The Sea-Tac site would not be altered.

Under Alternative No. 24, the design of the Sea-Tac site would not be altered. Paine Field would have one runway which would involve depositing 400,000 cubic yards of fill on the site. Soils in and around the Paine Field location generally belong to the Alderwood-Everett Association. In addition, some soils are from the Mukilteo Series. Alternative No. 24 also involves constructing a one runway airport at Central Pierce. Approximately 9,120,000 cubic yards of fill would be moved on this site.

Secondary Alternatives No. 18 and 21 both involve building a new dependent runway at the Sea-Tac site similar to the preferred alternative. Alternative No. 18 would construct a new runway at the Arlington site for a total of two runways. This option would involve grading 500 acres of land. Alternative No. 21 would construct two runways at the Central Pierce site involving approximately 17,000,000 cubic yards of fill.

3.5.2.3 Other Alternatives

In general, most of the locations evaluated tended to have suitable soils for development. The exception is the Arlington location, which has poorly drained soils (south of 172nd Street) that may impose some limitations on construction (soils would have to be removed or extensive drainage systems constructed). All of the potential locations appear to have soils that would allow for airport construction. Additional soils analysis for each location will need to be conducted to determine specific soil types, suitability and potential impacts.

- Mukilteo Series soils tend to be very poorly drained and may present development limitations due to ponding.

Grading and excavations would be required to varying degrees for each of the options available. Fill, excavation, and site grading would change the local topography. Preliminary estimates on the amount of fill required for the various alternatives are discussed in the impacts section.

3.5.2 Significant Impacts

3.5.2.1 Preferred Alternative

The preferred alternative would involve constructing a new dependent runway at Sea-Tac and one runway at Paine Field, as well as planning for two runways at either McChord, Fort Lewis, or Olympia/Black Lake. Soils in the Sea-Tac area are primarily within the Alderwood-Everett Association and are suitable for development. Approximately 13,682,000 cubic yards of fill would be moved on the Sea-Tac site in order to build the new dependent runway.

The proposed McChord AFB and Fort Lewis airport runways are located above the Clover Chamber's Creek aquifer, an important groundwater resource for south and east Pierce County. A petition has been filed with the EPA for designation as a Sole Source Aquifer, which is expected to be granted within a year. This designation does not preclude development, but does establish a process whereby the EPA reviews all federally assisted projects. These reviews are to ensure that proper design, construction, and operational controls are used to protect the aquifer from contamination which could cause significant adverse affects on the public health.

The McChord Base area has a thick blanket of partially consolidated glacial deposits consisting mainly of sand and gravel. The soils tend to be excessively drained, gravelly sandy loams and suitable for construction. In order to build two runways at the McChord Air Force Base site, approximately 800 acres would require light grading.

Soils at the Fort Lewis location are similar to those described above for the McChord site. Approximately 36,000,000 cubic yards of fill would be needed at this site to construct two runways.

The Olympia/Black Lake site soils generally belong to the Alderwood-Everett Association. Development on the site would require approximately 19,280,000 cubic yards of fill in order to build two runways.

Vegetation and Wildlife

Revegetating any sites used for new airports, runways or extensions of runways, after construction, would reduce the impacts to plant and animal communities. The significance of any impacts to plants and animals would be determined on a case-by-case basis. Avoiding areas with wetlands would serve to ensure no disturbance in valuable areas.

3.4.4 Unavoidable Adverse Impacts

A significant unavoidable adverse impact of constructing the proposed runways would be the removal of some plant and animal habitat at any of the sites chosen. Specific impacts would depend on the characteristics of the chosen sites.

3.5 EARTH

Soils data in conjunction with other environmental conditions, provides an important information base for determinations of what land areas are suitable for certain uses. It also suggests some of the physical constraints and limitations which would be placed on development occurring in the planning area. Five of the proposed airport locations were examined in terms of overall soils suitability using the Soil Conservation Service's Soils Survey Maps. Soils information for the McChord and Fort Lewis locations was derived from the Final Environmental Impact Statement, Fort Lewis Military Installation.

3.5.1 Affected Environment

Typically, each layout and the area around the layout consists of one or more soils types or series (referred to as an association). The predominant soils for each area have been identified. The following is a brief description of the soils found on one or more of the alternative sites:

- Alderwood-Everett Association soils typically develop on glacial till material. These soils are generally characterized as moderately well drained, having seasonal groundwater tables well below the surface with a low-to-moderate erosion hazard. Normally, the surface layer and upper part of the subsoil are gravelly sandy loam. The lower part of the subsoil is very gravelly sandy loam. These soils have the natural ability to support heavy loads. The main limitation of the Alderwood-Everett Association soils, on urban development is seasonal soil wetness, depth to hardpan, and steepness of slope.

- Norma-Lynnwood-Custer soils tend to be poorly drained and found on outwash plains. The main limitations to urban development are soil wetness and ponding.

3.4.2.4 No-Action

If improvements to the existing airport system do not take place, plants and animals in the Puget Sound region would not be significantly affected. Areas that would have been considered for airport development would be available for other projects.

3.4.3 Mitigation Measures

Wetlands

Some of the wetlands potentially affected may be somewhat higher quality wetland. Higher quality wetlands typically have shrub or forested vegetation present, or mixtures of open water and emergent vegetation which provide a variety of wildlife habitats. On-site analysis is required to determine the level of wetland quality and the feasibility and design objectives of wetland mitigation. However, the large amount of land required by airports, the runoff generated from paved surfaces, and the large amounts of earth work required for construction will tend to make substantial and effective wetland mitigation necessary but feasible. In general, wetland mitigation should be located as close to the affected area as possible to minimize impacts to animal species dependent on the original wetland area. However, wetland mitigation too close to the airport may attract birds and, potentially, create a safety hazard. The location chosen for wetland mitigation should consider what other wetland areas that are available in the general area to try to support an even distribution of wetlands throughout the Puget Sound region.

Ecology recommends avoiding and minimizing impacts to wetlands, and protecting wetlands with buffers ranging from 25 to 300 feet depending upon the quality of the wetlands. If a project cannot avoid wetland impacts, Ecology recommends preparation of a mitigation plan which seeks to replace the wetland functions and values that will be impacted by the project. In the case of severely degraded wetland, however, Ecology recommends that enhancement of wetland function be an objective. Wetland replacement plans are expected to use the following mitigation ratios of replacement to impacted areas:

Forested wetlands	3.0 : 1
Shrub wetlands	2.0 : 1
Emergent marsh	1.5 : 1
Open water	1.0 : 1

Streams

Mitigation of the streams on the Olympia/Black Lake site may be possible by creating or enhancing sufficient stream habitat in the general area to replace what is lost. Such stream mitigation is expensive, but may be possible if streams in the area are suitable.

Table 12. Wetland Impacts and Potential Mitigation by Airport Location.

		Acres of Wetland Affected							
Location	Runways	Forested	Shrub	Shrub/ Emergent	Emergent	Emergent/ Open Water	Open Water	Total	Potential Mitigation Area
SeaTac	Existing	0	0	0	0	0	0	0	0
SeaTac	Commuter	0	0	0	0	0	0	0	0
SeaTac	Dependent	0	0	0	0	0	0	0	0
Arlington	New Extension	0	0	0	0	0	0	0	0
Arlington	New Runway	0	0	0	0	0	0	0	0
Paine Field	Existing	0	0	13	0	22	0	35	53
Paine Field	New Runway	0	0	13	0	22	0	35	53
McChord AFB	Existing	1	0	0	1	0	0	2	5
McChord AFB	New Runway	1	0	0	1	0	0	2	5
Central Pierce	One	0	0	0	0	0	0	0	0
Central Pierce	Two	3	0	0	0	0	0	3	9
Central Pierce	Three	28	0	0	0	0	0	28	84
Olympia/Black Lake	One	0	0	0	0	0	0	0	0
Olympia/Black Lake	Two	9	7	15	5	0	0	36	71
Olympia/Black Lake	Three	26	9	31	15	0	1	81	164
Fort Lewis	Three	0	0	0	0	0	0	0	0

Mitigation area based on replacement ratios recommended by the Department of Ecology
Wetland impacts based on National Wetland Inventory maps. Actual wetland determination will require field investigation and would likely be greater.

Streams

Development of the McChord Air Force Base, Fort Lewis, and Olympia/Black Lake options would directly impact the streams in those areas. These streams would have to be relocated or buried beneath the airport. Under the Olympia/Black Lake option, approximately 2,000 feet would be affected based on the one runway concept; 7,000 feet based on the two-runway concept; and approximately 22,000 feet under the three-runway concept. Approximately 4,000 feet would be affected under the Fort Lewis three-runway concept. Under the McChord new runway option, approximately 2,750 feet would be affected by development (this stream does not support salmon).

Vegetation and Wildlife

Endangered, threatened and sensitive plant and animal species on the Fort Lewis site are discussed in Section 3.4.2.1.

Falcon. Reported sitings of Peregrine Falcons on the post are unconfirmed; most are probably the unlisted Peale's subspecies. The Northern Bald Eagle has been placed on the list of Rare and Endangered Species by the Department of the Interior. A sizeable wintering population of eagles use the post while feeding on spawned out salmon on the Nisqually River and Muck Creek (Muck Creek flows across the southern portion of the proposed Fort Lewis site). No known endangered or threatened animal species exist on the Sea-Tac, Paine Field, McChord AFB or Olympia/Black Lake sites.

3.4.2.2 Secondary Alternatives

Wetlands

Under alternatives 8, 18, 23 and 25, no wetlands would be impacted. Due to the forested wetland located in the Central Pierce site, No. 21 would impact 3 acres of wetland. The alternative that would impact the greatest amount of wetland would be No. 24 which would impact a total of 35 acres of wetland located in the Paine Field site, 13 of which are shrub/emergent with 22 acres emergent/open water.

Streams

The only alternative which would have any impact on a stream or streams is No. 25. Because the alternative includes development in the Olympia/Black Lake site, 2000 feet of Salmon Creek, Bloom's Ditch, and Allen Creek would be impacted by the construction and operation of one runway.

Vegetation and Wildlife

There would be no significant impacts to plants or animals under any of the secondary alternatives.

3.4.2.3 Other Alternatives

Wetlands

A preliminary analysis of wetlands on the potential airport layouts has been completed from using National Wetland Inventory Maps. Table 12 shows the identified wetland impacts by airport location alternative. As stated earlier in Section 3.4.1, these preliminary estimates have not been verified by on-site analysis and probably represent the minimum amount of wetlands present.

In general, the layouts evaluated have relatively fewer wetland acres than are typically found on similar-sized land parcels. In all cases the wetlands identified are a small percentage of the total airport area. The Olympia/Black Lake option has considerably more wetlands and streams than other sites.

Creek does support some salmon, in part due to a citizen group's salmon enhancement project. No direct impacts to the streams are expected based on the preliminary layouts.

A tributary of Swamp Creek is located approximately 2,000 feet south and east of the existing main runway at Paine Field. Based on the 1983 Paine Field Comprehensive Plan, Swamp Creek was identified as a salmon bearing stream. According to the plan, salmon spawns have declined dramatically and even curtailed on some of the tributaries. The plan recognizes that this may have been a direct result of urban development. Swamp Creek would not be directly impacted by airport construction.

The streams and lakes on Fort Lewis, along with the Nisqually River, support a wide variety of native, stocked, and anadromous fish. Muck Creek and South Creek are located on the site. Muck Creek has been identified as an important salmon-producing stream. According to the Catalog of Washington Streams and Salmon Utilization, South Creek also supports salmon populations. The replacement airport layout would impact approximately 4,000 feet of stream.

If a new runway at McChord Air Force Base is required, it would impact 2,750 feet of stream. According to the Catalog of Washington Streams and Salmon Utilization, these streams do not support salmon fisheries.

Three streams flow across the proposed Olympia/Black Lake site: Salmon Creek, Bloom's Ditch, and Allen Creek. All three streams support populations of Coho Salmon. A fish passage facility has been constructed on Bloom's Ditch near Littlerock Road. The two runway layout would impact 7,000 feet of stream. Loss of these streams could significantly impact salmon resources and would be very difficult to mitigate.

Vegetation

An endangered plant is likely to occur on the Fort Lewis base. A subspecies of the Alaska Rein-orchid, which is found in dry woods, gravelly streambanks and open mountainsides, may occur on the site. None have actually been observed (Army, 1979). The Washington State Department of Natural Resources has identified two areas next to Lake Mondress near the northern boundary of the base, as possibly containing the plant known as Aster curtus. A field visit conducted by Parametrix for another project confirmed the locations. The plant is listed by the state as a sensitive species and by the United States Fish and Wildlife Service (USFWS) as a candidate for listing as a threatened or endangered species. No known endangered or threatened plant species exist on the Sea-Tac or Paine Field sites.

Wildlife

Two vertebrate species with endangered or threatened status that might be expected to occur on or near Fort Lewis are the Northern Bald Eagle and the American Peregrine

3.4.2 Significant Impacts

Because of the large numbers and scattered distribution of wetlands in the Puget Sound Basin, it is unlikely airport construction can totally avoid wetland impacts.

A determination was made (based on the conceptual airport layouts) of the approximate number of linear feet of stream affected for each airport option. A data search on salmon-bearing streams was conducted using the Washington State Department of Fisheries Catalog of Washington Streams and Salmon Utilization.

Specific impacts to vegetation and wildlife (for the airport construction alone) would vary significantly with the option selected and on current land use. Because some of the proposed sites such as McChord, Paine Field, Sea-Tac, and Arlington, are already developed, the additional loss of vegetation and wildlife habitat would be comparatively minimal. Conversely, much greater impacts to plants and animals would occur under the Fort Lewis, Central Pierce and Olympia/Black Lake options, since these are the areas that are generally rural or undeveloped. Indirect impacts to plants and animals in the general area of each airport, as a result of induced growth, are more difficult to assess.

3.4.2.1 Preferred Alternative

Wetlands

The existing Sea-Tac airport with a new dependent runway would not affect any wetlands. Airfield improvements at Paine Field, if required, would affect approximately 13 acres of shrub/emergent and 22 acres of emergent/open water wetland, for a total of 35 acres of wetland.

Constructing two runways at Fort Lewis would not affect any wetlands and only one acre of forested and one acre of emergent wetland on the McChord Base. The greatest wetland impact would occur if the Olympia/Black Lake site were planned for construction of an additional two runways. A total of 36 acres of wetlands — including 9 acres of forested, 7 acres of shrub, 15 acres of shrub/emergent, and 5 acres of emergent — would be impacted.

Streams

Based on the Catalog of Washington Streams and Salmon Utilization (1975), chum and coho salmon are present in both Miller and Des Moines Creeks, which flow through the study area. However, jet fuel spills in November 1985 and April 1986 killed nearly all aquatic life in Des Moines Creek. According to the SeaTac Area Update, fish and aquatic life are returning to the stream, but pollutants from urban runoff are making recovery slow. Miller land. Some forested areas occur just east of the airport and southwest of the airport near Smokey Point.

Waterfowl can be found in moderately dense concentrations south and north of the airport. Portage Creek is the nearest salmon-bearing stream in the airport vicinity. The stream is approximately 2,000 feet north of the airport at its closest point. A public fishing access point is located on the creek just north of the airport. Based on conceptual airport layout drawings, the creek would not be directly impacted by airport construction.

- A variety of natural and introduced vegetation occurs in the Paine Field area. Generally, most of the area is characterized by natural vegetation such as dense stands of second-growth evergreen and deciduous trees or a combination of a few trees and substantial undergrowth. While specific data on terrestrial fauna in the area was not available, it is expected that the area hosts a wide variety of wildlife typical of an urban and semi-urban community in the Puget Sound region.

- Aerial photos of Central Pierce show wooded areas mixed with some open pasture land. These areas are probably used by many animal species typically found in similar habitats in suburban settings. No streams have been identified for this area.

- Aerial photos of the McChord Air Force Base site show most wooded areas interspersed with some areas of open grasslands. As is typical with similar habitats in Puget Sound, these areas are probably used by many animal species.

- Specific terrestrial flora and fauna data for the Olympia/Black Lake area was not available. According to the Thurston County Comprehensive Plan (1988), special plant and animal communities have been identified near the site. At locations just west of the site, west of Littlerock Road and east of the site just east of Interstate 5. Numerous other special plant and animal sites are located further out from the site. One of the policies of the Thurston County Comprehensive Plan is to protect special plant and animal communities.

- A variety of habitat types are present on Fort Lewis: wet and dry coniferous forest, wet and dry broadleaf woodlands, moist and dry thickets, and dry grassland. Dry coniferous forest dominates most of the post; dominance of this habitat type is attributable to droughty soils and frequent fires. Prairies occur in the artillery impact area in the eastern portion of the reservation.

  A wide diversity of animals species occurs on the reservation. Several species of mammals, and raptors, as well as upland birds and waterfowl, can be found.

Ecology (Ecology), and county or city planning departments. The EPA can exercise veto powers over permit decisions made by the Corps.

Ecology regulates development in and around wetlands through the State Environmental Policy Act (SEPA) review process. SEPA requires documentation of anticipated environmental impacts of development actions. A SEPA analysis specifies requirements needed to obtain permits. Governor Booth Gardner has mandated Ecology to protect wetlands through SEPA to the "extent legally permissible" (Executive Order 90.04, April 21, 1990).

Many counties have their own wetland regulations that must be met. Wetland protection is accomplished through grading ordinances and SEPA review in Pierce and Snohomish Counties. In addition, a wetland protection regulation is presently before the Pierce County Council. In King County the Sensitive Areas Ordinance protects wetlands and streams from development by establishing buffers for various class wetlands and streams. In Thurston County, wetland protection is accomplished through SEPA review. Further, counties are now developing programs to protect critical areas, which include wetlands, in compliance with the Growth Management Act.

A preliminary analysis of wetlands on the potential airport layouts has been completed using National Wetland Inventory Maps. The preliminary estimates have not been verified by on-site analysis and probably represent the minimum amount of wetlands present. On-site analysis for wetlands typically results in the identification of additional small to medium-sized wetlands not mapped by the National Wetland Inventory. Such an analysis would be conducted in follow-on site-specific studies. In addition, activities developed adjacent to an airport could result in additional wetland impacts.

Vegetation and Wildlife

Because of the level of analysis at this preliminary planning stage, only a general distribution of plants and animal species information has been compiled. Plants and animals common to the Puget Sound region would likely be found at or near all the proposed sites. More site-specific wildlife information would be compiled during the site-specific EIS phase of the projects.

A summary analysis of vegetation and wildlife occurring at the seven alternative sites indicates the following:

- Some areas of deciduous, coniferous and mixed forests occur in the Sea-Tac vicinity. Such forested habitats are generally used by small rodents, birds, and other mammals, including shrews, moles, squirrels, rabbits, raccoons and deer.

- The predominant vegetative cover around the Arlington Airport can be described as agricultural. This includes both agricultural cropland as well as meadows and pasture

If the most likely rail alignment options turn out to be equally preferable, packaging of final HCT alignment commitments with future airport locations is one possibility that could improve any needed long-term airport siting decision process.

Rail

Airport locations that are planned to have railway facilities will require the least amount of upgrading and capital input. Both Sea-Tac and Paine Field are proposed to have stations on the regional light rail system.

3.3.4 Unavoidable Adverse Impacts

Development of any of the airport system alternatives will result in some local increase in traffic levels, congestions, and reduced level of service. The extent of the impact is based on the existence and capacity of the surface transportation network.

3.4 PLANTS AND ANIMALS

This section evaluates potential environmental consequences to plants and animals from various airport system alternatives, within the Puget Sound region, at a generalized level. The purpose of environmental analysis at this stage is to provide a comparative evaluation of the alternative systems. After an airport system is chosen, more detailed studies will be conducted to fully evaluate all environmental impacts.

3.4.1 Affected Environment

Wetlands

Recently, the federal government has proposed revisions to the methodology currently used to identify wetlands which are subject to regulation by the 404 permit program. In addition to changes in procedures and decision matrices, the definitions of wetland vegetation and wetland hydrology may be changed. Preliminary studies by the Washington Department of Ecology suggest that implementation of these changes would reduce the area of jurisdictional wetlands by 20 - 40%. The issue has been whether the earlier definition of wetlands is so inclusive that an imbalance exists between urban development and the preservation of functioning wetlands.

The Army Corps of Engineers (Corps) and the US Environmental Protection Agency (EPA) jointly administer a permit program which regulates the discharge of dredged or fill material into waters of the U.S., including wetlands. The Corps considers comments solicited from federal, state, and local groups when considering permit applications. Agencies reviewing and commenting on pending applications may include the US Environmental Protection Agency (EPA), US Fish and Wildlife Service (FWS), Washington State Department of

Olympia/Black Lake: Widening of Interstate 5, improved interchange with Interstate 5, and access from Lathrop Road at new access road.

3.3.3.2 Rail and HCT

High Capacity Transit (HCT) and rail are other modes of transportation that may be used to access airport locations. Generally, HCT and rail will reduce highway congestion and lower travel times to the airports. HCT and rail can provide more reliable access to users during poor weather conditions.

High Capacity Transit

High Capacity Transit planning was mandated in 1990 (HCT Act of 1990 and 1991, SHB 1825 and ESHB 2151, respectively). The 1990 Act created a Joint Regional Policy Committee and empowered it to prepare and adopt a regional HCT implementation program, including financing. These are to be consistent with the regional transportation plan (RCW 81.104.040). The Act is consistent with the Growth Management Act and with VISION 2020 through concurrency and consistency.

Regional plans and local comprehensive plans are to address the relationship between urban growth and an effective HCT system plan and to provide cooperation with transit agencies. Future airport needs and related development should be considered in the alignments of HCT corridors, the locations of transit stations, local feeder service, and the provision of remote baggage handling facilities (e.g., at the King Street Station site in Seattle for air travelers residing north of Sea-Tac).

The 1990 Regional Transportation Plan (linked to the regionally adopted VISION 2020 growth strategy) will be amended to respond to the Flight Plan results:

"The Regional Air Carrier System Plan is being developed separately and will be amended into the Growth Strategy and Transportation Plan upon completion. Any new airport and its attendant impacts will be evaluated as part of that amendment process. The air carrier plan will reflect the results of this regional plan update in any recommendations that are made." (VISION 2020, Assumptions, Sec. 2-1, September 1990).

Estimated capital and operating costs for HCT through 2020 range from $8.5 billion to $12 billion. The Joint Regional Policy Committee (JRPC) is required to prepare for the ballot a plan and financing strategy. The target deadline is late 1992, and the effective statutory deadline is 1995 (four years after completion of an interagency planning agreement between the operating agencies). The ballot issue likely will include an HCT financing program as part of a broader package also including funding for other modes, such as High Occupancy Vehicle (HOV) lanes.

3.3.2.4 No-Action Alternative

Under the no-action alternative, total passenger vehicle miles would be comparable to Sea-Tac constrained with two-runway supplemental airport scenarios. Daily passenger mileage would be 1,941 miles and annual passenger mileage (in millions) would 708 miles.

3.3.3 Mitigation Measures

3.3.3.1 Roadway Improvements

Regional

Based on VISION 2020, possible regional roadway improvements would include the addition of lane capacity to regional arterials and freeways, new regional arterials and freeways, new or revised interchanges, local street improvements, and other local and regional system investments such as signalization and channelization.

Possible Site Vicinity Improvements

Possible actions related to highway improvements for each airport location are summarized below. Detailed data on highway costs are provided in Working Paper No. 11.

Sea-Tac: Freeway improvements to Sea-Tac; widening along International Boulevard (Pacific Highway South); freeway improvements to SR 518 and SR 509.

Paine Field: SR 526 (the Evergreen Speedway) would be widened, and there would be a new interchange with SR 525. Independent widening of SR 525 is assumed.

McChord: Varied improvements under these options would include widening of Interstate 5, new access from SR 512 and a revised interchange at SR 512 and Steele Road. Independent widening of SR 512 is assumed.

Arlington Site: Depending upon the level of service, widening of Interstate 5, and either enlarged capacity on 67th or on SR 530. Improved Freeway access connection. These options assume independent improvements to 172nd (Edgecomb Road).

Central Pierce: Improvements would include widening of Interstate 5 and SR 161, and a share in the costs of the cross-base freeway eastbound from Interstate-5. Access improvements to 176th St. East (assumes widening of 176th St. E.).

Fort Lewis: New access would be required as no roads presently serve the area.

Table 11. Daily Passenger Mileage to Selected Airport Sites - 2020.

ALT NO.	SITE	PASSENGER MILES (in thousands) ALT. AIRPORT	SEA-TAC	TOTAL
A.	Sea-Tac Constrained			
1	Sea-Tac, alone	-----	1,941	1,941
2	Sea-Tac, commuter runway		2,122	2,122
33	Sea-Tac, demand management		2,721	2,721
B.	Sea-Tac Constrained (2 Airport Systems)			
3	Arlington	1,000	1,014	2,014
4	Paine Field	580	884	1,464
5	McChord	809	1,204	2,013
6	Central Pierce	740	1,245	1,985
7	Olympia/Black Lake	1,339	1,245	2,584
C.	Sea-Tac Constrained with 2 RWY Supplemental Airport (2 Airport Systems)			
8	Arlington	1,209	884	2,093
9	Paine Field	580	884	1,464
10	McChord	809	1,204	2,013
11	Central Pierce	908	1,204	2,112
12	Olympia/Black Lake	1,587	1,204	2,791
D.	Sea-Tac with New Dependent Runway (2 Airport Systems)			
13/18	Arlington	177	1,570	1,747
14/19	Paine Field	102	1,553	1,655
15/20	McChord	110	1,699	1,809
16/21	Central Pierce	137	1,686	1,823
17/22	Olympia/Black Lake	307	1,699	2,006
E.	Sea-Tac Constrained (3 Airport Systems)			
23	Arlington	403	869	1,596
	Central Pierce	324		
24	Paine Field	213	856	1,354
	Central Pierce	285		
25	Arlington	510	822	1,902
	Olympia/Black Lake	570		
26	Paine Field	260	845	1,610
	Olympia/Black Lake	505		
F.	Sea-Tac with New Dependent Runway (3 Airport Systems)			
27	Arlington	85	1,412	1,634
	Central Pierce	137		
28	Paine Field	102	1,297	1,536
	Central Pierce	137		
29	Arlington	85	1,594	1,818
	Olympia/Black Lake	139		
30	Paine Field	102	1,448	1,689
	Olympia/Black Lake	139		
G.	Replacement Airports			
31	Central Pierce	5,060	-----	5,060
32	Olympia/Black Lake	5,743	-----	5,743

Table 10. Annual Passenger Mileage to Selected Airport Sites - 2020.

ALTERNATIVE	Passenger Mileage (Annual, in millions)		
	ALTERNATIVE SITE	SEA-TAC	TOTAL
ONE AIRPORT SYSTEM			
Sea-Tac, alone	-----	708	708
Sea-Tac, with Commuter Runway	-----	775	775
Sea-Tac with Maximum Demand Management	-----	993	993
Replacement	1,847-2,096	-----	1,847-2,096
TWO AIRPORT SYSTEMS			
Existing Sea-Tac plus Supplemental Airport (1 Runway)	212-489	323-454	534-943
Existing Sea-Tac plus Supplemental Airport (2 Runways)	212-579	323-439	534-1,019
Sea-Tac plus new Air Carrier Runway plus Supplemental Airport (1 Runway)	37-112	567-620	604-732
Sea-Tac plus new Air Carrier Runway plus Supplemental Airport (2 Runways)	37-112	567-620	604-732
THREE AIRPORT SYSTEMS			
Existing Sea-Tac plus Supplemental Airports (1 Runway)	182-394	300-317	494-694
Sea-Tac plus New Air Carrier Runway plus Supplemental Airports (1 Runway)	81-88	473-582	567-664

- The multiple airport system offers best overall ground access for the region's residents of any of the options considered with Sea-Tac and two supplemental airports.

- Access is best where the supplemental airport is located near the population it will serve. Selection of a more distant supplemental airports significantly reduces overall system access.

In general, transportation impacts to the existing regional highway system will result primarily from airport-related traffic and traffic generated by airport-induced development. All of the airport options could increase local traffic congestion without improvements to existing roads and transit systems. Estimated airport related traffic (in terms of annual and daily passenger mileage) for the individual and system alternatives is presented below in Table 10 and Table 11.

3.3.2.1 Preferred Alternative

Under this alternative, both annual passenger mileage and daily passenger mileage are somewhat lower than other system alternatives. Alternative No. 28 (Sea-Tac plus Paine and Central Pierce) has the lowest daily passenger mileage of the preferred alternative scenarios with 1,536 miles (in thousands). Alternative No. 30 (Sea-Tac with dependent runway plus Paine Field and Olympia/Black Lake) has a total daily passenger mileage of 1,689 miles. Total daily passenger mileage under the preferred alternative options that include McChord or Fort Lewis would be somewhat lower due to their proximity to urban centers.

3.3.2.2 Secondary Alternatives

The secondary three-airport system alternatives (Alternatives 23, 24, 25, Table 2) are comparable to the preferred alternative in terms of overall daily and annual passenger mileage. Alternative No. 24 (Sea-Tac constrained with supplementary Paine Field or Central Pierce site) would have the lowest overall daily passenger mileage (1,354 miles). Alternative 25 would have the highest overall daily passenger mileage (1,920 miles). Of the two-airport secondary alternatives, Alternative No. 8 would have the highest daily passenger mileage with 2,093 miles (a result of travel distance and passenger allocation).

3.3.2.3 Other Alternatives

Replacement-airport alternatives would have the highest overall annual and daily passenger mileage (Alternatives 31 and 32, Table 11) due to extreme travel distances from major population centers. Alternatives under the Sea-Tac constrained scenario would have comparably higher overall passenger mileage as a result of greater passenger allocations. Generally, overall regional congestion would be less due to the dispersed airport locations.

transit is emphasized. Higher-density residential development (apartments, townhouses, condominiums, duplexes) is assumed and is encouraged to locate within walking distance of regional rapid transit stations, ferry terminals or bus transfer centers that can provide transit service to these major downtowns. In addition, connections between each center and its surrounding neighborhoods are designed to promote walking, bicycling, and the use of transit.

This alternative places a large share of transportation investments into rapid transit, buses, high occupancy vehicle lanes, passenger ferries and associated stations, terminals and service facilities. Also, it assures continued effort toward completing and maintaining the region's extensive system of regional and local streets and highways. It also includes a major change in local bus service in order to provide local service to each center from the surrounding neighborhoods. In addition, support is given to major demand management programs that encourage people to travel by transit or carpool, to adjust their travel time and avoid congested periods, or to eliminate trips altogether. These strategies include extensive ridesharing programs, providing preferential parking, transit pass fare subsidies, staggered work schedules, and use of telecommunications substitutes. Other programs include increased parking charges and charging for driving on congested roadways.

The VISION 2020 Preferred Alternative is related to Flight Plan in that it serves as a policy guide for growth and transportation services—including airports—in the urban centers.

3.3.2 Significant Impacts

Accessibility to Airport Locations

An analysis of the accessibility of each system option to the residents of the Puget Sound region was conducted by the Puget Sound Regional Council staff (See working Paper No. 9) to determine the relative time differences between the airport alternatives. A summary of this analysis is given below.

Findings

- Most of the region's residents can currently reach Sea-Tac Airport in an hour or less but worsening traffic will make access more difficult in the future.

- All replacement airport sites are much less accessible to the region's residents than Sea-Tac Airport.

- Sea-Tac's central location makes it much more accessible to the region's residents than any of the other airport locations. This is true for trips made by automobile and by transit. The other airport locations are less accessible because they are all relatively distant from the region's population and employment centers.

consistent with county, city and town comprehensive plans and state transportation plans" (Section 55(1)b).

3.3.1 Affected Environment

Congestion on the regional highway system has increased significantly in the past 30 years. Many factors have contributed to this: much of the new housing and businesses have located in the suburbs rather than in the central cities; growth patterns have become more dispersed, creating even more dependence on the automobile; and the number of trips per household has increased. Data from the State Department of Licensing shows that in 1988 there were 2,450,000 vehicles registered in the four-county region. This is an increase of 25% from 1980.

Primarily due to the geography of the region, especially the City of Seattle's, the region's highway system was constructed to carry demand along north-south alignments. Additionally, population and employment growth in the suburban and rural areas over the past two decades has created a demand for travel on other major corridors and arterials in the region. Although excess demand is a primary contributor to congestion, vehicular incidents, accidents, or breakdowns are other key contributors to the problem.

Planned Improvements

In September, 1990, PSRC (formerly PSCOG) integrated the Regional Transportation Plan (adopted in 1982) and the Regional Development Plan (adopted in 1979) into one plan entitled VISION 2020. VISION 2020 will replace all existing regional transportation and development plans and policies and will serve to guide transportation and related land use decisions for the 1990-2020 period.

Initially, 16 regional growth alternatives were defined under the plan. During the development of these alternatives, concern was given to mobility, density, location of jobs and housing, and related issues of resource management and quality of life. These alternatives were refined to five Draft EIS transportation and land use alternatives. Following public review, a sixth alternative (the preferred alternative) was developed.

Under the VISION 2020 Preferred Regional Growth Alternative, urbanization and new employment growth would be concentrated into 10 to 15 urban centers located throughout the Puget Sound Region. The centers are part of a regional design that includes a hierarchy of central places. Areas that are not centers will be designated either as activity clusters, small towns, pedestrian pockets, or identified as open space, resource preservation areas.

The emphasis is on creating centers that can be efficiently served by regional rapid transit (rail, passenger ferries, or exclusive busways). The centers must either have or be redesigned to have downtowns that can be served effectively by transit. Access to jobs by

3.2.4 Unavoidable Adverse Impacts

Development of any of the airport system alternatives will result in increased air pollutant emissions and a decrease in overall air quality in the Puget Sound Region.

3.3 TRANSPORTATION

Introduction

The transportation section is derived from Working Papers Nos. 5 and 9, Ground Access/Primary Market Analysis — Phase II Report, and the VISION 2020 Growth Strategy and Transportation FEIS prepared by the Puget Sound Regional Council.

Significant Issues

Because the Flight Plan Project is designed to provide air carrier service for the entire Central Puget sound Region, it must be integrated into the present and future ground transportation system to be an effective solution. Transportation problems are the cumulative result of our region's rapid growth and their solution will pose a significant challenge.

Under the Washington State Growth Management Act (GMA), coordination between land use planning and transportation planning is required. One of GMA's goals is to "encourage efficient multimodal transportation systems that are based on regional priorities and coordinated with county and city comprehensive plans." Countywide and multicounty (for King, Pierce and the Snohomish County area) "growth policy plans" are required to address regional and state transportation and siting needs; these are required by July of 1992.

Comprehensive plans are required by July 1993. These are to be coordinated at the countywide level. Comprehensive plans are to include long range (at least six years) capital facilities elements, and the provision of services "concurrent with development".

Concurrency is defined as follows (GMA, Section 7(6)e):

> "Concurrent with the development," shall mean that improvements or strategies are in place at the time of development, or that a financial commitment is in place to complete the improvements or strategies within six years.

The Act also requires that "all transportation projects within the region that have an impact upon regional facilities or services must be consistent with the plan" (GMA, Section 55(2)). In addition, the Regional Transportation Planning Organization (specified in the GMA as the federally recognized Metropolitan Planning Organization(s), or the PSRC, for this four-county region) must "Develop and adopt a Regional Transportation Plan that is

Table 9. Total Combined Aircraft and Vehicular Emissions (Year 2020).

ALT	AIRPORT	CO (tons/day)	NOx (tons/day)	SOx (tons/day)	PART (tons/day)	HC (tons/day)
1	*Sea-Tac without Commuter R/W	35.6	7.8	0.9	0.7	7.4
2	*Sea-Tac with Commuter R/W	38.5	8.4	0.9	0.8	7.9
3	*Alternate 1 + Arlington 1 R/W	39.0	9.0	1.0	0.7	8.3
4	Alternate 1 + Paine 1 R/W	30.1	7.9	0.8	0.6	6.5
5	Alternate 1 + McChord 1 R/W	37.5	9.1	1.0	0.7	7.8
6	*Alternate 1 + Central Pierce 1 R/W	38.6	9.0	1.0	0.7	8.2
7	*Alternate 1 + Olympia/Black Lake 1 R/W	46.7	10.2	1.1	0.9	9.6
8	Alternate 1 + Arlington 2 R/W	38.7	9.3	1.0	0.8	8.0
9	Alternate 1 + Paine 2 R/W	30.1	7.9	0.8	0.6	6.5
10	Alternate 1 + McChord 2 R/W	37.5	9.1	1.0	0.7	7.8
11	Alternate 1 + Central Pierce 2 R/W	39.0	9.3	1.0	0.8	8.1
12	Alternate 1 + Olympia/Black Lake 2 R/W	48.2	10.8	1.2	1.0	9.7
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	34.4	8.6	0.9	0.7	7.3
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	32.7	8.3	0.9	0.6	7.0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	35.2	8.7	0.9	0.7	7.4
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	35.1	8.7	0.9	0.7	7.4
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	39.7	9.1	1.0	0.7	7.9
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	34.2	8.5	0.9	0.7	7.3
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	32.7	8.3	0.9	0.6	7.0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	35.0	8.7	0.9	0.7	7.4
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	35.1	8.7	0.9	0.7	7.4
22	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 2 R/W	37.7	9.1	1.0	0.7	7.9
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	32.2	8.2	0.9	0.6	6.9
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	28.7	7.7	0.8	0.5	6.3
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	36.3	8.9	0.9	0.7	7.6
26	Alternate 1 + Paine 1 R/W + Olym./Blk. Lake 1 R/W	32.1	8.2	0.9	0.6	6.9
27	Alternate 13 + Central Pierce 1 R/W	30.4	8.1	0.8	0.6	6.3
28	Alternate 14 + Central Pierce 1 R/W	28.3	7.8	0.8	0.6	5.8
29	Alternate 13 + Olympia/Black Lake 1 R/W	34.8	8.6	0.9	0.7	7.3
30	Alternate 14 + Olympia/Black Lake 1 R/W	31.8	8.3	0.8	0.6	6.7
31	Central Pierce 3 R/W	75.7	15.5	1.7	1.6	14.1
32	Olympia/Black Lake 3 R/W	84.9	17.0	1.9	1.8	15.7
33	Central Pierce/Fort Lewis 3 R/W	75.7	15.5	1.8	1.6	14.1
34	*Alternate 1 + Demand Management	46.1	9.5	1.1	0.9	9.2

* Alternative which does not meet system capacity demand.

Consequently, under several alternatives, total vehicle emissions would actually be greater even though individual travel distance is less when compared to other alternatives.

Replacement-airport alternatives would generate the highest vehicle emissions because the average trip length to these airports is much longer when compared with the other airport alternatives. For example, the average trip length to Sea-Tac is 24 miles, while the average trip length to Central Pierce and Olympia Black Lake is 45 and 52 miles, respectively.

Overall vehicle emissions are comparable to both the preferred alternative and to the secondary alternatives.

3.2.2.4 No-Action Alternative

Total combined vehicular and aircraft emissions under this alternative are equal to those under Alternative No. 34 (Sea-Tac with Demand Management). These alternatives have the lowest overall air pollutant emissions of all the alternatives.

Total Combined Airport Emissions

Table 9 presents the total airport emissions levels from both aircraft and motor vehicles. Of all the alternatives which would meet system capacity demand, the three-airport alternatives 27, 28, 29 and 30, and the two-airport alternatives 4, 8, and 9 would generate the least combined emissions for CO and hydrocarbons. The major contributions of the total emissions for these alternatives are aircraft emissions for CO.

The replacement-airport alternatives generate the highest combined emissions, due primarily to long travel distances to the airport locations.

A preliminary analysis has determined that the projected emissions are consistent with the VISION 2020 air quality estimates. VISION 2020 is based on the same level of aircraft passenger demands.

3.2.3 Mitigation Measures

The most significant reductions in regional and local air pollutant emissions are attainable through programs which reduce the vehicular travel associated with the project. Support and compliance with the VISION 2020 plan is the most important measure to achieve this goal. The plan includes the improvement of mass transit facilities, implementation of vehicular usage reduction programs, and transportation demand management programs. This plan will help reduce project trips by automobile and thus reduce overall traffic congestion and total emissions.

Table 8. Vehicular Traffic Emissions (Year 2020).

ALT	AIRPORT	CO (tons/day)	NOx (tons/day)	SOx (tons/day)	PART (tons/day)	HC (tons/day)
1	*Sea-Tac without Commuter R/W	26.2	4.2	0.5	0.6	4.6
2	*Sea-Tac with Commuter R/W	28.7	4.6	0.6	0.6	5.0
3	*Alternate 1 + Arlington 1 R/W	27.2	4.4	0.5	0.6	4.8
4	Alternate 1 + Paine 1 R/W	19.8	3.2	0.4	0.4	3.5
5	Alternate 1 + McChord 1 R/W	27.2	4.3	0.5	0.6	4.8
6	*Alternate 1 + Central Pierce 1 R/W	26.8	4.3	0.5	0.6	4.7
7	*Alternate 1 + Olympia/Black Lake 1 R/W	34.9	5.6	0.7	0.8	6.1
8	Alternate 1 + Arlington 2 R/W	28.3	4.5	0.6	0.6	5.0
9	Alternate 1 + Paine 2 R/W	19.8	3.2	0.4	0.4	3.5
10	Alternate 1 + McChord 2 R/W	27.2	4.3	0.5	0.6	4.8
11	Alternate 1 + Central Pierce 2 R/W	28.5	4.6	0.6	0.6	5.0
12	Alternate 1 + Olympia/Black Lake 2 R/W	37.7	6.0	0.7	0.8	6.6
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	23.6	3.8	0.5	0.5	4.1
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	22.3	3.6	0.4	0.5	3.9
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	24.6	3.9	0.5	0.5	4.3
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	24.6	3.9	0.5	0.5	4.3
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	27.1	4.3	0.5	0.6	4.8
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	23.6	3.8	0.5	0.5	4.1
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	22.3	3.6	0.4	0.5	3.9
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	24.4	3.9	0.5	0.5	4.3
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	24.6	3.9	0.5	0.5	4.3
22	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 2 R/W	27.1	4.3	0.5	0.6	4.8
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	21.6	3.4	0.4	0.5	3.8
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	18.3	2.9	0.4	0.4	3.2
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	25.7	4.1	0.5	0.6	4.5
26	Alternate 1 + Paine 1 R/W + Olym./Blk. Lake 1 R/W	21.7	3.5	0.4	0.5	3.8
27	Alternate 13 + Central Pierce 1 R/W	22.1	3.5	0.4	0.5	3.9
28	Alternate 14 + Central Pierce 1 R/W	20.7	3.3	0.4	0.5	3.6
29	Alternate 13 + Olympia/Black Lake 1 R/W	24.5	3.9	0.5	0.5	4.3
30	Alternate 14 + Olympia/Black Lake 1 R/W	22.8	3.6	0.4	0.5	4.0
31	Central Pierce 3 R/W	68.3	10.9	1.3	1.5	12.0
32	Olympia/Black Lake 3 R/W	77.5	12.4	1.5	1.7	13.6
33	Central Pierce/Fort Lewis 3 R/W	68.3	10.9	1.3	1.5	12.0
34	*Alternate 1 + Demand Management	36.7	5.9	0.7	0.8	6.4

* Alternative which does not meet system capacity demand.

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ALT	AIRPORT	CO (tons/day)	NOx (tons/day)	SOx (tons/day)	PART (tons/day)	HC (tons/day)
1	*Sea-Tac without Commuter R/W	9.4	3.6	0.3	0.1	2.8
2	*Sea-Tac with Commuter R/W	9.8	3.9	0.4	0.1	2.9
3	*Alternate 1 + Arlington 1 R/W	11.8	4.7	0.4	0.2	3.5
4	Alternate 1 + Paine 1 R/W	10.4	4.7	0.4	0.1	3.0
5	Alternate 1 + McChord 1 R/W	10.4	4.7	0.4	0.1	3.0
6	*Alternate 1 + Central Pierce 1 R/W	11.8	4.7	0.4	0.2	3.5
7	*Alternate 1 + Olympia/Black Lake 1 R/W	11.8	4.7	0.4	0.2	3.5
8	Alternate 1 + Arlington 2 R/W	10.5	4.7	0.4	0.1	3.1
9	Alternate 1 + Paine 2 R/W	10.3	4.7	0.4	0.1	3.0
10	Alternate 1 + McChord 2 R/W	10.3	4.7	0.4	0.1	3.0
11	Alternate 1 + Central Pierce 2 R/W	10.5	4.7	0.4	0.1	3.1
12	Alternate 1 + Olympia/Black Lake 2 R/W	10.5	4.7	0.4	0.1	3.1
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	10.8	4.8	0.4	0.1	3.2
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	10.3	4.7	0.4	0.1	3.0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	10.6	4.7	0.4	0.1	3.1
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	10.5	4.7	0.4	0.1	3.1
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	10.6	4.7	0.4	0.1	3.1
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	10.6	4.7	0.4	0.1	3.1
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	10.3	4.7	0.4	0.1	3.0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	10.6	4.7	0.4	0.1	3.1
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	10.5	4.7	0.4	0.1	3.1
22	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 2 R/W	10.6	4.7	0.4	0.1	3.1
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	10.6	4.8	0.4	0.1	3.1
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	10.4	4.7	0.4	0.1	3.1
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	10.6	4.8	0.4	0.1	3.1
26	Alternate 1 + Paine 1 R/W + Olym./Blk. Lake 1 R/W	10.4	4.7	0.4	0.1	3.1
27	Alternate 13 + Central Pierce 1 R/W	8.3	4.6	0.4	0.1	2.4
28	Alternate 14 + Central Pierce 1 R/W	7.6	4.5	0.4	0.1	2.2
29	Alternate 13 + Olympia/Black Lake 1 R/W	10.2	4.7	0.4	0.1	3.0
30	Alternate 14 + Olympia/Black Lake 1 R/W	9.0	4.6	0.4	0.1	2.7
31	Central Pierce 3 R/W	7.3	4.6	0.4	0.1	2.1
32	Olympia/Black Lake 3 R/W	7.3	4.6	0.4	0.1	2.1
33	Central Pierce/Fort Lewis 3 R/W	7.4	4.6	0.4	0.1	2.2
34	*Alternate 1 + Demand Management	9.4	3.6	0.3	0.1	2.8

* Alternative which does not meet system capacity demand.

Vehicle Emissions

Alternative No. 8 would have the overall lowest vehicle emissions of the secondary alternatives. This is a result of lower anticipated passenger demand. Alternatives 23, 24, and 25 would result in slightly higher overall vehicle emissions due to passenger allocation and travel distance. Alternatives 18 and 21 would have the highest overall emissions due mainly to passenger allocation.

3.2.2.3 Other Alternatives

The results of the air quality analysis are summarized in Tables 7 and 8. This table presents an emission inventory of selected pollutants for each of the system alternatives. These data are presented for CO emissions relating to vehicular traffic associated with airport access and the NOX emissions relating to aircraft operations. The CO emissions indicate the impacts from vehicular traffic because, in the Puget Sound area, these are primarily the result of vehicular traffic. The NOX emissions are used to indicate the impacts from aircraft operations because aircraft operations mainly contribute to the secondary pollutants in the area of which NOX is an important factor.

Aircraft Emissions

Generally, aircraft emissions are similar for all alternatives. This would be expected in that the alternatives are based on the same levels of aircraft activity. The exception is that the emissions are less for those alternatives that do not meet system capacity demand for 2020 (Alternatives 1,2,3,6,7 and 34).

All other airport options that meet system capacity demand would experience the greatest delay and aircraft emissions. Those alternatives that do not meet projected demand would result in somewhat fewer aircraft emissions.

Vehicle Emissions

Projections show that vehicular emissions are comparable. The least amount of emission would be generated by the two-airport and three-airport systems. In general, these systems have the advantage of location. Since passengers are located closer to more airports, shorter average auto trip lengths are anticipated. Options such as Paine Field and McChord are located closer to major population areas and would result in fewer vehicle automotive emission impacts than options such as Arlington or Olympia/Black Lake which are located further from major population areas.

Vehicle emissions are tied to passenger allocation. More passengers will utilize the Paine Field or Central Pierce airports over the Arlington or Olympia/Black Lake airports.

Table 6. Emissions Comparison for Each System Alternative.

	TRAFFIC EMISSIONS		AIRCRAFT EMISSIONS		TOTAL EMISSIONS		RANKING
	CO (tons/day)	NOX (tons/day)	CO (tons/day)	NOX (tons/day)	CO (tons/day)	NOX (tons/day)	
SEA-TAC AIRPORT SYSTEMS							
Existing Sea-Tac with maximum demand management	26-37	4.2-5.9	9-10	3.6-3.9	36-46	7.8-9.5	3*
Sea-Tac with new commuter runway	10	1.9	20	7.7	30	9.6	3*
REPLACEMENT AIRPORT SYSTEM							
Replacement airport	68-78	10.9-12.4	7	4.6	76-85	15.5-17.0	4
TWO AIRPORT SYSTEMS							
Existing Sea-Tac + Supp(1 rwy)	20-35	3.2-5.6	10-12	4.7	30-47	7.9-10.2	2*
Existing Sea-Tac + Supp(2 rwy)	20-38	3.2-6.0	11	4.7	30-48	7.9-10.8	2
Sea-Tac with new AC rwy + Supp(1 rwy)	22-27	3.6-4.3	10-11	4.7-4.8	33-38	8.3-9.1	3
Sea-Tac with new AC rwy + Supp(2 rwy)	22-27	3.6-4.3	10-11	4.7	33-38	8.3-9.1	4
THREE AIRPORT SYSTEMS							
Existing Sea-Tac + 2 Supp(1 rwy)	18-26	2.9-4.1	10-11	4.7-4.8	29-36	7.7-8.9	2
Sea-Tac with new Air Carrier rwy + 2 Supp(1 rwy)	21-25	3.3-3.9	9-10	4.5-4.7	28-35	7.8-8.6	1

* Not meeting system capacity demand

such as idling, or at start-up because of incomplete combustion. The amount of NOX produces during start-up is small compared to that produced during takeoff. SO_2 is a result of the oxidation of sulfur compounds in aircraft fuel. Aircraft fuel is highly refined and contains only about 0.1% sulfur. Particulate matter emitted from aircraft engines, particularly turbine engines, is extremely small in diameter ranging between 0.04 and 0.12 microns.

Of all the alternatives which meet the system capacity demand, the difference between the alternatives -- in terms of aircraft emissions -- is the amount of aircraft delays that may occur under each scenario. Idling time for aircraft increases as delays increase; this can significantly affect the daily tonnage of aircraft emissions.

Vehicle Emissions

Vehicle emissions are related to vehicle miles travelled and are a function of airport location and passenger volume.

3.2.2.1 Preferred Alternative

Aircraft Emissions

Based on 2020 projections, under the preferred alternative, aircraft emissions would be the lower of the three-airport system alternatives (Alternatives 28 and 30). This is a result of lower overall and average operational delays at Sea-Tac due to the addition of a new dependent runway. Total projected aircraft emissions are presented in Table 6.

Vehicular Emissions

Generally, vehicle emissions would be somewhat greater for the preferred alternative when compared with other three-airport options. Alternative No. 29 would have the highest overall vehicle emissions. Total projected vehicular emissions are presented in Table 6.

3.2.2.2 Secondary Alternatives

Aircraft Emissions

Under the secondary alternatives, aircraft emissions would exceed emissions projected under the Preferred Alternative. Three of the secondary alternatives (See Section 2.2) are three-airport systems that incorporate existing Sea-Tac without a new dependent runway. More delays are expected under these alternatives and consequently, more emissions. The remaining secondary alternatives (two of which incorporate a new dependent runway at Sea-Tac) are two airport systems which would have less efficient operations (as opposed to a three-airport system) increasing both aircraft emissions.

must be controlled. Ozone results in eye irritation, damage to lung tissues, and reduced resistance to colds and pneumonia. It also aggravates heart disease, asthma, bronchitis and emphysema.

Carbon monoxide (CO) is a colorless, odorless toxic gas produced by incomplete combustion of carbon-containing substances. The highest ambient concentrations of CO occur near congested roadways and intersections during periods of low temperatures, light winds, and stable atmospheric conditions. CO, which has been shown to interfere with oxygen transport in the blood, produces cardiovascular disease, and decreases visual perception. CO has also been associated with lower birth weight and increased death of infants in highly polluted areas.

Particulate matter is classified as Total Suspended Particles (TSP) and the inhalable subgroup of TSP, which is comprised of particles 10 microns or less in diameter (PM10). Suspended particles aggravate chronic disease and heart and lung disease symptoms and often transport toxic elements such as lead, arsenic, nickel, vinyl chloride, asbestos and benzene compounds which then enter respiratory, digestive, and lymphatic systems.

Hydrocarbons result from the release of unburned fuel or incomplete combustion of fuel. Hydrocarbons can be gases or particulate. Volatile organic compounds (VOC) are gaseous hydrocarbons which can react with oxidizing pollutants in the atmosphere to produce photochemical smog. VOC are also precursors of ozone. Hydrocarbon particulate of concern to human health are those with diameters ranging from 0.1 to 3 microns. Particulates of this size can enter the small passageways in the lungs and deposit there.

Sulfur dioxide (SO_2) is a nonflammable, non-explosive, colorless gas. It reacts in the atmosphere to form sulfur trioxides (SO_3) and sulfuric acid. SO_2 and sulfuric acid have been shown to produce asthma which decreases human respiratory functions both at the acute and chronic levels. These air pollutants are commonly grouped as sulfur oxides (SOX).

Nitrogen oxides (NOX), which include nitrogen oxide (NO) and nitrogen dioxide (NO_2), result from the high temperature oxidation of nitrogen in the present in the air. In the presence of moisture, NO can form particulate by coalescing, reducing visibility and contributing to acid deposition. NO_2, like sulfur dioxide, is also a bronchoconstrictor that can cause irritation and injury to the lungs. Nitrogen oxides are more a factor in the generation of secondary pollutants such as ozone.

3.2.2 Significant Impacts

Aircraft Emissions

Aircraft engines emit CO, hydrocarbons, NOX, SOX, and particulates as by-products of the combustion process. More CO and hydrocarbons are produced at low engine power settings

3.2.1 Affected Environment

Existing Air Quality

Three agencies have air quality jurisdiction in the Puget Sound region: the United States Environmental Protection Agency (EPA), Washington State Department of Ecology and the Puget Sound Air Pollution Control Agency (PSAPCA). Each agency has established its own standards. Unless the state or local agency has adopted a more stringent standard, the EPA standards apply.

Ecology and PSAPCA maintain a network of monitoring stations throughout the Puget Sound area. In general, these stations are located where agencies believe there might be an air quality problem. Other stations are located in more remote areas to measure regional or background air pollution levels. These stations measure total suspended particles (TSP), carbon monoxide, sulfur dioxide, arsenic, lead, and ozone. Of these substances, carbon monoxide is predominantly generated by transportation sources.

Of the 6 criteria pollutants discussed below, the Puget Sound Region is in attainment with three of them: Sulfur oxides, nitrogen oxides and hydrocarbons. A downward trend in the ambient concentration of air pollutants generated by motor vehicles, especially carbon monoxide, has been observed in the Puget Sound area over the past decade. The replacement of older vehicles with newer cleaner ones, and vehicles meeting the requirements of the Inspection and Maintenance (I/M) program have been the major factors for reducing the carbon monoxide emissions. Carbon monoxide emissions have been reduced by 13% in Seattle due to the I/M program.

Current aircraft operations at Sea-Tac Airport are a major source of air pollutant emissions in the local area. Based on a Department of Ecology emissions inventory (May 1991), Sea-Tac Airport contributes approximately 8% of the carbon monoxide and 5% of the nitrogen oxide emissions in King County.

Criteria Pollutants and Health Effects

The nature of pollutants emitted from airports is the same as those emitted from other transportation sources. Carbon monoxide, sulfur and nitrogen oxides (SOX and NOX), and unburned hydrocarbons are common pollutants emitted from the combustion processes. Six criteria pollutants regulated by federal standards are ozone, carbon monoxide, particulate and nitrogen dioxide, sulfur dioxide and hydrocarbons. These pollutants are described below.

Ozone (O3) is a colorless gas resulting from the reaction of hydrocarbons and oxides of nitrogen in the presence of sunlight. Although ozone is the air contaminant for which standards are set, its precursors, hydrocarbons and nitrogen oxides, are the pollutants which tives, the highest estimated population experiencing 65 Ldn in the year 2020 would be less than the existing 1990 population experiencing noise exposure of 75 Ldn. This is a result of the tremendous reduction in cumulative noise impacts at Sea-Tac from a 100% Stage III aircraft fleet. It should be noted that additional cumulative and single-event noise will occur at the supplemental airports.

3.2 AIR QUALITY

Introduction

The air quality section addresses potential impacts to air quality resulting from aircraft air pollutant emissions and from airport-related vehicular air pollutant emissions. Other air pollutants attributable to airport operations (such as fueling and boiler room operations in airport buildings and other sources) comprise approximately 0.1% of total air pollutant emissions and were not considered critical for this level of analysis. Aircraft and vehicular traffic air pollutant levels were used to compare the impacts of each system alternative on regional air quality.

Issues

Based on the Washington State Clean Air Act of 1991, the PSRC region, which includes Snohomish, King and Pierce Counties, is currently in non-attainment (not meeting the applicable state standards) for CO and ozone emissions (See Section 3.2.2 for a discussion of these pollutants). Additionally, portions of Seattle, the Tacoma tide flats and the City of Kent are in non-attainment for particulate matter. As a result, a State Implementation Plan (SIP) required under the Federal Clean Air Act of 1977, is being developed by the Washington State Department of Ecology (Ecology) to bring the region into compliance with state standards. The plan will detail how to meet the attainment goals for CO, ozone and particulate matter and is expected to be completed in November 1992.

Under the new Washington State Clean Air Act, transportation projects will have to meet the test of "conformity," meaning, they will have to conform with SIP standards within a specific time period. Conformity could affect transportation projects within a non-attainment area (due to potential impacts on air quality in an area that is not meeting current standards) and will be subject to close scrutiny (O'Sullivan, personal communication 1991). Ecology has not yet developed the criteria to make conformity determinations.

Methodology

A description of the methodology used for determining aircraft and vehicular emissions is presented in Working Paper No. 9.

Operational Management

The operational assumptions for a dependent runway at Sea-Tac include arrivals, departures and nighttime operations. Should these assumptions be changed to arrivals only, as might occur with anticipated use primarily during low-visibility weather conditions and during less noise-sensitive time periods, then the noise impacts would be lessened considerably.

Operational effects of side-step maneuvering

An example of an operational mitigation procedure for restricted use of the dependent runway utilizing a *side-step maneuver*, is described below. The noise effects of this mitigation measure have been modeled and a noise contour map showing the results has been included as an exhibit in Appendix 1 (see Map 37.4). The results of implementing a side-step maneuver would narrow the noise contours on the western margin of Sea-Tac such that the 2020 55 Ldn noise contour would closely approximate the existing 1990 65 Ldn noise level.

The following technical description outlines the concept of a side-step maneuver employed as part of the mitigation for restricted dependent runway operation, which would involve the use of a new runway utilized only during less noise-sensitive hours by commuter aircraft and air carrier aircraft. A side-step maneuver is an FAA authorized approach procedure in which an aircraft is using the runway approach to a runway that is parallel to the runway on which it will land. Pilots would commence the side-step maneuver as soon as the runway was in sight.

For the noise model, aircraft were assumed to commence the side-step maneuver at four nautical miles from the approach end of the landing runway at an altitude of 1,100 feet above ground level (AGL) and conclude the maneuver at 1.6 nautical miles from the approach end of the landing runway at an altitude of 500 feet AGL utilizing a twenty degree heading change. A minor increase in engine thrust due to aircraft maneuvering required by this procedure was also considered in the noise contour modeling.

Since the side-step maneuver is a visual procedure, higher landing weather minimums are required. Considering the prevailing meteorological conditions of the Seattle area, this procedure was modeled to be available and used by 20% of daytime air carrier arrivals. At this level of analysis, the 4-Post procedure was not modified, nor has the FAA had the time to establish feasible operational procedures since this alternative surfaced so late in the project.

3.1.4 Unavoidable Adverse Impacts

Any of the airport system alternatives, including the no-action alternative, increase aircraft noise impacts. However, under the preferred alternative, or any of the secondary alterna-

- Preferential Runway Use
- Preferential Runway Direction
- Flight Track Modifications
- Special Nighttime Procedures
- Nighttime Operational Restrictions
- Aircraft Use Restrictions
- Noise Abatement Arrival and Departure Procedures
- Nighttime Ground Noise Control Measures

For example, the potential noise impacts from construction of the dependent runway at Sea-Tac could be minimized for the long term by explicitly restricting the use of that runway for arrivals only during less noise-sensitive time periods through a noise abatement policy. When noise mitigation measures are included, alternative airport systems that include Sea-Tac with a new dependent runway, would lessen the noise exposure impacts estimated.

Additional mitigation measures, such as those listed above, were not included in the noise impact analysis for the programmatic EIS because of the complexity in applying mitigation to a large number of new airport sites with varying layouts and operational levels. Also, many of the potential mitigation measures restrict the operational characteristics of an airport and it was necessary to first analyze the potential noise impacts without constraints to the operations. Thus, unless explicitly stated otherwise, the noise exposure analysis presents operationally comparable worst case estimates.

The noise impacts of the McChord or Fort Lewis alternatives could be reduced through a preferential runway program that maximizes the amount of time the operations are in south flow, as there is very little development south of these airport sites. The noise impacts at the remaining supplemental airport sites could be minimized through the restriction of nighttime operations, especially in a multiple airport system with Sea-Tac as the primary airport. However, under the existing laws, it is very difficult to implement new restrictions on Stage III aircraft, and it may therefore be impossible to legally restrict nighttime operations in the future.

The potential for mitigating the noise impacts for the supplemental airport sites was analyzed for a number of sample alternatives. Although it was not feasible to analyze all of the alternatives, the preliminary results from analyzing sample alternatives show that the potential noise impacts at the supplemental sites themselves could be reduced by approximately 10% through mitigation measures.

It is recommended that noise control measures be included in the planning process as part of any implementation plan. Once a system alternative, airport sites, and layouts are determined, specific mitigation measures can be presented. For any alternative, a site-specific EIS would require a thorough discussion of mitigation.

65 Ldn noise levels under the secondary alternatives is estimated at between 7,500 and 8,500 residents (see Tables 3, 4, and 5; also see Working Paper 12A, Tables 12-3, 12-4, A-3, A-4 and A-5). While these noise levels are a significant improvement over the aircraft noise levels that exist in Seattle today, it may be expected that some level of adverse community response to aircraft noise would still be experienced with any of the alternatives. The secondary alternatives would result in similar populations newly exposed to 65 Ldn as the preferred alternative.

3.1.2.3 Other Alternatives

Based on the estimated population subjected to noise impacts, the only markedly different alternatives are the replacement airports. Of all the alternatives evaluated, the replacement airport in Central Pierce (No. 31) would affect the greatest population, while the Olympia/Black Lake replacement would affect the least. The low population impacts of the Olympia/Black Lake (No. 32) and the Central Pierce/Fort Lewis (No. 33) replacement airports are due to the location of these alternatives outside of existing urban development areas.

3.1.2.4 No-Action Alternative

By the end of the 1990's, the new Federal Airport Noise and Capacity Act of 1990 will result in reductions in noise over the next ten years as older, noisier aircraft are phased out of service. This will occur at Sea-Tac at a faster rate due to the noise budget and nighttime Stage II aircraft prohibitions. Assuming that the noise restrictions contained in the new law would be in effect, the no-action alternative at Sea-Tac results in a 65 Ldn contour area of 5.1 square miles. Working Paper 12A, Table 12-4 shows an estimated population of approximately 7,000 within the 2020 noise contours. A more detailed 1990 census block analysis of the neighborhoods immediately surrounding Sea-Tac conducted for the FAR Part 150 Update, estimated a resident population of 9,155 within the 1990 existing 75 Ldn noise contour of 5.09 square miles. Thus, the actual population noise exposure of the no-action alternative would be dependant on land use changes in the immediate vicinity surrounding Sea-Tac.

3.1.3 Mitigation Measures

A number of additional mitigation measures could be designed to minimize the potential noise impacts of airport development. However, the most effective noise control measures are those which are tailored to the wishes and needs of the local communities and generally are accomplished through a process such as the FAA's Part 150 program. Any adopted airport system recommendation would include a noise mitigation planning process that includes the communities', airport operators' and airlines' input.

The following is a brief list of a number of noise abatement measures that should be considered for minimizing the noise impacts around each of the airports.

in Appendix 1). These tables show both the range of total population exposed to each of the noise level metrics and the areas within the Ldn noise contours. The preferred alternative is represented under "Three Airport Systems" at the bottom of Table 3 as *SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)*. The first line of data for this alternative presents the worst case population noise exposure estimates. A "mitigated" version of this alternative is also presented (beneath it in parentheses) which incorporates demand management and restricted use of the new dependent runway to less noise-sensitive time periods for arrival traffic only.

Based on these data, the following conclusions may be drawn regarding the potential population noise exposure impacts:

The analysis of noise impacts must be based on an understanding of what is predicted for noise exposure in the next ten years. For example, at Sea-Tac, noise will be significantly reduced over current levels due to the Sea-Tac Noise Budget and nighttime Stage II restrictions. These programs, and the national noise policy, require the airlines to replace Stage II aircraft with the quieter Stage III. Improvements to the noise environment around Sea-Tac will continue into the 21st Century as the airline fleets further modernize with the quietest Stage III equiopment. Therefore, the most significant conclusion of the noise analysis is that the future noise environment for all of the system alternatives represents a significant improvement over that which exists around Sea-Tac today. The aircraft forecast to be operating in 2020 are significantly quieter, resulting in reductions in both the overall Ldn noise levels and the single-event SEL levels. For example, under the preferred alternative without demand management mitigation, the area within Sea-Tac's 65 Ldn noise contour in 2020 would be between 6.6 and 6.9 square miles. The 65 Ldn contour area for the north airport at Paine Field would be 0.8 square miles, and from 0.5 to 0.7 square miles for the south airport. The total population exposed to 65 Ldn noise level would be 12,600 to 13,100 without mitigation, and 8,100 to 8,600 people with mitigated runway use and demand management mitigation, including a population newly exposed to 65 Ldn noise level of approximately 100 to 600 residents.

No increase of capacity at Sea-Tac would result in more significant growth and noise at the supplemental airport sites. With restricted use of a new dependent runway at Sea-Tac, a multiple airport system would be more favorable from an overall noise management perspective than a multiple airport system without improvements to Sea-Tac. This is because the preferred alternative reflects a balance of some growth at Sea-Tac with limited growth at supplemental airport sites.

3.1.2.2 Secondary Alternatives

Based on population exposure to significant noise levels greater than 65 Ldn, none of the secondary alternatives (No. 23, 25, 8, 24, 18, or 21) is markedly superior to the preferred alternative with restricted use mitigation. The range of the total population experiencing

Table 5. Population Summaries Within 2020 Noise Contours.

ALT	AIRPORT SYSTEM ALTERNATIVES	TOTAL POPULATION 55 LDN (000)*	POPULATION NEWLY EXPOSED TO 55 LDN (000)*	TOTAL POPULATION 65 LDN (000)*	POPULATION NEWLY EXPOSED TO 65 LDN (000)*	TOTAL POPULATION 80 SEL (000)*
1	**Sea-Tac without Commuter R/W	112		7.0		91
2	**Sea-Tac with Commuter R/W	119		7.0		94
3	**Alternate 1 + Arlington 1 R/W	123	11	7.7	0.7	116
4	Alternate 1 + Paine 1 R/W	135	23	8.2	1.2	143
5	Alternate 1 + McChord 1 R/W	135		7.8		138
6	**Alternate 1 + Central Pierce 1 R/W	123	11	7.5	0.5	123
7	**Alternate 1 + Olympia/Black Lake 1 R/W	116	4	7.1	0.1	115
8	Alternate 1 + Arlington 2 R/W	127	15	7.5	0.5	127
9	Alternate 1 + Paine 2 R/W	138	26	8.3	1.3	153
10	Alternate 1 + McChord 2 R/W	135		7.8		147
11	Alternate 1 + Central Pierce 2 R/W	127	15	7.5	0.5	135
12	Alternate 1 + Olympia/Black Lake 2 R/W	117	5	7.1	0.1	125
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	135	4	13.1	0.1	129
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	138	7	13.1	0.1	160
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	141		13.1		152
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	135	4	13.5	0.5	137
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	133	2	13.0		128
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	136	5	13.0		140
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	139	8	13.1	0.1	167
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	141		13.1		161
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	136	5	13.5	0.5	149
22	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 2 R/W	133	2	13.0		138
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	125	13	7.9	0.9	148
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	132	20	7.6	0.6	175
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	121	9	7.5	0.5	139
26	Alternate 1 + Paine 1 R/W + Olym./Blk. Lake 1 R/W	127	15	7.1	0.1	167
27	Alternate 13 + Central Pierce 1 R/W	133	7	12.6	0.6	162
28	Alternate 14 + Central Pierce 1 R/W	137	11	12.6	0.6	189
29	Alternate 13 + Olympia/Black Lake 1 R/W	132	4	13.1	0.1	153
30	Alternate 14 + Olympia/Black Lake 1 R/W	136	8	13.1	0.1	180
31	Central Pierce 3 R/W	53	53	2.8	2.8	55
32	Olympia/Black Lake 3 R/W	19	19	0.3	0.3	49
33	Central Pierce/Fort Lewis 3 R/W	62	62	1.3	1.3	52
34	**Alternate 1 + Demand Management	112		7.0		91

* Population estimates based on 2000 population projection

** Denotes system alternatives that include Airport Development Alternatives that do not meet System Capacity Demands

ALT	AIRPORT SYSTEM ALTERNATIVES	SEA-TAC AIRPORT 55 LDN	SEA-TAC AIRPORT 65 LDN	NORTH AIRPORTS 55 LDN	NORTH AIRPORTS 65 LDN	SOUTH AIRPORTS 55 LDN	SOUTH AIRPORTS 65 LDN
1	*Sea-Tac without Commuter R/W	30.9	5.1				
2	*Sea-Tac with Commuter R/W	32.7	5.5				
3	*Alternate 1 + Arlington 1 R/W	30.9	5.1	12.8	1.8		
4	Alternate 1 + Paine 1 R/W	30.9	5.1	14.6	2		
5	Alternate 1 + McChord 1 R/W	30.9	5.1			15.7	2.2
6	*Alternate 1 + Central Pierce 1 R/W	30.9	5.1			12.8	1.8
7	*Alternate 1 + Olympia/Black Lake 1 R/W	30.9	5.1			12.8	1.8
8	Alternate 1 + Arlington 2 R/W	30.9	5.1	17.6	2.3		
9	Alternate 1 + Paine 2 R/W	30.9	5.1	15.1	2.3		
10	Alternate 1 + McChord 2 R/W	30.9	5.1			15.8	2.3
11	Alternate 1 + Central Pierce 2 R/W	30.9	5.1			17.6	2.4
12	Alternate 1 + Olympia/Black Lake 2 R/W	30.9	5.1			17.6	2.3
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	38.3	7.1	5.5	0.7		
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	38.2	7.1	5.5	0.8		
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	38.3	7.1			6.7	1
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	38.2	7.1			5.5	0.7
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	38.3	7.1			5.5	0.7
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	38.3	7.1	6.9	0.8		
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	38.2	7.1	6	1		
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	38.3	7.1			7	1.1
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	38.2	7.1			6.9	0.9
22	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 2 R/W	38.3	7.1			7	0.8
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	30.9	5.1	8.2	1.1	9.3	1.3
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	30.9	5.1	8.6	1.2	8.7	1.2
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	30.9	5.1	9.1	1.2	8.2	1.1
26	Alternate 1 + Paine 1 R/W + Olym./Blk. Lake 1 R/W	30.9	5.1	9.7	1.3	7.7	1
27	Alternate 13 + Central Pierce 1 R/W	36.9	6.8	4.3	0.6	5.5	0.7
28	Alternate 14 + Central Pierce 1 R/W	36.2	6.6	5.5	0.8	5.5	0.7
29	Alternate 13 + Olympia/Black Lake 1 R/W	38.1	7.1	4.3	0.6	3.3	0.5
30	Alternate 14 + Olympia/Black Lake 1 R/W	37.4	6.9	5.5	0.8	3.3	0.5
31	Central Pierce 3 R/W					59.2	8.5
32	Olympia/Black Lake 3 R/W					59.4	8.6
33	Central Pierce/Fort Lewis 3 R/W					59.2	8.5
34	*Alternate 1 + Demand Management	30.9	5.1				

* Alternative which does not meet system capacity demand.

Table 3. Population Range by Category Within 2020 Noise Contours.

SYSTEM ALTERNATIVES	TOTAL POPULATION 55 LDN (000)*	POPULATION NEWLY EXPOSED TO 55 LDN (000)*	TOTAL POPULATION 65 LDN (000)*	POPULATION NEWLY EXPOSED TO 65 LDN (000)*	TOTAL POPULATION 80 SEL (000)*	RANK (1 BEST)
EXISTING SEA-TAC AIRPORT SYSTEM						
Existing Sea-Tac with maximum demand management	112-119		7		91-94	2**
REPLACEMENT AIRPORT SYSTEM						
Replacement	19-62	19-62	0.3-2.8	0.3-2.8	49-55	1
TWO AIRPORT SYSTEMS						
Existing Sea-Tac + Supp (1 Rwy)	116-135	0-23	7.1-8.2	0-1.2	115-143	6**
Existing Sea-Tac + Supp (2 Rwy)	117-138	0-26	7.1-8.3	0-1.3	125-153	7
Sea-Tac with new AC Rwy + Supp (1 Rwy) (Mitigated Sea-Tac with New AC Rwy + Supp (1 Rwy))	133-141 (127-135)	0-7 (0-7)	13-13.5 (8-8.5)	0-0.5 (0-0.5)	128-160 (118-150)	9 3
Sea-Tac with new AC Rwy + Supp (2 Rwy) (Mitigated Sea-Tac with New AC Rwy + Supp (2 Rwy))	133-141 (127-135)	0-8 (0-8)	13-13.5 (8-8.5)	0-1 (0-1)	138-167 (128-157)	10 4
THREE AIRPORT SYSTEMS						
Existing Sea-Tac + 2 Supp (1 Rwy)	121-132	9-20	7.1-7.9	0.1-0.9	139-175	8
Sea-Tac with new AC Rwy + 2 Supp (1 Rwy) (Mitigated Sea-Tac with New AC Rwy + 2 Supp (1 Rwy))	132-137 (128-133)	4-11 (4-11)	12.6-13.1 (8.1-8.6)	0.1-0.6 (0.1-0.6)	153-189 (143-149)	11 5

* Population estimates based on 2000 population projection

** Denotes system alternatives that include Airport Development Alternatives that do not meet System Capacity Demands

is expected to result in noise levels similar to the Stage III generation of quieter aircraft. Any substantial future reductions in aircraft noise would require new developments in engine technology or noise control and therefore are not anticipated by this study.

Single-event noise contours for aircraft types and procedures expected to be in operation in 2020 were also generated and mapped (see maps in Appendix 1). The departure noise levels were used because departure noise represents the highest single-event noise level. The aircraft selected to represent the single-event noise level was the McDonnell Douglas MD82. This aircraft is typical of the MD80 fleet, and is expected to be the loudest aircraft in operation through the early part of the 21st century. The associated contour maps present a composite of the single-event noise levels to all of these primary flight tracks and are intended to reflect typical single-event noise levels in different communities.

Population Impact Analysis

The noise contour analysis was used to determine the population that would be exposed to certain noise levels. The analysis is based upon the projected year 2000 population levels. The year 2000 was selected on the assumption that protective land use zoning would be initiated by the appropriate land use decision-making authorities by that date. At that time, proposed development could be restricted or regulated in order to promote noise and land use compatibility between the airport and the surrounding area. The year 2020 projected population data were not used because any new airport development would be expected to include land use restrictions that would alter the population development around the airport.

Population data were obtained from the Puget Sound Regional Council (PSRC), which maintains a population data base by travel analysis zones (TAZs). Within the 4-county region there are 546 TAZs; these are similar in size to census tracts and thus tend to be smaller in urbanized areas and larger in rural areas. TAZ maps and the noise contour maps were overlaid. The percentage area of each TAZ covered by a given contour was calculated and multiplied by the population in the TAZ to obtain the proportionate population within the noise contour. These proportionate population figures were then summed to obtain the total population within each contour (see Appendix 1 for further explanation).

The VISION 2020 projected population data indicate that people will be living around nearly all of the airport sites. The most densely populated areas are expected to be around Sea-Tac and Paine Field Airports. The least densely populated area would be around Olympia/Black Lake and Arlington. Also, no private homes are located to the south of the McChord and Fort Lewis sites because that area is part of the Fort Lewis Army Base.

3.1.2.1 Preferred Alternative

The results of the noise analysis for all the system alternatives considered are summarized on Tables 3, 4, and 5 (see also Working Paper 12A, Tables 12-1, 12-3 and 12-4 reproduced

(2) Residential population newly exposed to 55 Ldn or greater. A newly exposed population consists of residents experiencing new exposure to aircraft noise as a direct result of the alternative. In accordance with many recent studies, this category reflects that around a new airport or an airport which previously had very few operations, the population newly exposed is likely to exhibit a high level of annoyance to the new aircraft noise.

(3) Residential population exposed to aircraft noise of 65 Ldn or greater. The 65 Ldn indicates the population that is significantly affected by aircraft noise. This is the FAA's mitigation threshold for determining compatibility of residential land use with aircraft noise levels.

(4) Residential population newly exposed to aircraft noise of 65 Ldn or greater. Since population that is newly exposed to aircraft noise has been shown to exhibit higher annoyance than a population that has had a long term exposure, this measure indicates a significantly affected population that will most likely need special action.

(5) Residential population exposed to single-event aircraft noise of 80 SEL or greater. The 80 SEL single-event noise contour is an indicator of where speech interference and sleep disturbance are expected to occur. The 80 SEL single-event contour is thus a good indicator of where single-event disturbance is likely to result in annoyance from aircraft operations for a segment of the population.

Noise Contour Analysis

Noise contour maps for the 55 and 65 Ldn, and 80 SEL, were generated for each of the airport alternatives using the FAA's Integrated Noise Model. The contours are based upon 2020 operational assumptions. Noise contour maps for sixteen of the airport development alternatives are presented in Working Paper 12A (see Appendix 1). These exhibits present the noise contours for the highest operational assumptions for one, two and three runway scenarios for each airport site.

The aircraft assumed to be operating into the 21st century are expected to generate similar noise levels to those of the quietest of the new generation aircraft that are being built today. The contour analysis assumes that by 2020 the entire air carrier fleet would be composed of Stage III aircraft, such as the MD80, MD90, B737-300, B757, B767, MD11, B747-400 as well as other new generation aircraft. (Stage III refers to the quietest category of aircraft as currently defined by the FAA Federal Aircraft Regulation 36 which regulates the noise levels generated by jet aircraft. FAA certification of Stage III aircraft is based on engine weight and noise). Given the 25 to 30 year life span for commercial aircraft, these aircraft would be expected to still be in service by 2020. Although Stage III aircraft are significantly quieter than many in the current fleet of aircraft, such as the B727, they still generate noticeable noise levels. New aircraft currently under development utilize technology that square miles, the total population was estimated to be 31,300 including a population of 9,155 residing within the 75 Ldn area of 5.09 square miles.

According to FAA Part 150 guidelines, specified levels of structural noise insulation can be used as a mitigation measure within the 65-70 Ldn and the 70-75 Ldn contour intervals to achieve compatibility of residential land use with these levels of aircraft noise exposure. The Port of Seattle is actively engaged in an FAA-funded Noise Remedy Program to provide neighborhood reinforcement and noise insulation for residences surrounding Sea-Tac. Also, new building codes established by some local jurisdictions since 1987 require noise insulation in all new construction. Thus, by the year 2020, a substantial portion of the residential housing stock within the currently established Noise Remedy Program boundaries would be compatible land uses within the 65 Ldn noise level.

With the exception of Olympia/Black Lake and the Central Pierce area, all of the other alternatives are at existing airport sites which currently experience some significant level of aircraft noise. For example, Paine Field has a mix of general aviation activity including business jets and test flights of commercial aircraft. Since McChord is an active military airfield, and military aircraft are generally much noisier than commercial carriers, its surrounding population currently experiences relatively higher Ldn and SEL noise levels for the number of operations.

3.1.2 Significant Impacts

Overview of Noise Impact Analysis

The noise impact analysis estimated the total population noise exposure for each of the airport system alternatives (see Table 3). The following noise assessment criteria were used in the analysis: (1) population exposed to cumulative noise levels in excess of 55 Ldn, (2) population that would be newly exposed to cumulative noise levels in excess of 55 Ldn, (3) population exposed to cumulative noise levels in excess of 65 Ldn, (4) population that would be newly exposed to cumulative noise levels in excess of 65 Ldn, and (5) population that would be exposed to single-event SEL noise levels in excess of 80 SEL. Rationales for use of these various noise assessment criteria are further explained below:

(1) Residential population exposed to aircraft noise of 55 Ldn or greater. A noise level of 55 Ldn and greater indicates the population to which the aircraft noise will be noticeable and some degree of annoyance or adverse community response would be expected to occur. Experience at Sea-Tac indicates most (but not all) areas where noise complaints occurred were exposed to Ldn levels of 55 or greater. For a new airport site, the 55 Ldn represents the area in which future residential land use development may consider zoning and other land use control measures to avoid significant noise-related residential land use impacts.

protecting the public health and welfare with an adequate margin of safety. This includes both residential land use with outdoor use areas and recreational land uses. This recommendation does not constitute an EPA regulation or standard. Rather, it is intended to identify a goal for safe levels of environmental noise exposure without consideration for the economic cost of achieving these levels. In this study, the 55 Ldn is considered for comparative evaluation of the potential noise impacts around airport sites. Although it is not feasible as a mitigation level in developed areas, the 55 Ldn is indicative of a desired goal for the noise environment within the communities of Puget Sound.

The 65 Ldn noise level is utilized by the Federal Aviation Administration and most government agencies throughout the country as the threshold level for determining compatibility of aircraft noise with residential land use. This reflects a balance between a desired sound environment and the economic costs of attaining this level. For the purposes of this programmatic EIS, population exposure to noise levels in excess of 65 Ldn would be considered the threshold for determining a significant adverse impact.

SEL Noise Metric. While it has been demonstrated that cumulative noise metrics correspond well with overall community ratings of the noise environment, a number of airport studies have shown community response to noise is not completely predicted through one descriptor, such as Ldn. While the total noise exposure as described by the cumulative noise metric serves as the basis for a person's judgment of the noise environment, it is often a single interference with some activity that people use to express their immediate concern over noise. In such cases, single-event metrics can be used to supplement the analysis as a predictor of when annoyance from aircraft noise is likely to occur.

Sound Exposure Level (SEL) is a "single-event" descriptor of an individual overflight; is often used to supplement the Ldn analysis. A single-event SEL level of 80 dBA corresponds to the level at which sleep disturbance and speech interference start to occur in the general population. Thus, the 80 SEL level was selected as one of the evaluation criteria for this study.

Existing Aircraft Noise Levels

Indications of community response information obtained from studies around Sea-Tac confirm that the 55 Ldn and 80 SEL are good indicators of the overall noise levels at which complaints and annoyance from aircraft start to occur. The 65 Ldn represents the threshold for significant impacts from cumulative noise exposure.

The existing noise conditions around Sea-Tac, based on 1990 noise exposure data produced for the Port of Seattle's Federal Aviation Administration FAR Part 150 Update, estimated a resident population of approximately 66,000 within the 1990 existing 65 Ldn noise contour area of 22.08 square miles. Within the 1990 existing 70 Ldn noise contour area of 11.11

Induced land use was estimated as follows for office, light industrial, and hotel uses:

Office: Office acreage is based on an average 3-story height with 50% lot coverage to provide for parking and landscaping. This density is representative of many office developments in the Puget Sound area, although considerable variation can be found.

Light Industrial: Light industrial use (including manufacturing and warehousing) is calculated as 2.5 times the office acreage. Nationally this use is approximately twice office space, while in the Sea-Tac vicinity it is almost four times office space. It should be noted that the study of west coast airports by P&D Aviation did not find a significant association between airports and industrial use, and hence it could be inferred that this activity may not be necessary for a successful airport operation. This type of land use is included here given the potential for airport-related manufacturing (Working Paper No. 8) and the existing pattern observed at Sea-Tac.

Hotel: Hotel land use is calculated at 200 rooms per acre. This is lower density than presently found around Sea-Tac (approximately 300 rooms per acre) where hotels use appears to have been constrained by limited local circulation patterns.

Opportunities for development and land use change vary considerably between airport locations. In areas with existing development, it is likely that activities already in the area and not dependent on an airport would be displaced to other locations in the region while airport-related activities would remain and potentially expand. Sea-Tac, Paine Field, McChord, and Central Pierce are locations where relatively little undeveloped area remains. The Central Pierce area has significant development in place and substantially more is anticipated. Arlington and Olympia/Black Lake are locations where new development could occur. Development around Fort Lewis may be considerably constrained by surrounding army activities.

Table 14 shows the 1990 population and employment, with density, for the general area around each potential airport location. The figures given are by Forecast Analysis Zones (FAZ's) developed by the PSRC based on census tracts and used for regional planning and forecasting purposes. Because the FAZ's are different sizes and are not centered on the airport locations, the figures given should not be interpreted as definitive. However, clear distinctions between the airport locations are evident. Overall, Sea-Tac and Paine Field are the most densely developed locations, and Arlington and Olympia/Black Lake appear the least developed. Sea-Tac has substantially higher employment developed than any other FAZ, followed by the Paine Field area. All other locations show relatively similar low employment densities. Paine Field has the highest household density, followed by Sea-Tac. Arlington shows much lower household density than any other area.

Table 14. 1990 Households and Employment and 1990 Density.

Airport Location	FAZ	Total Developable Acreage[1]	1990 Households[2]	1990 Employment	1990 Household Density per acre	1990 Employment Density per acre
Sea-Tac	3700	6,293	40,454	37,076	5.00	30.03
Arlington	8500	7,197	7,362	5,818	2.14	3.39
Paine Field	7530	5,083	26,082	12,943	6.82	17.37
Central Pierce	500	14,057	20,053	2,220	4.01	2.21
McChord	2930	15,748	27,750	43,625	4.87	5.35
Fort Lewis	2930	15,748	27,750	43,625	4.87	5.35
Olym. Blk. Lake	17[3]	N/A	6,800(pop.)	2,900	N/A	N/A

1 - Developable area from Table A2, "Land Use and Neighborhood Character, Supplementary Report, Second Edition", October 1990, PSRC, and includes both residential and employment land.
2 - 1990 households and employment from "Interim Population and Employment Estimates, 1990 and 2010", September 1991, PSRC.
3 - Not included in PSRC reports. 1990 population and employment from "The Profile", March 1991, Thurston Regional Planning Council.

3.6.2 Significant Impacts

3.6.2.1 Preferred Alternative

Sea-Tac. Construction of a dependent runway on the western property boundary at Sea-Tac International Airport would require the acquisition of approximately 110 acres containing 230 homes between 9th and 12 Avenues South and between South 176th Street and State Route 518.

The new approach and takeoff areas would have to be reviewed for any obstructions within the Runway Protection Zone for all sites.

Paine Field. While commercial service would initially require only minor facility improvements, new facilities would eventually have to be constructed on the field with approximately 140 acres of parkland, commercial, and industrial uses being induced.

Fort Lewis, McChord, and Olympia/Black. Without adequate precautions, land use speculation could precede actual plans for a new airport facility. The GMA calls for urban growth to occur within urban growth boundaries to prevent sprawl. Urban services are to be provided by cities, not by counties. Urban growth boundaries are now being established and the siting of airport facilities will be accomplished using the GMA guidelines.

The impacts to Central Pierce would involve property acquisition, road relocation and improvements, and the military operations at Fort Lewis and McChord AFB. Depending on site location, the impacts to military operations may impair or prevent the Army and the Air Force from completing their missions as presently defined at these locations.

The Air Force recently changed its command structure to better fulfill its global responsibilities. The Army, in a synergetic operation with the Air Force, is also responsible for new global operations. Fort Lewis and McChord AFB are expanding by receiving additional military personnel from other base closures and assuming new operational requirements.

Civilian airport land uses and facilities are not easily compatible with the military training and operational missions of the bases. The bases contain hazardous cargo loading areas, munitions storage areas, superfund sites, and numerous functional requirements that are not compatible with public use. Hazardous cargo loading and munitions areas are located close to runways to allow for rapid deployment and logistical support for Army and Air Force missions. Safety and security requirements would not allow a civilian terminal and associated support facilities to be in the same location without adequate separation.

The acreage affected by induced land uses from Table 15 are 242 acres for Sea-Tac, 39 acres for Paine Field, and up to 60 acres at the Fort Lewis or McChord AFB sites or 80 acres for Central Pierce or Olympia/Black Lake areas.

Impacts to Olympia/Black Lake area include the acquisition of 800 acres containing 50 homes and 550 vacant acres. Road improvements to I-5 would also be required and new roads constructed.

3.6.2.2 Secondary Alternatives

The impacts on the secondary alternatives are generally the same as for the preferred alternative with the provision that impacts will vary depending on present and potential land uses which would be developed or redeveloped as described in the previous section. Additional property would be needed to support runway expansions or new facilities. Outlying sites are more rural with more open space and are generally designated as rural, suburban, or a resource area. Induced development will tend to occur more rapidly at outlying sites without controlling plans or regulations.

The acreage affected by induced land uses from Table 15 are 242 acres for Sea-Tac, 127 acres for Arlington, up to 260 acres at Central Pierce, and up to 127 acres at Olympia/Black Lake.

Table 15. Induced Land Use Estimates.

Alternative	Location	2020 MAP[1]	Acres in Airport Influence Area (1.5 to 3 miles)			
			Office [2]	Light Industrial [3]	Hotel [4]	Total
27,29	Arlington	2	6	15	5	26
13,18	Arlington	3	9	22	6	37
23	Arlington	6	16	41	10	67
25	Arlington	7	19	48	11	79
3	Arlington	11	26	66	15	107
8	Arlington	13	31	78	18	127
16,21,27,28	Cen. Pierce	3	9	23	7	38
6,11	Cen. Pierce	5	14	36	9	59
24	Cen. Pierce	7	18	45	11	73
23	Cen. Pierce	7	20	49	11	80
31	Cen. Pierce	45	62	155	43	260
33	Fort Lewis	45	62	155	43	60
15,20	McChord	3	9	22	6	37
5,10	McChord	13	31	78	18	127
29,30	Olym. Blk. Lake	1	4	9	3	16
17,22	Olym. Blk. Lake	3	9	22	6	37
26	Olym. Blk. Lake	5	15	37	9	61
25	Olym. Blk. Lake	6	17	41	10	68
7	Olym. Blk. Lake	11	26	66	15	107
12	Olym. Blk. Lake	13	31	78	18	127
32	Olym. Blk. Lake	45	62	155	43	260
14,19,28,30	Paine Field	3	9	23	7	39[5]
24	Paine Field	7	18	45	11	73
26	Paine Field	8	21	52	12	85
4,9	Paine Field	13	31	78	18	127
1,23,24,25,26	Sea Tac	32	44	110	33	188
2,29	Sea Tac	35	48	120	36	204
28,34	Sea Tac	38	53	132	38	223
27	Sea Tac	40	54	136	39	229
30	Sea Tac	40	56	139	39	234[5]
13,14,15,16,17, 18,19,20,21,22	Sea Tac	42	58	144	41	242

1 - Constrained allocation of million annual passengers from Working Paper No. 5.
2 - Office space from Working Paper No. 8. Assumes 50% lot coverage with 3-story buildings
3 - Includes warehousing and manufacturing. Assumes 2.5 times office space, higher density than at present around Sea Tac.
4 - Hotel rooms from Working Paper No. 8. Assumes approximately 200 rooms per acre, slightly lower density than at present around SeaTac.
5 - Preferred Alternative.

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Arlington. The impacts to Arlington are caused by the acquisition of approximately 100 to 675 acres containing 20-95 homes, commercial and industrial uses including Bayliner Industries and a major commercial nursery, and pasture and wooded areas.

Road relocation and improvements would be required. Roads would be subject to the level of service and the design and construction standards of the respective jurisdictions.

Land use changes surrounding the airport would occur. The change in real estate values may cause a desire to urbanize and change land uses from rural and suburban to those associated with airport activities. The GMA allows for comprehensive plans to be changed once a year.

Central Pierce. The impacts to the military bases were discussed under the preferred alternative. The site located east of Fort Lewis west of SR 161 would be a new facility. It requires the acquisition of 1,140 acres containing 594 homes, 75 commercial acres, 620 vacant acres, and a 134-unit condominium complex. Development would significantly impact existing land uses. Surrounding rural and suburban property will become urbanized. Road improvements would be required to SR 161.

3.6.2.3 Other Alternatives

The other alternatives will impact the same environmental elements as the other sites. The degree of impact will vary with each alternative. If the combined operational and acreage needs of Ft. Lewis and McChord Air Force Base do not change (possibly releasing land for alternate uses), or if the Olympia/Black Lake site is not feasible, other alternatives would be reviewed using the GMA guidelines. Displaced businesses on a site would either relocate or go out of business.

Land use impacts due to airport expansion or new facilities will involve the development of unused and vacant land, property improvements, and redevelopment from existing land uses to new land uses associated with airport activity. Commercial land uses that are associated with airport activities now exist in varying degrees at Sea-Tac, Paine Field, and Arlington. They do not exist at McChord AFB, Fort Lewis, Central Pierce, or Olympia/Black Lake.

Total induced acreage at a single location ranges from 16 acres for the supplemental airport option at Olympia/Black Lake (alternatives 29 and 30) to 260 acres for a replacement airport at Central Pierce, Fort Lewis, or Olympia/Black Lake. By system alternative, induced land use change is:

Existing Sea-Tac (No-Action)	188 to 204 acres
Replacement Airport	260 acres
Two-Airport System	279 to 315 acres
Three-Airport System	282 to 334 acres

Table 15 shows estimates of induced land use changes by type at each airport location in the order of increasing area. The distribution of induced land use estimates between counties is determined largely by the forecast allocation of passengers, as described above. Figure 1 shows the estimated total induced land use by county and alternative. The lowest total induced acreage (without unsatisfied airport demand, and discounting environmental, ownership, or other constraints) is found with a replacement airport at the Central Pierce, Olympia/Black Lake, or Fort Lewis locations. The highest total induced acreage is found with a 3-airport system without a dependent runway at Sea-Tac. The difference in induced land use (by county) illustrates how similar levels of activity may be distributed in the Puget Sound region. A regional decision on how to distribute the economic activity and related land use resulting from an airport is a very important aspect of selecting an airport system alternative.

3.6.2.4 No-Action

Under the no-action alternative no additional facilities would be developed at any location. Demand management would be used to the maximum extent possible at Sea-Tac, but regional demand for air travel would not be satisfied. Lack of an adequate air transportation system would indirectly affect regional land use by constraining economic growth and development.

3.6.3 Mitigation Measures

Mitigation measures for each type of impact are discussed by categories: housing and development/redevelopment.

Housing. The mitigation measure for housing is necessary due to the impacts of displacement caused by acquisition. Housing availability and affordability are also a factor. Housing relocation assistance, as necessary, would be available to those who are eligible. Relocation and acquisition programs would probably be managed by the airport operating authority, the Department of Transportation, and local jurisdictions.

New housing is generally available in the Puget Sound region. A recent capacity analysis accomplished in King County indicates there is available land with urbanized communities to accommodate new housing for the next 20 years. Real estate agencies and vacancy rates indicate sufficient existing housing availability for the next three years.

Affordable housing is currently in short supply in the more urbanized areas. Renters moving to housing with similar standards may have to travel several miles taking families away from familiar neighborhoods and inducing transportation impacts from trips generated to and from work. Displaced home owners will either buy existing homes available in their area or build new homes. New housing is more expensive due to new building code requirements, new development regulations, and new impact fees.

In accordance with the GMA, approximately $2,000 is available for low-income relocation assistance; one-half to be provided by the developer and the other half to be provided by the jurisdiction.

Development/Redevelopment. Local jurisdictions are responsible for land use decisions and will control what is allowed with the area of the facility and when it would be permitted. Decisions will be necessary for open space, recreation, commercial and industrial activities, public facilities, and all the required elements of comprehensive planning listed in the Growth Management Act.

Relationship to GMA. The consistency requirement of GMA I applies to planning for new facilities such as airports. To be in compliance with the acts at the time the comprehensive plans are adopted, the elements of housing, land use, transportation, capital facilities, and utilities must be consistent. City and county plans must be coordinated and consistent with each other.

The multi-county policies (Snohomish, King, and Pierce), as well as the individual policies for planning public facilities should be adopted by Snohomish, King, Pierce, and Thurston Counties by July 1, 1992. This project would be subject to review by the affected agency.

The GMA calls for planning to be accomplished for three time frames; 20 years for land use planning, 10 years for transportation planning, and 6 years for capital improvement planning. Land capacity analyses are in progress to help determine urban growth boundaries, urban densities, and levels of service for public facilities. Transportation plans establish levels of service for roads. Provisions for bringing existing roads up to standards and concurrency requirements for new roads will be addressed. Capital improvement plans include new and old facilities, cost, and sources of funding.

3.6.4 Unavoidable Adverse Impacts

Redevelopment to airport facilities and access will displace homes, businesses, and other land uses in the acquisition areas. Such unavoidable impacts may be reduced if protective zoning and land use planning is implemented before the year 2000.

3.7 PUBLIC SERVICES AND UTILITIES

3.7.1 Affected Environment

Public and urban governmental services are defined in the GMA and include fire, police, health, schools, recreation, environmental, governmental (administrative support facilities), storm and sanitary sewer systems, water systems, street cleaning, and public transit. Sewer and water district comprehensive plans, special district plans, and services areas that have their own comprehensive plans must be incorporated into jurisdictional comprehensive plans.

The local demand for public services (including fire, police, water, and sewer service) would increase for each of the alternatives, even the no-action alternative. The actual net demand for public services and utilities will depend upon specific types, densities and locations of commercial, light industrial, office space and other land uses. Because of the GMA concurrency requirement, adequate services must be provided (either developed or substantially planned for) before a new facility is developed. A study of public service costs prepared for the VISION 2020 Plan found that at a very general level overall per capita costs remain virtually unchanged with increases in population and density. This is because demand for public services increases with density of development, thus offsetting apparent cost savings. Results in specific cases would vary. The total cost of public services and utilities will be lower (generally) where there is existing infrastructure and where fewer new facilities are required.

In general, the Sea-Tac and Paine Field locations have the most developed public service and utility infrastructure and would require fewer additional services. Arlington, McChord, and the Central Pierce locations have somewhat limited infrastructures and would require substantial improvements. Fort Lewis and Olympia/Black Lake have very limited services, if any, and would require building entirely new infrastructure systems.

Sea-Tac

Existing Services. Four fire districts provide fire protection and emergency medical services in the Sea-Tac area. All four districts are members of the King County Interlocal Mutual Aid Program, which allows each district to call on any other County district for assistance. In addition, each has first-alarm agreements with neighboring districts. This means that in the event of a major alarm, neighboring districts are notified at the same time as the jurisdictional district is notified.

The Port of Seattle Aviation Division has responsibility for fire fighting at Sea-Tac International Airport. The Port of Seattle has entered into mutual-aid agreements and may back-up arrangements with King County and with local districts.

The Port of Seattle provides police services for Sea-Tac International Airport. The King County Police Department provides police protection to the neighborhoods surrounding the Sea-Tac area. The King County Police Department does not have a mutual agreement with the Port, but there is informal cooperation with other local jurisdictions on an incident-by-incident basis.

Three water districts currently supply potable water in the Sea-Tac Airport area. All districts receive their water supply from the City of Seattle; each district has mutual agreements with adjacent districts to share water in emergencies such as heavy fire flow demands or water shortages.

The Sea-Tac study area is currently served by four sewer sewer districts, each with a comprehensive plan to aid them in future planning and coordination with other service districts and regulatory agencies.

Currently, sewer trunk lines in the Sea-Tac Planning Area (as previously defined by King County) are reported to be adequate for conveying existing waste water flows. All the sewer districts have capital improvement programs that are updated annually to accommodate changes in the capital facilities required.

Arlington

Existing Services. Fire and police services for the airport and vicinity are provided by the City of Arlington. Police operations are centered in the central business district. Two fire stations, one near the downtown core and one on airport property, would respond to emergency assistance calls depending on the nature of the call. Sewer and water service are provided at the airport and neighboring vicinity. Some sewer service near the airport is piped to Marysville for treatment. Both the Arlington and Marysville wastewater treatment systems have limited capacity.

Paine Field

Existing Services. Several fire protection districts, including Fire Districts 1, 2, and 11 along with the cities of Everett, Mukilteo, Lynnwood and Edmonds, provide fire protection for the Paine Field area. A total of nine fire stations are located in the Paine field area. In addition, both Snohomish County and the Boeing Company maintain well-equipped and professionally manned fire stations at Paine field to provide fire protection for all property under their respective ownerships. Both of these stations have special equipment for handling aircraft crashes and petroleum fires. In addition, the airport has a backup agreement with the City of Everett.

Police protection in the area is provided by the Cities of Everett, Mukilteo, Edmonds and Lynnwood. Police protection within the unincorporated portion of the study area, as well as to Paine Field, is provided by the Snohomish County Sheriff's Office.

Public water service is provided to most all of the Paine Field area by the Mukilteo Water District, the Alderwood Water District, and the cities of Everett, Edmonds and Lynnwood. Nearly all of the water provided by these suppliers is purchased from the City of Everett and originates from its Spada Lake Reservoir system located in the Sultan Basin watershed.

Public sewer service is provided in the area by the cities of Everett, Lynnwood and Edmonds, Olympus Terrace Sewer District. The airport is directly served by Olympus Terrace Sewer District.

McChord Air Force Base

Existing Services. McChord Air Force Base maintains its own fire and police units. One fire station near the flight line serves the entire base. Its primary purpose is to respond to aircraft fire emergencies. The fire department also provides backup for Fort Lewis and the residential community of American Lake Gardens just south of the base. On base Security Police provide the police services. Military prisoners are brought to Fort Lewis for holding and sentencing.

The base maintains its own sewer system. Sewage is carried to Fort Lewis Military Reservation where it is treated. Approximately 10 wells provide water for the base. No public water mains are on base. The Coordinated Water System Plan (CWSP) for Pierce County anticipates development of groundwater systems in conjunction with an expanded transmission and distribution grid that will allow districts to share their resources.

Central Pierce

Existing Services. Fire protection is provided by Fire District #9 and Fire District #21. Fire District #9 maintains a station at 172nd Street East and 110th Avenue East immediately east of Thun Air Field. Fire District #21 maintains a station at 188th Street East and 78th Avenue East and another station just south of the Paul Bunyan Rifle Range near 188th Street East and Highway 161. All three stations are within the airport layout boundaries. Police protection is provided by the Pierce County Sheriff's Department.

Pierce County provides sewer service in the area. The County maintains a 24-inch sewer interceptor that extends south from 176th Street East south down Meridian Avenue (Highway 161). Firgrove Water Company provides water service in the area. The company maintains a 12-inch main along Meridian Avenue past the site. Both Firgrove and Pierce County provide Thun Airfield with water and sewer service.

Olympia/Black Lake

Existing Services. Fire service in the area is provided by District #11. The district is primarily volunteer. The nearest fire station is located at approximately 93rd Avenue and Lathrop Road. Police services are provided by Thurston County Sheriff's Department. The City of Tumwater may occasionally provide mutual-aid assistance.

No sewer systems or sewer mains are located near the site. There is a 12-inch water main along Lathrop Road that is operated by a private water company in the area.

Fort Lewis

Existing Services. Because most of the site is in a remote area of the Fort Lewis Military reservation, fire and police services are not readily available. The southeast portion of the site, located in unincorporated Pierce County would be served by local fire districts in the area. Police protection would be provided by the Pierce County Sheriff.

Water service is not provided on the military portion of the site. On the portion of the site south of the reservation, water is provided by well systems. East of the site, east of the National Park Highway (Mountain Highway), water is supplied by the Richardson Water Company which maintains a 12-inch main along the highway.

3.7.2 Significant Impacts

3.6.2.1 Preferred Alternative

There are no significant impacts to public services at Sea-Tac or the Paine Field areas. Required improvements can likely be accommodated in capital improvement plans and accounted for in the Capital Facilities Element, and Public Utilities and Facilities elements of comprehensive plans.

Impacts on school enrollment in surrounding communities will be affected by airport development. A disincentive for residential development will occur because of noise impacts and adjacent commercial and industrial development. However, because the GMA calls for reduced sprawl, and in general, urban densities that support urban services, urban densities could be increased by including multiple-unit housing units close to urban centers. A jurisdiction may decide to zone for multi-family housing with increased densities closer to airports to comply with the GMA; this would impact schools. In this case, new construction and soundproofing methods would be used. School capital improvement plans are to be integrated into comprehensive plans of the local jurisdictions.

Sea-Tac. All public services would require some expansion to accommodate direct and induced levels of activity at Sea-Tac airport under the no-action and all action alternatives. The existing level and range of services available would minimize the additions required compared to less developed airport options.

Paine Field. All public services would require some expansion to accommodate direct and induced levels of increased activity at Paine Field. The existing level and range of services would minimize the additions required, compared to less developed airport options.

McChord AFB. Any substantial growth in the McChord area would require additions to the fire and police services with more stations and equipment. Services to duplicate the base's own fire and police would be necessary. Both a new public water supply and sewage treatment would be required to serve the airport. Activities in the airport vicinity could be served to some extent by existing supply and treatment systems.

Fort Lewis. As part of the Fort Lewis Military reservation, the area is outside any anticipated service area for public services. Development of an airport would require substantial development of new or greatly expanded infrastructure systems.

Olympia/Black Lake. The area identified is located outside of Thurston County's long-range Urban Growth Management Area boundary and only limited public services area are expected to be provided. Development of an airport would require substantial development of new or greatly expanded infrastructure systems.

Planning for two runways at Fort Lewis, McChord AFB, or Olympia/Black Lake area would require substantial public service improvements. The GMA requires that urban services be provided by cities and be within urban growth boundaries. New airport facilities would comply with GMA concurrency and consistency requirements, both internal and external.

3.7.2.2 Secondary Alternatives

Secondary alternative impacts are the same categorically as for the preferred alternative with the addition of Arlington. Arlington impacts for public services are more substantial than for Sea-Tac or Paine Field due to the lack of improved facilities. Provisions for adequate water and sewer services would have to be accounted for in the water and sewer comprehensive plans.

Arlington. Any substantial growth in the Arlington area, as the result of an expanded airport, would require additions to the fire and police services with more stations and equipment. Groundwater supplies in northern Snohomish County are limited and would probably not be sufficient to serve an airport and surrounding activities. The North Snohomish Coordinated Water Supply Plans (CWSP) anticipate a water transmission line to the Arlington area to tie into the City of Everett system and the Sultan River supply. Substantial improvement and expansion would be required to provide adequate sewage treatment capacity.

Central Pierce. All public services would probably require expansion to accommodate direct and induced levels of activity at the Central Pierce location, especially for a replacement airport. A full range of services is available, however, and could provide some of the capacity needed for a small airport.

Based on conceptual drawings, the one runway option would displace the fire station at 188th Street and Highway 161 maintained by Fire District #21. The two runway option would displace both of the stations maintained by Fire District #21. Under the replacement airport option, all three fire stations would be displaced.

3.7.2.3 Other Alternatives

The other alternatives will impact the same public service and utilities elements as the other sites. The degree of impact will vary with each alternative. If Fort Lewis, McChord AFB, or Olympia/Black Lake sites are not feasible, other alternatives would be reviewed using the guidelines of the GMA.

3.7.2.4 No-Action

Under the no-action alternative no additional public services and utilities would be required at any airport location.

3.7.3 Mitigation Measures

Mitigation procedures for public services for all sites would be the same. A level of service would be established for fire, police, and other public services in the local jurisdiction. Special district, water and sewer comprehensive plans, and regional plans would be incorporated in the jurisdictional comprehensive plan. The jurisdictional comprehensive plan would be coordinated and made consistent with county and regional plans.

Mitigation measures will vary proportionally with the impacts and will depend on adopted levels of service and design and construction standards.

3.7.4 Unavoidable Adverse Impacts

There are no unavoidable adverse impacts to public services.

REFERENCES

Department of the Army, Headquarters 9th Infantry Division and fort Lewis. 1979. Final Environmental Fort Lewis Military Installation.

King County Planning and Community Development Division. 1988. Sea-Tac Area Update Draft Environmental Impact Statement.

King County Planning and Community Development Division. 1989. Sea-Tac Area Update.

King County Planning and Community Development Division. 1989. Sea-Tac Area Update Final Environmental Impact Statement.

P & D Technologies. 1988. Port of Seattle, Sea-Tac International Airport. Comprehensive Planning Review Working Papers.

Pierce County Department of Planning and Land Services. 1991. Draft Environmental Impact Statement. Lakewood Community Plan.

Pierce County Department of Planning and Land Services. 1991. Supplemental Draft Environmental Impact Statement. Boeing-Pierce County Fredrickson Site Master Plan.

Reid, Middleton, & Associates, Inc. 1981. Paine Field Snohomish County Airport Master Plan.

Reid, Middleton, & Associates, Inc. 1988. Arlington Municipal Airport, Master Plan Update.

Snohomish County Department of Planning and Community Development, Planning Division. 1985. City of Arlington. Final Comprehensive Plan.

Snohomish County Office of Community Planning. 1982. Marysville Area Comprehensive Plan.

Snohomish County Planning Department. 1977. Arlington Area Comprehensive Plan.

Snohomish County Planning Department. 1983. Paine Field Area Comprehensive Plan.

Thurston County Planning Department. 1988. Thurston County Comprehensive Plan.

Thurston Regional Planning Council. 1990. Shoreline Master Program.

Thurston Regional Planning Council. 1991. The Profile.

U.S. Department of Transportation Federal Aviation Administration and Snohomish County. 1983. Final Environmental Impact Statement. Snohomish County Airport.

United States Department of Agriculture Soil Conservation Service. 1983. Soil Survey of Snohomish County Area Washington.

United States Department of Agriculture Soil Conservation Service. 1990. Soil Survey of Thurston County, Washington.

United States Department of Agriculture Soil Conservation Service. 1979. Soil Survey of Pierce County Area, Washington.

LIST OF MAPS

United States Department of the Interior Geological Survey. 7.5 Minute Series Quadrangle Maps.

U.S. Department of the Interior. National Wetlands inventory maps.

State of Washington Department of Natural Resources. Orthophoto Maps. 1983.

GLOSSARY

Airport systems

Multiple commercial airports serving the same region. There are two predominant system types. One system has two or more airports with similar capacity levels and service (such as New York's systems). The other system type contains a primary airport supported by one or more supplemental airports (such as San Francisco and Los Angeles area airport systems).

Capacity

Refers to the capability of an airport, or its components, to process air traffic over a period of time. For this project, the focus is airfield capacity, which is measured by the number of aircraft operations (i.e., either takeoff or landing) that can be accommodated within a specific time period without substantial delay. Capacity can be exceeded, but the result in longer delays.

Concurrency

One of the main requirements of the Growth Management Act which mandates that adequate infrastructure be in place or scheduled to be provided in order for development to occur.

Consistency

One of the main requirements of the Growth Management Act mandating that development regulations (zoning, subdivision, and other controls) be consistent with the comprehensive plans for an area. Both city and county comprehensive plans must also be coordinated.

Delay

When the hourly or daily capacity of an airport is exceeded delay occurs. This increases the time that an aircraft takes to move from its origin to destination. Commercial aviation delays increase costs and lower efficiency and convenience for the air traveler.

Demand management

Using an existing airport facility to handle demand through efficiency measures. These measures may include flying larger aircraft, requiring higher occupancy levels on flights, and travelling during non-peak hours to reduce delays.

Dependent runway

A runway which is not physically separated by enough distance from another runway for traffic on either runway to be independent of each other. A 7,000-foot dependent runway, to be sited along the western boundary of Sea-Tac, is a component of the preferred alternative.

FAA Federal Aviation Administration; the branch of the U.S. Department of Transportation responsible for regulating all commercial and private aviation.

GMA Growth Management Act of 1990 (also called 2929). The Act requires all cities and counties in the state to do some planning and calls for the fastest growing counties to plan extensively in accordance with state goals. Supplemented in 1991 by the State Legislature.

HCT High Capacity Transit; the general term used to describe modes of ground transportation capable of carrying substantially more passenger volumes than private automobiles. HCT includes light and heavy rail and bus systems.

IFR Instrument Flight Rules; navigation method implemented when weather decreases visibility to the point where pilots must rely on instruments to maneuver. IFR conditions require greater separation between aircraft on arrival and significantly lower an airport's capacity.

Induced Land Use

Increased levels of growth and activity as a result of a specific project or development. The hotel and commercial area near Sea-Tac Airport is a good example of induced airport-related land use.

Infrastructure

A general term used to describe many types of public facilities including water and sewer systems, roads and freeways, and schools. Infrastructure systems are usually expensive to build and operate, and are funded by taxes or use fees.

Ldn A cumulative Day/Night Noise Level measurement which combines the loudness of each overflight, the duration of these events, the total number of overflights and the time of day the events occur into one single scale -- with a 10-decibel weight added to nighttime noise levels.

MAP Millions of Annual Passengers; commonly used to measure demand for air transportation.

Non-attainment

Areas that do not meet state or federal air quality standards for specific air pollutants. Non-attainment classification can limit approval for new sources of air pollutant emissions and require plans be implemented to achieve compliance.

Operations

Refers to aircraft activity at an airport. A takeoff or landing is a single operation.

PSAPCA

Puget Sound Air Pollution Control Agency; authorized by Ecology and the EPA to enforce air pollution regulations for King, Snohomish, Pierce, and Kitsap Counties. PSAPCA also issues some of its own standards that are stricter than the underlying state or federal requirements.

PSATC

Puget Sound Air Transportation Committee; a thirty-nine member steering group comprised of citizens, local and elected officials, members of the business community, and other interested citizens charged with developing a plan for the central Puget Sound air transportation system.

PSRC

Puget Sound Regional Council, replaces the Puget Sound Council of Governments. An intergovernmental agency established pursuant to state and federal regulations and covering King, Snohomish, Pierce, and Kitsap Counties as well as most of their municipalities. PSRC is responsible for regional transportation planning and has additional authority under the Growth Management Act. PSRC also provides regional land use planning and analysis.

Remote Airport

Includes the coordination of service at Sea-Tac Airport and another airport connected to Sea-Tac by high-speed ground transportation. The PSATC recommended the elimination of this option because of the extremely high cost of developing the site and the transit connection as well as other factors.

Replacement airport

An airport that would completely replace Sea-Tac capable of providing full domestic and international service. The capacity of the replacement airport would be sufficient to accommodate future passenger and air cargo traffic well beyond the year 2020.

SEL Single Event Sound Exposure Level; used to describe the maximum noise level occurring at any one time.

Sole-Source Aquifer

An area designated by the EPA as having an aquifer that supplies at least 50 percent of the drinking water supply with no economically feasible alternative available. Designation as a sole-source aquifer requires EPA review and approval of all federally financed projects.

Stage II or III

Refers to aircraft noise characteristics which are regulated by FAA Federal Aircraft Regulation 36. Stage II aircraft (like the Boeing 727) are older and produce considerably more noise than newer Stage III aircraft (like the Boeing 767). The FAA has mandated that all Stage II aircraft be phased out of service by about 2000.

Supplemental Airport

An additional one- or two-runway airport designed to relieve demand at Sea-Tac Airport. The supplemental airport could be an existing airport or a new site.

VFR Visual Flight Rules; navigation method used when weather and visibility do not effect the pilot's ability to see. During VFR conditions less separation is required between aircraft approaching an airport.

APPENDIX 1

Working Paper 12A, Noise Assessment Study

DATE: November 6, 1991

TO: Puget Sound Transportation Committee

FROM: Mestre Greve Associates/P&D Aviation

SUBJECT: **WORKING PAPER NO. 12A - NOISE ASSESSMENT STUDY**

INTRODUCTION

This report summarizes the results of the analysis of the potential noise impacts associated with each of the airport system alternatives under consideration. To effectively evaluate and explain potential noise impacts well into the future, this study utilized methods and criteria that consider noise impacts much farther from the airport sites than is usual for traditional airport noise studies. The methods and data assumptions were selected to be conceptually uncomplicated and capable of treating all systems alternatives as equally as possible.

The study utilized standard industry-wide methods of computer modeling and noise assessment analysis such as the use of the 65 Ldn criteria. Supplemental noise assessment criteria were also included so that the potential noise impacts could be more thoroughly evaluated. The analysis identified the population that would be exposed to a less significant level of aircraft noise (55 Ldn) and to a level of single event noise (80 SEL). Populations that would be newly exposed to noise (55 and 65 Ldn) were also evaluated.

The criteria used in the analysis were applied to the total populations contained within the noise contours developed for each of the various noise assessment criteria. The noise contours are based upon 2020 operational assumptions. The population analysis was based upon 2000 population projections on the assumption that protective land use zoning around the selected airport site(s) would go into effect by that date.

This report is divided into the following sections:

- *Summary of Results*
- *Background Information*
- *Evaluation Criteria*
- *Noise Contour Analysis*
- *Population Impacts*
- *Comparative Analysis*
- *Mitigation Alternatives*

Appendix A contains more detailed information on the study. This includes background information on the descriptions of noise, noise metrics, assessment guidelines, aircraft operational assumptions, and the results of the noise contours and population projections.

SUMMARY OF RESULTS

The noise analysis compared the total population that would be exposed to various noise assessment criteria for each of the airport system alternatives. The noise assessment criteria used in the analysis included: (1) population exposed to cumulative noise levels in excess of 55 Ldn, (2) population that would be newly exposed to cumulative noise levels in excess of 55 Ldn, (3) population exposed to cumulative noise levels in excess of 65 Ldn, (4) population that would be newly exposed to cumulative noise levels in excess of 65 Ldn, and (5) population that would be exposed to single event SEL noise levels in excess of 80 SEL. The Ldn noise metric, used by the FAA and EPA, is the most prominent noise metric used in the assessment of aircraft noise impacts.

The results of the analysis are summarized in Table 12-1 for each of the system alternatives. This table shows both the range of total population exposed to noise per each criteria and a ranking based upon the consultant's recommendation.

In assessing the relative difference in noise impacts between the system alternatives, it is important to point out the inherent difference between the community response to noise associated with an airport that has existed for many years and the response to noise that will occur at a new airport. It is very difficult to compare the relative noise impacts between these two different environments and the criteria used in this analysis attempts to account for the difference.

Each of the noise assessment criteria is important in the evaluation of an airport alternative. The rating of the preference of alternatives depends upon which criteria is considered most important and weighted accordingly. A description of the methodology used by the consultant in weighting each of these factors that was used in the ranking of the alternatives is presented on Page 10. Based upon these weightings, a number of important conclusions can be drawn:

- The most important conclusion from the noise analysis is that the future noise environment for all of the system alternatives represents a significant improvement over that which exists around Sea-Tac today. The aircraft that are forecast to be operating at these airports in 2020 are significantly quieter and will result in reductions in both the overall Ldn noise levels as well as the single event SEL levels. A comparison of existing and future noise contours for Sea-Tac are presented in the Appendix. For example, approximately 70,000 people currently reside in Sea-Tac's existing 65 Ldn noise contour. By 2020, the population within Sea-Tac's 65 Ldn noise contour for the worst case scenario is projected to be less than 13,000 people.

- The ranking of the system alternatives is dependent upon the actual airport sites. The rating of the system alternatives can vary when different airport sites are considered and the ranking in the table reflects a mid-range of impacts.

- The alternative that is rated the most favorable is the replacement airport alternative. This would only be true for a new airport site such as Olympia/Black Lake where the population around the proposed site is projected to be minimal. For sites with a significant population near the airport site, such as Central Pierce, this alternative is not considered favorable.

Table 12-1
Population Range by Category within 2020 Noise Contours

System Alternatives	Total Population 55 LDN (000)*	Population Newly Exposed to 55 LDN (000)*	Total Population 65 LDN (000)*	Population Newly Exposed to 65 LDN (000)*	Total Population 80 SEL (000)*	Rank (1 Best)
EXISTING SEA-TAC AIRPORT SYSTEM						
EXISTING SEA-TAC WITH MAXIMUM DEMAND MANAGEMENT	112-119		7		91-94	2**
REPLACEMENT AIRPORT SYSTEM						
REPLACEMENT	19-62	19-62	0.3-2.8	0.3-2.8	49-55	1
TWO AIRPORT SYSTEMS						
EXISTING SEA-TAC + SUPP(1 RWY)	116-135	0-23	7.1-8.2	0-1.2	115-143	6**
EXISTING SEA-TAC + SUPP(2 RWY)	117-138	0-26	7.1-8.3	0-1.3	125-153	7
SEA-TAC WITH NEW AC RWY+SUPP(1 RWY)	133-141	0-7	13-13.5	0-0.5	128-160	9
(Mitigated Sea-Tac with New AC Rwy + Supp (1 Rwy)	(127-135)	(0-7)	(8-8.5)	(0-0.5)	(118-150)	3
SEA-TAC WITH NEW AC RWY+SUPP(2RWY)	133-141	0-8	13-13.5	0-1	138-167	10
(Mitigated Sea-Tac with New AC Rwy + Supp (2 Rwy)	(127-135)	(0-8)	(8-8.5)	(0-1)	(128-157)	4
THREE AIRPORT SYSTEMS						
EXISTING SEA-TAC + 2 SUPP(1 RWY)	121-132	9-20	7.1-7.9	0.1-0.9	139-175	8
SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)	132-137	4-11	12.6-13.1	0.1-0.6	153-189	11
(Mitigated Sea-Tac with New AC Rwy + 2 Supp (1 Rwy)	(128-133)	(4-11)	(8.1-8.6)	(0.1-0.6)	(143-149)	5

* Population Estimates Based on 2000 Population Projection
** Denotes System Alternatives that include Airport Development Alternatives that do not meet System Capacity Demands

- The ranking of System Alternatives that include the dependent runway at Sea-Tac are considered less favorable (rated 9, 10, and 11). If measures such as restricting use of the runway to daytime use and for arrival traffic only are imposed, then the potential noise impacts from this alternative are reduced. With restricted use of the new runway, a multiple airport system that involves a new air carrier runway at Sea-Tac is rated more favorably (rated 3, 4 and 5) than a multiple airport system without improvements to Sea-Tac (rated 6, 7 and 8). This is because it reflects a balance of some growth at Sea-Tac with limited growth at supplemental airport sites. No increase of capacity at Sea-Tac would result in more significant increase in growth and noise at the supplemental airport sites.

- None of the alternatives stand out as far superior to any of the others in terms of noise impacts. Each of the airport system alternatives result in similar level of noise impacts. While these noise levels are a significant improvement over the aircraft noise levels that exist in Seattle today, it is expected that some level of adverse community response to aircraft noise would still be experienced with any of the alternatives.

BACKGROUND INFORMATION

The following presents background information on the methodology and criteria used in the assessment of aircraft noise impacts for each system alternative. A more detailed description of background information on noise and noise assessment criteria are also presented in the Appendix.

The description, analysis, and reporting of community sound levels from aircraft are made difficult by the complexity of human response to sound and the myriad of sound-rating scales and metrics that have been developed for describing acoustic effects. For example, community noise is generally not constant but varies with time. Therefore, some type of statistical metric is necessary to mathematically express a varying noise level that can be correlated to community response. As a result of the complexity of describing noise, several noise metrics have been developed to account for characteristics of noise such as loudness, duration, time of day, and cumulative effects of multiple noise events.

Noise is known to have several adverse effects on health and does cause disruption in human activities. The identified adverse effects of noise on people include hearing loss (not a factor with community airport noise), communication interference, sleep interference, physiological responses and annoyance.

Many factors influence how a sound is perceived and whether or not it is considered annoying to the listener. This includes not only physical characteristics of the sound but also secondary influences such as sociological and external factors. Factors that describe human response to sound in terms of both acoustic and non-acoustic factors are presented in Table 12-1 and rating scales have been developed to account for the factors that affect human response to sound. Based upon these identified adverse effects of noise and the factors that influence annoyance, noise metrics and criteria have been established to help protect the public health and safety and prevent disruption of certain human activities.

TABLE 12-2
Factors that Affect Individual Annoyance to Noise

Primary Acoustic Factors
- Sound Level
- Frequency
- Duration

Secondary Acoustic Factors
- Spectral Complexity
- Fluctuations in Sound Level
- Fluctuations in Frequency
- Rise-time of the Noise
- Localization of Noise Source
- Background Noise Levels

Non-acoustic Factors
- Physiology
- Adaptation and Past Experience
- How the Listener's Activity Affects Annoyance
- Predictability of When a Noise will Occur
- Is the Noise Necessary?
- Individual Differences and Personality

Source: C. Harris, 1979

A number of different noise criteria were examined in this study of the noise environment at each of the alternative sites. It was desirable to utilize nationally accepted metrics that would best predict the potential community response to aircraft noise in the neighborhoods surrounding the airport sites and were defensible in their application to the aircraft noise issues in the Puget Sound area.

Ldn Noise Metric. The cumulative noise metric, Day Night Noise Level (Ldn), was the primary noise metric selected to assess the noise impacts from aircraft operations. The Ldn metric is useful because it combines the loudness of each aircraft overflight, the duration of these events, the total number of overflights and the time of day these events occur into one single number rating scale. The Ldn scale is specified by most government agencies, including the FAA and the EPA, for the assessment of the noise impacts around airports.

Extensive research using the Ldn index has been conducted on human responses to exposure of different levels of aircraft noise. Community noise standards are derived from tradeoffs between the impacts expressed in community response surveys and economic considerations for achieving these levels. Examples of the results of these surveys are expressed in Exhibit 12-1 in terms of community reaction versus Ldn noise level. These charts are derived from case histories involving aircraft noise problems at civilian and military airports and the resultant community response.

The Ldn noise level can be used as an indicator for when significant impacts from noise and when annoyance from aircraft noise is likely to occur. The EPA has identified 55 Ldn as the highest noise level requisite to protect the public health and welfare with an adequate margin of safety. This includes both residential land use with outdoor use areas and recreational areas. This criteria does not constitute EPA regulations or standards. Rather, it is intended to identify a goal of safe levels of environmental noise exposure without consideration for economic cost for achieving these levels.

The consultant recommends that 55 Ldn be an important criteria for the evaluation of the potential noise impacts around new airport development sites and,while it is not technology feasible as a mitigation in developed areas, it be considered in evaluating the noise impacts around existing airport sites for comparative purposes. 55 Ldn best reflects a noise environment that is indicative of a desired goal for thc noise environment within the communities of Puget Sound.

The Federal Aviation Administration and most government agencies throughout the country utilize 65 Ldn as the criteria to indicate compatibility of aircraft noise with residential land use. This level reflects a balance between a desired sound environment and the economic costs for meeting this level. Note that when examining Exhibit 12-1, adverse community reaction still occurs at 65 Ldn. A population exposed to noise levels in excess of 65 Ldn would be considered significantly impacted by noise. Therefore, this criteria is important in the evaluation of noise impacts from all of the airport sites.

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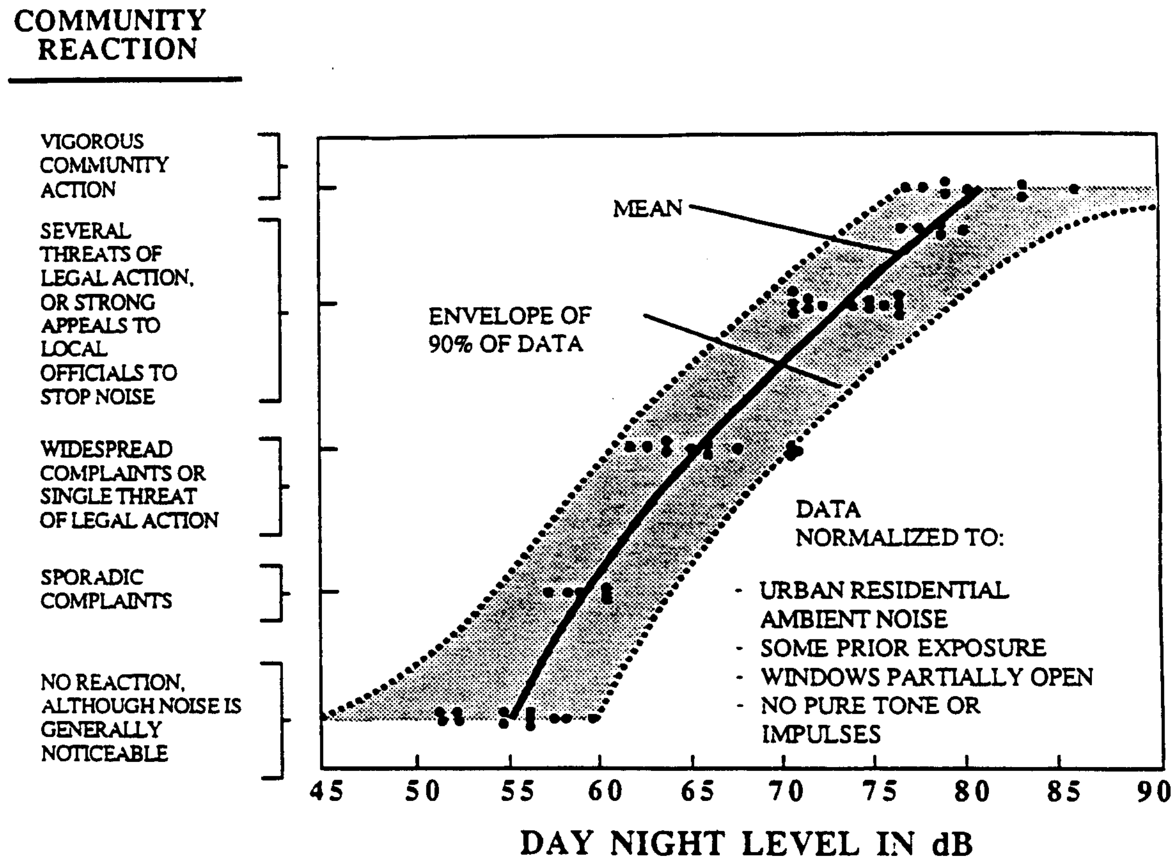

Exhibit
12-1

Example of Community Reaction to Aircraft Noise

<u>SEL Noise Metric.</u> While it has been demonstrated that cumulative noise metrics correspond well with overall community ratings of the noise environment, they will not always accurately predict community response. A number of airport studies have shown community response to noise is not always completely predicted through one descriptor such as Ldn. In such cases, single event metrics can be used to supplement the analysis. Single event noise analysis is often a predictor of when annoyance from aircraft noise is likely to occur.

While the total noise exposure as described by the cumulative noise metric serves as the basis for a person's judgment of the noise environment, it is often a single event interference with some activity that people will use to express their immediate concern over noise.

Sound Exposure Level (SEL) is a "single event" descriptor of an individual overflight and is often used to supplement the Ldn analysis. An SEL level of 80 dBA corresponds to the level at which sleep disturbance and speech interference start to occur in the general population. A single event SEL of 80 dBA was thus selected as one of the evaluation criteria for this study.

The results from community response information obtained from studies around Sea-Tac were used as supplemental information. Experience at Sea-Tac showed that the 55 Ldn and 80 SEL are good indicators of the overall cumulative noise level at which complaints and annoyance from aircraft start to occur.

EVALUATION CRITERIA

As stated in previous sections, the evaluation of the potential noise impacts for each of the airport system alternative sites involved the use of various noise assessment criteria. These criteria were presented in previous sections and they are further explained below.

- Residential population exposed to aircraft noise of 55 Ldn or greater. A noise level of 55 Ldn and greater indicates the population to which the aircraft noise will be noticeable and some degree of annoyance or adverse community response would be expected to occur. The EPA has identified 55 Ldn as the requisite noise level for residential land use. It is the level below which social surveys have shown that most residences consider the noise environment to be acceptable. Experience at Sea-Tac showed most areas (but not all),where noise complaints occurred were exposed to Ldn levels of 55 or greater.

  For a new airport site the 55 Ldn is the most important criteria. This level represents that area in which future residential land use development may require the start of some level of land use protection. This is not to say that no homes should be located within the 55 Ldn noise contour, but that the desired goal should be to minimize the number.

  There are a number of reasons why the 55 Ldn is an important criteria. First, we know from studies at other airports and experience at Sea-Tac that a degree of annoyance or adverse community response can be expected to occur at the 55 Ldn. (The EPA identified 55 Ldn as a goal for residential areas, without consideration for technical or economic feasibility.) Generally, in a densely populated urban environment, it is not economically feasible to insulate every home within the 55 Ldn contour nor is it desirable from a neighborhood integrity standpoint to buy homes on such a large scale. At a new airport site, however, it may indeed be possible to consider early zoning and other land use control measures to avoid significant residential land use impacts.

- Residential population newly exposed to 55 Ldn or greater. A newly exposed population consists of those people experiencing new exposure to aircraft noise as a direct result of the alternative. Studies have shown that people newly exposed to aircraft noise initially experience a much stronger adverse reaction than those who have had a long term exposure to the same level. This fact, coupled with the information provided on the use of the 55 Ldn criteria, provides a basis for using this as an important evaluation criteria. This category reflects the population around a new airport or an airport that previous had very few operations and is therefore likely to notice the addition of new aircraft noise and exhibit a higher level of annoyance.

- Residential population exposed to aircraft noise of 65 Ldn or greater. The 65 Ldn indicates the population that is significantly impacted by aircraft noise. The FAA noise assessment criteria is 65 Ldn for the compatibility of residential land use with aircraft noise levels. It is likely that for a new airport site, existing homes will need to be either purchased or insulated within the 65 Ldn contour.

- Residential population newly exposed to aircraft noise of 65 Ldn or greater. A population that is newly exposed to aircraft noise has been shown to show higher annoyance to aircraft noise than a population that has had a long term exposure to the noise. This criteria will indicate the most highly noise impacted population. This area will most likely need special action, such as buy-out or insulation.

- Residential population exposed to single event aircraft noise of 80 SEL or greater. The 80 SEL single event noise contour is an indicator for when speech interference and sleep disturbance start to occur. The 80 SEL single event contour is therefore a good indicator of where single event disturbance is likely to result in annoyance from aircraft operations for a segment of the population. Experience at Sea-Tac has shown that most noise complaints occur in areas where the SEL noise level exceeds 80 dBA.

NOISE CONTOUR ANALYSIS

Noise contours, both Ldn and SEL, for each of the airport alternatives were generated using the FAA's Integrated Noise Model described in the Appendix. These contours were developed for both the cumulative Ldn noise level and the single event SEL noise levels. The contours are based upon 2020 operational assumptions derived from the Flight Plan operational analysis updated in Phase III by P&D Technologies. More detailed information on the operational assumptions can be found in the Appendix.

The aircraft that are assumed to be operating into the 21st century are expected to generate similar noise levels as those of the quietest of the new generation aircraft that are being built today. The contour analysis assumes all Stage III aircraft such as the MD80, MD90, B737-300, B757, B767, MD-11, B747-400 as well as other new generation aircraft. *(Stage III refers to the quietest category of aircraft as defined by the FAA Federal Aircraft Regulation 36 which regulates the noise levels generated by jet aircraft. FAA certification of Stage III aircraft is based on engine weight and noise.).* Given the 25 to 30 year life span for commercial aircraft, these aircraft would be expected to still be in service by 2020.

Although these aircraft are significantly quieter than many of the current fleet of aircraft such as the B727, they still generate noticeable levels of noise. Aircraft that are currently under development utilize similar technology that is expected to result in noise levels that are also similar to the current generation of quieter aircraft. Any significant future reductions in noise will require new developments in engine technology or noise control that are not currently available.

The Ldn noise levels were determined for each of the airport development alternatives. The 55 and 65 Ldn noise contours for fifteen of the airport development alternatives are presented in the Appendix. These exhibits present the noise contours for the highest operational assumptions for one, two and three runway scenarios for each airport site. The amount of land in terms of square miles that is within each noise contour for each alternative is presented in Table 12-3.

Single event noise contours for aircraft types and procedures expected to be in operation in 2020 were also generated. The departure noise levels were used because departure noise represent the highest single event noise level. The aircraft selected to represent the single event noise levels is the McDonnell Douglas MD-82. This aircraft is typical of the MD80 fleet, which is expected to be the loudest aircraft in operation through the early part of the 21st century.

The 80 SEL noise contours for MD82 departures are also presented for the same fifteen alternative airport development scenarios. These contours are presented in the Appendix. These single event contours were developed in terms of the departure noise levels along the many different primary flight tracks around the airport. These contour maps present a composite of the single event noise levels of all of these primary flight tracks and are intended to reflect typical single event noise levels in different communities.

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Table 12-3
Size of LDN Noise Contours (Square Miles)

Alt.	Airport System Alternatives	Seatac Airport 55 LDN	Seatac Airport 65 LDN	North Airports 55 LDN	North Airports 65 LDN	South Airports 55 LDN	South Airports 65 LDN
1	* Sea-Tac without Commuter R/W	30.9	5.1				
2	* Sea-Tac with Commuter R/W	32.7	5.5				
3	* Alternate 1 + Arlington 1 R/W	30.9	5.1	12.8	1.8		
4	Alternate 1 + Paine 1 R/W	30.9	5.1	14.6	2		
5	Alternate 1 + McChord 1 R/W	30.9	5.1			15.7	2.2
6	* Alternate 1 + Central Pierce 1 R/W	30.9	5.1			12.8	1.8
7	* Alternate 1 + Olympia/Black Lake 1 R/W	30.9	5.1			12.8	1.8
8	Alternate 1 + Arlington 2 R/W	30.9	5.1	17.6	2.3		
9	Alternate 1 + Paine 2 R/W	30.9	5.1	15.1	2.3		
10	Alternate 1 + McChord 2 R/W	30.9	5.1			15.8	2.3
11	Alternate 1 + Central Pierce 2 R/W	30.9	5.1			17.6	2.4
12	Alternate 1 + Olympia/Black Lake 2 R/W	30.9	5.1			17.6	2.3
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	38.3	7.1	5.5	0.7		
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	38.2	7.1	5.5	0.8		
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	38.3	7.1			6.7	1
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	38.2	7.1			5.5	0.7
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	38.3	7.1			5.5	0.7
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	38.3	7.1	6.9	0.8		
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	38.2	7.1	6	1		
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	38.3	7.1			7	1.1
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	38.2	7.1			6.9	0.9
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	38.3	7.1			7	0.8
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	30.9	5.1	8.2	1.1	9.3	1.3
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	30.9	5.1	8.6	1.2	8.7	1.2
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	30.9	5.1	9.1	1.2	8.2	1.1
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	30.9	5.1	9.7	1.3	7.7	1
27	Alternate 13+ Central Pierce 1 R/W	36.9	6.8	4.3	0.6	5.5	0.7
28	Alternate 14+Central Pierce 1 R/W	36.2	6.6	5.5	0.8	5.5	0.7
29	Alternate 13+Olympia/Black Lake 1 R/W	38.1	7.1	4.3	0.6	3.3	0.5
30	Alternate 14+Olympia/Black Lake 1 R/W	37.4	6.9	5.5	0.8	3.3	0.5
31	Central Pierce 3 R/W					59.2	8.5
32	Olympia/Black Lake 3 R/W					59.4	8.6
33	Central Pierce/Fort Lewis 3 R/W					59.2	8.5
34	* Alternate 1 + Demand Management	30.9	5.1				

* Alternative which does not meet system capacity demand.

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The contour analysis does not assume any special noise abatement measures. The operational assumptions for a dependent runway at Sea-Tac include both arrivals and departures and nighttime operations. Should these assumptions be changed to daytime arrivals only, as might occur with the anticipated use, then the noise impacts would be considerably lessened.

It is important to note that the Ldn and SEL noise contours presented in this report for the existing airports of Sea-Tac and McChord are significantly smaller than the current noise contours for these airports (For Paine Field, the SEL noise contours are also much smaller in the future). This is a result of the widespread use of quieter aircraft that will be in use by the year 2020. These aircraft are significantly quieter than the majority of the current aircraft that are operating at these airports.

POPULATION IMPACTS

The noise contour analysis was used to determine the population that would be exposed to certain noise levels. The analysis is based upon the year 2000 population levels. The year 2000 was selected on the assumption that protective land use zoning would go into effect by that date. At that time, any future development may be restricted or regulated in order to promote noise and land use compatibility between the airport and the surrounding area. The year 2020 population data was not used because any new airport development would include land use restrictions that would alter the population development around the airport.

Population data were obtained from the Puget Sound Regional Council (PSRC) which maintains a population data base by travel analysis zones (TAZs). There are 546 TAZs within the 4-county region. TAZs are similar in size to census tracts and tend to be smaller in urbanized areas and larger in rural areas. TAZ maps and the noise contour maps were overlaid. The area of each of the TAZs in the various airport vicinities was calculated. Then the percentage area of each TAZ covered by a given contour was calculated. This percentage was then multiplied by the population of the TAZ to obtain the population of that TAZ within the noise contour. The population figures for each of the TAZs were added to obtain the total population within each contour.

It is important to note that the size of the TAZs is more detailed in the urbanized area. The population counts for airports in the urban area (Sea-Tac, McChord &Paine) tend to be larger than those in rural areas (Arlington & Olympia/Black Lake). Central Pierce and Fort Lewis are between these extremes since they are located on the edge of the urban area and have TAZs of both small and large size in their vicinities. To further refine the population counts, it was assumed that anyone living within the land area that would be acquired for an airport site for any of the options would no longer be impacted by noise. This displaced populations was therefore subtracted from the total counts for each contour.

The results of the population impact analysis for each airport development alternative are summarized in Table 12-4. The detailed data for each airport is presented in the Appendix. These tables present the number of people within the 55 and 65 Ldn and within the 80 SEL noise contours. These contours are based upon the 2020 operational levels.

The population data show that people will be living around nearly all of the airport sites. The most densely populated areas will be around Sea-Tac and Paine Field Airports. The least densely populated area will be around Olympia/Black Lake and Arlington. It is also important to note that there are no homes to the south of the McChord and Fort Lewis sites because all of the land is part of the Fort Lewis Army Base.

It is important to note that the population within the noise contours are also significantly less than the number of people at Sea-Tac that are currently exposed to similar noise levels. For comparative purposes, the population within the existing Sea-Tac 65 Ldn noise contour is approximately 70,000. This reduction in impacted population is as a result of the noise control measures at the airport as well as the shift to quiet Stage III aircraft.

Table 12-4
Population Summaries within 2020 Noise Contours

Alt	Airport System Alternatives	Total Population 55 LDN (000)*	Population Newly Exposed to 55 LDN (000)*	Total Population 65 LDN (000)*	Population Newly Exposed to 65 LDN (000)*	Total Population 80 SEL (000)*
1	** Sea-Tac without Commuter R/W	112		7.0		91
2	** Sea-Tac with Commuter R/W	119		7.0		94
3	** Alternate 1 + Arlington 1 R/W	123	11	7.7	0.7	116
4	Alternate 1 + Paine 1 R/W	135	23	8.2	1.2	143
5	Alternate 1 + McChord 1 R/W	135		7.8		138
6	** Alternate 1 + Central Pierce 1 R/W	123	11	7.5	0.5	123
7	** Alternate 1 + Olympia/Black Lake 1 R/W	116	4	7.1	0.1	115
8	Alternate 1 + Arlington 2 R/W	127	15	7.5	0.5	127
9	Alternate 1 + Paine 2 R/W	138	26	8.3	1.3	153
10	Alternate 1 + McChord 2 R/W	135		7.8		147
11	Alternate 1 + Central Pierce 2 R/W	127	15	7.5	0.5	135
12	Alternate 1 + Olympia/Black Lake 2 R/W	117	5	7.1	0.1	125
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	135	4	13.1	0.1	129
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	138	7	13.1	0.1	160
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	141		13.1		152
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	135	4	13.5	0.5	137
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	133	2	13.0		128
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	136	5	13.0		140
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	139	8	13.1	0.1	167
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	141		13.1		161
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	136	5	13.5	0.5	149
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	133	2	13.0		138
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	125	13	7.9	0.9	148
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	132	20	7.6	0.6	175
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	121	9	7.5	0.5	139
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	127	15	7.1	0.1	167
27	Alternate 13+ Central Pierce 1 R/W	133	7	12.6	0.6	162
28	Alternate 14+Central Pierce 1 R/W	137	11	12.6	0.6	189
29	Alternate 13+Olympia/Black Lake 1 R/W	132	4	13.1	0.1	153
30	Alternate 14+Olympia/Black Lake 1 R/W	136	8	13.1	0.1	180
31	Central Pierce 3 R/W	53	53	2.8	2.8	55
32	Olympia/Black Lake 3 R/W	19	19	0.3	0.3	49
33	Central Pierce/Fort Lewis 3 R/W	62	62	1.3	1.3	52
34	** Alternate 1 + Demand Management	112		7.0		91

* Population Estimates Based on 2000 Population Projection
** Denotes System Alternatives that include Airport Development Alternatives that do not meet System Capacity Demands

COMPARATIVE ANALYSIS

The airport systems alternatives were analyzed in terms of the potential noise impacts based upon the five previously presented criteria. The results of the analysis are presented in Table 12-1 for each of the system alternatives. Table 12-1 shows the range of total population exposed to noise per each criteria and presents the number of residents in the year 2000 that we estimate will be within the noise contours for each of the five above presented alternatives. The table also ranks each alternative based upon the consultant's recommendation. In examining the results in Table 12-1, different alternatives could be considered more favorable than others depending upon the criteria that is used. The consultant's recommendation is based upon a methodology that accounts for each of these factors by weighting their importance in predicting the overall noise impacts for each airport system alternative.

These weightings of the importance of each of these criteria is based upon acoustic research in the prediction of adverse community response to aircraft noise, experience from other airports and Sea-Tac. Important factors in the development of this weightings and in the development of the rating of the alternatives are listed below:

- A population newly exposed to aircraft noise will show a higher level of adverse response to aircraft noise than a population that has a history of long-term exposure to that noise. This has been shown in acoustic research and in cases throughout the country. It is important to not just compare the total population within a noise contour. Simply reducing the total population within a noise contour by shifting some of the noise to another airport does not necessarily mean that the adverse community response will be reduced.

- A airport that has been in existence for many years is evaluated differently than a completely new airport. A population that is living around that airport will respond differently as a result of adaptation and past experience. This is the case for Sea-Tac and McChord and to a lessor extent Paine Field. This is not to say that adverse community response would not be expected if increased air carrier activity occurred at these airports, but that airports that have operated for some time will have a higher threshold of adverse community response then a new airport site.

- The 55 Ldn noise level was considered the most important criteria level when evaluating the noise impacts at a new airport site. In evaluating a new airport site, a criteria such as 55 Ldn is recommended in that it best reflects a noise environment that is indicative of a desired environment within the communities.

- A commercial airport that is developed at an existing airport site, such as McChord or Paine Field, would likely elicit a lower overall adverse community response to aircraft noise than a completely new airport that would expose a population to "new" noise.

- The single event noise environment is a good indicator of where aircraft noise is likely to be noticeable, and where some level of annoyance from the aircraft operations is likely to occur. Although this criteria is not judged to be as critical as the Ldn data, the single event noise impacts must be considered, especially when evaluating the noise impacts between the single airport system and the multiple airport system.

For weightings that consider minimizing the total population within the Ldn noise contours as the most important factor, then the most favorable alternative is the replacement airport alternative and the multiple airport system is less favorable. For weightings that consider minimizing newly exposed population within the Ldn noise contours, then the multiple airport system alternatives that include the new runway at Sea-Tac are considered the most favorable and the Replacement airport system is rated the least favorable. The consultant considers it very important that both of these criteria be considered and for this study have weighted them equally.

In order to rank each of the system alternatives a weighing value was applied to noise assessment criteria. One hundred points was divided among each of the five criteria. The alternative with the lowest overall point total was rated the best. In order to account for the difference in total population number between the different criteria, the population numbers were scaled. For the ranking presented in this report the points were allocated as follows:

- 25 Points - Population exposed to cumulative noise levels in excess of 55 Ldn.
- 25 Points - Population that would be newly exposed to cumulative noise levels in excess of 55 Ldn.
- 20 Points - Population exposed to cumulative noise levels in excess of 65 Ldn.
- 20 Points - Population that would be newly exposed to cumulative noise levels in excess of 65 Ldn.
- 10 Points - Population that would be exposed to single event SEL noise levels in excess of 80 SEL.

Based upon the consultants recommendations each of the system alternatives were ranked relative to each other. The ranking of the system alternatives is dependent upon the actual airport sites. The rating of the system alternatives can vary when different airport sites are considered and the ranking in the table reflects a mid-range of impacts.

The replacement airport system ranked as the most favorable alternative. This is as a result of the assumed lower population around the airport sites. However, this was only true for a new airport site such as Olympia/Black Lake where the population around the proposed site is currently predicted to be minimal. An airport site such as Central Pierce was not considered as favorably because there is a significant population around the airport site.

The alternative that ranked second was that which included Sea-Tac only. However, it is important to note that in comparing this alternative to other alternatives, it can be misleading. Because forecasted passenger demand is not met by these alternatives, there are less aircraft operations and thus the noise contours are smaller.

The ranking of System Alternatives that include the dependent runway at Sea-Tac are considered the least favorable (rated 9, 10, and 11). However, the operational assumptions for a dependent runway at Sea-Tac include both arrivals and departures and nighttime operations. Should these assumptions be changed to daytime arrivals only, as might occur with the anticipated use, then the noise impacts would be considerably lessened.

With restricted use of the new runway, a multiple airport system that involves a new air carrier runway at Sea-Tac is rated more favorably (rated 3, 4 and 5) than a multiple airport system without improvements to Sea-Tac (rated 6, 7 and 8). This is because it reflects a balance of some growth at Sea-Tac with limited growth at supplemental airport sites. No increase of capacity at Sea-Tac would result in more significant increase in growth and noise at the supplemental airport sites.

It is important to note that no one alternative was rated significantly better than any of the others in terms of population impacts and it is safe to say that all alternatives are likely to result in some level of adverse community response to aircraft noise. All of the alternatives that are based upon these sites have a significant population that will be exposed to aircraft noise in the future.

MITIGATION ALTERNATIVES

Mitigation specific to each alternative could affect the preliminary ranking presented in this study but the analysis does not take into consideration any special mitigation measures to minimize the potential noise impacts. A number of measures could be considered to minimize the potential noise impacts from the airport development alternatives. Some of these measures are presented below. The most effective noise control measures are those that are tailored to the wishes and needs of the local communities and generally this is done through a process such as the FAA part 150 program. Any airport system alternative recommendation should include a noise mitigation planning process that would include the communities, airport operators' and airlines' input. The new Noise and Capacity Act of 1990 will result in reductions in noise over the next ten years as the older noisier aircraft are phased out of service. It is assumed that the current restrictions in development of noise programs that are contained in the new law will be in effect.

The following are a brief list of a number of the noise abatement measures that should be considered for minimizing the noise impacts around each of the airports.

- *Preferential Runway Use*
- *Preferential Runway Direction*
- *Flight Track Modifications*
- *Special Nighttime Procedures*
- *Nighttime Operational Restrictions*
- *Aircraft Use Restrictions*
- *Noise Abatement Arrival and Departure Procedures*
- *Alternative Runway Development Plans*
- *Nighttime Ground Noise Control Measures*

For example, the potential noise impacts from construction of the dependent runway at Sea-Tac could be minimized for the long-term by formalizing the daytime and arrivals only use of that runway into a noise abatement policy. The potential eefects of this mitigation measure was presented previously. When noise abatement measures are included, airport development systems that include the Sea-Tac with the dependent runway alternatives can be considered more favorable then when mitigation is not included.

Applying mitigation measures to each supplemental airport site might also affect that ranking. Mitigation to the supplemental sites was not included in the preliminary analysis because of the complexity in applying mitigation to a large number of new airport sites with varying layouts and operational levels. In addition, many of the potential mitigation measures restrict the operational characteristics at an airport, and, it was therefore necessary to first analyze the potential noise impacts without constraints to the operations.

A number of measures could be considered to minimize the potential noise impacts at the supplemental airport sites. The most effective noise control measures are those that are tailored to the characteristics of each airport and the needs of the local community.

The noise impacts at the McChord or Fort Lewis alternatives could be reduced through a preferential runway program to maximize the amount of time the operations are in south flow. For both of these airport sites, there is very little development south of the airport. The noise impacts at the remaining supplemental airport sites could be minimize through the restriction of nighttime operations. In a multiple airport system with Sea-Tac as the primary airport, it may be possible to constrain nighttime operations at the supplemental sites. However, it is very important to note that under the existing laws it is very difficult to implement new restrictions on Stage 3 aircraft, therefore, it may not be possible to legally restrict nighttime operations in the future.

The potential for mitigating the noise impacts for the supplemental airport sites was analyzed for a number of sample alternatives. Although it was not feasible to analysis all of the alternatives, the preliminary results of analyzing sample alternatives show that the potential noise impacts at the supplemental sites themselves could be reduced by approximately 10 percent through mitigation measures.

The ranking of the different system alternatives is not significantly altered by including mitigation at the supplemental airport sites. The primary affect is that the difference between the potential noise impacts of each of the multiple airport system alternatives is lessened. (Mitigation measures at Sea-Tac tend to show a greater effect because of the higher population.)

It is recommended that noise control measures be included in the planning process as part of any implementation plan. Once a specific system alternative and specific airport sites and layouts is developed, more specific mitigation measures can be presented. For any alternative, a site specific EIS would require a thorough discussion of mitigation.

Appendix A

NOISE ASSESSMENT BACKGROUND INFORMATION

INTRODUCTION

The Appendix summarizes background information on a number of important issues relating to the assessment of the noise environment at each of the alternative airport development sites. This is intended to give the reader a greater understanding of noise, of criteria used to assess potential impacts from aircraft noise, and in the assumptions used in quantifying the noise environment at each of the airport sites. This section is divided into the following subsections:

- *Description of Noise*
- *Noise Metrics*
- *Noise Assessment Guidelines*
- *Methodology in Determining the Noise Environment*
- *Aircraft Operational Assumptions*
- *Noise Contour Results*

DESCRIPTION OF NOISE

Decibels. The purpose of this subsection is to present properties of sound that are important for technically describing sound in the airport setting. Sound can be technically described in terms of the sound pressure (amplitude) of the sound and frequency (similar to pitch) of the sound. The sound pressure is a direct measure of the magnitude of a sound without consideration for other factors that may influence its perception.

A standard unit of measurement of sound is the decibel (dB). The range of sound pressures that occur in the environment is so large that it is convenient to express these pressures as sound pressure levels on a logarithmic scale. The sound pressure level in decibels is the pressure of a sound relative to a reference pressure. The logarithmic scale compresses the wide range in sound pressures to a more usable range of numbers in a manner similar to the Richter scale for earthquakes. For example, a sound level of 70 dB has 10 times as much acoustic energy as a level of 60 dB while a sound level of 80 has 100 times as much acoustic energy as 60 dB.

The frequency of a sound is expressed as Hertz (Hz) or cycles per second. The normal audible frequency for young adults is 20 Hz to 16,000 Hz. The prominent frequency range for aircraft noise is between 50 Hz and 5,000 Hz. The human ear is not equally sensitive to all frequencies with some frequencies judged to be louder for a given signal than another. As a result of this, various methods of frequency weighting have been developed, with the A-weighting (dBA) scale the most prominent of these scales.

The A-weighted decibel scale (dBA), widely used in community noise analyses, performs this compensation by discriminating against frequencies in a manner approximating the sensitivity of the human ear. Many research studies reveal that when individuals make relative judgments of the "loudness" or "annoyance" of a noise, their judgments correlate reasonably well with the A-weighted sound levels of these noises. The advantages of the A-weighted decibel are that it is widely accepted, has shown good correlation with community response, and is easily measured. Most community noise metrics are based upon the dBA scale.

In terms of human response to noise, a sound 10 dBA higher than another is judged to be twice as loud; and 20 dBA higher four times as loud; and so forth. Everyday sounds normally range from 30 dBA (very quiet) to 100 dBA (very loud). Examples of various noise levels in the dBA scale in different environments are shown in Exhibit A-1.

SOUND LEVELS AND LOUDNESS OF ILLUSTRATIVE NOISES IN INDOOR AND OUTDOOR ENVIRONMENTS

(A-Scale Weighted Sound Levels)

dB(A)	OVER-ALL LEVEL Sound Pressure Level Approx. 0.0002 Microbar	COMMUNITY (Outdoor)	HOME OR INDUSTRY	LOUDNESS Human Judgement of Different Sound Levels
130	UNCOMFORTABLY	Mil. Jet Aircraft Take-Off with After-burner From Aircraft Carrier @ 50 Ft. (130)	Oxygen Torch (121)	120 dB(A) 32 Times as Loud
120 110	LOUD	Turbo-Fan Aircraft @ Take Off Power @ 200 Ft. (90)	Riveting Machine (110) Rock-N-Roll Band (108-114)	110 dB(A) 16 Times as Loud
100	VERY	Jet Flyover @ 1000 Ft. (103) Boeing 707. DC-8 @ 6080 Ft. Before Landing (106) Bell J-2A Helicopter @ 100 Ft. (100)		100 dB(A) 8 Times as Loud
90	LOUD	Power Mower (96) Boeing 737. DC-9 @ 6080 Ft. Before Landing (97) Motorcycle @25 Ft. (90)	Newspaper Press (97)	90 dB(A) 4 Times as Loud
80		Car Wash @ 20 Ft. (89) Prop. Airplane Flyover @ 1000 Ft. (88) Diesel Truck, 40 MPH @ 50 Ft. (84) Diesel Train, 45 MPH @ 100 Ft. (83)	Food Blender (88) Milling Machine (85) Garbage Disposal (80)	80 dB(A) 2 Times as Loud
70	MODERATELY LOUD	High Urban Ambient Sound (80) Passenger Car, 65 MPH @ 25 Ft. (77) Freeway @ 50 Ft. From Pavement Edge, 10:00 AM (76 +or- 6)	Living Room Music (76) TV-Audio, Vacuum Cleaner	70 dB(A)
60		Air Conditioning Unit @ 100 Ft. (60)	Cash Register @ 10 Ft. (65-70) Electric Typewriter @ 10 Ft. (64) Dishwasher (Rinse) @ 10 Ft. (60) Conversation (60)	60 dB(A) 1/2 as Loud
50	QUIET	Large Transformers @ 100 Ft. (50)		50 dB(A) 1/4 as Loud
40		Bird Calls (44) Lower Limit Urban Ambient Sound (40)		40 dB(A) 1/8 as Loud
	JUST AUDIBLE	(dB[A] Scale Interrupted)		
10	THRESHOLD OF HEARING			

SOURCE. Reproduced from Melville C. Branch and R. Dale Beland Outdoor Noise in the Metropolitan Environment. Published by the City of Los Angeles, 1970. p.2.

Exhibit
A-1

Examples of Typical Sound Levels

NOISE METRICS

Many factors influence how a sound is perceived and whether or not it is considered annoying to a listener. This includes not only physical characteristics of the sound (i.e., loudness, frequency & duration) but also nonacoustic factors (i.e., activity interference & listener expectation). Sound rating scales (noise metrics) are developed to attempt to account for these factors that affect human response to sound.

Community noise is generally not constant and varies with time. Under conditions of non-constant noise, some type of statistical metric is necessary to mathematically express a varying noise level in order to correlate to community response. As a result, several noise metrics have been developed for the analysis of adverse effects of community noise on people.

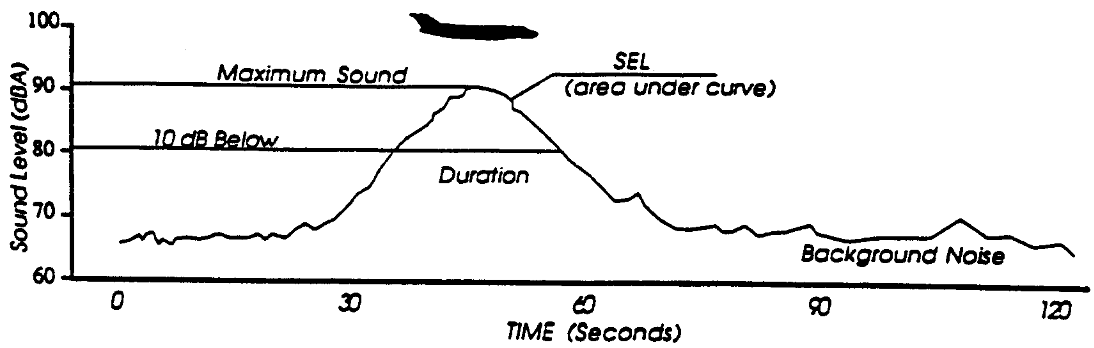
Noise metrics can be divided into two general categories: "cumulative" and "single event". Cumulative metrics average the total combined noise over a specific time period (which is typically 24-hours for airport noise). These metrics are useful because they combine the total noise throughout the day into a single number rating system. They are the primary methods used in the assessment of aircraft noise in relationship to most noise/land use compatibility criteria.

Single event metrics describe the loudness of a single flyover regardless of the time of day or the number of such events. Single event levels are very useful supplemental predictors when assessing community response to aircraft noise. They can be used in describing the noise levels associated with interference with activities such as speech or sleep. The following paragraphs present summary descriptions of the most prominent noise metrics used to describe aircraft noise.

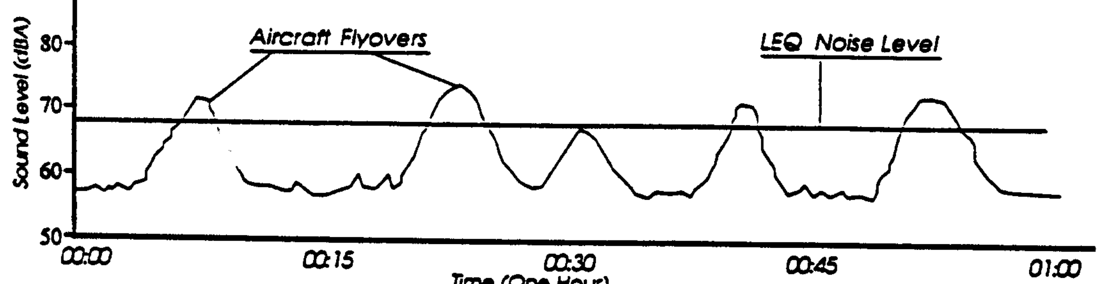
Single Event Noise Metrics. As an aircraft approaches, the sound of the aircraft begins to rise above ambient noise levels. The closer the aircraft gets the louder it is until the aircraft is at its loudest point. Then as the aircraft passes, the noise level decreases until the sound level again settles to ambient levels. Such a flyover history is plotted in the top half of Exhibit A-2. The highest noise level reached during the flyover is, not surprisingly, called the "Maximum Noise Level," or Lmax. It is to this noise level that people instantaneously respond when an aircraft flyover occurs.

Another metric that is reported for aircraft flyovers is the Sound Exposure Level (SEL). Referring again to Exhibit A-2, the shaded area or the area within 10 dBA of the maximum noise level is the area from which the SEL is computed. The SEL is mathematically equivalent to the noise level if the total noise energy from the event was compressed into one second. This metric takes into account both the maximum noise level of the event as well as the duration of the event. The SEL is important because it can be used to compare with such health effects of noise such as sleep disturbance and speech interference.

Single Event Sound Exposure Level (SEL)



One Hour of Events (Hourly LEQ)



(Time Axis not drawn to scale. Aircraft Events are much shorter than shown here)

24-Hour Noise Level (LDN)

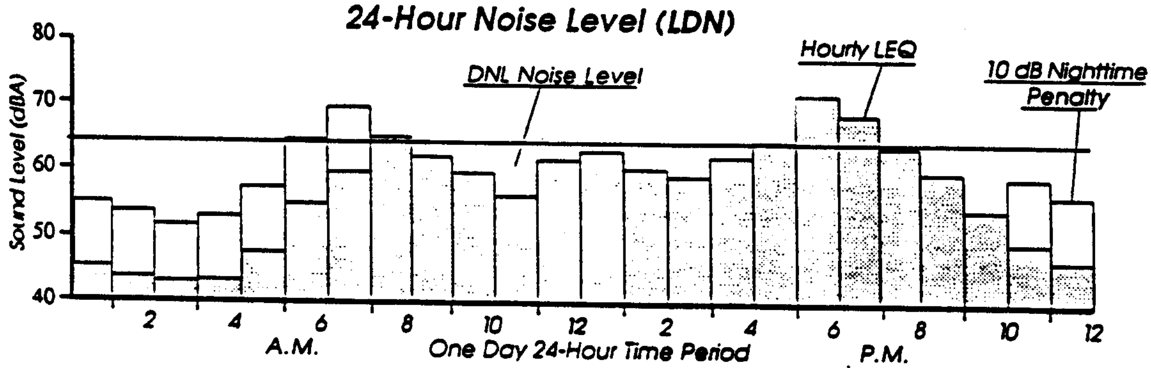


Exhibit
A-2

SEL, LEQ and LDN Illustrations

Cumulative Noise Metrics. Cumulative noise metrics have been developed to account for the identified health effects of noise and the community response to that noise. They are useful because these scales attempt to combine the loudness of each event, the duration of these events, the total number of events and the time of day these events occur into one single number rating scale. Many cumulative metrics are based on the observation that the potential for a noise to impact people is dependent on the total acoustical energy content of the noise. The two predominate scales, Equivalent Noise Level (LEQ) and the Day Night Noise Level (LDN) are based on this observation. These scales are described in the following paragraphs.

LEQ is the sound level corresponding to a constant sound level containing the same total energy as a time-varying signal over a given sample period. This is graphically illustrated in the center of Exhibit A-2. LEQ is the "energy" average noise level during the time period of the sample. LEQ can be measured for any time period, but is typically measured for 1 hour. This is also referred to as the Hourly Noise Level (HNL). LEQ can also be expressed as the energy sum of all the noise events that occur during a specific time period divided by duration of that time period.

LDN is a 24-hour, time-weighted annual average noise level. It is a measure of the overall noise experienced during an entire day. The time-weighted refers to the fact that noise that occurs during certain sensitive time periods is penalized for occurring at these times. In the LDN scale, those events that take place during the night (10 pm to 7 am) are penalized by adding 10 dB to nighttime events. This penalty was selected to attempt to account for increased human sensitivity to noise during the quieter evening hours, when people are most likely to be at home, and sleep is the most probable activity.

Referring again to Exhibit A-2, the bottom of the exhibit illustrates how hourly LEQs are summed and weighted to compute the daily LDN level. The LDN is the energy average of the weighted hourly LEQs. The LDN scale is specified by the Federal Aviation Administration (FAA) and the Environmental Protection Agency (EPA) for the assessment of noise and land use compatibility conflicts around airports.

NOISE ASSESSMENT GUIDELINES

Noise has been defined as unwanted sound and it is known to have several adverse effects on people. From these known effects of noise, criteria have been established to help protect the public health and safety and prevent disruption of certain human activities. This criteria is based on such known effects of noise on people as hearing loss (not a factor with community noise), communication interference, sleep interference, physiological responses and annoyance.

The public reaction to different noise levels varies from community to community. Extensive research has been conducted on human responses to exposure of different levels of aircraft noise. Community noise standards are derived from tradeoffs between community response surveys and economic considerations for achieving these levels. From these surveys governmental agencies have developed noise assessment criteria.

The purpose of this sub-section is to present criteria regarding the compatibility of various land uses with environmental noise. Noise/Land Use guidelines have been produced by a number of agencies including the Federal Aviation Administration and the Environmental Protection Agency. A number of these guidelines are summarized below.

Federal Aviation Administration. As a means of implementing the Aviation Safety and Noise Abatement Act of 1979, the FAA adopted Regulations on Airport Noise Compatibility Planning Programs. As part of the FAA sponsored Federal Aviation Regulations (FAR) Part 150 Noise Control program, the FAA published noise and land use compatibility guidelines to be used for land use planning with respect to aircraft noise. These guidelines represent recommendations to local authorities for determining acceptability and permissibility of land uses. The guidelines specify maximum amount of noise exposure (in terms of the cumulative noise metric LDN) that will be considered acceptable to or compatible for to people in living and working areas. These noise levels are derived from case histories involving aircraft noise problems at civilian and military airports and the resultant community response. Residential land use is deemed acceptable for noise exposures up to 65 LDN.

The FAA has also developed guidelines (Order 5050.4) for the environmental analysis of airports. Federal requirements dictate that increases in noise levels over 1.5 LDN in noise sensitive land uses within the 65 LDN contour are considered significant and require further environmental analysis (1050.1 Directive 12.21.83).

Environmental Protection Agency. The Environmental Protection Agency (EPA) has developed compatibility guidelines for the assessment of noise compatibility and land uses planning. The 55 LDN is described as the requisite level with an adequate margin of safety for areas with outdoor uses, this includes residences, and recreational areas. The EPA guideline does not constitute a standard, specification or regulation but identifies safe levels of environmental noise exposure without consideration for economic cost for achieving these levels.

<u>Single Event Guidelines.</u> Single event analysis refers to the noise levels associated with single overflights of an aircraft. There are no noise and land use compatibility standards in terms of single event noise levels, however, disturbances from aircraft noise (i.e., speech and sleep interference) can be related to a single event noise level. Single event noise levels are often a good supplemental predictor of annoyance from aircraft noise. When annoyance occurs can generally be predicted from speech interference and sleep disturbance data.

An 80 SEL represents a level at which communication interference starts to occur in the outdoor environment and complaints start to become more acute. This is particularly true for summer time, when the weather is mild and people are more likely to be outdoors. Indoor noise levels are reduced by about 10 dBA relative to outdoor noise levels with windows and doors open. With windows closed, typical construction reduces the indoor noise levels by 20 dBA. Sleep interference criteria shows that, with windows closed, sleep disturbances typically start to occur with an outdoor SEL of 80 dBA.

This has generally been found to be the case with the majority of the noise complaint areas around Sea-Tac. Most residential communities around Sea-Tac voicing complaints experience typical peak SEL noise levels of 80 or greater. Peak single event noise levels of 80 SEL will be used as the single event criteria for this study.

METHODOLOGY IN DETERMINING THE NOISE ENVIRONMENT

The foundation to an airport site review noise study is the accurate prediction of airport noise levels. The noise environment at each of the airport sites was determined through the employment of an airport noise computer model.

The noise environment is commonly depicted in terms of lines of equal noise levels, or noise contours. Generating accurate noise contours is largely dependent on the use of a reliable, validated, and updated noise model. Testing the reasonableness of the computer model results using on-site noise measurements is one of the most effective methods of ensuring valid noise contours. In essence, noise measurements "fine tune" the noise model to the conditions and characteristics specific to the conditions in the Puget Sound area. The following paragraphs detail the methodology used in the computer modeling of these results into noise contours.

Computer Modeling. Contour modeling is a very key element of the noise study. Generating accurate noise contours is largely dependent on the use of a reliable, validated, and updated noise model. It is imperative that these contours be accurate for the meaningful planning and implementation of a noise control program. There are several noise contour computer models in use. The FAA's Integrated Noise Model (INM) is most commonly used to model commercial airports and was used for this study.

The airport noise contours were generated using the INM Version 3.9. The original version was released in 1977, and the present Version 3.9 was released in May 1987 with an updated aircraft data base. (FAA-EE-81-17). The INM is a large computer program developed to plot noise contours for airports. The program is provided with standard aircraft noise and performance data for over 80 aircraft types that can be tailored to the characteristics of the airport in question.

One of the most important factors in generating accurate noise contours is the collection of precise data. The INM program requires the input of the physical and operational characteristics of the airport. Physical characteristics include runway coordinates, airport altitude, and temperature. Operational characteristics include various types of aircraft data. This includes not only the aircraft types and flight tracks, but also departure procedures, arrival procedures and load factors that are specific to the operations at the airport. Aircraft data needed to generate noise contours include:

- *Number of aircraft operations*
- *Types of aircraft*
- *Day/night time distribution*
- *Flight tracks*
- *Flight profiles*
- *Typical operational procedures*
- *Noise abatement departure & arrival procedures, if any*

AR 038158

Testing the reasonableness of the computer model results using existing field noise measurements is one of the most effective methods of ensuring valid noise contours. The noise model used in the study has been calibrated from the noise measurement data from Sea-Tac. This calibrated computer model can then be used to predict the noise environment as a result of any of the alternative options under consideration.

It is important to note that the FAA conducted field testing for the latest version of the noise model at Sea-Tac ("*FAA Integrated Noise Model Validation: Analysis of Carrier Flyovers at Seattle-Tacoma Airport*", FAA Office of Environment and Energy, FAA-EE-82-19, November 1982). Therefore, the model has been found to very closely matches the characteristics of operations and meteorological effects that are present in the Puget Sound area. Very little adjustments to the model assumptions were necessary.

AR 038159

AIRCRAFT OPERATIONAL ASSUMPTIONS

The noise environment for each airport was analyzed for the year 2020 operational conditions. A number of different operational information is necessary in order to model the noise environment around the airports. This data includes the following summary information:

- *Aircraft Activity Levels*
- *Fleet Mix*
- *Time of Day*
- *Runway Use*
- *Flight Path Utilization*

Aircraft Activity Levels. The analysis is based upon 2020 operational conditions. The aircraft operational levels were derived directly from the Flight Plan Study. The operations are based on 45 millions of Annual Passengers (MAP). The 2020 aircraft operations for each airport are summarized in Table A-1. These operations consist of air carriers and commuter aircraft, with some general aviation and military aircraft.

Fleet Mix. The aircraft that are projected to operate at these airports include most types of commercial and commuter aircraft that operate within the United States. These range in size from the Boeing 747 aircraft used for long haul international flights to small single engine Cessna planes used for local commuter flights. The types of aircraft that operate at these airports are dictated by the Puget Sound's aviation demands and are designed to match those needs.

The fleet mix distribution for aircraft operating at these airports is presented in Table A-2. This table presents the different types of air carrier, commuter, general aviation and military aircraft that operate at the airport. The analysis assumes an all Stage III fleet mix, and a fleet mix that is primarily composed of the quieter Stage III aircraft. This would be expected for the 2020 time frame.

Stage III refers to the FAA's Federal Aircraft Regulations 36 that categorizes jet aircraft based upon noise levels. Stage III refers to the newer generation quieter aircraft. Stage II refers to the older louder aircraft. Recently, the FAA has mandated the phase out of Stage II aircraft by approximately 2000.

Time of Day. In the LDN metric, any operations that occur after 10 p.m. and before 7 a.m. are considered more intrusive and are weighted by 10 dBA. Therefore, the number of nighttime operations is very critical in determining the LDN noise environment. The number of nighttime operations per aircraft type was assumed to be the same as is currently operating at Sea-Tac. The analysis assumes that 15 percent of the air carrier operations occur during the nighttime hour and that 8 percent of the commuter operations occur during the nighttime hour.

Table A-1
ANNUAL COMMERCIAL OPERATIONS (Air Carrier & Commuter)

Alt.	Airport System Alternatives	ANNUAL COMMERCIAL OPERATIONS (X1000) Seatac	Paine	Arling	Pierce	McCord	OBL	TOTAL
1	Sea-Tac without Commuter R/W	356						356
2	Sea-Tac with Commuter R/W	386						386
3	Alternate 1 + Arlington 1 R/W	356		112				468
4	Alternate 1 + Paine 1 R/W	356	133					489
5	Alternate 1 + McChord 1 R/W	356				133		489
6	Alternate 1 + Central Pierce 1 R/W	356			112			468
7	Alternate 1 + Olympia/Black Lake 1 R/W	356					112	468
8	Alternate 1 + Arlington 2 R/W	356		133				489
9	Alternate 1 + Paine 2 R/W	356	133					489
10	Alternate 1 + McChord 2 R/W	356				133		489
11	Alternate 1 + Central Pierce 2 R/W	356			133			489
12	Alternate 1 + Olympia/Black Lake 2 R/W	356					133	489
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	456		33				489
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	454	35					489
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	456				33		489
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	455			34			489
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	456					33	489
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	456		33				489
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	454	35					489
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	456				33		489
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	455			34			489
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	456					33	489
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	356		60	73			489
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	356	67		67			489
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	356		72			61	489
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	356	78				55	489
27	Alternate 13+ Central Pierce 1 R/W	430		23	34			486
28	Alternate 14+Central Pierce 1 R/W	416	35		34			484
29	Alternate 13+Olympia/Black Lake 1 R/W	453		23			13	488
30	Alternate 14+Olympia/Black Lake 1 R/W	439	35				13	487
31	Central Pierce 3 R/W				500			500
32	Olympia/Black Lake 3 R/W						500	500
33	Central Pierce/Fort Lewis 3 R/W				500			500
34	Alternate 1 + Demand Management	356						356

Source: P & D Technologies

AR 038161

Table A-2
Aircraft Fleet Mix

PRIMARY AIRPORT AIRCRAFT FLEET MIX				SUPPLEMENTAL AIRPORT AIRCRAFT FLEET MIX	
AIRCRAFT CATEGORY	AIRCRAFT TYPE	PERCENT OF TOTAL BY CATEGORY	PERCENT OF TOTAL BY TYPE	PERCENT OF TOTAL BY CATEGORY	PERCENT OF TOTAL BY TYPE
Commuter		24%		24%	
	SF340		24%		24%
Small Jet		35%		50%	
	MD80		17%		25%
	B737-300		17%		25%
Medium Jet		21%		16%	
	B757		21%		16%
Large Jet		15%		10%	
	B767		15%		10%
Jumbo Jet		5%		0%	
	B747		5%		0%

Source: P & D Technologies

Runway Use. An additional important consideration in developing the noise contours is the percent of time each runway is utilized. The runway direction that is utilized by an aircraft is dictated by the speed and direction of the wind. From a safety and stability stand point, it is desirable, and usually necessary, to arrive and depart an aircraft into the wind. When the wind direction changes, the operations are shifted to the runway that favors the new wind direction.

The Puget Sound region generally has two types of weather patterns that result in wind directions from either the south or from the north. South flow refers to aircraft arriving and departing to the south. North flow refers to aircraft arriving and departing to the north.

Sea-Tac ATC maintains hourly records in terms of south flow versus north flow runway use. For the year of 1989 the airport utilized the south flow runways 63% of the hours of the day. For modeling purposes, the 63% figure was used for all of the airport sites under study.

Flight Path Utilization. Air traffic control (FAA) has established paths for aircraft arriving and departing the Sea-Tac, Paine Field and McChord airspace. These paths have been developed from ATC procedure requirements and specific noise abatement procedures that have evolved over a number of years. These paths are not precisely defined ground tracks, but represent a broad area over which the aircraft will generally fly. These paths will also be used for this study. New airport sites assume straight arrival and departure paths.

NOISE CONTOUR RESULTS

The total populations located within each of the airport development alternatives was determined. The methodology was presented in the main text of this document. The total number of residences located within each noise contour for the 2000 population projects is presented in Tables A-3 through A-5 for Sea-Tac, North Airports and South Airports respectively.

Noise contour were generated for each of the airport development alternatives. These contours were generated in terms of the cumulative LDN and SEL noise levels. These contours are presented in back of the Appendix for a number of airport alternatives. These contours are presented for the largest MAP assumed for each airport development scenario (i.e., 1 runway, 2 runway or 3 runways) and for other MAP levels that are typical of the remaining alternatives. These contours present the 55 and 65 LDN as well as the 80 SEL contour. These contours are based upon the assumptions presented previous. The noise contours are presented in Exhibits labeled: SE for Sea-Tac, AR for Arlington, PF for Paine Field, MC for McChord, OB for Olympia/Black Lake, and CP for Central Pierce Alternatives.

In order to illustrate the change in noise levels that will occur in the future, the 1990 noise contours for Sea-Tac are also presented. The 80 SEL noise contours for the B-727-200, MD-83 and B737-300 for Sea-Tac are presented. This graph presents the SEL noise contours for an older Stage 2 aircraft (B727-200), a Stage 3 aircraft (MD-83) and a quieter Stage 3 (B737-300). This is presented in Exhibit E-1. The change in LDN noise levels is also presented. Exhibit E-2 presents the 65 LDN noise contours for existing 1990 conditions at Sea-Tac and the 2020 noise contours for with and without the dependent runway. The results show significantly smaller noise contours in the future.

AR 038164

Table A-3
Population Estimates for Sea-Tac

Alt	Airport System Alternatives	Total Population 55 LDN (000)	Population Newly Exposed to 55 LDN (000)	Total Population 65 LDN (000)	Population Newly Exposed to 65 LDN (000)	Total Population 80 SEL (000)
1	Sea-Tac without Commuter R/W	112		7		91
2	Sea-Tac with Commuter R/W	119		7		94
3	Alternate 1 + Arlington 1 R/W	112		7		91
4	Alternate 1 + Paine 1 R/W	112		7		91
5	Alternate 1 + McChord 1 R/W	112		7		91
6	Alternate 1 + Central Pierce 1 R/W	112		7		91
7	Alternate 1 + Olympia/Black Lake 1 R/W	112		7		91
8	Alternate 1 + Arlington 2 R/W	112		7		91
9	Alternate 1 + Paine 2 R/W	112		7		91
10	Alternate 1 + McChord 2 R/W	112		7		91
11	Alternate 1 + Central Pierce 2 R/W	112		7		91
12	Alternate 1 + Olympia/Black Lake 2 R/W	112		7		91
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	125		8		95
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	125		8		95
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	125		8		95
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	125		8		95
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	125		8		95
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	125		8		95
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	125		8		95
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	125		8		95
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	125		8		95
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	125		8		95
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	112		7		91
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	112		7		91
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	112		7		91
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	112		7		91
27	Alternate 13+ Central Pierce 1 R/W	122		8		95
28	Alternate 14+Central Pierce 1 R/W	122		8		95
29	Alternate 13+Olympia/Black Lake 1 R/W	124		8		95
30	Alternate 14+Olympia/Black Lake 1 R/W	124		8		95
31	Central Pierce 3 R/W					
32	Olympia/Black Lake 3 R/W					
33	Central Pierce/Fort Lewis 3 R/W					
34	Alternate 1 + Demand Management	112		7		91

* Population Estimates Based on 2000 Population Projections

AR 038165

Table A-4
Population Estimates for North Airports

Alt	Airport System Alternatives	Total Population 55 LDN (000)	Population Newly Exposed to 55 LDN (000)	Total Population 65 LDN (000)	Population Newly Exposed to 65 LDN (000)	Total Population 80 SEL (000)
1	Sea-Tac without Commuter R/W					
2	Sea-Tac with Commuter R/W					
3	Alternate 1 + Arlington 1 R/W	11	11	0.7	0.7	24
4	Alternate 1 + Paine 1 R/W	23	23	1.2	1.2	52
5	Alternate 1 + McChord 1 R/W					
6	Alternate 1 + Central Pierce 1 R/W					
7	Alternate 1 + Olympia/Black Lake 1 R/W					
8	Alternate 1 + Arlington 2 R/W	15	15	0.5	0.5	35
9	Alternate 1 + Paine 2 R/W	26	26	1.3	1.3	62
10	Alternate 1 + McChord 2 R/W					
11	Alternate 1 + Central Pierce 2 R/W					
12	Alternate 1 + Olympia/Black Lake 2 R/W					
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	4	4	0.1	0.1	24
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	7	7	0.1	0.1	55
15	Sea-Tac w/Dependent R/W + McChord 1 R/W					
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W					
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W					
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	5	5			35
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	8	8	0.1	0.1	62
20	Sea-Tac w/Dependent R/W + McChord 2 R/W					
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W					
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W					
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	6	6	0.4	0.4	24
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	13	13	0.1	0.1	52
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	7	7	0.5	0.5	24
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	13	13	0.1	0.1	52
27	Alternate 13+ Central Pierce 1 R/W	3	3	0.1	0.1	24
28	Alternate 14+Central Pierce 1 R/W	7	7	0.1	0.1	52
29	Alternate 13+Olympia/Black Lake 1 R/W	3	3	0.1	0.1	24
30	Alternate 14+Olympia/Black Lake 1 R/W	7	7	0.1	0.1	52
31	Central Pierce 3 R/W					
32	Olympia/Black Lake 3 R/W					
33	Central Pierce/Fort Lewis 3 R/W					
34	Alternate 1 + Demand Management					

* Population Estimates Based on 2000 Population Projections

Table A-5
Population Estimates for South Airports

Alt	Airport System Alternatives	Total Population 55 LDN (000)	Population Newly Exposed to 55 LDN (000)	Total Population 65 LDN (000)	Population Newly Exposed to 65 LDN (000)	Total Population 80 SEL (000)
1	Sea-Tac without Commuter R/W					
2	Sea-Tac with Commuter R/W					
3	Alternate 1 + Arlington 1 R/W					
4	Alternate 1 + Paine 1 R/W					
5	Alternate 1 + McChord 1 R/W	23		0.8		47
6	Alternate 1 + Central Pierce 1 R/W	11	11	0.5	0.5	32
7	Alternate 1 + Olympia/Black Lake 1 R/W	4	4	0.1	0.1	23
8	Alternate 1 + Arlington 2 R/W					
9	Alternate 1 + Paine 2 R/W					
10	Alternate 1 + McChord 2 R/W	23		0.8		56
11	Alternate 1 + Central Pierce 2 R/W	15	15	0.5	0.5	44
12	Alternate 1 + Olympia/Black Lake 2 R/W	5	5	0.1	0.1	33
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W					
14	Sea-Tac w/Dependent R/W + Paine 1 R/W					
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	10		0.1		47
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	4	4	0.5	0.5	32
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	2	2			23
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W					
19	Sea-Tac w/Dependent R/W + Paine 2 R/W					
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	10		0.1		56
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	5	5	0.5	0.5	44
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	2	2			33
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	7	7	0.5	0.5	32
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	7	7	0.5	0.5	32
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	3	3			23
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	2	2			23
27	Alternate 13+ Central Pierce 1 R/W	4	4	0.5	0.5	32
28	Alternate 14+Central Pierce 1 R/W	4	4	0.5	0.5	32
29	Alternate 13+Olympia/Black Lake 1 R/W	1	1			23
30	Alternate 14+Olympia/Black Lake 1 R/W	1	1			23
31	Central Pierce 3 R/W	53	53	2.8	2.8	55
32	Olympia/Black Lake 3 R/W	19	19	0.3	0.3	49
33	Central Pierce/Fort Lewis 3 R/W	62	62	1.3	1.3	52
34	Alternate 1 + Demand Management					

* Population Estimates Based on 2000 Population Projections

AR 038167

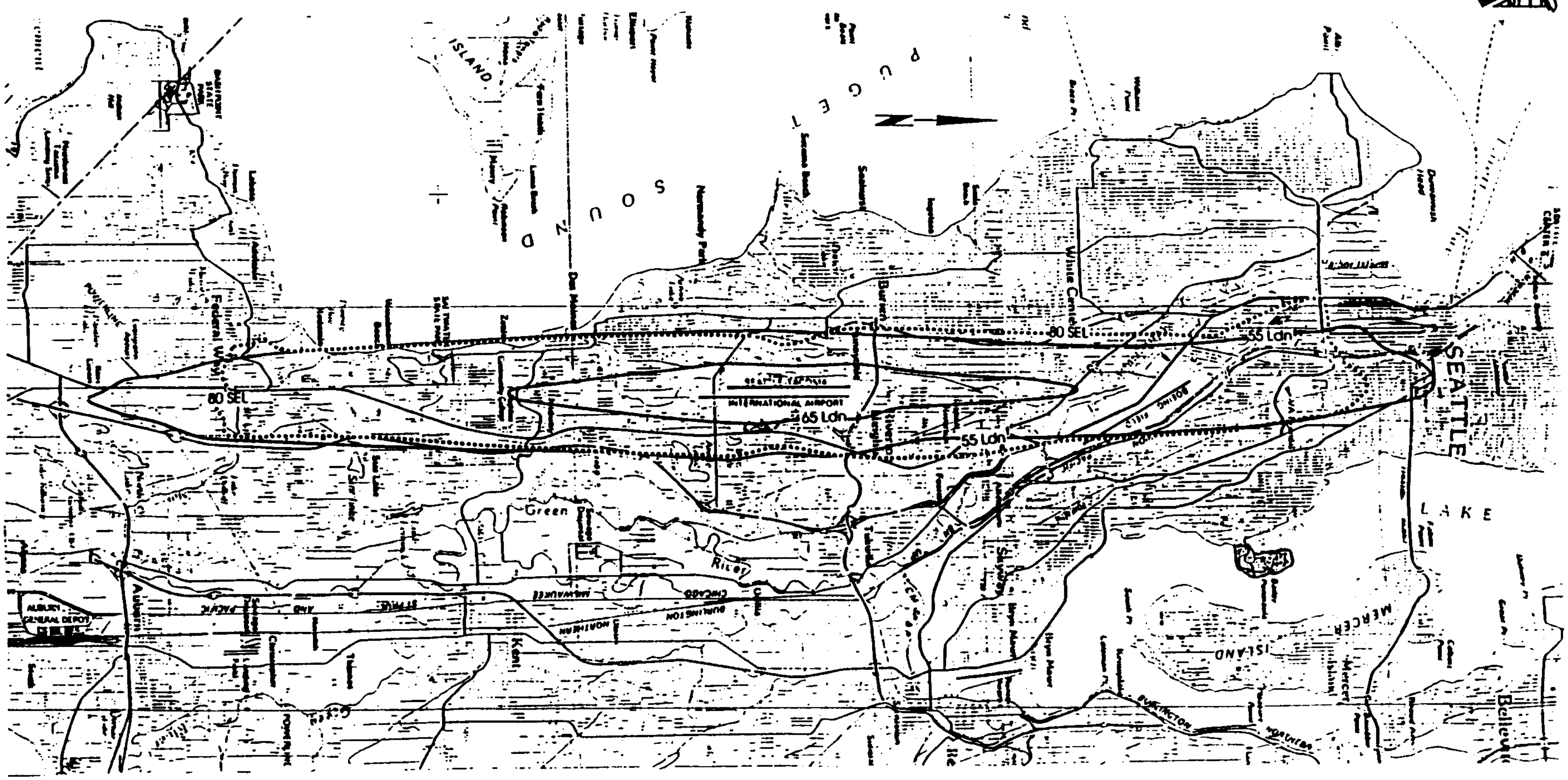


Exhibit SE-1

2020 Sea-Tac Without Commuter R/W - 32 MA

Alternatives 1, 2 through 12

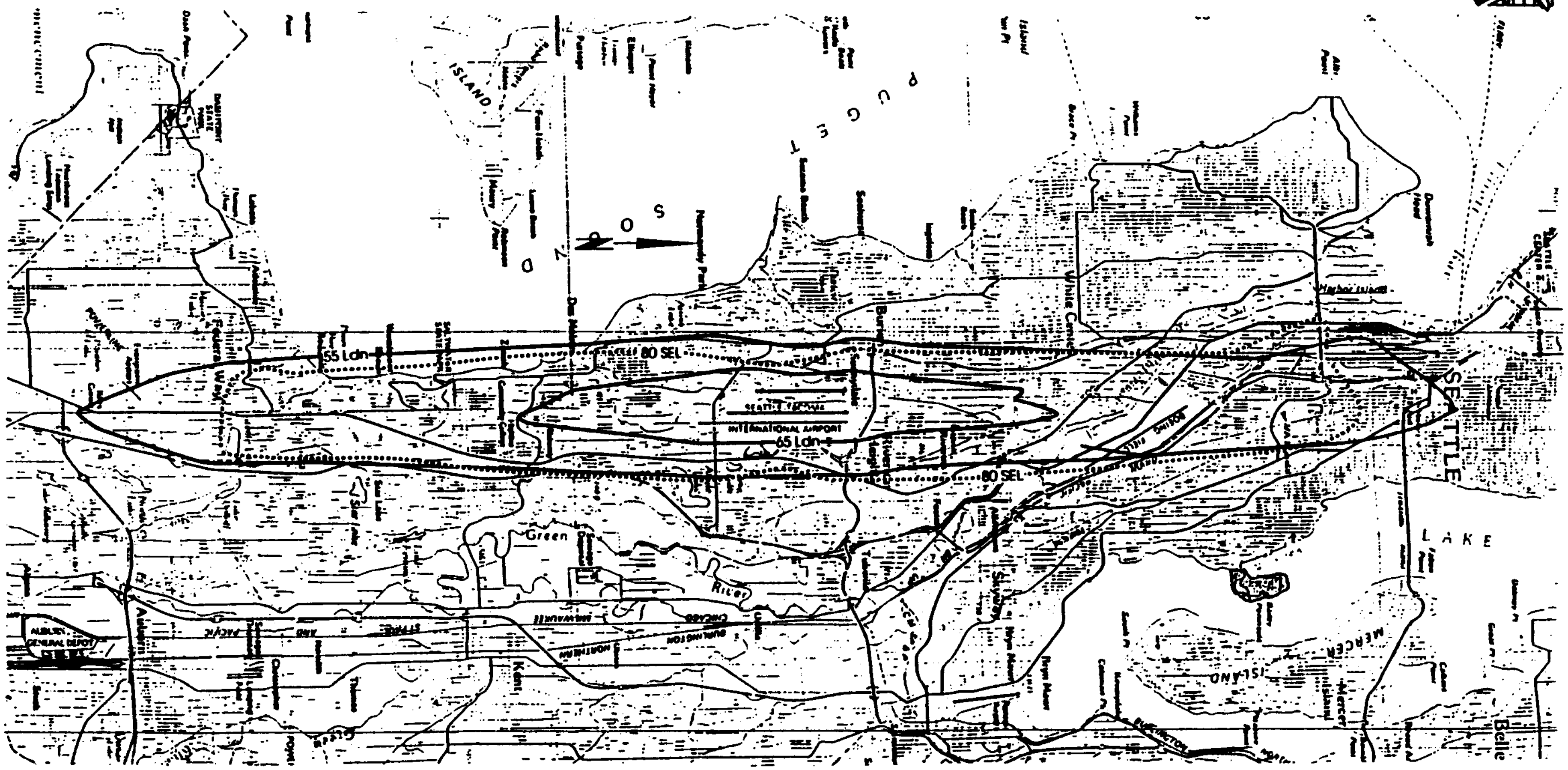


Exhibit SE-4

2020 Sea-Tac With New Air Carrier R/W - 38.3 MAF

Alternative 28

AR 038169

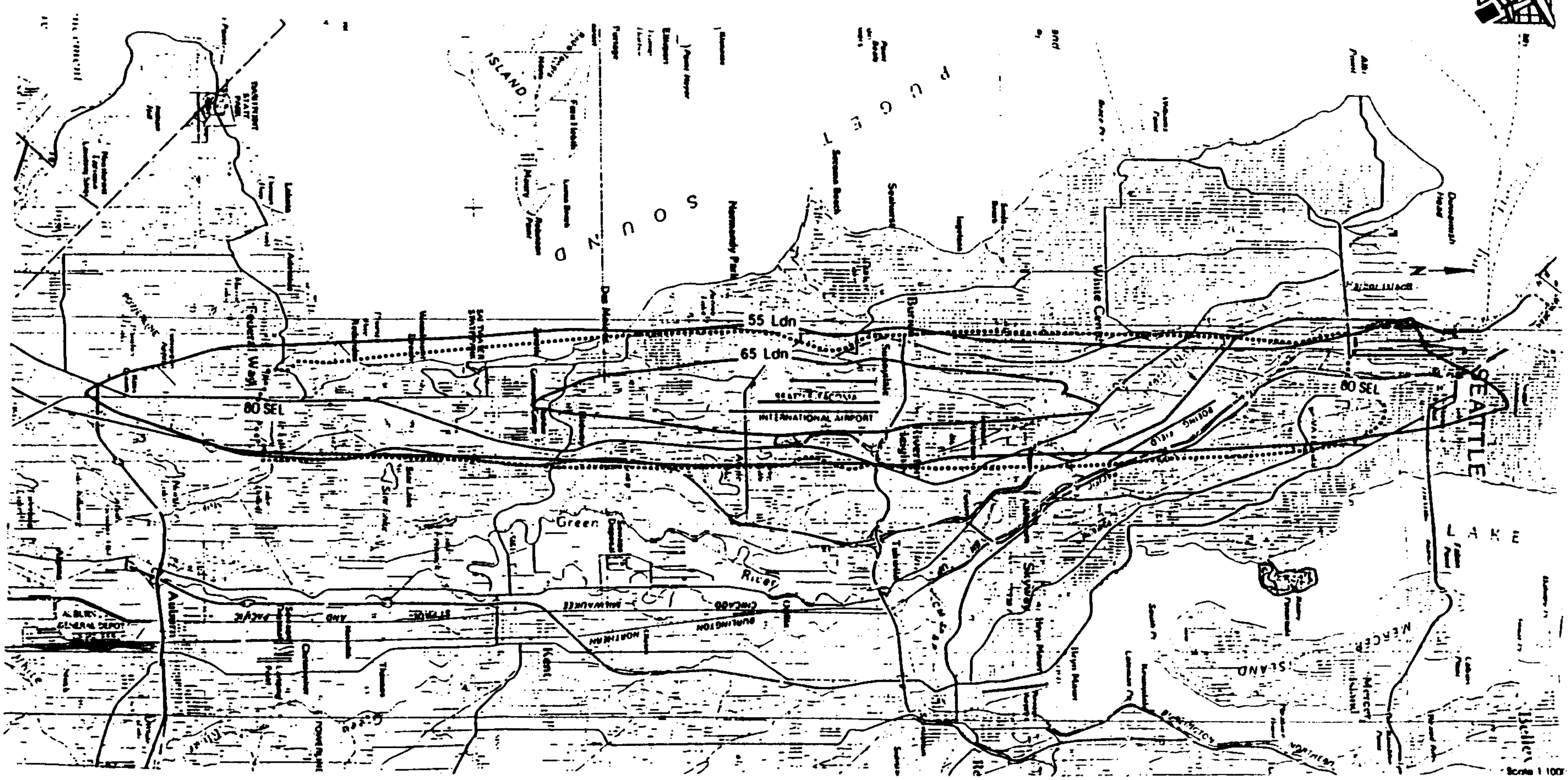


Exhibit SE-6

2020 Sea-Tac With New Air Carrier R/W - 41.8 MAP

Alternatives 13 through 22

he Flight Plan Project Phase III

UGET SOUND AIR TRANSPORTATION COMMITTEE

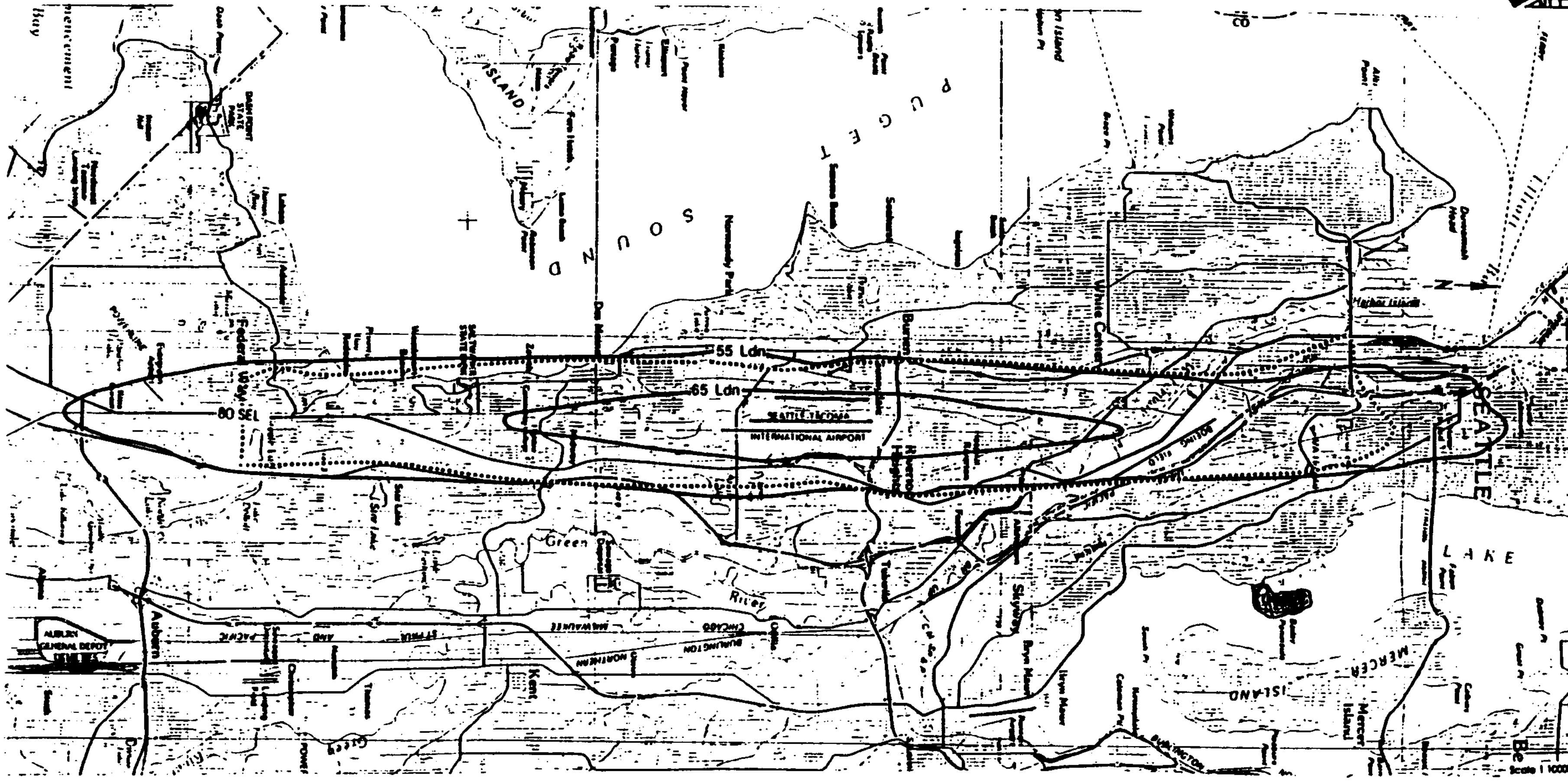


Exhibit
SE-5

* Dependent Air Carrier R/W used only for arrivals & only during daylight hours

2020 Sea-Tac With New Air Carrier R/W - 41.8 MAP

Alternatives 13 through 22

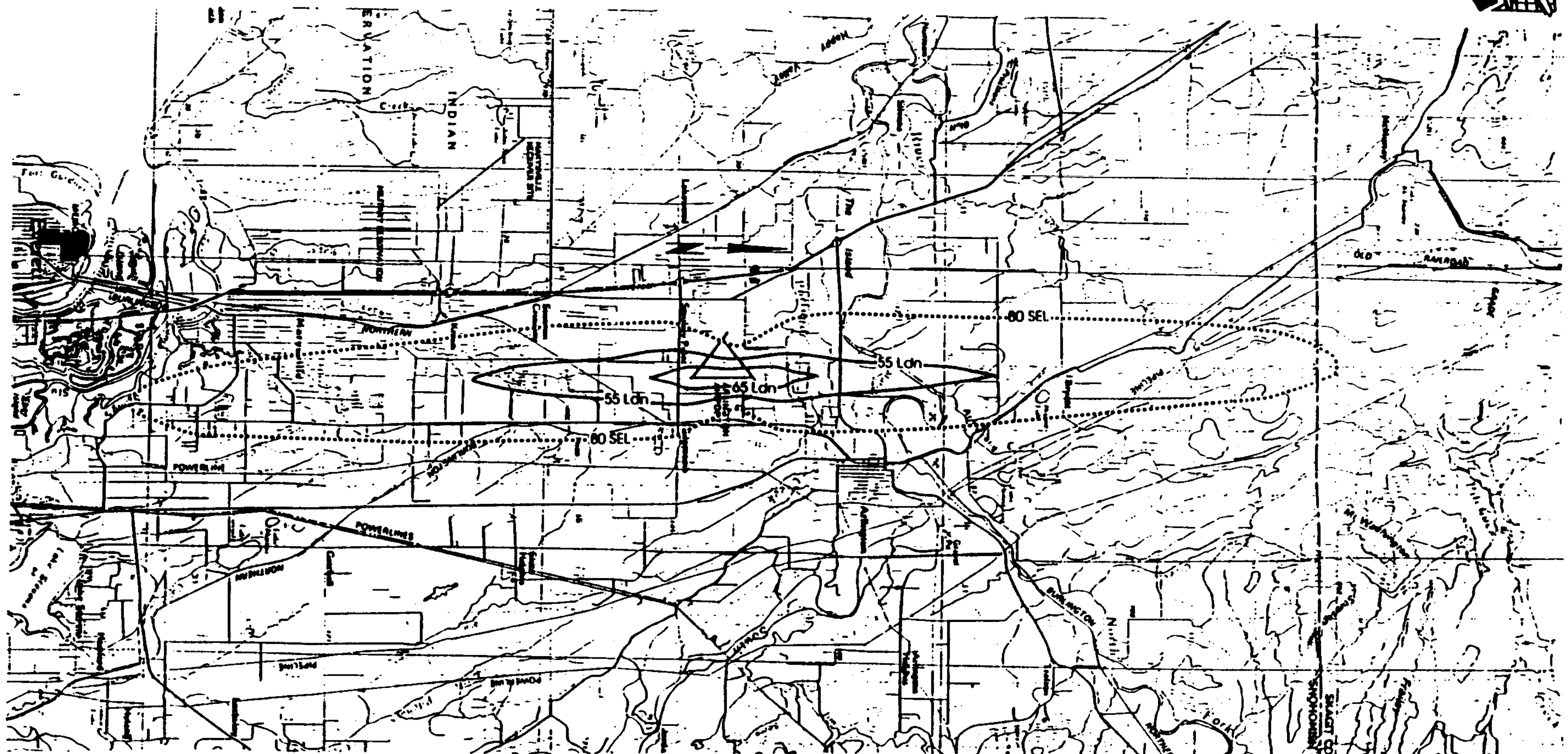


Exhibit
AR-1

2020 Arlington Supplemental Airport 1 R/W - 2.2 MAP

Alternatives 27 & 29

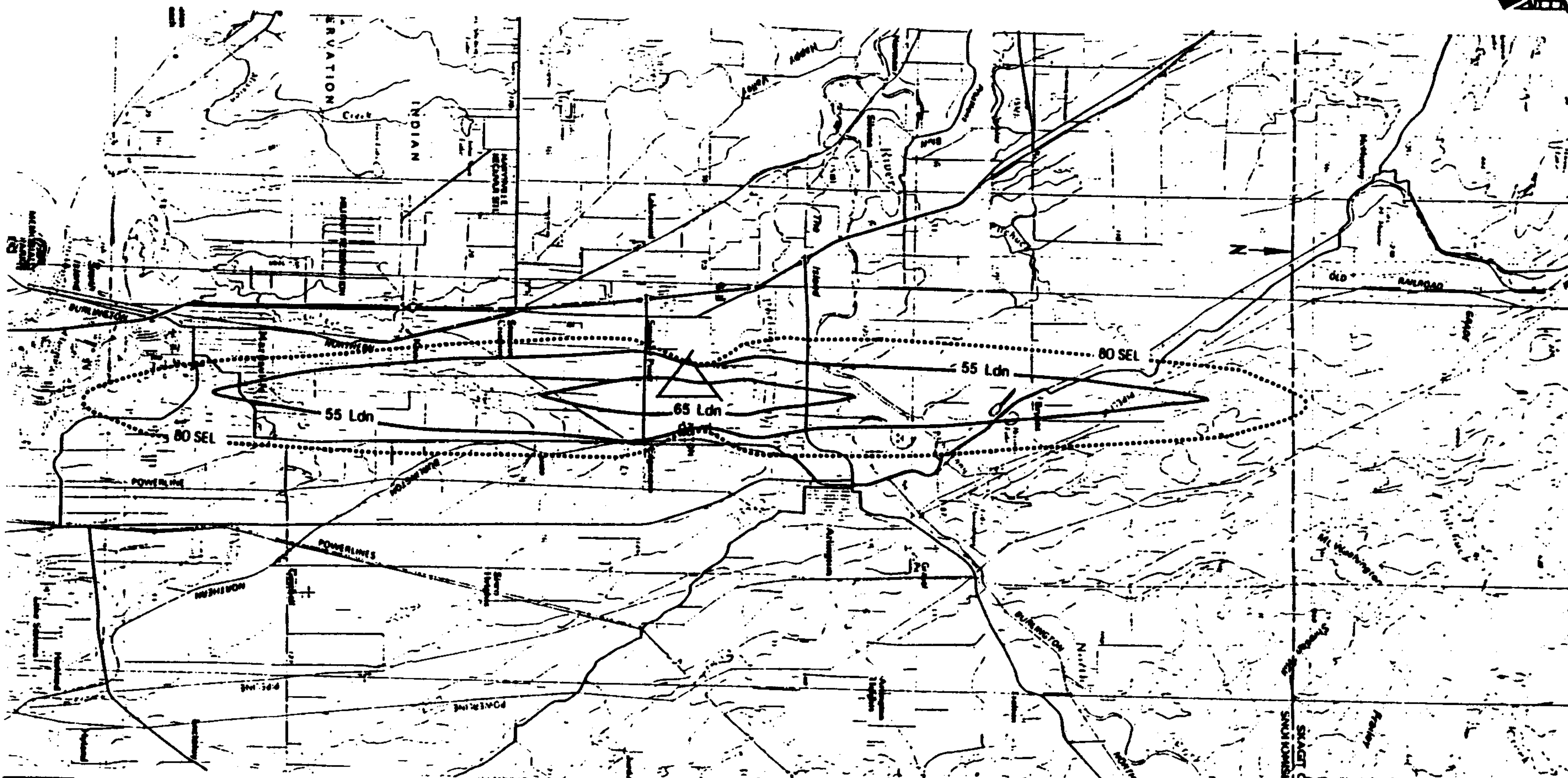


Exhibit AR-2

2020 Arlington Supplemental Airport 1 R/W - 10.9 MAP

Alternative 3

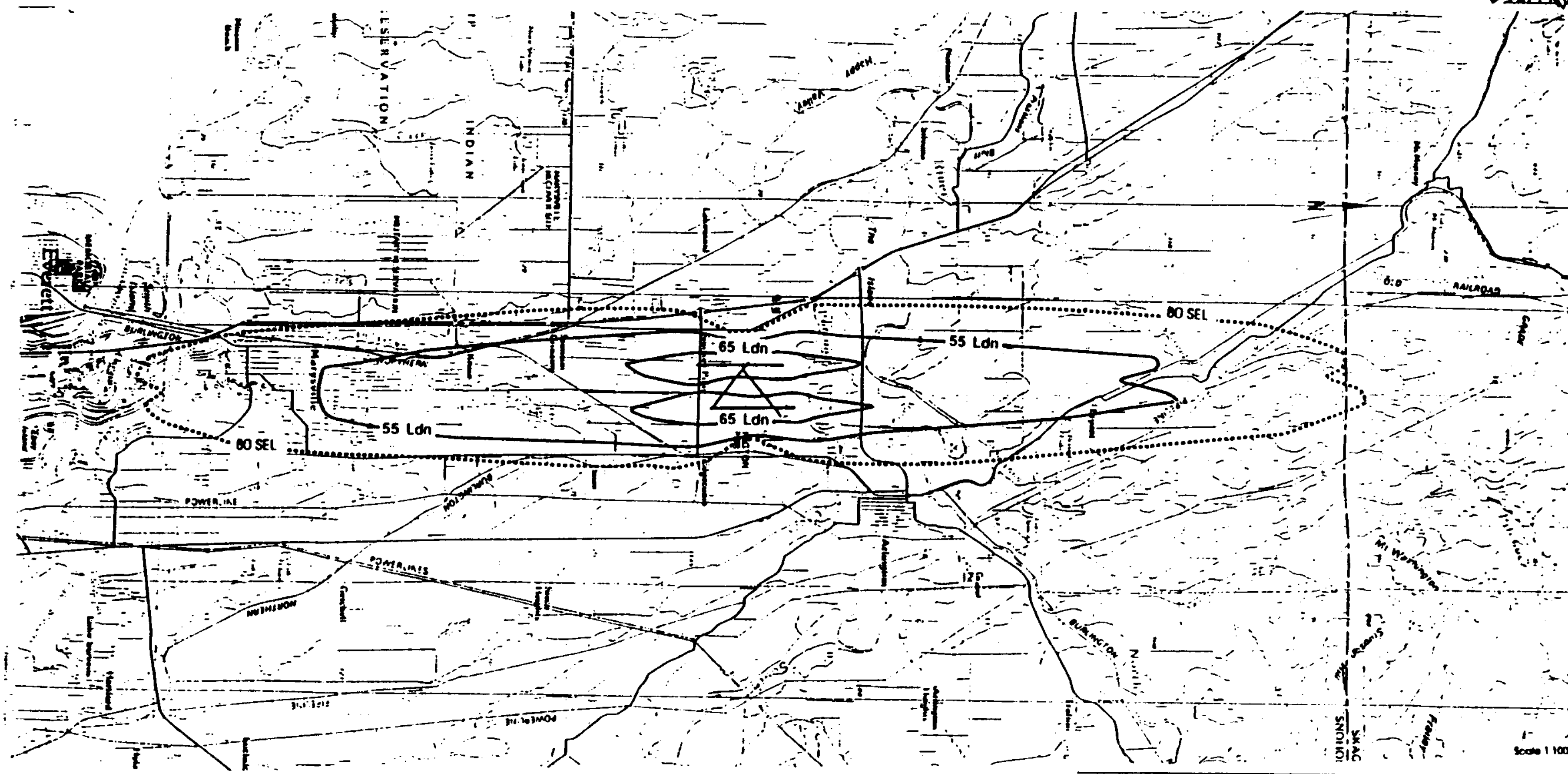


Exhibit AR-3

2020 Arlington Supplemental Airport 2 R/W - 13.0 MAP

Alternative 8

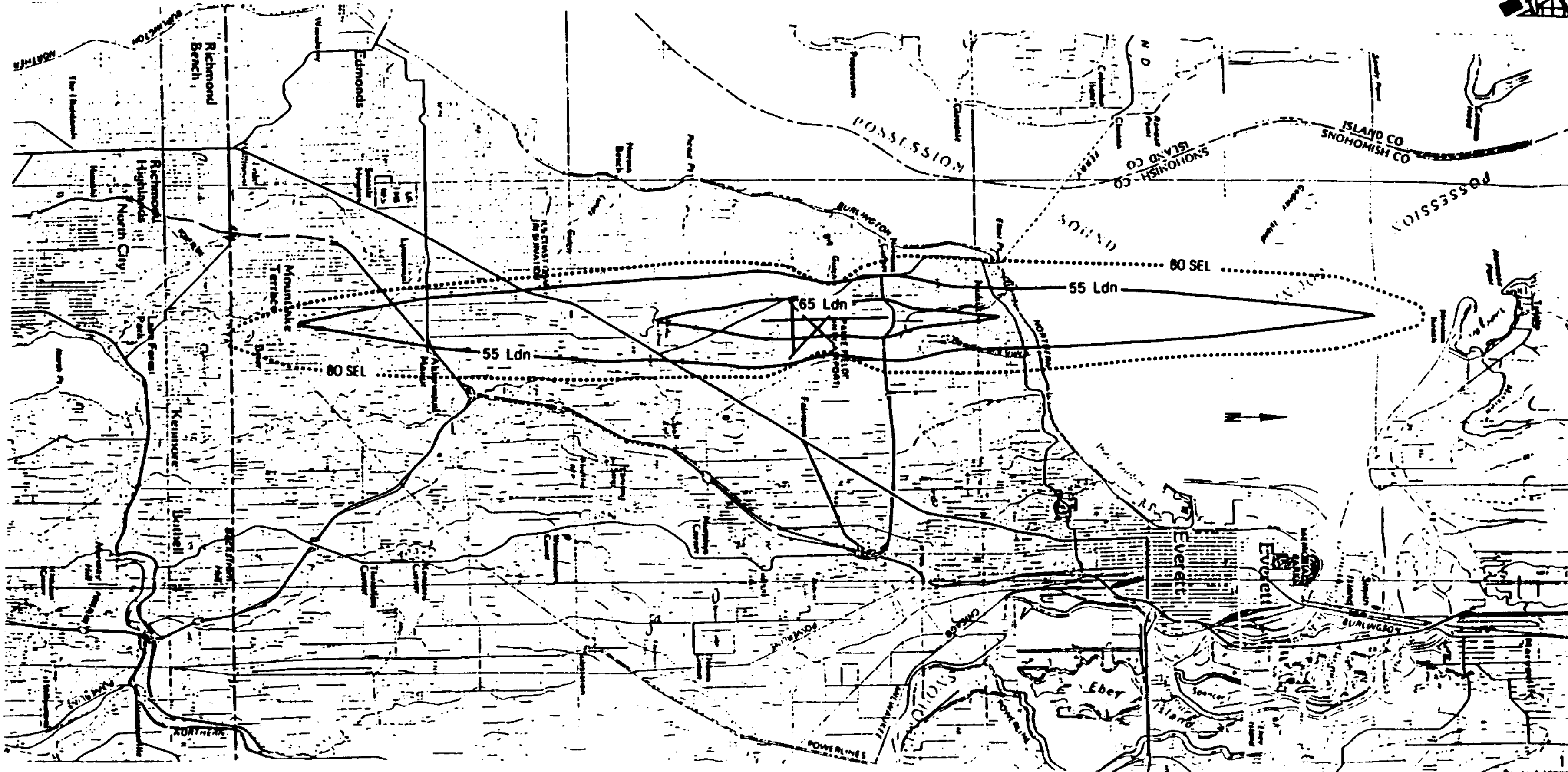


Exhibit PF-2

2020 Paine Supplemental Airport 1 R/W - 13.0 MAP

Alternative 4

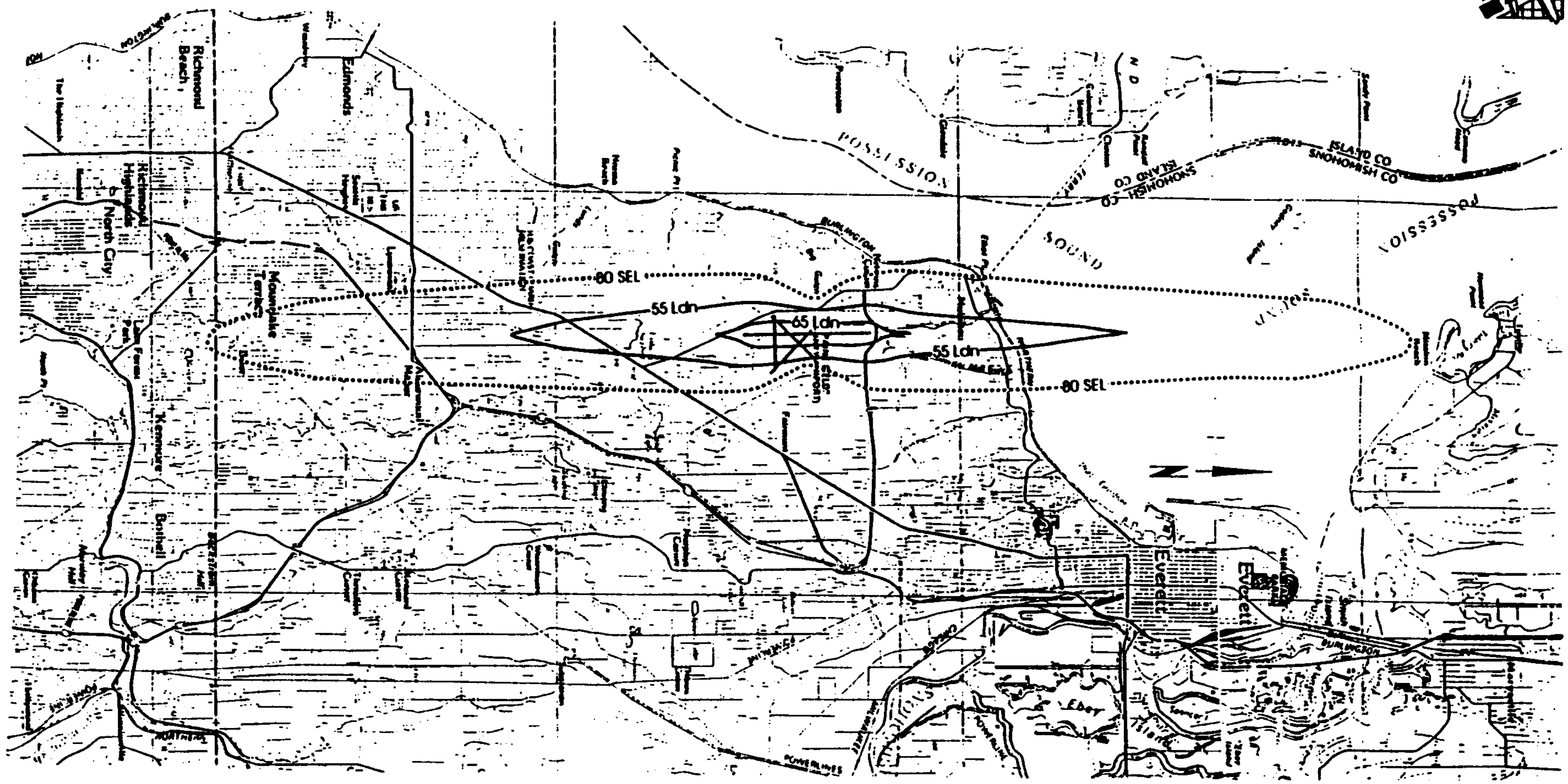


Exhibit PF-1

2020 Paine Supplemental Airport 1 R/W - 3.4 MAP

Alternatives 14, 28 & 30

AR 038176

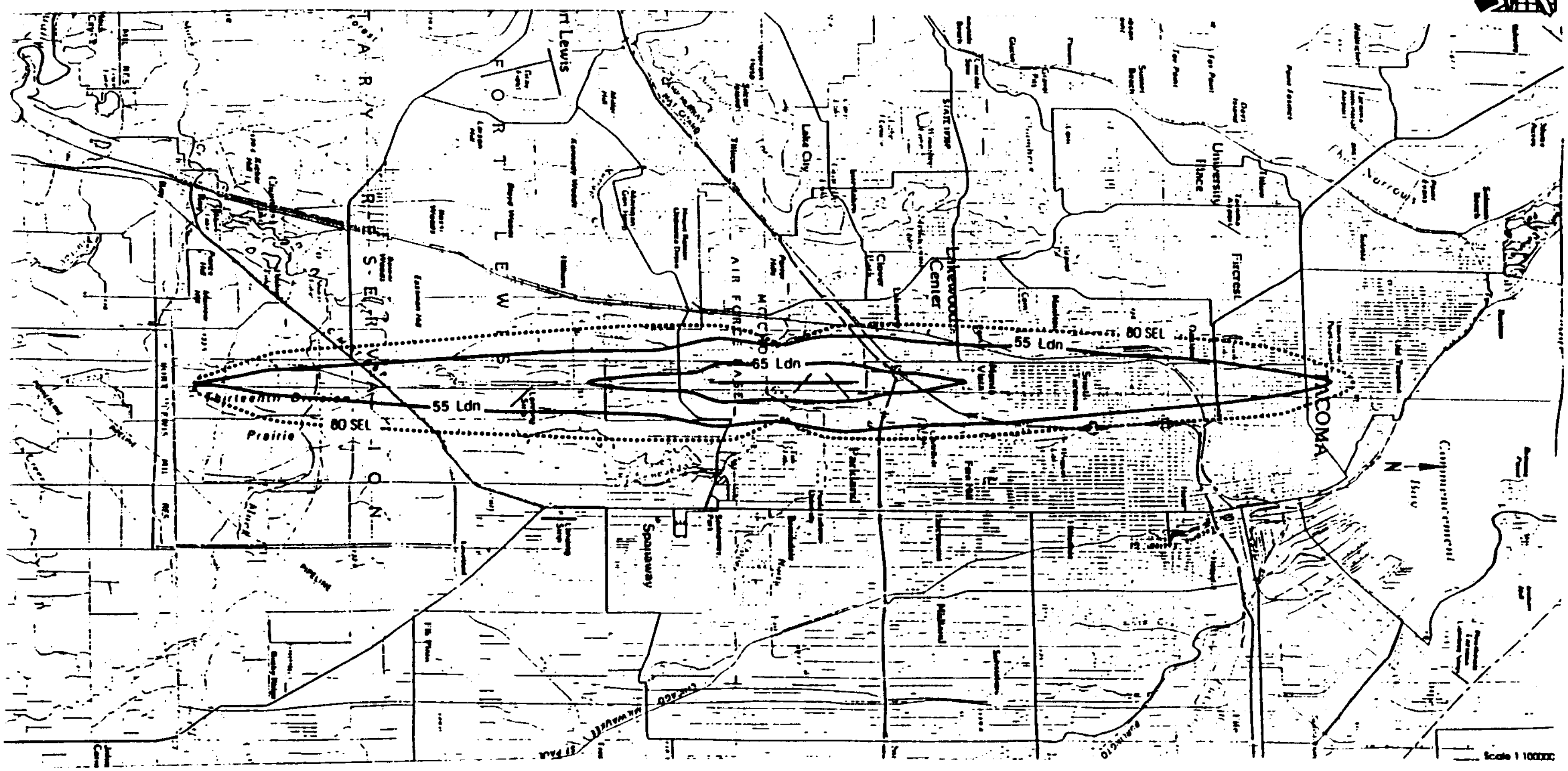


Exhibit
MC-1

2020 McChord Supplemental Airport 1 R/W - 13.0 MAP
Alternative 5

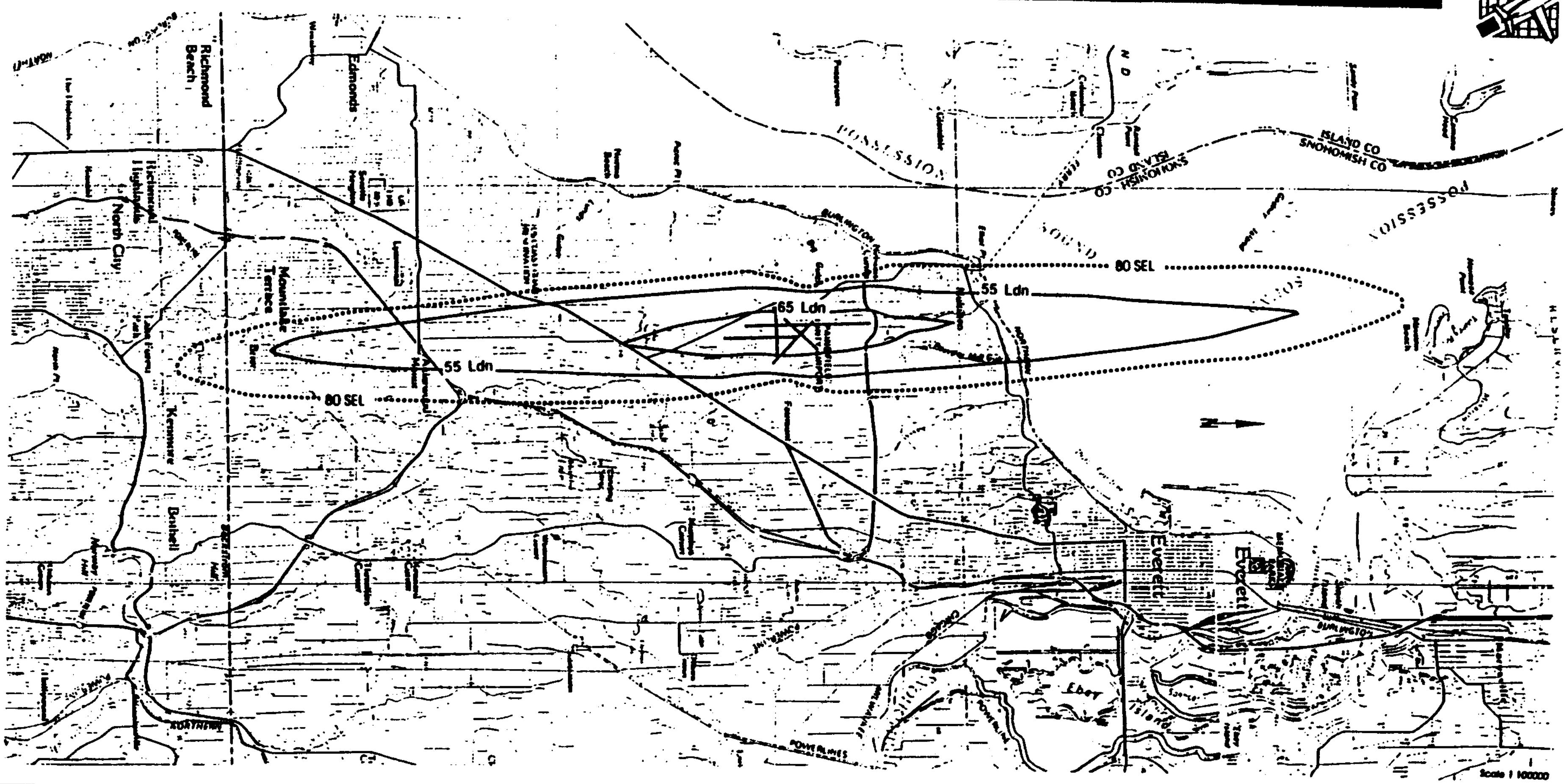


Exhibit PF-3

2020 Paine Supplemental Airport 2 R/W - 13.0 MAP

Alternative 9

AR 038178

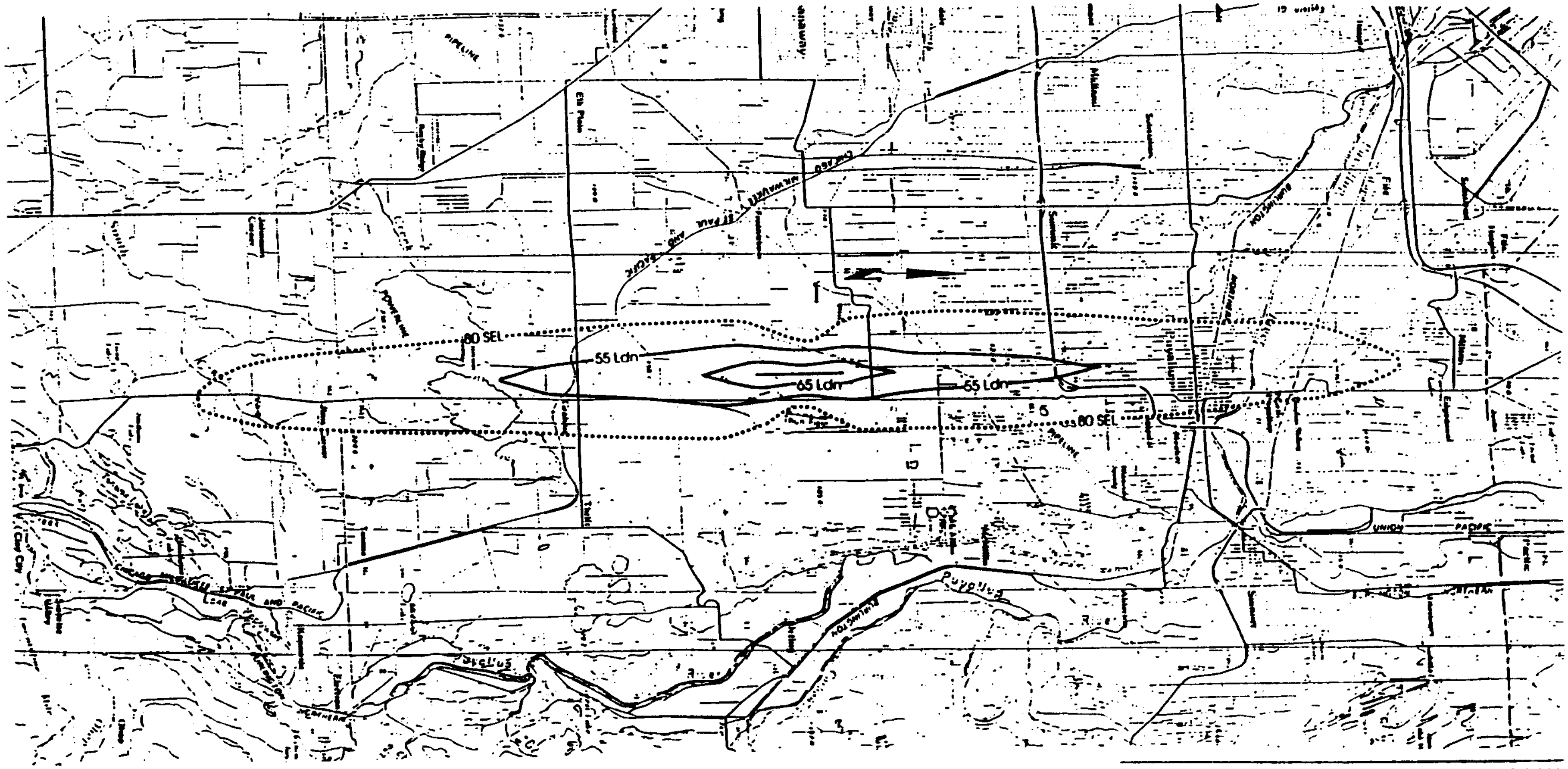


Exhibit CP-1

2020 Central Pierce Supplemental Airport 1 R/W - 3.3 MAI

Alternatives 16, 27 & 28

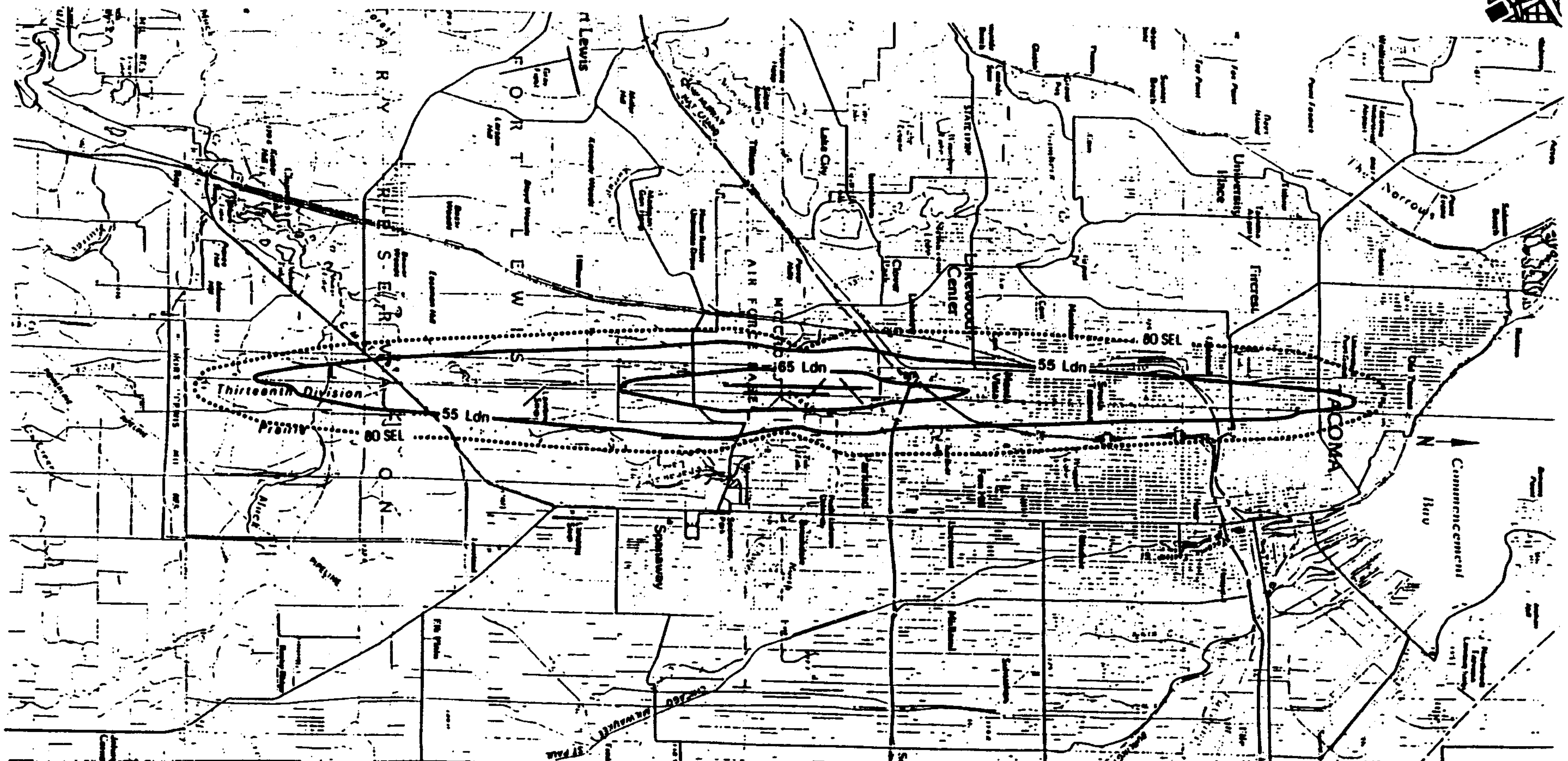


Exhibit MC-2

2020 McChord Supplemental Airport 2 R/W - 13.0 MA

Alternative 10

AR 038180

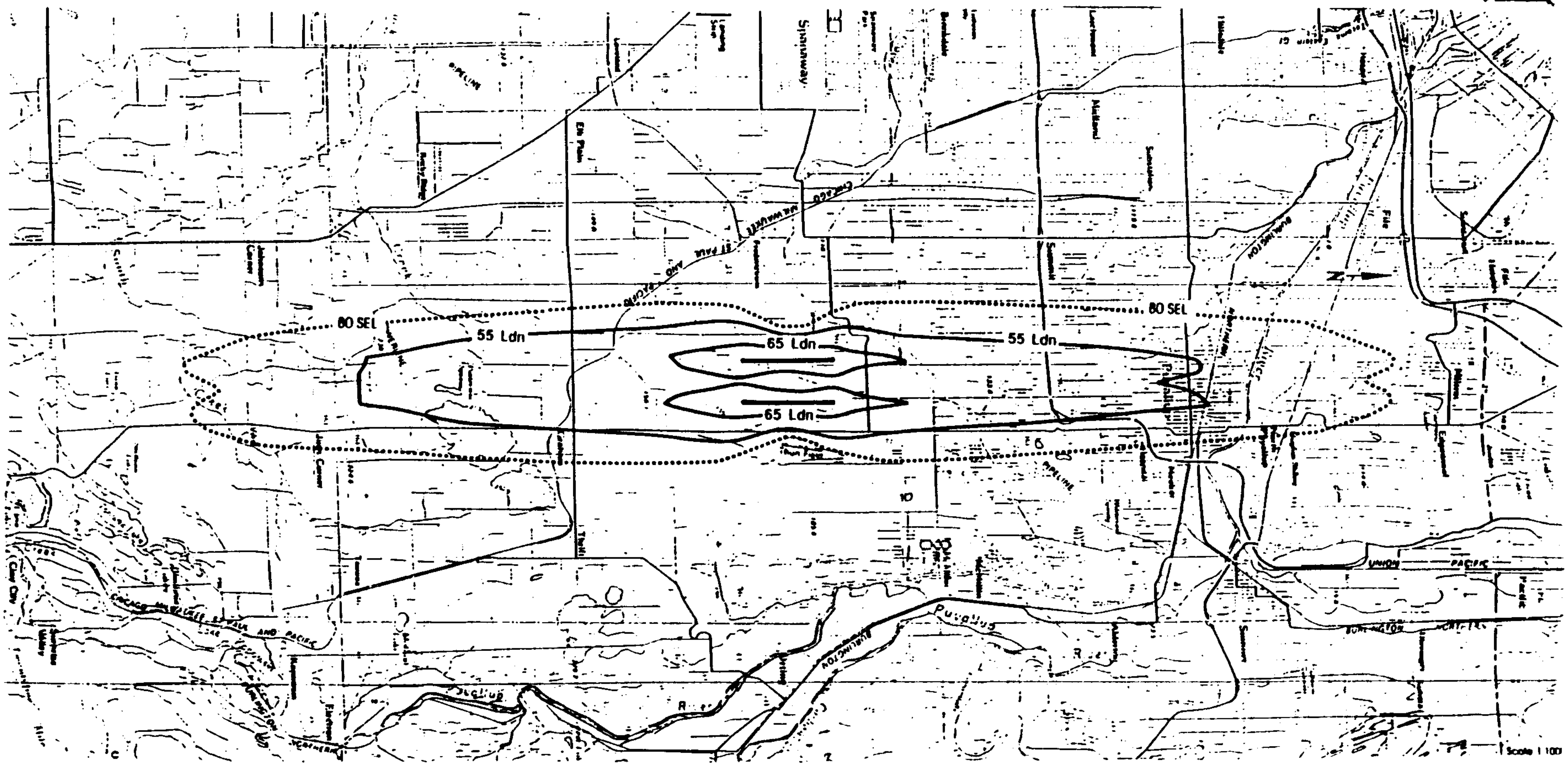


Exhibit CP-3

2020 Central Pierce Supplemental Airport 2 R/W - 13.0 MA

Alternative

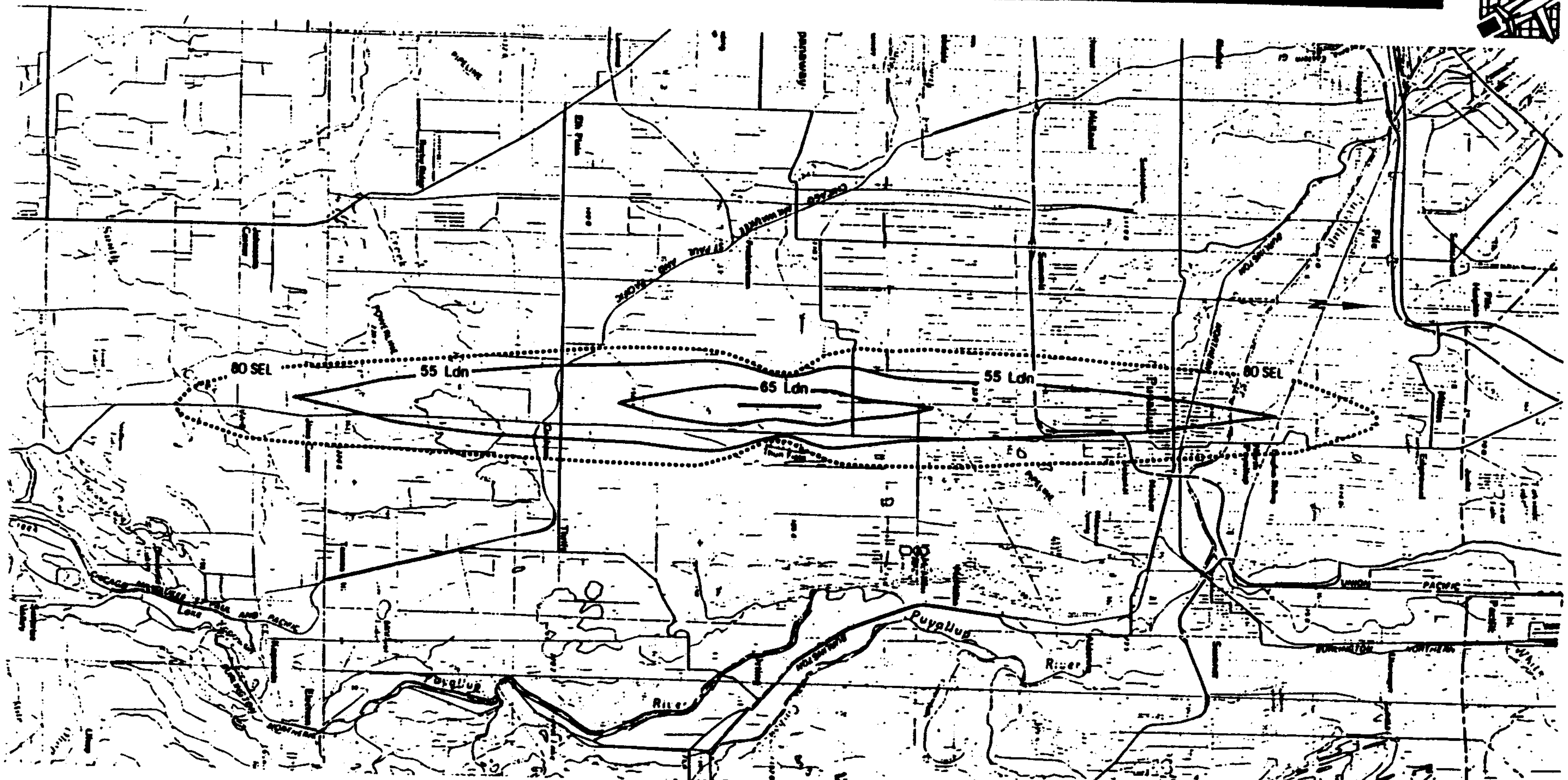


Exhibit CP-2

2020 Central Pierce Supplemental Airport 1 R/W - 10.9 MAP

Alternative 6

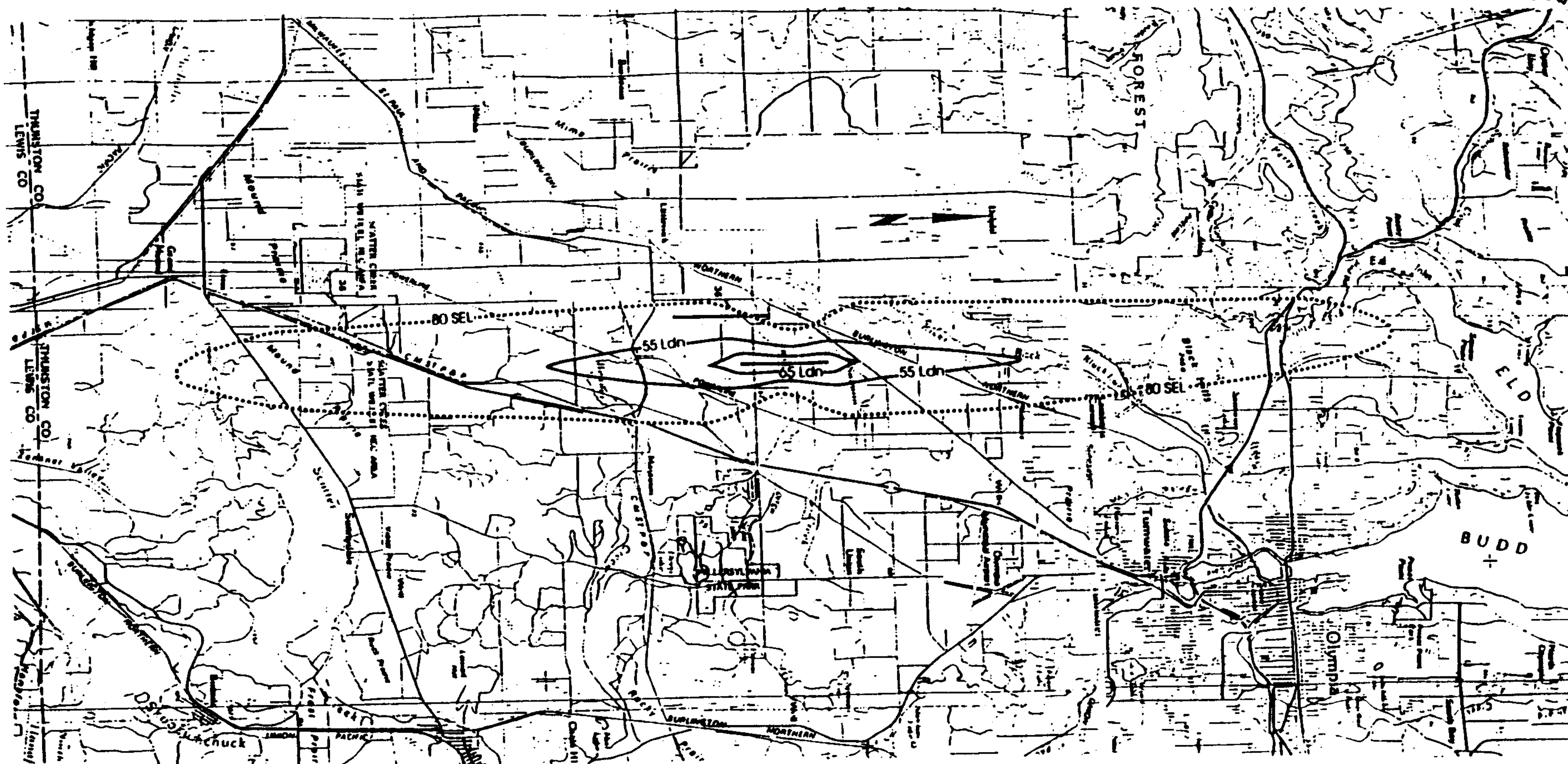


Exhibit
OB-1

Olympia/Blacklake Supplemental Airport 1 R/W - 1.3 MAP

Alternatives 29 & 30

AR 038183

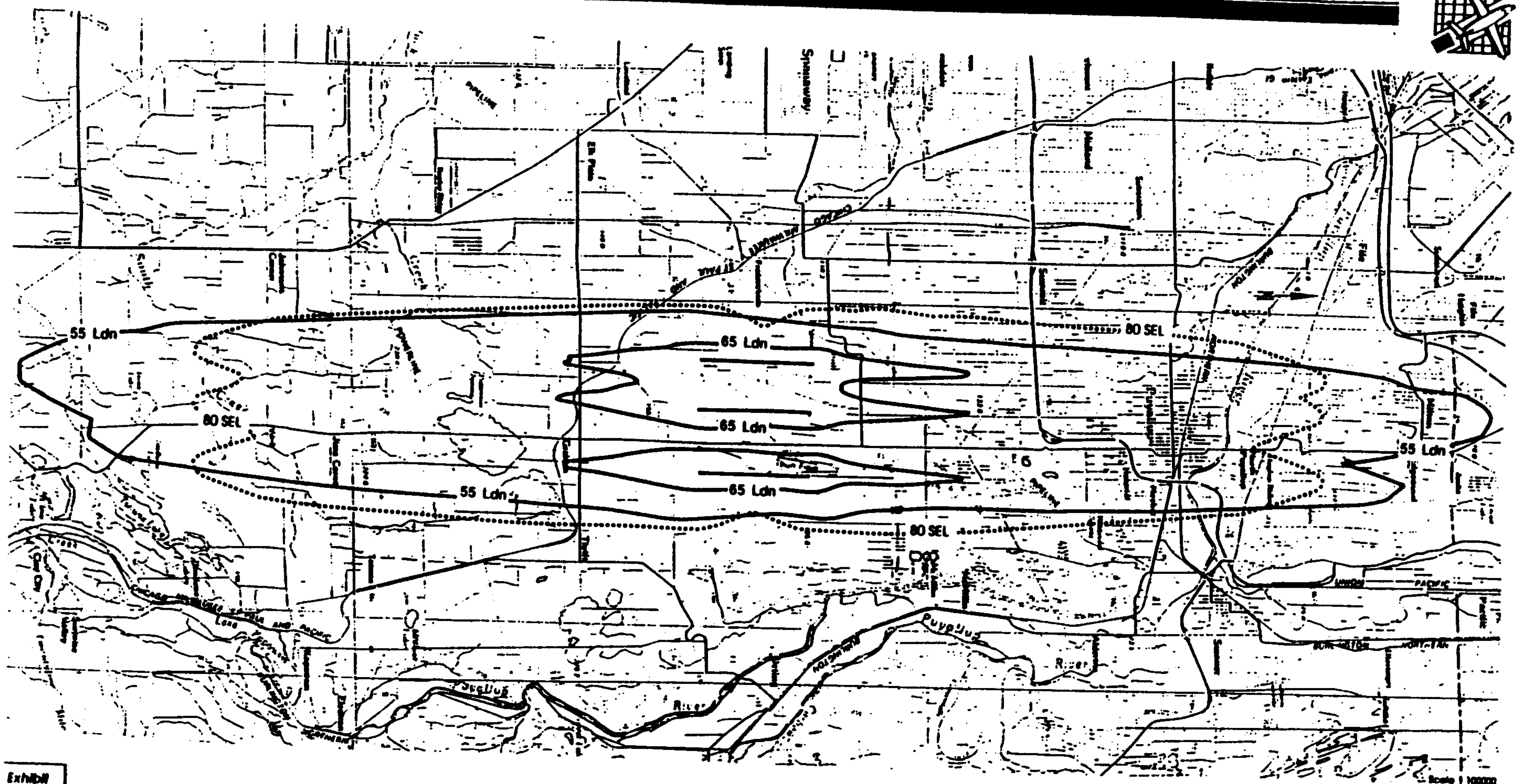
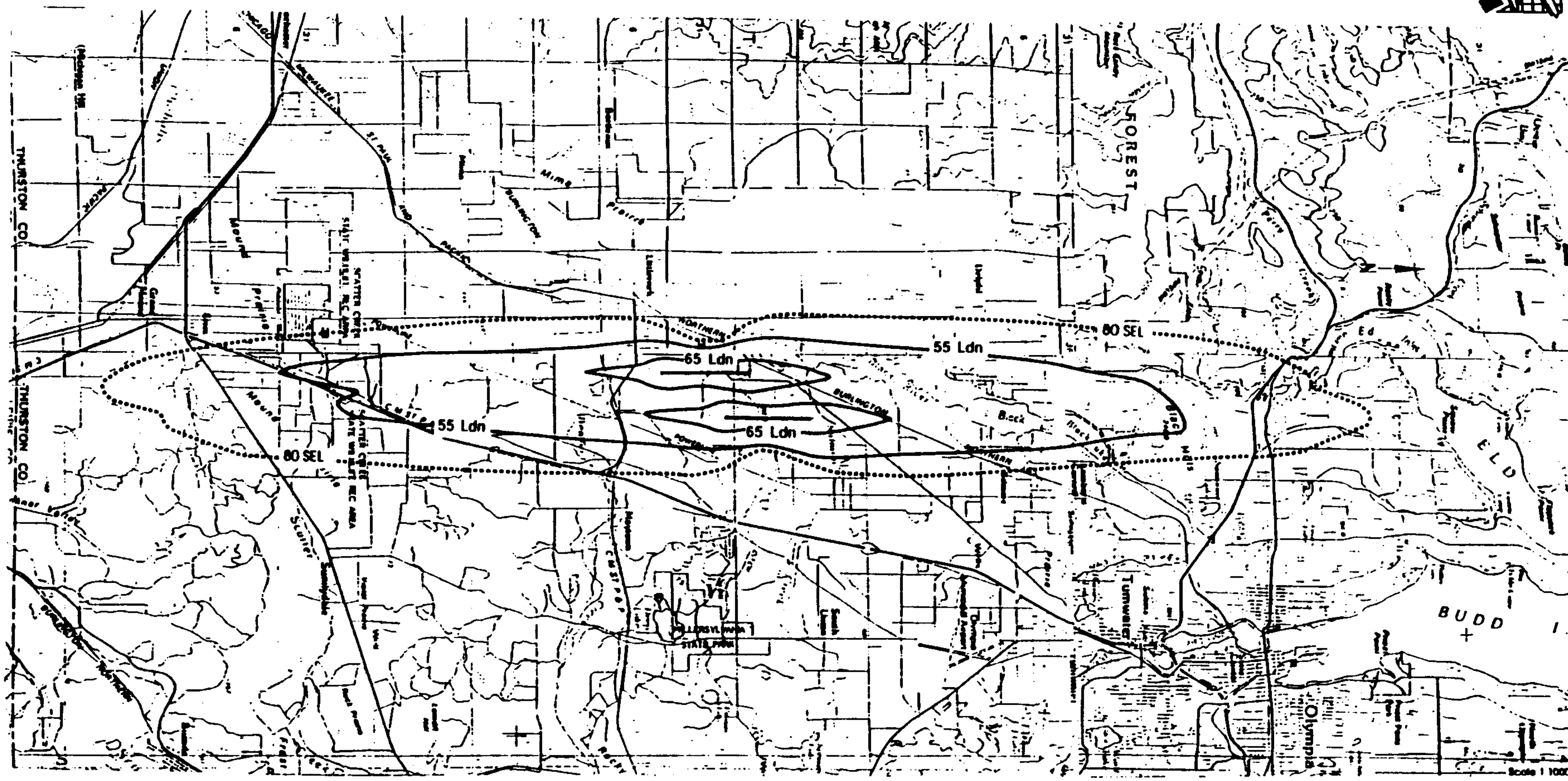


Exhibit CP-4

2020 Central Pierce Replacement Airport 3 R/W - 45.0 MAP

Alternative 31



xhibit
OB-3

2020 Olympia/Blacklake Supplemental Airport 2 R/W - 13.0 MAP
Alternative 12

AR 038185

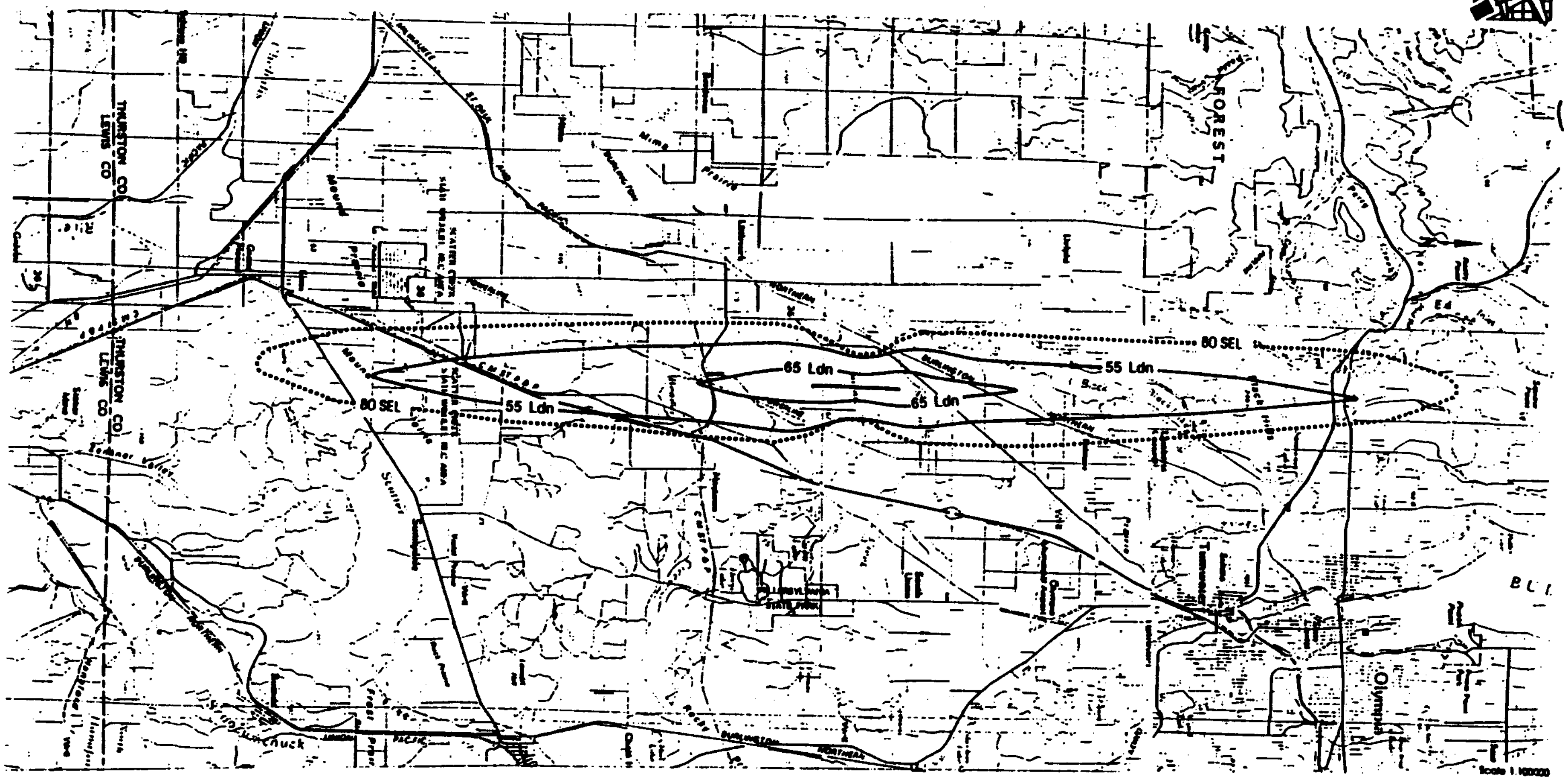


Exhibit	OB-2

2020 Olympia/Blacklake Supplemental Airport 1 R/W - 10.9 MAP

Alternative 7

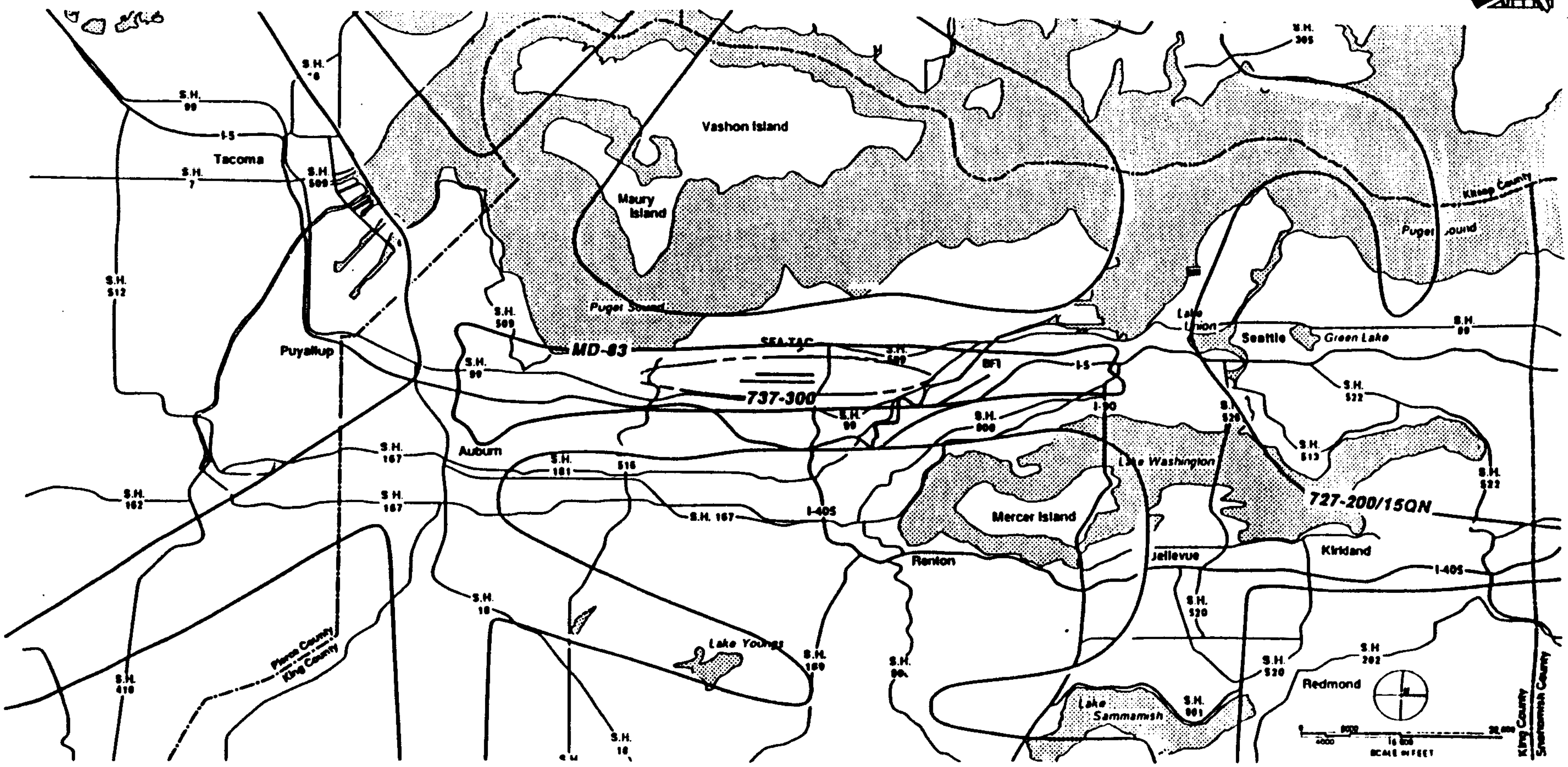


Exhibit
E - 1

Composite 80 SEL Noise Contours (727-200,737-300 & MD83)

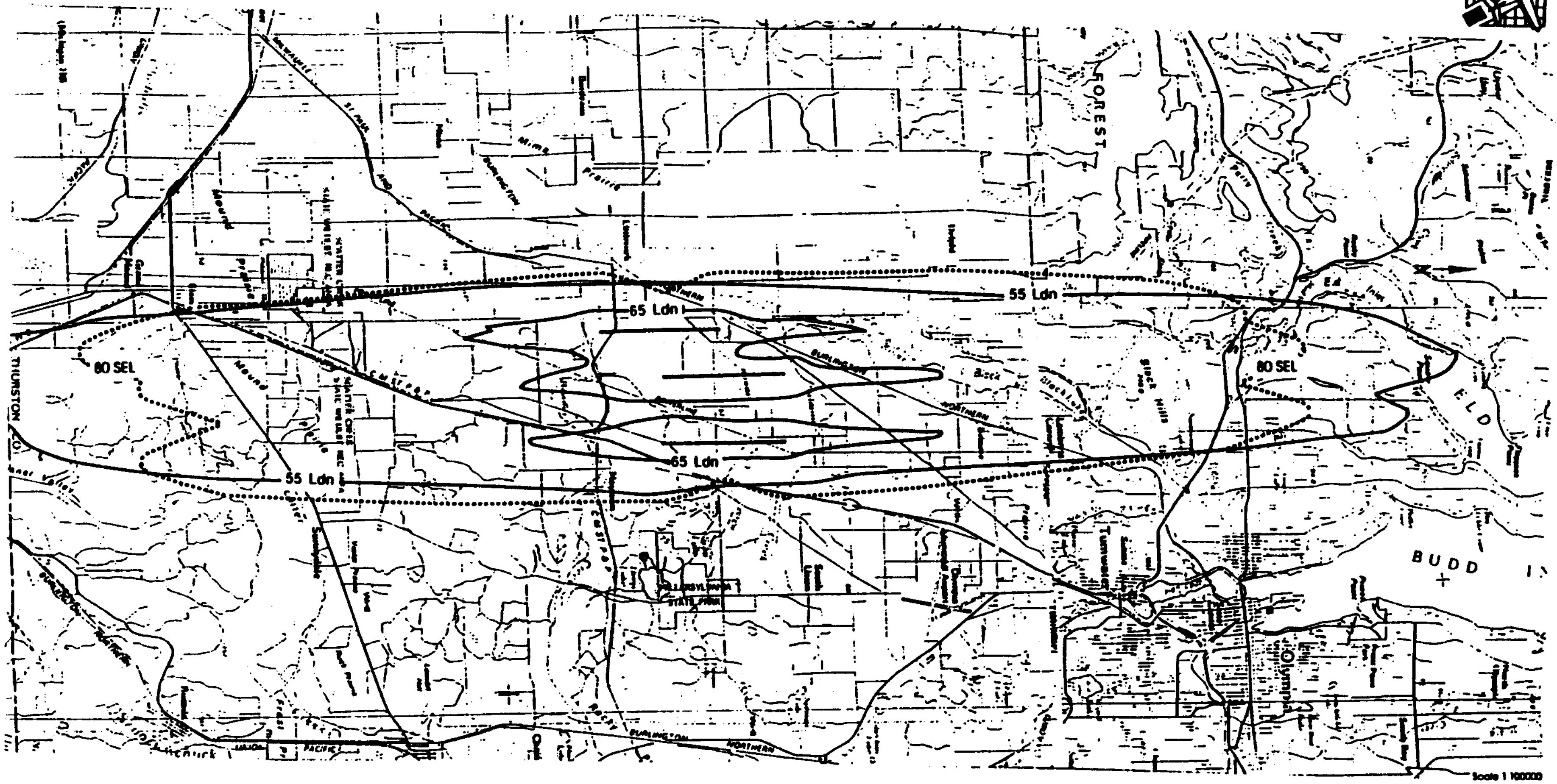
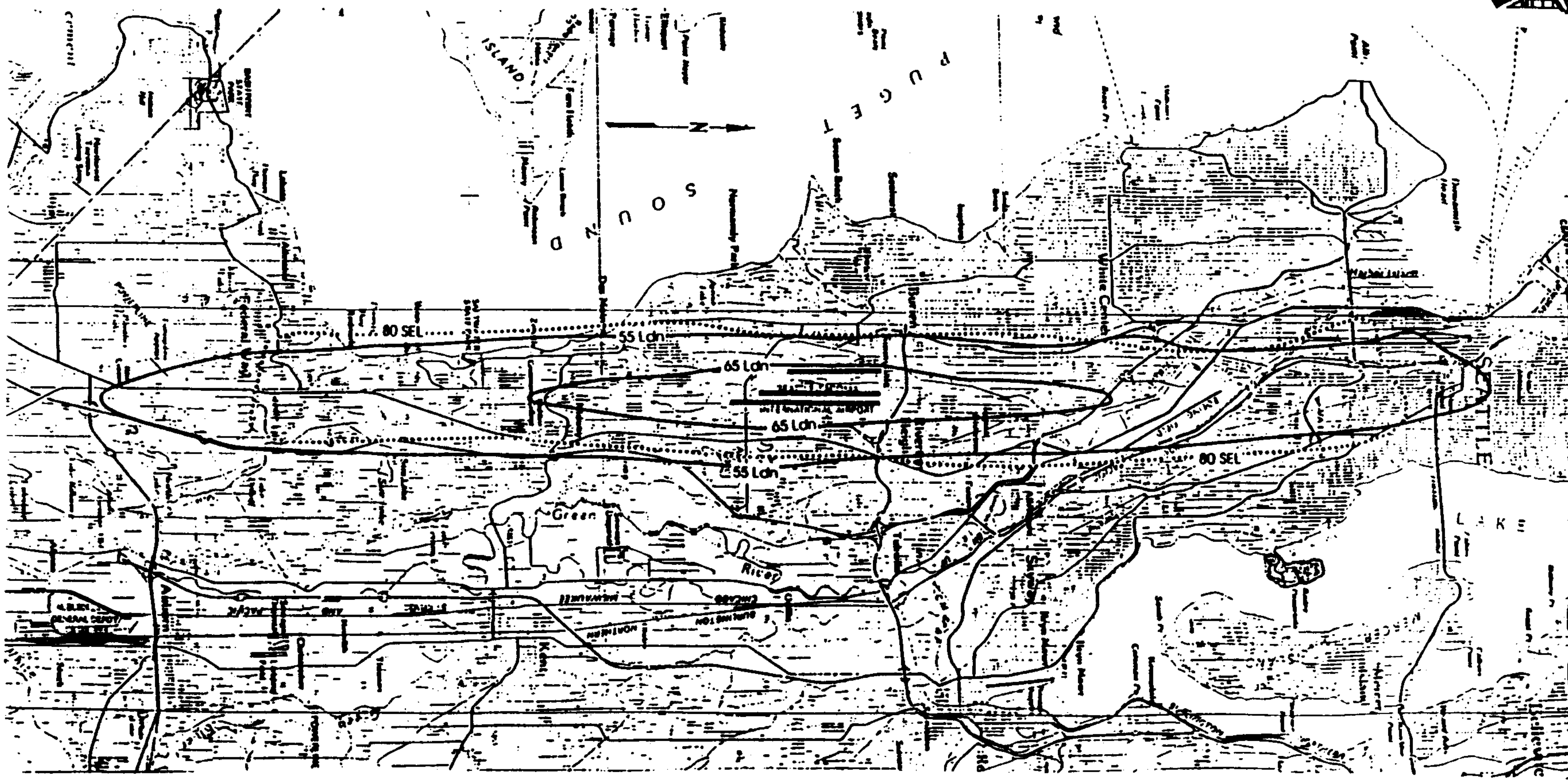


Exhibit	2020 Olympia/Blacklake Replacement Airport 3 R/W - 45.0 MAP
OB-4	Alternative 32

ne Flight Plan Project Phase III

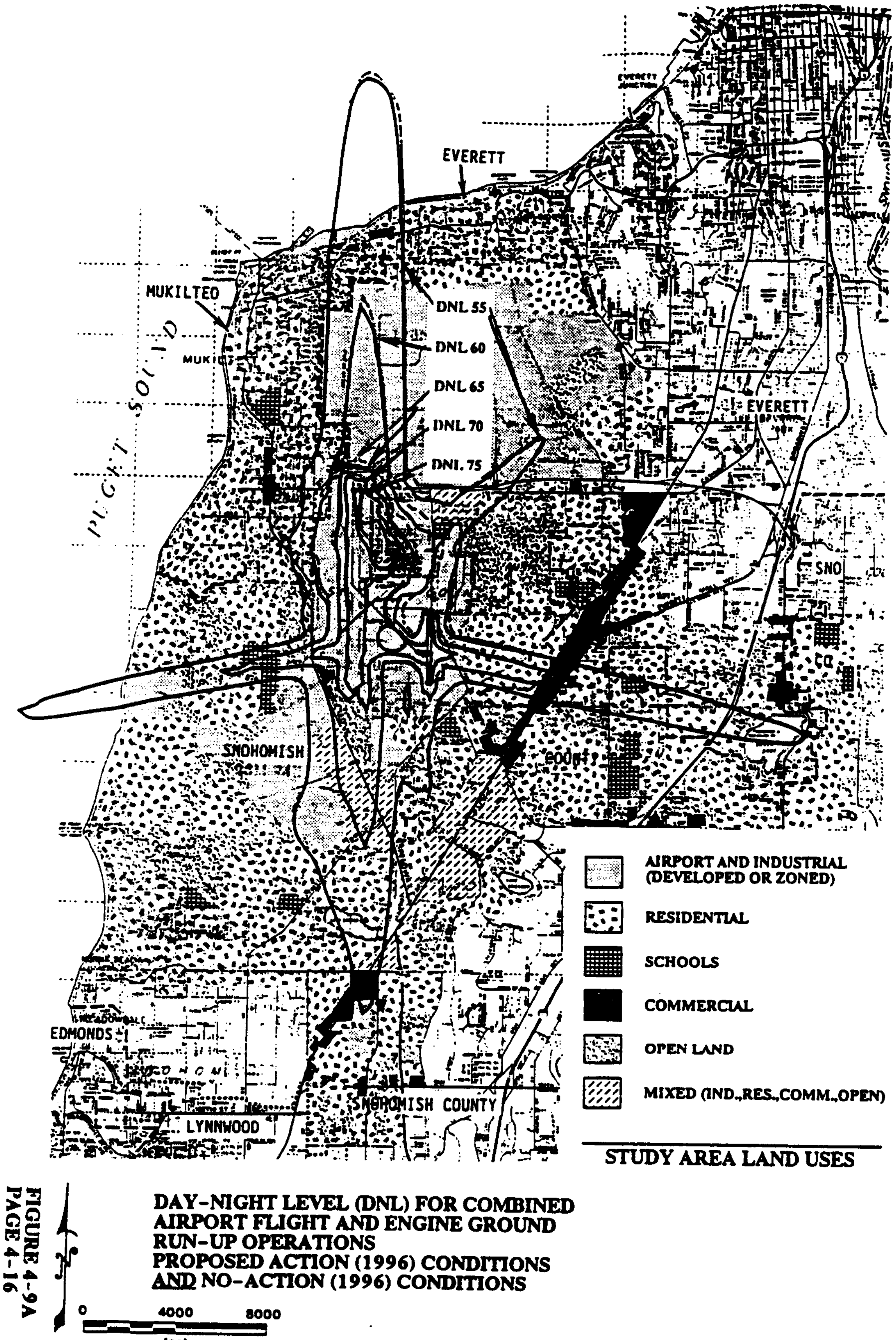
UGET SOUND AIR TRANSPORTATION COMMITTEE



Exhibit

Sea-Tac with Restricted Dependent Runway - 37.4 MAP

430,000 Annual Operations



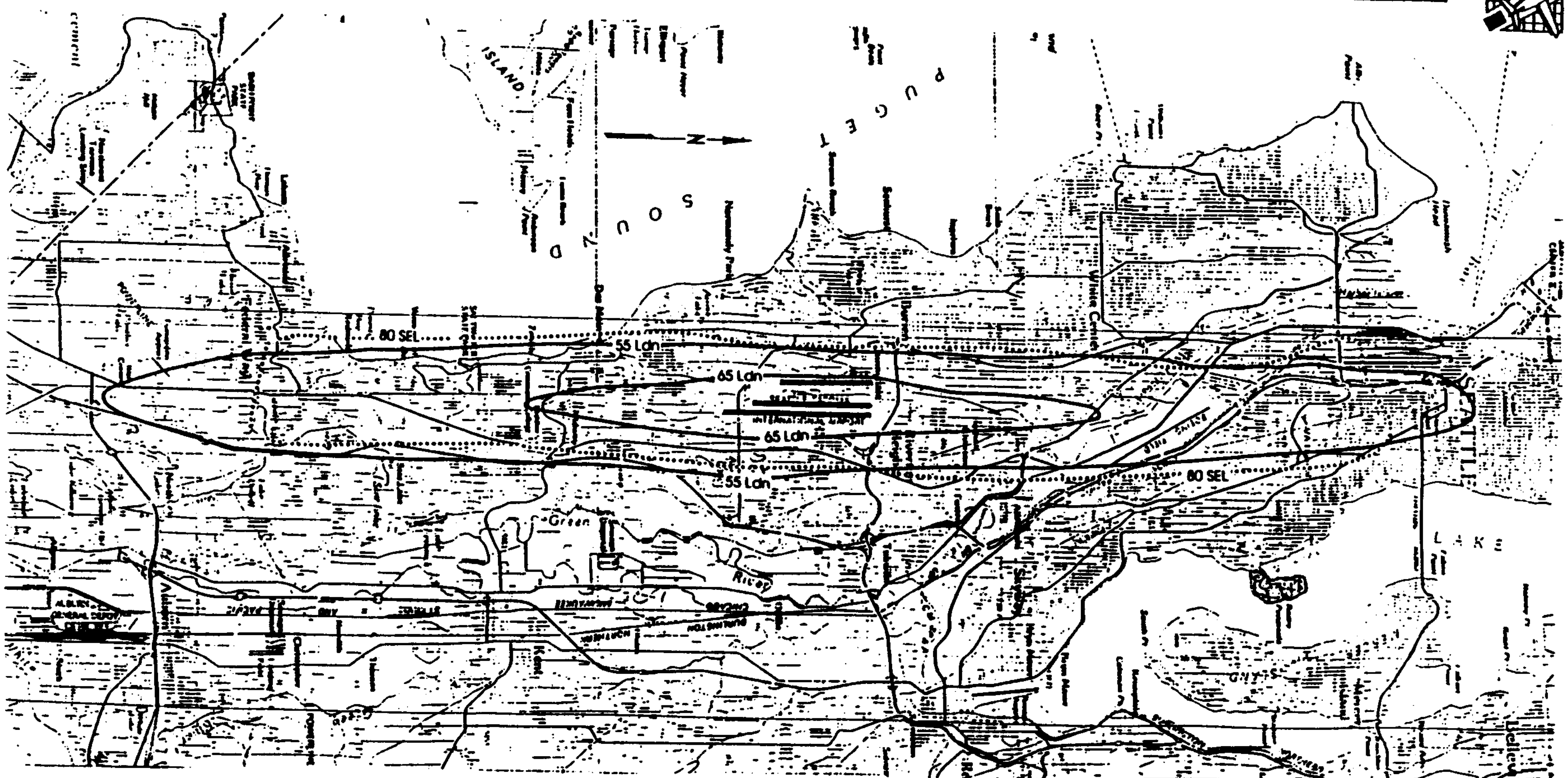
DAY-NIGHT LEVEL (DNL) FOR COMBINED AIRPORT FLIGHT AND ENGINE GROUND RUN-UP OPERATIONS
PROPOSED ACTION (1996) CONDITIONS AND NO-ACTION (1996) CONDITIONS

FIGURE 4-9A
PAGE 4-16

Seatac Integrated Noise Model Assumptions

Alt.	Airport System Alternatives	Seatac Annual Operations (x1000)	Seatac MAP	Dependent Runway Utilization
1	Sea-Tac without Commuter R/W	380	32	N/A
2	Sea-Tac with Commuter R/W	410	34.9	Commuter Only
3	Alternate 1 + Arlington 1 R/W	380	32	N/A
4	Alternate 1 + Paine 1 R/W	380	32	N/A
5	Alternate 1 + McChord 1 R/W	380	32	N/A
6	Alternate 1 + Central Pierce 1 R/W	380	32	N/A
7	Alternate 1 + Olympia/Black Lake 1 R/W	380	32	N/A
8	Alternate 1 + Arlington 2 R/W	380	32	N/A
9	Alternate 1 + Paine 2 R/W	380	32	N/A
10	Alternate 1 + McChord 2 R/W	380	32	N/A
11	Alternate 1 + Central Pierce 2 R/W	380	32	N/A
12	Alternate 1 + Olympia/Black Lake 2 R/W	380	32	N/A
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	480	41.8	33% of all operations
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	477.7	41.6	33% of all operations
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	480	41.8	33% of all operations
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	478.9	41.7	33% of all operations
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	480	41.8	33% of all operations
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	480	41.8	33% of all operations
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	477.7	41.6	33% of all operations
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	480	41.8	33% of all operations
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	478.9	41.7	33% of all operations
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	480	41.8	33% of all operations
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	380	32	N/A
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	380	32	N/A
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	380	32	N/A
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	380	32	N/A
27	Alternate 13+ Central Pierce 1 R/W	453.6	39.5	33% of all operations
28	Alternate 14+Central Pierce 1 R/W	439.8	38.3	33% of all operations
29	Alternate 13+Olympia/Black Lake 1 R/W	476.6	41.5	33% of all operations
30	Alternate 14+Olympia/Black Lake 1 R/W	462.8	40.3	33% of all operations
31	Central Pierce 3 R/W	N/A	N/A	N/A
32	Olympia/Black Lake 3 R/W	N/A	N/A	N/A
33	Central Pierce/Fort Lewis 3 R/W	N/A	N/A	N/A
34	Alternate 1 + Demand Management	380	38	N/A
*	Sea-Tac w/Dependent R/W Mitigated	-	-	33% of Daytime Arrivals
**	Sea-Tac w/Restricted R/W Utilizing Side-step	430	37.4	Daytime Commuter ***

*** Side-step Maneuver utilized by 20% of daytime air carrier aircraft, initiated at 4 nautical mi. and concludes at 1.6 nautical mi. to runway 16R/34L



Exhibit

* Aircraft thrust increased during side-step maneuver

Sea-Tac with Restricted Dependent Runway - 37.4 MAP

430,000 Annual Operations

APPENDIX 2

Working Paper 12B, Air Quality Assessment

DATE: November 6, 1991

TO: Puget Sound Transportation Committee

FROM: Mestre Greve Associates/P&D Aviation

SUBJECT: **WORKING PAPER NO. 12B - AIR QUALITY ASSESSMENT**
(12.21)

INTRODUCTION

The purpose of this report is to determine the potential air quality impacts attributable to each of the airport system alternatives. The potential impacts of the alternatives are compared relative to the impacts on the regional air quality emissions within the Puget Sound area. The report discusses the potential future air pollutant emissions based on the general trend of jet aircraft emissions and on the airport-related vehicular emissions. Both the aircraft and vehicular traffic air pollutant emission levels were used in the comparison of each system alternative on the impacts on the regional air quality.

The report presents background information on issues important to the assessment of air quality impacts, projects the emissions for each of the sources of pollutants attributable to airport operations, and determines the total contribution to the regional air quality for each of the system alternatives. The air quality analysis is based on 2020 aircraft operational levels, passenger demands, and pollutant emission factors.

SUMMARY

The results of the air quality analysis are summarized in Table 12B-1. This table presents an emission inventory of selected pollutants for each of the system alternatives. This data is presented for both the carbon monoxide (CO) emissions and the nitrogen oxides (NOx) emissions. Carbon monoxide emissions are best used to indicate the impacts from vehicular traffic because the CO emissions in the Puget Sound area are primarily the result of vehicular traffic. The NOx emissions are best used to indicate the impacts from both traffic and aircraft operations combined because both these sources contribute to the secondary pollutants of which NOx is an important factor.

Table 12B-1
2020 EMISSIONS COMPARSION FOR EACH SYSTEM ALTERNATIVE

	Traffic Emissions		Aircraft Emissions		Total Emissions		
	CO (tons/day)	NOX (tons/day)	CO (tons/day)	NOX (tons/day)	CO (tons/day)	NOX (tons/day)	RANKING (1 Best)
SEA-TAC AIRPORT SYSTEMS							
EXISTING SEA-TAC WITH MAXIMUM DEMAND MANAGEMENT	26-37	4.2-5.9	9-10	3.6-3.9	36-46	7.8-9.5	4*
REPLACEMENT AIRPORT SYSTEM							
REPLACEMENT AIRPORT	68-78	10.9-12.4	7	4.6	76-85	15.5-17.0	5
TWO AIRPORT SYSTEMS							
EXISTING SEA-TAC + SUPP(1 RWY)	20-35	3.2-5.6	10-12	4.7	30-47	7.9-10.2	4*
EXISTING SEA-TAC + SUPP(2 RWY)	20-38	3.2-6.0	11	4.7	30-48	7.9-10.8	4
SEA-TAC WITH NEW AC RWY+SUPP(1 RWY)	22-27	3.6-4.3	10-11	4.7-4.8	33-38	8.3-9.1	3
SEA-TAC WITH NEW AC RWY+SUPP(2RWY)	22-27	3.6-4.3	10-11	4.7	33-38	8.3-9.1	3
THREE AIRPORT SYSTEMS							
EXISTING SEA-TAC + 2 SUPP(1 RWY)	18-26	2.9-4.1	10-11	4.7-4.8	29-36	7.7-8.9	2
SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)	21-25	3.3-3.9	9-10	4.5-4.7	28-35	7.8-8.6	1

* Denotes System Alternatives that include Airport Development Alternatives that do not meet System Capacity Demands

NOTE: *Figures have been updated subsequent to PSATC adoption using new and more-refined data.*

Table 12B-1
2020 EMISSIONS COMPARSION FOR EACH SYSTEM ALTERNATIVE

	Traffic Emissions		Aircraft Emissions		Total Emissions		
	CO (tons/day)	NOX (tons/day)	CO (tons/day)	NOX (tons/day)	CO (tons/day)	NOX (tons/day)	RANKING (1 Best)
SEA-TAC AIRPORT SYSTEMS							
EXISTING SEA-TAC WITH MAXIMUM DEMAND MANAGEMENT	26-37	4.2-5.9	9-10	3.6-3.9	36-46	7.8-9.5	3*
REPLACEMENT AIRPORT SYSTEM							
REPLACEMENT AIRPORT	68-78	10.9-12.4	7	4.6	76-85	15.5-17.0	4
TWO AIRPORT SYSTEMS							
EXISTING SEA-TAC + SUPP(1 RWY)	20-35	3.2-5.6	10-12	4.7	30-47	7.9-10.2	2*
EXISTING SEA-TAC + SUPP(2 RWY)	20-38	3.2-6.0	11	4.7	30-48	7.9-10.8	2
SEA-TAC WITH NEW AC RWY+SUPP(1 RWY)	22-27	3.6-4.3	10-11	4.7-4.8	33-38	8.3-9.1	2
SEA-TAC WITH NEW AC RWY+SUPP(2RWY)	22-27	3.6-4.3	10-11	4.7	33-38	8.3-9.1	2
THREE AIRPORT SYSTEMS							
EXISTING SEA-TAC + 2 SUPP(1 RWY)	18-26	2.9-4.1	10-11	4.7-4.8	29-36	7.7-8.9	1
SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)	21-25	3.3-3.9	9-10	4.5-4.7	28-35	7.8-8.6	1

* Denotes System Alternatives that include Airport Development Alternatives that do not meet System Capacity Demands

NOTE: *Figures have been updated subsequent to PSATC adoption using new and more-refined data.*

Table 12B-1 also ranks the alternatives in the order that the consultant considers to be most favorable in terms of air quality impacts. The important findings from the air quality analysis and the basis for these findings are listed below:

- The results show that for the system alternatives that meet forecast demand, the three-airport system alternative with and without the dependent runway at Sea-Tac are considered the most favorable. This is because the emissions are less with these system alternative as a result of a reduction of vehicular travel distances and a reduction in aircraft delays. The three-airport system alternative with the dependent runway at Sea-Tac shows some slight preference because it has the lower aircraft delays as well as reduced travel distances.

- A multiple airport system locates more airport sites throughout the region so the average driving distance to the airport(s) is less. Supplemental airport sites such as Paine Field and McChord that are located closer to the population centers are more favorable than sites such as Arlington or Olympia/Black Lake that are located further from populated areas.

- The emissions from aircraft operations are less with alternatives that include the dependent runway at Sea-Tac as a result of the reduction in aircraft delays that will occur when the airport is not operating at capacity.

- Of those alternatives that meet forecast demand, the replacement-airport alternatives showed the least amount of aircraft emissions because the aircraft delays are significantly less as a result of the elimination of Sea-Tac. However, this alternative was rated the worst in terms of overall air quality because of the very long travel distances to the potential airport sites.

- Airport related CO emissions are projected to constitute less than 4% of the total regional CO emissions in the four county area in the year 2020. Increased transit use and other transportation demand management techniques as well as airport emissions mitigation measures have the potential to further reduce commercial aviation contribution to regional air quality.

- The air quality impacts from all of the alternative airport systems can be partially mitigated through transportation measures and improvements. Those sites that are located near the proposed light rail line (Sea-Tac and Paine Field) show the most potential for trip reduction through increased transit use.

BACKGROUND INFORMATION ON AIR QUALITY

Criteria Pollutants and Health Effects

Air pollutants are divided into two categories. The first is primary pollutants. These are the pollutants that are directly emitted from a source. Primary pollutants include carbon monoxide, nitrogen oxides, hydrocarbons, sulfur oxides, and particulates. The other category of pollutants is secondary pollutants. Secondary pollutants are those pollutants that result from chemical reactions between other pollutants in the atmosphere. Ozone is a secondary pollutant that is not directly emitted by any source but a result of reactions between nitrogen oxides and hydrocarbons.

The nature of the pollutants emitted from airports is the same as those emitted from other transportation projects. Carbon monoxide, sulfur and nitrogen oxides, and unburned hydrocarbons are common pollutants emitted from the combustion processes. Six criteria pollutants regulated by federal standards are ozone, carbon monoxide, particulates and nitrogen dioxide, sulfur dioxide and lead. They are described below.

Ozone (O3) is a colorless gas which comes from the reaction of hydrocarbons and oxides of nitrogen in the presence of sunlight. Although ozone is the air contaminant for which standards are set, its precursors, hydrocarbons and nitrogen oxides, are the pollutants which must be controlled. Ozone results in eye irritation and damage to lung tissues, reduced resistance to colds and pneumonia, and aggravates heart disease, asthma, bronchitis and emphysema.

Carbon monoxide (CO) is a colorless, odorless and toxic gas produced by incomplete combustion of carbon-contaning substances. The highest ambient concentrations of carbon monoxide occur near congested roadways and intersections during periods of low temperatures, light winds, and stable atmospheric conditions. CO has been shown to interfere with oxygen transport in the blood, produce cardiovascular disease, and decrease visual perception. CO has also been associated with lower birth weight and increased deaths of infants in highly polluted areas.

Particulate matter which is composed of particles 10 microns or less in diameter is referred to as PM10 , and is the inhalable subgroup of total suspended particulates (TSP). Suspended particles aggravate chronic heart and lung disease and often transport toxic elements such as lead, arsenic, nickel, which can enter respiratory, digestive and lymphatic systems.

Hydrocarbons (HC) result from the release of unburned fuel or incomplete combustion of fuel. HC plays a very important role in determining regional air quality. HC react with nitrogen oxides in the presence of sunlight to form ozone and nitrogen dioxide. The amount of ozone formed is more related to the amounts of HC released than to any other pollutant.

Table 12B-2
Aircraft Emissions (Year 2020)

ALT	AIRPORT	CO (tons/day)	NOx (tons/day)	SOx (tons/day)	PART (tons/day)	HC (tons/day)
1	* Sea-Tac without Commuter R/W	9.4	3.6	0.3	0.1	2.8
2	* Sea-Tac with Commuter R/W	9.8	3.9	0.4	0.1	2.9
3	* Alternate 1 + Arlington 1 R/W	11.8	4.7	0.4	0.2	3.5
4	Alternate 1 + Paine 1 R/W	10.4	4.7	0.4	0.1	3.0
5	Alternate 1 + McChord 1 R/W	10.4	4.7	0.4	0.1	3.0
6	* Alternate 1 + Central Pierce 1 R/W	11.8	4.7	0.4	0.2	3.5
7	* Alternate 1 + Olympia/Black Lake 1 R/W	11.8	4.7	0.4	0.2	3.5
8	Alternate 1 + Arlington 2 R/W	10.5	4.7	0.4	0.1	3.1
9	Alternate 1 + Paine 2 R/W	10.3	4.7	0.4	0.1	3.0
10	Alternate 1 + McChord 2 R/W	10.3	4.7	0.4	0.1	3.0
11	Alternate 1 + Central Pierce 2 R/W	10.5	4.7	0.4	0.1	3.1
12	Alternate 1 + Olympia/Black Lake 2 R/W	10.5	4.7	0.4	0.1	3.1
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	10.8	4.8	0.4	0.1	3.2
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	10.3	4.7	0.4	0.1	3.0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	10.6	4.7	0.4	0.1	3.1
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	10.5	4.7	0.4	0.1	3.1
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	10.6	4.7	0.4	0.1	3.1
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	10.6	4.7	0.4	0.1	3.1
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	10.3	4.7	0.4	0.1	3.0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	10.6	4.7	0.4	0.1	3.1
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	10.5	4.7	0.4	0.1	3.1
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	10.6	4.7	0.4	0.1	3.1
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	10.6	4.8	0.4	0.1	3.1
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	10.4	4.7	0.4	0.1	3.1
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R	10.6	4.8	0.4	0.1	3.1
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	10.4	4.7	0.4	0.1	3.1
27	Alternate 13+ Central Pierce 1 R/W	8.3	4.6	0.4	0.1	2.4
28	Alternate 14+Central Pierce 1 R/W	7.6	4.5	0.4	0.1	2.2
29	Alternate 13+Olympia/Black Lake 1 R/W	10.2	4.7	0.4	0.1	3.0
30	Alternate 14+Olympia/Black Lake 1 R/W	9.0	4.6	0.4	0.1	2.7
31	Central Pierce 3 R/W	7.3	4.6	0.4	0.1	2.1
32	Olympia/Black Lake 3 R/W	7.3	4.6	0.4	0.1	2.1
33	Central Pierce/Fort Lewis 3 R/W	7.4	4.6	0.4	0.1	2.2
34	* Alternate 1 + Demand Management	9.4	3.6	0.3	0.1	2.8

* Alternative which does not meet system capacity demand.

NOTE: *Figures have been updated subsequent to PSATC adoption using new and more-refined data.*

Table 12B-3
Vehicular Traffic Emissions (Year 2020)

ALT	AIRPORT	CO (Tons/day)	NOx (Tons/day)	SOx (Tons/day)	PART (Tons/day)	HC (Tons/day)
1	* Sea-Tac without Commuter R/W	26.2	4.2	0.5	0.6	4.6
2	* Sea-Tac with Commuter R/W	28.7	4.6	0.6	0.6	5.0
3	* Alternate 1 + Arlington 1 R/W	27.2	4.4	0.5	0.6	4.8
4	Alternate 1 + Paine 1 R/W	19.8	3.2	0.4	0.4	3.5
5	Alternate 1 + McChord 1 R/W	27.2	4.3	0.5	0.6	4.8
6	* Alternate 1 + Central Pierce 1 R/W	26.8	4.3	0.5	0.6	4.7
7	* Alternate 1 + Olympia/Black Lake 1 R/W	34.9	5.6	0.7	0.8	6.1
8	Alternate 1 + Arlington 2 R/W	28.3	4.5	0.6	0.6	5.0
9	Alternate 1 + Paine 2 R/W	19.8	3.2	0.4	0.4	3.5
10	Alternate 1 + McChord 2 R/W	27.2	4.3	0.5	0.6	4.8
11	Alternate 1 + Central Pierce 2 R/W	28.5	4.6	0.6	0.6	5.0
12	Alternate 1 + Olympia/Black Lake 2 R/W	37.7	6.0	0.7	0.8	6.6
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	23.6	3.8	0.5	0.5	4.1
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	22.3	3.6	0.4	0.5	3.9
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	24.6	3.9	0.5	0.5	4.3
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	24.6	3.9	0.5	0.5	4.3
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	27.1	4.3	0.5	0.6	4.8
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	23.6	3.8	0.5	0.5	4.1
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	22.3	3.6	0.4	0.5	3.9
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	24.4	3.9	0.5	0.5	4.3
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	24.6	3.9	0.5	0.5	4.3
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	27.1	4.3	0.5	0.6	4.8
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	21.6	3.4	0.4	0.5	3.8
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	18.3	2.9	0.4	0.4	3.2
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R	25.7	4.1	0.5	0.6	4.5
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	21.7	3.5	0.4	0.5	3.8
27	Alternate 13+ Central Pierce 1 R/W	22.1	3.5	0.4	0.5	3.9
28	Alternate 14+Central Pierce 1 R/W	20.7	3.3	0.4	0.5	3.6
29	Alternate 13+Olympia/Black Lake 1 R/W	24.5	3.9	0.5	0.5	4.3
30	Alternate 14+Olympia/Black Lake 1 R/W	22.8	3.6	0.4	0.5	4.0
31	Central Pierce 3 R/W	68.3	10.9	1.3	1.5	12.0
32	Olympia/Black Lake 3 R/W	77.5	12.4	1.5	1.7	13.6
33	Central Pierce/Fort Lewis 3 R/W	68.3	10.9	1.3	1.5	12.0
34	* Alternate 1 + Demand Management	36.7	5.9	0.7	0.8	6.4

* Alternative which does not meet system capacity demand.

NOTE: *Figures have been updated subsequent to PSATC adoption using new and more-refined data.*

AR 038200

Sulfur dioxide (SO_2) is a nonflammable, non explosive, colorless gas. It reacts in the atmosphere to form sulfur trioxides (SO_3) and sulfuric acid. SO_2, sulfuric acid, and other inorganic sulfates have been shown to produce asthma which decreases human respiratory function both at the acute and chronic levels. SO_2 also contributes to acid deposition.

Nitrogen oxides (NO, NO_2 & NO_x) result from the high temperature oxidation of nitrogen present in air. In the presence of moisture, NO can form particulates by coalescing, reducing visibility and contributing to acid deposition. NO_2, like sulfur dioxide, is also a bronchoconstrictor that can cause irritation and injury to the lungs. NO_x is more of a factor in the generation of secondary pollutants such as ozone.

Air Quality Standards

The Federal Clean Air Act, as amended in 1977, required states to have State Implementation plans (SIP) to achieve established air quality goals. The result is the National Ambient Air Quality Standards (NAAQS). The Federal Clean Air Act requires that urban areas which do not meet standards for carbon monoxide (CO) and/or photochemical oxidants (ozone) must implement transportation plans to achieve the standards for these pollutants. Washington State and the Puget Sound region have adopted ambient air quality standards.

The Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) in the Clean Air Act of 1970. These standards have been established for both the primary and secondary pollutants: ozone, carbon monoxide, particulates and nitrogen dioxide, sulfur dioxide and lead. Areas that exceed these standards are considered non attainment areas and a plan must be developed to ultimately bring the area into compliance. CO is one of the major air pollutant problems within the Puget Sound Region. For the Puget Sound area, CO is primarily a problem associated with motor vehicles.

The Clean Air Act, Title II, Part B, directs the EPA to establish aircraft emission standards throughout the United States. The Code of Federal Regulations volume 40, part 87 contains engine emission standards that apply only to large commercial passenger jets. The FAA is responsible for implementing the standards through engine certification data provided by the manufacturers. These regulations do not extend to piston powered, smaller turbofan or military aircraft.

Existing Air Quality

The Washington State Department of Ecology and the Puget Sound Air Pollution Control Agency (PSAPCA) maintain a network of instrumented air quality monitoring stations throughout the Puget Sound area. In general, these stations are located where the agencies believe there might be an air quality problem. Other stations are located in remote areas to measure regional or background air pollution levels.

The PSRC region, which includes Snohomish, King and Pierce Counties, is currently in non-attainment for CO emissions. Recently (March 1991) the EPA has reportedly determined that Snohomish, King and Pierce Counties have exceeded the national standards for ozone pollutants. On this basis, the EPA and the State of Washington are proposing that these three counties be designated non-attainment areas for ozone. EPA action with regard to the State's submittal for this non-attainment designation is currently scheduled for late 1991.

Aircraft operations at the existing Sea-Tac are currently a major source of air pollutant emissions in that local area and are currently under study by the Department of Ecology (Olympia, Washington, May 1991).

A downward trend in the ambient concentration of air pollutants generated by motor vehicles, especially CO, has been observed in the Puget Sound area over the past decade. The replacement of older vehicles with newer, cleaner ones, and vehicles meeting the requirements of the Inspection and Maintenance (I/M) program have been the major factors for reducing the CO emissions. CO emissions have been reduced by 13% in Seattle due to the I/M program (May 1991).

EMISSIONS CALCULATIONS

The main sources of air pollutants attributable to airports are aircraft traffic, motor vehicles, boilers, and fueling operations. Most of the airport emissions are generated by aircraft operations and motor vehicle traffic. Aircraft and motor vehicles together comprise a majority of the airport emissions. Other emissions due to tank farms, ground support vehicles, boilers and training fires are minor sources at the airport.

Aircraft Emissions

The quantity of pollutants emitted into the atmosphere from aircraft operations is a function of the type of aircraft and engine, mode of operation, and how long the engine is operated in each mode. Large jet aircraft operations produce the largest amount of airport pollutants. Small aircraft also contribute in the summation of an airport's emissions.

Aircraft engines emit CO, hydrocarbon, NOx, SOx, and particulates as by-products from the combustion process. The emission rates are determined by engine types. More CO and hydrocarbons are produced at low engine power settings, such as idling or at start-up because of incomplete combustion. The amount of NOx produced during start-up is small compared to that produced during takeoff. SO2 is a result of the oxidation of sulfur compounds in the aircraft fuel. Aircraft fuel is usually highly refined and contains only about 0.1% sulfur. Particulate matters emitted from the aircraft engines, particularly turbine engines, is extremely small in diameter ranging between 0.04 and 0.12 microns.

Aircraft emissions can be divided into idle, taxi, climb and approach. Climb and approach emissions, which are calculated from ground level up to 3500 feet, are the major source of nitrogen oxide emissions, and takeoffs contribute about 25% of the total aircraft NOx emissions. Sulfur oxide and particulate emissions are more evenly divided among the four aircraft modes with climb and approach still being the most significant contributing mode. Aircraft taxi and idle queues are the major source of carbon monoxide and hydrocarbons.

The Emissions and Dispersions Modeling System (EDMS) computer model, developed by the FAA and U.S. Air Force, was utilized to assess the projections of aircraft pollutant emissions. The number of operations per day and the length of time each type of aircraft spends in the queue mode was also required. All aircraft operations were estimated according to each of the airport development alternatives. These alternatives and the total concentration levels are presented in Table 12B-2. Operations data including fleet mix was obtained from the P&D Aviation - Allocation of Passengers and Aircraft Operations, August 1991. The operational data is presented in the Appendix of the noise assessment. Data on aircraft delays for each of the airport development alternatives was also provided by P&D Technologies.

The results of the emission inventory for aircraft operations are presented in Table 12B-2. The results indicate that the aircraft emissions are similar for all alternatives. This would be expected in that the alternatives are based on the same levels of aircraft activity. The exception is that the emissions are less for those alternatives that do not meet system capacity demand for 2020 (Alternatives 1, 2, 3, 6, 7 and 34). Emissions levels for these alternatives are less because the number of operations are less.

Of all the alternatives which meet the system capacity demand, the difference between the alternatives is the amount of aircraft delays that may occur under each scenario. The replacement-airport alternatives result in the least emissions. This is because these replacement-airports have the least amount of aircraft delays. The three-airport Alternative results in the next smallest emissions. This is again as a result of reduced delays because of more efficient operations at Sea-Tac.

The highest aircraft emissions are anticipated to result from the two-airport system. The higher level of emissions are a result of delays at Sea-Tac that would be anticipated to occur as the airport operated near capacity.

Motor Vehicle Emissions

Estimates of the emissions relating to vehicular traffic to and from each of the airport development alternatives were projected. The vehicle miles traveled per day were determined from the O/D passenger forecast and the average trip lengths for passengers traveling to each of the airports. The average trip length was determined from the PSRC travel area zones that determined the travel distance from each zone in the four counties. The number of passengers from each zone traveling to each site was then determined.

Emission factors for 2020 are based on MOBILE 4 and EMFAC7D model inputs program. These programs are computerized program which calculates the composite emission rates based on a number of factors such as vehicle operating mode, vehicle types, vehicle distribution, speed and temperature.

The emissions are projected for the year 2020. The total projected vehicular emissions are presented in Table 12B-3. The results show that the vehicular emissions for most scenarios are comparable. The least amount of emissions would be generated by the three-airport Alternatives. In general, the two and three-airport systems have the advantage of two or three airport locations. Since passengers are located closer to more airports, shorter average traveled trip lengths are anticipated. Sites such as Paine Field and McChord that are located closer to the population areas are more favorable then sites such as Arlington or Olympia/Black Lake that are located further from population areas.

Table 12B-4
Total Combined Aircraft and Vehicular Emissions (Year 2020)

ALT	AIRPORT	TOTAL CO (Tons/day)	TOTAL NOx (Tons/day)	TOTAL SOx (Tons/day)	TOTAL PART (Tons/day)	TOTAL HC (Tons/day)
1	* Sea-Tac without Commuter R/W	35.6	7.8	0.9	0.7	7.4
2	* Sea-Tac with Commuter R/W	38.5	8.4	0.9	0.8	7.9
3	* Alternate 1 + Arlington 1 R/W	39.0	9.0	1.0	0.7	8.3
4	Alternate 1 + Paine 1 R/W	30.1	7.9	0.8	0.6	6.5
5	Alternate 1 + McChord 1 R/W	37.5	9.1	1.0	0.7	7.8
6	* Alternate 1 + Central Pierce 1 R/W	38.6	9.0	1.0	0.7	8.2
7	* Alternate 1 + Olympia/Black Lake 1 R/W	46.7	10.2	1.1	0.9	9.6
8	Alternate 1 + Arlington 2 R/W	38.7	9.3	1.0	0.8	8.0
9	Alternate 1 + Paine 2 R/W	30.1	7.9	0.8	0.6	6.5
10	Alternate 1 + McChord 2 R/W	37.5	9.1	1.0	0.7	7.8
11	Alternate 1 + Central Pierce 2 R/W	39.0	9.3	1.0	0.8	8.1
12	Alternate 1 + Olympia/Black Lake 2 R/W	48.2	10.8	1.2	1.0	9.7
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	34.4	8.6	0.9	0.7	7.3
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	32.7	8.3	0.9	0.6	7.0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	35.2	8.7	0.9	0.7	7.4
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	35.1	8.7	0.9	0.7	7.4
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	37.7	9.1	1.0	0.7	7.9
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	34.2	8.5	0.9	0.7	7.3
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	32.7	8.3	0.9	0.6	7.0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	35.0	8.7	0.9	0.7	7.4
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	35.1	8.7	0.9	0.7	7.4
22	Sea-Tac w/Dependent R/W + Olym./Blk Lake 2 R/W	37.7	9.1	1.0	0.7	7.9
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	32.2	8.2	0.9	0.6	6.9
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	28.7	7.7	0.8	0.5	6.3
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R	36.3	8.9	0.9	0.7	7.6
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	32.1	8.2	0.9	0.6	6.9
27	Alternate 13+ Central Pierce 1 R/W	30.4	8.1	0.8	0.6	6.3
28	Alternate 14+Central Pierce 1 R/W	28.3	7.8	0.8	0.6	5.8
29	Alternate 13+Olympia/Black Lake 1 R/W	34.8	8.6	0.9	0.7	7.3
30	Alternate 14+Olympia/Black Lake 1 R/W	31.8	8.3	0.8	0.6	6.7
31	Central Pierce 3 R/W	75.7	15.5	1.7	1.6	14.1
32	Olympia/Black Lake 3 R/W	84.9	17.0	1.9	1.8	15.7
33	Central Pierce/Fort Lewis 3 R/W	75.7	15.5	1.8	1.6	14.1
34	* Alternate 1 + Demand Management	46.1	9.5	1.1	0.9	9.2

* Alternative which does not meet system capacity demand.

NOTE: *Figures have been updated subsequent to PSATC adoption using new and more-refined data.*

TOTAL AIRPORT EMISSIONS

Table 12B-4 presents the total airport emission levels from both aircraft and motor vehicles. Of all the alternatives which would meet the system capacity demand, the three-airport Alternatives 24 and 28 generate the least emissions.

The major contributions of the total CO emissions for these alternatives are vehicular traffic.CO is a good indicator pollutant for vehicular activity. CO emissions increase with increased vehicular usage and with increased congestion. Air quality problems local to roadways are usually the result of CO emissions.

Vehicular and aircraft emissions of NOx are important because they contribute to the regional air quality. NOx is an important pollutant in the formation of Ozone. With the introduction of high by-pass engines into the aircraft fleet, NOx is also becoming the pollutant of primary concern local to airports.

The replacement-airport alternatives generate the highest emissions for CO, NOx, SOx and particulates. Although the replacement-airport alternatives have the least aircraft emissions, the major contributions of these total emissions are due to the traffic emissions. The traffic emissions for these alternatives are the highest due to the longest distance traveled lengths.

These emissions can also be compared to the total regional emissions for the four country area. The Vision 2020 study forecasts the total mobile emissions for year 2020. Theses emissions estimates for the airport system account for less than 4 percent of the four county total for CO emissions.

MITIGATION MEASURES

The most significant reductions in regional and local air pollutant emissions are attainable through programs which reduce the vehicular travel associated with the project. Support and compliance with the Vision 2020 plan is the most important measure to achieve this goal. The plan includes improvement of mass transit facilities, implementation of vehicular usage reduction programs, and transportation demand management programs. This plan has been been designed to reduce project trips to reduce the traffic congestion and the total emissions. Any airport development plan will require the development of mitigation measures as part of the environment process. The air quality impacts from any of the alternative airport systems can be mitigated through transportation measures and improvements such as these. Those sites that are located near the proposed light rail line (Sea-Tac and Paine Field) show the most potential for vehicular transportation control measures.

The highest vehicular emissions will be generated by the three replacement-airport alternatives. This is because the average traveled trip lengths for these replacement-airport alternatives are much longer when compared to all other airport alternatives. For example, the average trip length to Sea-Tac is 24 miles, while the average trip length to Central Pierce is 45 miles.

Boilers

Air pollution from boilers varies greatly depending on the fuel used, and the manner in which the boiler is operated. The least polluting fuel is the natural gas oil used as back-up fuel. Boilers are used to power heat exchangers in terminal buildings and other equipment. The emission levels generated from boilers are insignificant.

Fueling Operations

Hydrocarbon emissions during operations vary in degrees depending on the type of fuel and the efficiency of the operation. The fuel requirements for piston and turbine engines differ widely. Piston engines requires a high octane type of gasoline, while jet engines use much heavier fuel, usually Jet-A fuel or aviation kerosene. Aviation gasoline used for piston engine powered aircraft is much more volatile than Jet-A fuel. However, the emission levels generated from fueling operations are insignificant when compared with aircraft and traffic emissions.