RESOLUTION NO. 3245

A RESOLUTION of the Port Commission of the Port of Seattle, King County, Washington, reaffirming adoption of a Master Plan Update for Seattle-Tacoma International Airport, authorizing construction of a new dependent air carrier runway, an expansion of the existing parking garage, and a new north employee parking lot in accordance with the Master Plan Update, and reaffirming commitments to fulfill additional noise reduction measures in accordance with Puget Sound Regional Council Resolution A-96-02.

WHEREAS, the number of passengers and aircraft operations served by Seattle-Tacoma International Airport (STIA) have grown substantially in the last several decades and are projected to continue to increase significantly in the future; and

WHEREAS, in the mid-1980's, the Port completed the Airport Comprehensive Planning Review & Airspace Update Study which concluded that the existing runway system at STIA would not be capable of serving efficiently the increasing demand past the year 2000, and the Federal Aviation Administration (FAA) initiated an Airport Capacity Enhancement Study which concluded that there was extensive delay primarily in poor weather conditions as a result of the close spacing of the two existing runways; and, in 1995, the FAA conducted a Capacity Enhancement Update Study which confirmed the results of the earlier capacity study; and

WHEREAS, in 1989, the Port of Seattle and the Puget Sound Council of Governments - forerunner to the Puget Sound Regional Council (PSRC) - appointed the Puget Sound Air Transportation Committee (PSATC) and initiated the Flight Plan Project to study a wide range of alternatives for resolving air traffic capacity problems in the Puget Sound area, including use of new technologies, demand management, high-speed ground transportation, development of a replacement airport, development of a multiple airport system, and expansion of STIA; and

WHEREAS, in 1992, at the conclusion of its studies and following extensive public involvement, the PSATC issued its final report, recommendations, and programmatic environmental impact statement, in which the PSATC concluded that there is a pressing need for additional airfield capacity in the Puget Sound region to meet the increasing demand for aircraft operations, and the PSATC recommended implementation of a multiple airport system including the addition of a new dependent air carrier runway at STIA located 2500 feet west of existing runway 16L/34R; and

WHEREAS, in November 1992, the Port Commission enacted Resolution No. 3125, As Amended, taking the following actions, among others, subject to certain conditions: (a) adopted those portions of the PSATC recommendations relating to the addition of a third runway at STIA and recommended further study of other regional solutions to address the growing air travel demand; and (b) directed Port staff to prepare studies, plans, and a site-specific environmental impact statement for constructing a third runway, and to work with the PSRC and other jurisdictions to prepare a facility plan; and

WHEREAS, in April 1993, in response to the PSATC recommendations in the Flight Plan study and additional analysis, the PSRC General Assembly adopted Resolution A-93-03, amending the Regional Airport System Plan to authorize development of a third runway at STIA (1) unless a supplemental airport site is proven to be feasible to eliminate the need for a new runway at STIA, (2) after demand management and system management programs are achieved or proven not to be feasible, and (3) when noise reduction performance objectives are scheduled, pursued, and achieved based on independent evaluation and measurement of noise impacts; and

WHEREAS, pursuant to Resolution A-93-03, the PSRC undertook the Major Supplemental Airport Study, in which the PSRC conducted an exhaustive search for a new airport site, resulting in PSRC Executive Board Resolution EB-94-01 in which the PSRC concluded that "there are no feasible sites for a major supplemental airport within the four-county region", and affirmed the General Assembly's approval of a third runway at STIA, provided the project meets the demand management and noise conditions of Resolution A-93-03 and the environmental impact review process; and

WHEREAS, also pursuant to Resolution A-93-03, the State Secretary of Transportation appointed an independent panel of experts (PSRC Expert Panel) which conducted an extensive review of demand/system management programs and noise reduction performance, and on July 27 and December 8, 1995, the panel concluded that demand/system management would not eliminate the need for a third runway; and

WHEREAS, on March 27, 1996, the PSRC Expert Panel issued its final determination on noise reduction performance in which the panel majority found that the noise reduction was not sufficient to satisfy the noise condition imposed by Resolution A-93-03 and suggested additional noise reduction measures, and subsequently the PSRC Executive Board determined that the region should continue to support a third runway at Sea-Tac, with additional noise reduction measures based on the panel's recommendations, and following several months of deliberations and public review and comment, including the issuance by the PSRC of an EIS Addendum, the PSRC General Assembly on July 11, 1996 passed Resolution A-96-02 to amend the Metropolitan Transportation Plan to include a third runway with additional noise reduction measures and to amend Resolution A-93-03 accordingly; and

WHEREAS, in 1993, the Port initiated an Airport Master Plan Update, which identified and studied alternate means of meeting the following needs at the airport: (1) improve the poor weather airfield operating capacity, (2) provide sufficient runway length to accommodate warm weather operations without restricting passenger load factors or payloads, (3) provide Runway Safety Areas that meet current FAA standards, and (4) provide efficient and flexible landside facilities to accommodate future aviation demand; and

WHEREAS, in 1993, pursuant to the National Environmental Policy Act (NEPA) and the State Environmental Policy Act (SEPA), the FAA and the Port initiated preparation of a joint environmental impact statement (EIS) thoroughly analyzing the alternatives to, environmental impacts of, and possible mitigating measures for the improvements identified in the Master Plan Update; and

WHEREAS, in 1995, the FAA and the Port issued a Draft EIS for Proposed Master Plan Update Development Actions, conducted two public hearings, accepted and responded to voluminous written and oral comments, conducted additional studies and prepared project revisions in response to public comments, and on February 9, 1996, issued a Final EIS; and

WHEREAS, the Port Commission adopted Resolution No. 3212, As Amended, on August 1, 1996 which among other actions included adoption of an Airport Master Plan Update for STIA, and granted approval to develop the third runway at STIA; and

WHEREAS, the fiscal year 1996 and 1997 terminal area forecasts (TAF) prepared by the FAA Office of Policy and Plans in Washington, D.C., and a subsequent update to the Airport Master Plan forecasts prepared by the Port, predicted a higher growth rate for STIA air passengers and aircraft operations than did the Airport Master Plan Update; and

WHEREAS, based on the updated Master Plan forecasts, the Port and FAA determined that additional environmental analysis was warranted to assess the impacts of the Master Plan Update improvements relative to the anticipated higher levels of air passengers and aircraft operations; and

WHEREAS, on February 7, 1997, the Port and FAA issued a Draft Supplemental EIS (DSEIS) for the Airport Master Plan Update, conducted a public hearing, accepted and responded to extensive public comments, and on May 13, 1997, issued a Final Supplemental EIS (FSEIS); and

WHEREAS, the Commission has considered the potential environmental impacts and mitigating measures discussed in the Final EIS and Supplemental EIS, and has weighed this information with other relevant considerations including the need for improved air transportation facilities to meet growing demand and reduce poor weather air traffic delay, all as described more fully in Attachment A to this resolution; and

WHEREAS, in light of the Supplemental EIS the Commission desires to reaffirm its approvals and commitments made in Resolution No. 3212, As Amended, including adoption of the Airport Master Plan, approval of the third runway, and commitment to undertake additional noise reduction measures as called for in PSRC Resolution A-96-02; and

WHEREAS, existing parking facilities at STIA are increasingly overburdened by growing parking demand and the Master Plan Update identifies a major expansion to the parking garage, a new north employee parking lot, and other improvements to meet growing parking demand; and

WHEREAS, the Port has been a national leader in efforts to reduce noise impacts on residents surrounding the airport, including the Sea-Tac Communities Plan, the Part 150 Noise Compatibility Plans, and the innovative Noise Mediation Project, which have resulted in a series of measures expected to reduce aircraft noise by at least half by the year 2001; and

WHEREAS, there has been extensive public involvement in the decision-making process including, but not limited to, multiple public hearings conducted by the Puget Sound Air Transportation Committee in locations throughout the Puget Sound Region, the acceptance and review of extensive written comments on the draft Flight Plan EIS, review and public consideration by the Puget Sound Regional Council which consists of elected officials from throughout the Region, two public scoping meetings and two public hearings conducted by the FAA and the Port regarding the Master Plan Update Draft EIS, acceptance and review of extensive written comments on the Master Plan Update Draft EIS, a public hearing and acceptance and review of extensive written comments on the Master Plan Supplemental EIS, and the Port's acceptance and consideration of public comments on these matters.

NOW, THEREFORE, BE IT RESOLVED by the Port of Seattle Commission as follows:

Section 1. The Commission finds that the Supplemental EIS for Proposed Master Plan Update Development Actions is adequate and meets the requirements of the State Environmental Policy Act, Ch. 43.21C RCW.

Section 2. The Commission adopts the Airport Master Plan Update for Seattle-Tacoma International Airport as set forth in Master Plan Update Technical Reports No. 1-8, dated at various times from 1993 to 1996, copies of which are included as Attachment B to this resolution. The Commission also adopts the 1997 Airport Layout Plan (ALP), which consists of a set of drawings, copies of which are included as Attachment C to this resolution. Port staff are continuing to coordinate with the Federal Aviation Administration (FAA) for review and approval of the ALP pursuant to Resolution No. 3212, As Amended. Staff are authorized to adjust the Master Plan Update, ALP, and mitigating measures in order to finalize those plans provided that any substantial changes must be reviewed by the Commission.

Section 3. In accordance with the Master Plan Update, and subject to required permits and approvals from other governmental entities, the Commission grants full approval for the construction of a new 8500-foot dependent air carrier runway with its centerline located no further than 2500 feet west of the centerline of runway 16L/34R and development of taxiways, navigational aids, and other associated facilities (the "new runway"). The Executive Director and the Director, Aviation Division, are each authorized to take all necessary and appropriate actions to construct the new runway, within authorized budget limits, including but not limited to retaining professional services, preparing plans and specifications, accepting grants, advertising for bids, and executing contracts. This authorization includes, but is not limited to, the following:

a. Continue preparation of the final engineering design for the new runway within authorized budget limits.

b. Continue development and implementation of a program for the acquisition of necessary property interests for the new runway. The areas of acquisition are depicted in the ALP drawings at Attachment C. Authorization is granted to institute acquisition offers by July 1, 1997. The Manager of Noise Remedy is authorized to take all necessary steps to either arrange for the sale or demolition of acquired houses or other structures, as appropriate.

c. Acquisition of fill material and preparation of sites to place such fill.

d. Continue application for and processing of all necessary permits, approvals, and right-of-way vacations for construction of the new runway, including those necessary for the mitigation measures in Attachment D.

e. Execution of a memorandum of understanding between the Port and City of Auburn regarding development of a wetland mitigation site.

f. Execution of a Memorandum of Understanding between the Port and City of Des Moines for south borrow site development.

g. Execution of a reimbursable agreement with the FAA with regard to airfield improvements including relocation of navigational aids.

h. Continue to work with the FAA and other industry representatives on potential technological advances that could enhance the benefits of providing additional airfield capacity at Seattle-Tacoma International Airport.

i. Development and implementation of a comprehensive public information program to keep airport neighbors informed on the progress of acquisition and development, including an information "hotline."

Section 4. The Executive Director and the Director, Aviation Division, are each authorized to take all necessary and appropriate actions to continue preparation of plans for and implementation of the mitigating measures included in Attachment D to this resolution, within authorized budget limits.

Section 5. In accordance with PSRC Resolution A-96-02, the Port Commission reaffirms its commitment to undertake the additional noise reduction measures called for by the PSRC which are listed in "Section I: The Port of Seattle" of Appendix G to the Metropolitan Transportation Plan (included as Attachment E to this Commission Resolution). Further, in accordance with "Section V: Monitoring Compliance" of Appendix G to the Metropolitan Transportation Plan, the Port commits to continue reporting to the PSRC twice yearly on progress toward the additional noise reduction measures. In addition, the Commission strongly endorses the Puget Sound Regional Council's commitment, as set forth in Appendix G, Section III, Item I of the Metropolitan Transportation Plan, to develop options to provide for the region's long range air capacity needs beyond those provided by improvements to Sea-Tac International Airport.

Section 6. The Executive Director and the Director, Aviation Division, are each authorized, within authorized budget limits, to continue with implementation of an air quality monitoring plan to measure existing air pollutant conditions in the airport area, as recommended in Section IV.9 of the Final EIS for Proposed Master Plan Update Development Actions.

Section 7. The Executive Director, the Director, Aviation Division, or the Port SEPA responsible official, as appropriate, shall: (a) continue to monitor the volume of airport activity, new aviation activity forecasts, and new information regarding potential and actual environmental impacts of airport development; (b) conduct any additional environmental review pursuant to SEPA as deemed necessary in light of new information; and (c) recommend to the Port Commission any new mitigation measures, or revisions to ongoing mitigation measures, as deemed necessary to address the impacts of development contemplated in the Airport Master Plan Update.

Section 8. In accordance with the Master Plan Update, and subject to required permits and approvals from other governmental entities, the Commission grants approval for construction of an expansion to the existing parking garage and construction of the new north employee parking lot. The Executive Director and the Director, Aviation Division, are each authorized, to take all necessary and appropriate actions to construct the garage expansion and new north employee parking lot, within authorized budget limits, including but not limited to retaining professional services, preparing plans and specifications, advertising for bids, and executing contracts.

Section 9. The Executive Director or the Director, Aviation Division, shall recommend actions to the Commission regarding improvements contemplated in the Master Plan Update in addition to the new runway and parking expansions as demand for these other facilities warrants.

Section 10. The adoption of this resolution constitutes a "final decision" by the Port of Seattle for purposes of appeal of the Port's compliance with SEPA, Ch. 43.21C RCW. Notice of the adoption of this resolution shall be provided in the manner specified in the Port's SEPA Appeal Resolution No. 3211. Any appeal must be brought within the time and in the manner specified in the Port's SEPA Resolution No. 3211.

Section 11. If any provision of this resolution is held invalid, the remainder of this resolution remains in effect.

ADOPTED by the Port Commission of the Port of Seattle this 27th day of May, 1997, and duly authenticated in open session by the signatures of the Commissioners voting in favor thereof and the seal of the Commission duly affixed.

Paige R Miller

Paul Schell

ABSTAIN

Port Commission

ATTACHMENT A TO PORT RESOLUTION NO. 3245

Summary of Port's Decisionmaking Relating to Adoption of Sea-Tac International Airport Master Plan Update and Development of a New Dependent Air Carrier Runway

The purpose of this document is to summarize (i) the region's air travel demand, increasing delay, and needed airport improvements; (ii) the extensive public process followed by the Port of Seattle and other governmental agencies in addressing the region's air transportation facility shortage; (iii) the comprehensive analysis of a wide range of alternative courses of action; (iv) the potential environmental impacts and mitigating measures relating to the Sea-Tac Airport Master Plan Update development actions including the new runway; and (v) the balancing judgment made by the Port Commission in adopting the Sea-Tac Airport Master Plan Update and authorizing the new runway.

I. <u>Air travel demand, increasing delay, and needed airport improvements</u>

Air travel demand growth and the forecasts

The rate of air passenger growth at Sea-Tac International Airport has outpaced the national rate over the last four decades and the number of passengers and aircraft operations are projected to continue growing in the future. Growth at Sea-Tac is being driven by strong regional population and economic growth, along with our region's increasing reliance on air travel. The Puget Sound Region's population nearly doubled between 1960 and 1990 and 1 million more people are projected to live here by the year 2020.

In the past decade, a number of forecasts relating to SeaTac Airport activity have been prepared including the Flight Plan study forecast, the 1994 Master Plan Update forecast, and the more recent FAA and Port forecasts conducted prior to the preparation of the Master Plan Update Supplemental EIS. In May of 1996, the Northwest Mountain Region Office of the FAA identified the availability of the fiscal year 1996 Terminal Area Forecast (TAF) for Seattle-Tacoma International Airport (Sea-Tac Airport) prepared by its headquarters Office of Policy and Plans. In December 1996, the FAA Office of Policy and Plans released the fiscal year 1997 TAF. The 1996 and 1997 TAFs show airport activity (passengers and operations) growing at a rate faster than predicted by the Master Plan Update. Aviation demand forecasting is often incorrectly perceived as a science, where all variables are predictable and known. However, as is shown by comparing any forecast to conditions that actually occur during the period that was forecast, forecasting is more an art than a science. As a result, precise forecasting for specific future years, particularly years more than 10 years in the future in the volatile air travel industry, is very difficult.

As airport master plans are conducted, forecasts are the foundation upon which a future plan is built. In the forecasting process, projected air travel demand is assigned to specific time periods. Due to the need to base these assumptions on a number of variables, airport master plan improvements are typically associated with a level of activity instead of a precise year, as was the approach taken in the Sea-Tac Airport Master Plan Update. The Final EIS recognized the difficulty in forecasting and presented three possible scenarios of how growth might differ from the Master Plan Update forecast. The new forecast prepared by the Port of Seattle (hereafter referred to as "the Port") for the year 2010 are slightly higher than was examined for the faster growth scenarios (17.9 million enplanements versus 17.3 million enplanements) contained in the Final EIS.

As a consequence, the Port and FAA evaluated the FAA's TAF data: 1) to determine its reliability and 2) to examine the impacts of demand growing faster than the Master Plan Update. Based on this review and the development of the new Port forecast, the FAA and the Port then agreed that additional environmental analysis was warranted to assess the impacts of the Master Plan Update improvements relative to the higher passenger and operations forecast.

The new Sea-Tac forecast prepared by the Port is 17% greater (in terms of both passengers and operations) than the forecast prepared for the Master Plan Update in 1994. These new forecasts are anticipated to exceed the operational capability of the existing airfield between 2005 and 2010. Therefore, a review of forecast issues and their relationship to the purpose and needs identified by the Master Plan Update was conducted.

The table below provides a comparison of the Master Plan Update forecast, the FAA's fiscal year 1997 Terminal Area Forecast, and the new Port of Seattle forecasts. For the year 2010, the FAA's TAF is approximately 10% greater than the Port's operations forecast and 17% greater than the Master Plan Update forecast. The TAF enplanement forecast is also 6% greater than the Port's forecast and 23% greater than the Master Plan Update forecast for the year 2010. The new Port forecast is not substantially different than the forecasts prepared for the Flight Plan Study.

COMPARISON OF DEMAND FORECASTS

(Master Plan Update, FAA TAF, and new Port of Seattle forecast)

Unconstrained Aviation Demand Forecast Comparison	1995	2000	2005	2010
Operations				
Flight Plan	n/a	411,000	429,000	447,000
Master Plan Update	n/a	379,200	392,500	405,800
FAA 1997 TAF	386,536	433,470	478,050	528,200
New Port of Seattle	386,536	409,000	445,000	474,000
Enplaned Passengers				
Flight Plan	n/a	12,700,000	15,000,000	17,000,000
Master Plan Update	n/a	11,900,000	13,600,000	15,300,000
FAA 1997 TAF	11,386,000	13,920,000	16,290,100	18,950,000
New Port of Seattle	11,386,000	13,700,000	15,700,000	17,900,000

N/A = Not available

Existing poor weather delay problem and third runway

The close spacing - 800' - between Sea-Tac's existing two parallel runways does not allow for two arrival streams whenever cloud ceilings drop below 5,000' or whenever visibility is reduced below 5 miles. These conditions - which occur about 44% of the year - reduce the total number of arrivals that can be accommodated from 60 per hour to as low as 24, resulting in inefficient operations and aircraft delay. This situation is anticipated to become increasingly severe as air traffic increases. Because pilots cannot maintain visual separation in these conditions, Federal Aviation Administration (FAA) air traffic control rules require at least 2,500' between parallel runways for two staggered (dependent) arrival streams in such "poor weather." Over 85% of total Sea-Tac delays are during arrival.

While Sea-Tac currently has sufficient operating capability during good weather conditions, the existing runway system produces extensive arrival delays during poor weather. For instance, when weather worsens from VFR1 to VFR2, average arrival delay increases more than ten-fold (from 1.0 minutes to 11.4 minutes). Delays further worsen when IFR1/2/3 conditions occur. In these cases, arrival delay increases more than twenty-fold over VFR1 (21.7 minutes vs. 1.0 minutes). Because these figures are averages, some flights experience less delay, while others experience substantially higher delay. (In the National Plan of Integrated Airport Systems, the FAA concluded that when average annual delays exceed 9 minutes an airport is experiencing severe delay.) Using average aircraft operating costs developed by the FAA from U.S. Department of Transportation records, Sea-Tac aircraft delays cost the airlines about $42 million annually under 1992 demand. When annual aircraft operations reach 425,000 (now forecast to occur about 2002), delay costs are anticipated to exceed $176 million annually if a new runway is not added.

SEA-TAC WEATHER CATEGORIES, ARRIVAL ACCEPTANCES RATES,

AND AVERAGE ARRIVAL DELAY

Weather condition	Maximum arrivals	1993 average arrival delay (min)	% of occurrence
Good weather	60	1.0	56.1%
VFR1			
Poor weather			
VFR2	48	11.4	19.7%
IFR1	36	21.7	17.0%
IFR2/3	24	21.7	7.2%

Without additional airfield capacity, by 2002 average VFR2 arrival delays will exceed 40 minutes, IFR1 arrival delays will exceed 76 minutes, and IFR2/3 arrival delays will exceed one hour and forty minutes, based on the forecast demand.

A new runway separated by 2,500 feet from the existing east runway (16L/34R) would permit staggered dual stream arrivals in poor weather conditions. It would decrease average arrival delays in 2002 by about 80% over doing nothing - resulting in aircraft delay savings estimated at $132 million annually under year 2002 projected demand.

Other airfield and landside improvements

In addition to the proposed new runway, the Airport Master Plan Update recommends a range of other airfield improvements including, but not limited to, upgrading the existing runway safety areas (RSAs) to meet current FAA standards; developing dual parallel taxiways the full length of the east runway (16L/34R) to facilitate on-ground movement of aircraft; and lengthening of the east runway by 600' to accommodate the heaviest aircraft serving long-haul routes from Sea-Tac.

The Airport Master Plan Update also anticipates a range of landside improvements needed by the year 2010 to meet the growing air travel demand. These include approximately 25 additional aircraft gates (100 total); an additional 1 - 1.5 million square feet of new terminal area beyond the existing 2 million square feet; additional terminal curb space; and approximately 5,400 additional parking spaces (14,850 total). A range of potential improvements to the access roadways have also been identified, including development of the proposed SR 509 extension/South Access Roadway in conjunction with local and state agencies.

Other landside improvements envisioned in the Master Plan Update include, but are not limited to, redevelopment of the existing cargo area on the northeast portion of the airfield to improve its efficiency and capacity; eventual development of the South Aviation Support Area (SASA) for a mix of air cargo, aircraft maintenance, and other potential aviation uses; addition of the proposed on-airport hotel; and FAA development of a new air traffic control tower.

2. **Extensive studies and public process to address air transportation capacity issues**

The Port Commission's decision to adopt the Sea-Tac Airport Master Plan Update and authorize development of a new runway at Sea-Tac Airport is based on more than ten years of extensive air transportation planning conducted by the Port, the Puget Sound Regional Council (PSRC), Washington State, and the Federal Aviation Administration (FAA).

In 1984, the Port began a significant period of airport planning activity which culminated in the Commission's adoption of Resolution No. 3212, As Amended, and the Master Plan Update. The last Sea-Tac Airport Master Plan was completed in 1985 and many of the Plan's recommendations were implemented through the 1980's and early 1990's. In light of rapid air travel growth at Sea-Tac, the Port completed the Comprehensive Planning Review & Airspace Update Study in 1988 to assess the validity of previous plans for the Airport. A major finding of the study was that actual growth surpassed that predicted in previous plans and that the existing runway system would not be capable of efficiently serving increased demand beyond the year 2000. At the same time, the Puget Sound Council of Governments (PSCOG, now Puget Sound Regional Council -- PSRC) was preparing the Regional Airport

System Plan (RASP) element of the Metropolitan Transportation Plan, which also concluded that the existing Sea-Tac airfield would not be adequate to meet regional air travel needs past 2000.

Flight Plan Study and EIS

As a result of the Comprehensive Planning Review and the RASP, the Port and the PSCOG entered into an interlocal agreement to co-sponsor a process to identify a long-term solution to the Region's air transportation needs, with support from the Federal Aviation Administration (FAA). A 39-member panel with representatives from cities and counties throughout the Region, aviation industry experts, citizens, and the State - known as the Puget Sound Air Transportation Committee (PSATC) - was assembled and conducted the three-year long Flight Plan Study. The purpose of Flight Plan was to develop a regional solution that would meet the Region's commercial air travel needs to the year 2020 and beyond. The PSATC conducted a thorough review of a wide range of options including replacement airports, supplemental airports, new navigational technologies, demand management, and high-speed rail. The PSATC, Port and PSRC prepared, and issued for public review and comment, a programmatic environmental impact statement (EIS) examining the potential environmental impacts of the studied alternatives. Thousands of pages of written comments were received on the Flight Plan EIS, which were reviewed and responded to in the Final EIS. During its study process, the PSATC conducted a series of public hearings at locations throughout the Puget Sound Region. These hearings were well-attended and extensively covered by the local media. Following its deliberations, the PSATC recommended a multiple airport system that included a new air carrier runway at Sea-Tac Airport.

Concurrent with the Flight Plan Study, the FAA prepared the initial Sea-Tac Airport Capacity Enhancement Plan which examined in detail the existing poor weather capacity shortfall at Sea-Tac and estimated the delay savings benefits of a range of potential improvements, including a new runway.

As a result of Flight Plan, in November 1992, the Port of Seattle Commission adopted Resolution No. 3125, As Amended, which adopted the PSATC recommendations pertaining to adding a dependent air carrier runway at Sea-Tac Airport and directed Port staff to undertake the necessary detailed studies and a project-specific environmental impact statement (EIS).

The City of Federal Way filed an administrative appeal challenging the adequacy of the programmatic Flight Plan EIS that had been prepared jointly by the PSRC and the Port. Following extensive review of this issue, an independent hearing examiner of the PSRC determined that the EIS was adequate. Also during this time, the Airport Communities Coalition (Cities of Burien, Des Moines, Normandy Park, and Tukwila), filed a lawsuit against the Port challenging the adequacy of the Flight Plan EIS. The ACC eventually withdrew this suit.

Master Plan Update and EIS

In order to fulfill the directions of Port Commission Resolution No. 3125, As Amended, a comprehensive update to the Sea-Tac Airport Master Plan was undertaken to evaluate the long-term facility needs at the Airport and to develop an array of possible improvements for efficiently meeting forecast regional air travel demand to the year 2020. The Master Plan Update built on planning work undertaken at the Airport during the previous several years and sought to balance the capacity of the airfield, terminal, roadways, and parking facilities and to maintain an efficient level of service for the growing passenger and operational demands.

To evaluate the potential environmental impacts and mitigation measures for proposed airport improvements -including a new runway - the FAA and the Port entered into a memorandum of understanding (MOU) to serve as joint-lead agencies for preparing an environmental impact statement (EIS) on the Airport Master Plan Update. The FAA and Port conducted two public meetings to solicit comments on the proposed scope of the Master Plan Update EIS -- one for interested public agencies including the cities surrounding the airport, and the other for any other members of the public. Following review of the extensive written and oral comments, the FAA and Port agreed on the EIS scope and prepared and issued a Draft EIS.

The EIS focused on the potential environmental impacts and mitigation measures of three Sea-Tac improvement alternatives and the "do nothing" option. Each of the three improvement alternatives include construction of a new parallel runway with a length up to 8,500' and development of a range of landside support facilities in either the central terminal area or through the addition of either a north unit terminal or south unit terminal. The Master Plan Update recommended development of a new two-concourse terminal building north of the existing terminal, including approximately 20-25 new gates and new parking facilities (the North Unit Terminal Option).

The FAA and Port conducted two public hearings on the Draft Master Plan Update EIS and solicited public comment on the EIS and the proposed Master Plan Update. The hearings were well-attended and extensively covered by the local media. Again, thousands of pages of written comments were received, and the FAA and Port reviewed and responded to the comments in the Final EIS that was issued in February 1996.

Master Plan Update Supplemental EIS

As a result of the higher airport activity projections in the updated forecasts discussed earlier, the FAA and the Port made the decision in December 1996 to prepare a Supplemental EIS (SEIS). Based on the new forecasts, Port staff re-examined the timing of when new facilities would be needed. As demand is expected to grow faster than earlier identified, new terminal and landside facilities would be needed sooner. The new phasing plan indicated that while the new runway should be initiated as soon as possible, extending the construction schedule from 5 years to 8 years would enable the Port to undertake the necessary terminal and landside improvements needed to alleviate passenger congestion and inconveniences. In addition to these issues, the SEIS also updated information on the actions by local communities, the PSRC, and others that had occurred since the Final EIS was prepared.

Some comments on the Draft SEIS suggested that the EIS should have considered the potential impacts of the Master Plan Update actions beyond the year 2010 (i.e., year 2020) as was done in the prior EIS. However, as discussed in the Final SEIS responses to comments, the SEIS did consider the potential impacts through the year 2020. This information, which is set forth at Appendix D of the SEIS, was based on an extrapolated analysis of information from earlier years.

A more detailed analysis than what is included in Appendix D would not be productive and is not essential to a reasoned choice among alternative courses of action in the Master Plan Update. Specific activity levels and their associated environmental impacts beyond the year 2010 (i.e., year 2020) are not reasonably foreseeable at this time. Because of the uncertainty of forecasting to the year

2020 and the fact that the resulting impact analysis would be very speculative, this information is of limited value in the decision-making process. Also, as discussed in detail in the alternatives section of the FEIS, SEIS and in other documents, even if the impacts of the Master Plan Update improvements are greater than anticipated, conclusions concerning these proposed improvements, relative to their alternatives, would not differ.

In approving the projects in the Master Plan Update, the Port is not making decisions that will accommodate ever-increasing aircraft operations at SeaTac Airport through the year 2020. Further decisions will be necessary, especially with regard to necessary landside improvements, before the airport will be able to accommodate substantially more aircraft operations than the airport can accommodate in 2010. Before these decisions are made, there will be further environmental review and consideration of applicable environmental regulations.

The SEIS presented the new information in the context of the purpose and need for the proposed Master Plan Update improvements, the alternatives to satisfying the needs, and the affected environment. The Draft SEIS was released on February 14, 1997 which began a 45-day public and agency comment period. Concurrently, a comment period occurred on the air conformity analysis. A public hearing was conducted on March 4, 1997 attended by 65 individuals. Testimony was provided by 33 individuals. The public and agency comment period closed on March 31, 1997 and 85 letters were received. The Final SEIS was released on May 13, 1997.

PSRC-mandated studies of alternative airport sites, demand/system management, and noise mitigation

Also in response to Flight Plan, the PSRC undertook a six-month review and decision process of the PSATC recommendations which culminated in adoption of PSRC Resolution A-93-03 in April 1993. The Resolution stated "That the region should pursue vigorously, as the preferred alternative, a major supplemental airport and a third runway at Sea-Tac." Over the course of a year, the PSRC conducted an exhaustive evaluation and public review of twenty-six existing and potential new airport sites and concluded in October 1994 that a supplemental airport was not feasible. In so doing, the PSRC Executive Board in Resolution EB-94-01 affirmed PSRC approval of a new runway at Sea-Tac and concluded that it would provide adequate capacity for the region through the year 2030. Also as part of the direction established in PSRC Resolution A-93-03, the PSRC established an independent three-member panel of experts from outside the region to determine whether the Port's noise reduction goals are being met and whether demand/system management measures could defer the need for the proposed new runway. After more than a year of review, the PSRC Expert Panel determined in a series of written orders that demand/system management measures are not feasible for deferring the need for the proposed runway and that this condition of PSRC Resolution A-93-03 had been fully satisfied.

On March 27, 1996, the PSRC Expert Panel issued its Final Decision on Noise Issues. The panel was unanimous in finding that the Port was substantially in compliance with the Airport Noise Mediation Agreement and its goals. Two of the three panelists, however, concluded that "Although the Port of Seattle has scheduled, pursued, and achieved an impressive array of noise abatement and mitigation programs," the noise reduction achieved was not sufficient to satisfy the noise condition imposed by Resolution A-93-03. Included in the Final Decision document, the panel offered a number of recommendations for potential additional noise reduction measures that if implemented, may have resulted in an affirmative panel decision. Based on the continuing regional need for additional airport capacity, the PSRC Executive Board determined that the region should continue to support a third runway at Sea-Tac, with additional noise reduction measures based on the panel's recommendations. PSRC requested and received input on the panel's recommendations from the Airport Communities Coalition, the FAA, the Port, other affected agencies, and citizens. As a result, PSRC prepared and circulated for further public review a draft list of noise reduction measures and monitoring steps that would be included as part of PSRC approval for the third runway. Following further deliberations and public comment, the PSRC General Assembly on July 11, 1996 voted 84% in favor to adopt Resolution A-96-02, which amended the Metropolitan Transportation Plan to include a third runway with additional noise reduction measures, and amended Resolution A-93-03 accordingly.

Other Studies

In 1990, the Washington State Legislature created the Air Transportation Commission (AIRTRAC) to recommend statewide air transportation policies. The Commission's recommendations noted and 5) implementation feasibility. The screening process resulted in a recommendation for further study of: a multiple airport system including the addition of a third runway at Sea-Tac; a replacement airport; use of Boeing Field as a close-in remote airport; and continued use of Sea-Tac in conjunction with demand management, new technologies, and alternate modes of transportation. The alternatives recommended for further study were evaluated in detail in terms of technical/operational, economic/financial, institutional, and environmental criteria. Several technical reports and a programmatic level Environmental Impact Statement (EIS) were prepared, and a total of thirty-five options were studied within these five system alternatives. An extensive search was conducted of potential sites for a replacement or supplemental airport, and detailed study was conducted of the most promising sites. The sites that were studied in detail included Boeing Field, Paine Field, Arlington Airport, McChord Air Force Base, and potential new sites in central Pierce County and in the Black Lake area of Thurston County. (Earlier in the study process, other airports and sites were considered and rejected, including Auburn, Bellingham, Bremerton, Moses Lake, Olympia, Port Angeles, Renton, Skagit/Bayview, and Tacoma Narrows.) Based on this analysis and public review of the alternatives, the Flight Plan Study recommended implementation of a multiple airport system which included a third air carrier-length runway at Sea-Tac Airport.

Sea-Tac Airport Master Plan Update/EIS

The Sea-Tac Airport Master Plan Update and EIS were designed to address the range of issues related to developing a new runway that were beyond the scope of the Flight Plan Project. This included a detailed analysis of the range of potential lengths and separations for a new runway. The Master Plan Update evaluated the operational benefits of the following eight airfield options:

- Do nothing
- 5,200' runway separated by 1,500' from the existing east runway
- 5,200' runway separated by 2,500' from the east runway
- 7,000' runway separated by 2,500'
- 7,000' runway separated by 2,500' and staggered 1,435' on the north end

- 7,500′ runway separated by 2,500′ and staggered 935′ on the north end
- 8,500′ runway separated by 2,500′
- 8,500′ runway separated by 3,300′

A new runway separated less than 2,500 feet from the existing east runway would not permit dual poor weather arrival streams and thereby would not significantly reduce delay. Options separated by 2,500′ would permit dual staggered arrivals, with the types of aircraft able to use the runway dependent on its length. A 7,000′, 7,500′, or 8,500′ runway at 2,500′ separation would be sufficiently long to accommodate between 91- 99% (depending on its length) of aircraft using Sea-Tac in 2020 and would provide substantial delay savings benefits. A new runway separated 3,300′ from the east runway with the use of fast-radar (precision runway monitor) could potentially allow for independent dual simultaneous (non-staggered) arrival streams during poor weather, but would not produce substantially more delay savings benefits through the year 2020 planning horizon than would a runway separated by 2,500′. In addition, a 3,300′ separation would have greatly increased environmental impacts and construction costs. Based on these findings, the Master Plan and EIS evaluated new runway options separated by 2,500′ from the east runway with lengths of 7,000′, 7,500′, and 8,500′.

In addition to the new Sea-Tac runway alternatives, the Airport Master Plan Update EIS considered a range of other alternatives including a supplemental airport; other transportation modes such as bus or rail; airport demand management; new navigational technologies; improvements at Sea-Tac; and doing nothing.

4. **Potential environmental impacts of the Master Plan development actions including the new runway**

The following is a summary of the potential environmental impacts and mitigating measures relating to the development actions included in the Master Plan Update and discussed in the Master Plan Update EIS and SEIS.

that Sea-Tac was approaching its airfield capacity and called for the state to ensure that capacity at airports throughout the state is preserved and that new capacity needs are addressed.

In summer 1996, the City of Burien released a preliminary draft report titled "City of Burien Seattle-Tacoma Airport Master Plan Update Studies Environmental Issues Mitigation." On November 25, 1996, the Port submitted comments on the preliminary draft report and, on March 27, 1997, the City issued the report. A response to this report is set forth at pp. F-58 through F-65, Appendix F, of the Final SEIS. This report and the response were considered prior to the Port Commission's adoption of Resolution No. 3245.

3. **Alternatives considered**

Flight Plan Study

Numerous alternatives for meeting the Region's future air travel needs have been evaluated in a range of studies. The previously discussed Puget Sound Regional Council/Port of Seattle "Flight Plan Study" evaluated the following nine system alternatives:

- No action
- Limited expansion of Sea-Tac Airport
- Expansion of Sea-Tac Airport, including a new air carrier length runway
- Closure of Sea-Tac and development of a replacement airport
- Multiple airport system involving Sea-Tac and one or more smaller supplemental airports
- A single remote airport to be functionally linked to Sea-Tac
- Demand management measures
- New air navigation and airplane technologies
- High-speed ground transportation

These system alternatives were evaluated based on a series of criteria which included: 1) airspace and the presence of conflicts with other airports or terrain; 2) operational capacity; 3) accessibility to the Region's residents; 4) economic impacts;

Noise and land use

The percentage of people, housing units, and area affected by sound levels of DNL 65 and greater is expected to decline in the future in comparison to current and past noise exposure, regardless of future development at Sea-Tac Airport. This decline in impacts is expected due to the Port's noise reduction program and the Federal mandate to phase-out Stage 2 aircraft no later than the year 2000.

AIRCRAFT NOISE
(DNL 65 and Greater)

	Population	Housing	Area (Sq Mi)
1994	31,800	13,620	12.23
2000			
Do-Nothing	11,310	4,820	6.81
"With Project"	11,310	4,820	6.81
2005			
Do-Nothing	11,310	4,450	6.61
"With Project"	11,310	4,400	6.85
2010			
Do-Nothing	11,310	5,060	7.08
"With Project"	11,310	4,520	7.68

Source: Final Supplemental EIS, May 13, 1997

The 65 DNL and greater noise exposure contours associated with the new forecast are about 12% greater than the noise contours prepared using the Master Plan Update forecast in the Final EIS. The new noise contours for the year 2010 would exceed the boundaries of the Port's existing Noise Remedy Program boundary by several blocks on the northwesterly edge of the Noise Remedy Program Boundary. In addition, a number of residential areas would experience a 1.5 DNL increase in noise (when comparing the "With Project" to the Do-Nothing) in year 2010.

While this analysis has focused on the areas exposed to DNL 65 and greater sound levels, the EIS also presented the impacts associated with DNL 60. For residents that are disturbed by noise less than DNL 65, these impacts could continue and change slightly. As is shown by the assessment of noise impacts caused by aircraft flying at altitudes between 3,000 feet and 18,000 feet, these impacts are not expected to be significant.

The Port of Seattle has a long standing noise abatement program that has lead the aviation industry in mitigating aircraft noise and land use conflicts. Through the implementation of the Noise Remedy Program, the Port of Seattle has conducted an extensive noise and land use compatibility effort. A notable portion of the existing and future noise exposed area has been subject to sound insulation and, for the more severely noise affected areas, acquired and relocated. To facilitate continued noise reduction, the noise and land use mitigation programs now in effect should continue to be implemented.

- Noise Budget - The goal of the Noise Budget of an all Stage 3 fleet is anticipated to be reached by the year 2001.

- Nighttime Limitations Program - limiting the hours of operation for Stage 2 aircraft.

- Ground Noise Control - reducing the noise of ground events such as powerback operations, run-ups, and reverse thrust on landing.

- Flight Corridorization - maintenance of runway heading flight tracks by departing jets until reaching altitudes above 4,000 feet.

- Flight Track and Noise Monitoring - maintenance of noise level records and flight track location information for identification of deviations and communication with the public and users.

The Final Environmental Impact Statement and Supplemental EIS summarizes the land use compatibility of the proposed Master Plan Update improvements with the current or proposed comprehensive plans of the City of SeaTac, Des Moines, Normandy Park, Burien and

Tukwila. In addition, the King County Comprehensive Plan and Countywide Planning Policies and Puget Sound Region Plan (Vision 2020) are discussed. The proposed improvements are consistent with the plans and policies of the Puget Sound Region as well as those of King County. Sea-Tac Airport lies wholly within the City of SeaTac, with the exception of a portion of property in Des Moines that was acquired for noise mitigation. The construction of the proposed new parallel runway and other elements of the Master Plan Update improvements will be conducted almost entirely in the City of SeaTac. The extent to which the comprehensive plan policies in the City of SeaTac would govern the Master Plan Update improvements is currently the subject of an interlocal process between the Port and City of SeaTac.

To address changes in specific noise conditions, primarily associated with the third parallel runway, the following mitigation actions would be undertaken:

Mitigating Significant Noise Impacts on Public Facilities and Historic Sites: The following nine public facilities or historic sites would experience significant increased noise impacts (i.e. an increase of 1.5 DNL or more) in the year 2010 in comparison to the Do-Nothing alternative:

- Sea-Tac Occupational Skills Center (S102) would experience an increase of 4.41 DNL in 2010;
- Woodside Elementary School (S105) would experience an increase of 3.1 DNL in 2010;
- Sunnydale Elementary (S21/A16) would experience a 2.8 DNL increase in year 2010
- Albert Paul House (A57) would experience an increase 3.9 DNL in 2010;
- Homer Crosby House (A22) would experience an increase of 3.6 DNL in 2010;

- Sunny Terrace Elementary School (S106) would experience an increase of 5.2 DNL in 2010;

- Brunelle Residence (A27) would experience an increase of 3.6 DNL in 2010 *(the house no longer exists on the property)*;

- Coil House (N16) would experience an increase of 1.9 DNL in 2010;

- Bryan House (A29) would experience an increase of 5.0 DNL in 2010.

Impacts on the facilities incompatible with noise associated "With Project" will be mitigated by acoustical insulation that would allow their uses to be compatible with increased noise levels. Two of the schools are currently not being used for educational uses, and future plans for these buildings need to be confirmed with the Highline School District. Port Commission Resolution Nos. 3125 and 3212 and the 1993 Update to Sea-Tac's Part 150 Noise Compatibility Program contain Port intentions to expand the Airport's insulation programs for public buildings. The Port has been discussing school insulation with the Highline School District, and through Resolution No. 3212 has agreed to commit $50 million to the insulation of schools. Depending upon the District's designation of the long-term use of the two impacted schools and on the District's desire to have these buildings insulated, they would undergo insulation treatment as needed for compatibility independent of a formal school or public building insulation program. The residences would be addressed by the existing Noise Remedy insulation program if the owners agree. Because of their historic value, these facilities could require custom treatment to avoid significant alteration of the architectural style. In pursuing sound insulation of these structures, the Port's Noise Remedy Office will work with a historian to preserve such characteristics.

Provide Directional Soundproofing: Residences that were insulated prior to 1992 may need additional directional soundproofing to mitigate noise generated from a new flight path from the operation of the proposed new third runway. To mitigate noise caused by the proposed airport improvements, these facilities would be further insulated. The Port of Seattle estimates that some 60 to 70 houses were evaluated and/or insulated prior to 1992 and could require additional soundproofing at a cost of about $6,000 to

$10,000 per residence. The additional sound insulation measures that could be required include new windows, new doors, and thicker walls.

Acquisition in the Approach Transitional Area: In recognition of the fact that the standard Runway Protection Zone (RPZ) dimensions do not always provide sufficient buffer to the satisfaction of nearby residents, the FAA has indicated that funding could be available to airport operators acquiring "up to 1,250 feet laterally from the runway centerline, and extending 5,000 feet beyond each end of the primary surface.[1] Based on the configuration of current airport land, local streets, and residential development patterns, the approach and transitional area selected for use as a mitigation area includes the standard Runway Protection Zone and a rectangular extension of the RPZ outward another 2,500 feet.

The acquisition of properties within the approach transitional areas north and south of the proposed runway may serve as a feasible and appropriate mitigation measure. This measure could involve the acquisition of all residential uses, and any vacant, residentially zoned properties which cannot be compatibly zoned, within selected areas both to the north and the south of the new runway ends. Commercial land uses, which make up most of the eligible area to the south, need not be acquired and may remain in place on both runway ends.

In the northern approach transitional area, 82 single-family residential parcels, 2 apartment buildings (with 28 units), and 2 mobile home parks, with 96 units, could be acquired. To the south, 71 single-family residential parcels and 6 apartment buildings (with 32 units) could be acquired. Based on the current assessed value of these 309 residential homes and multi-family buildings, it is estimated that the cost of acquisition and relocation could be approximately $35 million.

As was noted in the EIS, input from the affected residents is necessary to design and initiate an acceptable relocation program. Such input was solicited during the Draft EIS's 90-day public comment period and through display boards, which were created and used at the June 1, 1995 Public Hearing for the express purposes of soliciting feedback from the affected residents concerning this

[1]FAA Memorandum, Action: Land acquisition - eligible Runway Protection, Object Free Area and Approach and Transitional Zones, dated April 30, 1991

action. As is shown in Appendices R and T of the Final EIS few comments concerning the program were received. Therefore, as the probable impact of low flying aircraft would not be experienced until the opening of the proposed new parallel runway, this option will receive further consideration during the forthcoming Sea-Tac Airport FAR Part 150 Update, which the Port anticipates undertaking during 1997. It is anticipated that during the Part 150 Update, the Port would further explore this action with the specific residents within the Approach Transition Area, and, if the residents so desire, establish a program including relocation objectives, timing and funding priorities.

Sound insulation of residences affected by 1.5 DNL or greater within 65 DNL noise exposure: Approximately 1,000 residents living in 460 housing units would be impacted in 2010 as a result of the proposed improvements in comparison to the Do-Nothing alternative. About 170 of these homes within 65 DNL would be exposed to 1.5 DNL or higher noise levels as a result of the proposed improvements and are not already subject to the Port's existing Noise Remedy Program. No residential areas outside the existing Noise Remedy Program boundaries would experience 1.5 DNL increases in year 2005 as a result of the proposed improvements.

The Port will develop an implementation strategy to sound insulate these 170 additional homes within the 65 DNL noise contours as part of the Part 150 Noise Compatibility Plan study effort that will be initiated in 1997. The purpose of delegating finalization of the implementation approach for this action to determination during the Part 150 is to ensure that consideration is given to the proposed Approach Transition Area acquisition and the relationship of that area to the existing Noise Remedy Program boundary, as well as the westerly expansion of the Noise Remedy Program to accommodate this added insulation.

Port Resolution No. 3125 dated November 1992 states "Port staff is also directed to develop and implement a plan to insulate up to 5,000 eligible single family residences in the existing noise remedy program included on the waiting list as of December 31, 1993, before commencing construction of the proposed runway. The remaining eligible single family residences on the waiting list are to be insulated prior to operation of the proposed runway. In addition, the Port commits to complete insulation of all single-family residences that become eligible for insulation as a result of actions taken based on the site-specific EIS and are on the waiting list as of December 31, 1997, prior to commencing operations of said runway."

For the purpose of the Resolution, the term "eligible" is all single family properties located within the Noise Remedy Boundary, as established by the Port's 1985 Part 150 Study, with the exception of homes built after appropriate building codes were enacted in the Part 150 Study in 1985. As a result of this resolution and on-going implementation of the Part 150 Study, residents located in the Noise Remedy Boundary have come to expect the Port to complete the program, regardless of future airport facility improvements. Therefore, included as mitigation for implementing the third parallel runway, the Port agrees to insulate these single family residential areas regardless of the existing or future noise exposure.

Social impacts

The Master Plan Update alternatives were evaluated for their impact on adjacent residential communities and businesses. Social impacts considered in this section include the following: residential and business displacement, and disruption of existing communities and planned development.

The following number of properties could be acquired under the "With Project" alternatives to complete construction, to clear the runway protection zones (RPZs), and to mitigate adverse environmental impacts:

NUMBER TO BE ACQUIRED

8,500-ft Dependent	Single Family	Condos/ Apartments	Businesses
Runway related:			
Alternative 1	0	0	0
Alt. 2, 3, & 4	388	260	105
Non-Runway related:			
Alternative 1	3	0	0
Alternative 2 & 3	3	0	0
Alternative 4	3	0	12

Note: About 49 businesses located within the southern Runway Protection Zone (RPZ) for the third runway are included above for a worst-case assessment. Easements may be purchased from the property owners in lieu of fee-simple acquisition.

It does not appear that any minority, age or income group would be disproportionately affected by the proposed Master Plan Update improvements.

Human health impacts

The EIS assesses the human health related issues associated with:

- noise
- air quality
- water quality
- radio transmissions and light emissions
- aircraft incidents/accidents.

The Airport's current environmental conditions have the potential to affect human health, although that potential is difficult to assess and characterize because many research studies indicate conflicting reports of human health impacts.

In general, adverse environmental impacts are expected to decrease in the future as improved technology results in lower air, noise, and water pollutant emissions. The proposed Master Plan Update alternatives are expected to increase noise and stormwater flows slightly over the Do-Nothing alternative. However, the impacts of the future "With Project" alternatives are expected to be less than the current conditions.

Induced socio-economic impacts

As a major passenger and cargo transportation facility, Sea-Tac Airport directly and indirectly contributes to the economic structure of the Puget Sound Region. Induced socio-economic benefits are generated in the Region by changes in employment opportunities, payroll generation, business expenditures for goods and services, and tax revenues.

AIRPORT ACTIVITY RELATED IMPACTS

Alternative 1, 2, 3, and 4

	1993	2010	2020
Total Jobs	205,690	335,344	418,632
Personal Income (Millions)	2,585.6	4,215.4	5,262.4
Earnings/Dir Jobs	15,910	25,938.7	32,380.9
Business Revenue (Millions)	6,355.7	10,361.9	12,935.5
State & Local Taxes (Millions)	406.6	662.9	827.9

* includes airport-generated and visitor industry impacts

All of the Master Plan Update alternatives would create jobs in construction. Construction-related jobs would number approximately 8,200 for the Do-Nothing (Alternative 1) and about 45,500 for the "With Project" alternatives.

The activity-related, induced socio-economic impacts would be the same for all Master Plan Update alternatives. However, the acquisition effects would differ. The following table summarizes the impacts of the "With Project" alternatives compared to the Do-Nothing (Alternative 1):

IMPACTS DUE TO:	Alt 2	Alt 3	Alt 4
Annual Loss in Property Tax (Thousands)	$227.5	$227.5	$291.9
Annual Lost Taxable Sales Transactions (Millions)	$2.2	$2.2	$15.6
Jobs Displaced	627	627	822

Impacts are less if displaced businesses relocated within the area. Assumes the 8,500 ft new dependent parallel runway and that commercial property in the RPZ is acquired.

A new 8,500 foot parallel runway would displace businesses and numerous residences through property acquisitions, reducing the existing property and sales tax revenue and employment. The property tax and sales impacts to an individual community are less than five percent. This would occur primarily in the City of SeaTac and, to a lesser extent, in the City of Burien.

Reductions in tax revenues should be offset long term by positive net gains in future tax receipts as property is more intensely developed in the Airport vicinity. Local sales tax revenues will be generated by people directly employed at Sea-Tac Airport and by airport activity (e.g., taxable spending on goods and services by people employed at the Airport, air cargo businesses, hotel and commercial uses).

Air quality

Like the Final EIS, the Supplemental EIS evaluated the air quality impacts associated with the Master Plan Update improvements through a review of:

Aircraft emissions inventory in tons per year for comparison to the State Implementation Plan (SIP);

Local area-wide dispersion analysis of Airport and non-Airport sources for comparison to the Ambient Air Quality Standards (AAQS); and

A local roadway intersection dispersion analysis for comparison to the AAQS.

This analysis confirmed the results of the Final EIS, which showed that even with a higher demand forecast, that aircraft emissions would be below the 1995 SIP levels regardless of whether the improvements are undertaken at Sea-Tac Airport. The dispersion analysis shows that even with the higher demand forecast that the predominant air pollution source in the Airport environs are surface transportation vehicles.

The intersection dispersion analysis was conducted to examine conditions in the Airport area that would be affected by the proposed improvements. This analysis shows that, with the worst case modeling assumptions, the AAQS for Carbon Monoxide could be exceeded regardless of whether improvements are completed at Sea-Tac Airport due to high volumes of surface traffic on International Boulevard (SR 99). With the higher air travel demand forecast and the changes in the proposed Master Plan Update improvements described in the Supplemental EIS, the intersection analysis shows that the improvements associated with any of the "With Project" alternatives would result in pollutant concentrations equal to or less than would occur in the Do-Nothing.

Because the demand forecast has increased and changes were made in the phasing and definition of the proposed improvements, a Final Conformity Analysis was prepared. The analysis contained in the Final Supplemental EIS reflects responses to these comments and a thorough quality assurance review of the data input to the models. While some estimates of future air emissions changed over the levels presented in the Draft Supplemental EIS, the conclusions of the Draft remain the same and are supported by the revised analysis contained in the Final Supplemental EIS.

Water quality and hydrology

Changing the Airport's landscape, as would happen with the proposed Master Plan Update alternatives, could affect the hydrology of the airport area as well as the downstream systems. Alternatives 2, 3, and 4 ("With Project") would include earthwork and the addition of impervious land surface area. This decreases the amount of rainfall infiltrating the soil and increases stormwater runoff flow rates and volumes.

Preliminary estimates indicated that 61 acre-feet of new on-site detention storage would be required for the proposed developed areas that drain to Miller Creek, and 31 acre-feet of storage for areas draining to Des Moines Creek. These detention volumes would attenuate peak runoff rates from the Airport to provide protection from downstream flooding for storms having up to a 100-year return period. New impervious areas would increase annual runoff volumes to Miller Creek by 6 to 8 percent and volumes to Des Moines Creek by 1 to 2 percent. Most of the additional volume would flow through the downstream systems at rates that have low erosion potential. Higher runoff volumes could be partially offset by stormwater infiltration where on-site soils are suitable.

Although pollutant loading will increase somewhat because of greater amounts of stormwater runoff associated with the "With Project" alternatives, compliance with mitigation requirements is expected to prevent significant pollution or degradation of surface and groundwater resources.

The following stormwater management mitigation could be considered, along with other actions that basin planning determines would mitigate the impacts of the proposed improvements:

- Provide stormwater detention for construction and operation of new on-site development.
- Design stormwater facility outlets to reduce channel scouring, sedimentation and erosion, and improve water quality.
- Maintain existing and proposed new stormwater facilities.
- Tyee pond could be relocated and enlarged as part of the SASA.
- Effective erosion and sedimentation control could be achieved by using a system of erosion controls (e.g., mulching, silt fencing, sediment basins, and check dams) that are properly applied, installed, and maintained.
- Use of Best Management Practices at construction sites, such as spill containment areas and phasing of construction activities (to minimize the amount of disturbed and exposed areas) also could prevent or reduce potential impacts on surface water and groundwater quality.
- Temporary and permanent terraces could be used for fillslopes and cutslopes wherever possible because they reduce sheet and rill erosion. Terraces reduce slope length, reducing potential rill development and surface erosion. Terraces also increase deposition, reducing transport of eroded materials from construction sites.

The Port of Seattle's National Pollutant Discharge Elimination System (NPDES) permit requires the Port to prepare several plans and to carry out several studies to identify pollutants coming from the Airport, and to prevent and control potential operational impacts on surface and groundwater resources from industrial wastewater system (IWS) and storm drainage system (SDS) discharges.

Additional mitigation for potential operational impacts to surface water quality could be considered depending on the results of the stream monitoring study and the effects of Airport stormwater runoff on Miller and Des Moines Creeks. Potential additional mitigation that could be considered includes use of alternative, FAA-approved runway anti-icing chemicals (e.g., calcium magnesium acetate and sodium formate) or diversion of runway runoff to the IWS during anti-icing events. The latter option is being evaluated as part of ongoing IWS engineering study, which includes capital improvements to increase the treatment efficiency and capacity of the IWS treatment plant.

Basin planning is another method for investigating mitigation of water quality impacts on Miller and Des Moines Creeks and Puget Sound from Airport and urban runoff. Although the Airport affects relatively small proportions of both the Miller and Des Moines Creek drainage basins (approximately 5 and 30 percent, respectively), activities on these areas could significantly affect these drainages. The Port of Seattle is actively participating in basin planning activities in the Miller and Des Moines Creek basins with local jurisdictions, including King County and the cities of Des Moines, Normandy Park, SeaTac, and Burien.

Based on concerns of Seattle Water Department (now known as the Seattle Public Utilities), the Port undertook additional groundwater and geotechnical investigations concerning soil characteristics, including permeability and adsorptive capacity. This analysis found:

> "Permeability (or hydraulic conductivity) and adsorptive capacity of soil are significant factors because they largely control the rate at which contaminants can infiltrate and migrate in the subsurface....Near surface soils across the site largely consist of till or a thin layer of fill and recessional outwash over till. .. The till (or till-like outwash) underlying the site consists of a very dense mixture of silt, sand, and gravel. The ability of till to transmit water is very low. This is due in part to its relatively high silt content typically ranging between 25 percent and 40 percent ... and to its compression beneath thousands of feet of glacial ice after deposition...
> Calculating hydraulic conductivity from available grain size data ... resulted in permeability values in the range

of 3 to 4 x 10^{-5} cm/sec. ... These data and the wide recognition of Vashon Till as a low permeability aquitard, show that the till underlying the site has a very low permeability... We therefore conclude there is low potential for contaminants released during construction in the fill/outwash area to infiltrate..."

"Summary and Mitigation Recommendation: We conclude the proposed parking lot has a very low potential to impact groundwater quality in the Shallow Aquifer. This conclusion is based on the fact that threats to groundwater quality are largely governed by the degree to which surface water can be contaminated and then infiltrate and reach underlying groundwater. ... The extremely small fraction of surface water that does manage to bypass all of the above (drainage system, pavement basecourse, trench backfills, topsoil horizon, etc.) will have to migrate downward through up to 80 feet of dense till before reaching the Shallow Aquifer. In our opinion, the rate and volume of this movement would be so slow that it would pose essentially no risk to groundwater quality." *Draft Groundwater Quality Impact Evaluation Proposed North Employee Parking Lot, Seattle Tacoma International Airport*, AGI Technologies, April 1997.

Thus, this analysis confirmed the findings of the Final EIS concerning the potential for aquifer contamination.

Additional coordination is expected to occur with the Seattle Public Utilities concerning the development of the parking lot at this site. Construction and operational BMPs will be used to address concerns voiced by the Utility. These include:

- Prohibiting fuel or bulk material storage on the parking lot unless it is strictly inert material.

- Prohibit vehicle washing and maintenance activities on the parking lot

- Carefully design sealing methods for all joints and pipe connections, and establish quality assurance check during construction to confirm that sealing has been accomplished in accordance with project specifications

- Design bioswales for optimum petroleum hydrocarbon degradation

- Control agriculture chemical (landscaping fertilizer) application, particularly during the initial planting

- Regular maintenance of the drainage system, focusing on the removal of sediments from catch basins and detention vaults and oil from oil/water separators.

- Require contractor to prepare and implement a construction spill response plan

- Require the contractor to centralize equipment fueling and repair operations and to construct on-site spill containment measures for the operations area.

- Establish fill placement specifications which lower fill permeability to the greatest degree practicable

In addition, it is expected that a guard will be available in the parking lot to ensure that activities are not conducted in the lot or adjoining area that could result in contamination. The Port will also place signage in the lot to notify users that the lot is in near proximity to the Utilities wellhead. Because of the presence of the wellhead in this area, the Port and Seattle Public Utilities are expected to continue coordination to ensure that contamination does not occur.

Wetlands

Chapter IV of the Final EIS (located in Volume I) presents the impacts of the Master Plan Update improvements relative to biotic communities (including wetlands).

In December 1996, the Port submitted an application to the Army Corps of Engineers for a permit to fill wetlands at Sea-Tac Airport associated with the Master Plan Update improvements in compliance with the Clean Water Act, Section 404. The 404 permit application submitted to the Corps of Engineers includes a completed Joint Aquatic Resources Project Application (JARPA) form, in a report entitled "JARPA Application for Proposed Improvements at Seattle-Tacoma International Airport" dated December 1996.

The Final EIS noted that about 10.4 acres of wetland would be filled in order to complete the proposed improvements. Since issuance of the Final EIS, the Port has refined its evaluation of the projects affecting wetlands, including identification of about 2 additional acres of wetland impacts, and documented its review of in-basin mitigation options, and further defined plans for development of a wetland mitigation site in Auburn.

Based on a refined evaluation of the wetlands, the following impacts were identified:

Project Element	New Data	Final EIS
Runway impacts		
Embankment	5.46	5.48
Borrow Source impacts	1.92	2.38
Runway Safety Areas 16L/R	2.34	Included above
Runway 34R Extension	0.00	0.00
Terminal/Landside		
N. Employee Parking lot	0.81	0.81
Development in SASA	1.70	1.70
Total	**12.23**	**10.40**

Because of wildlife attraction issues, the Port cannot commit to maintaining sites on or near the Airport as wetland habitat mitigation in perpetuity. If a wetland site were to become a safety concern because of its attraction to wildlife, particularly birds, and jeopardize aircraft safety, the Port would be compelled to remove the hazard, including flora and/or fauna. To mitigate for the unavoidable impacts to wetlands, the Port proposes to create new wetlands on a 47-acre site of an approximately 69-acre parcel located within the city limits of Auburn, Washington. Wetland mitigation at the Airport, within the watersheds where the impacts may occur, is not feasible for three reasons: (1) most of the area surrounding the Airport is developed, and not enough available land exists in the watershed to create compensatory mitigation wetlands without relocation of additional business and residences; (2) the FAA has indicated that "wildlife attractions" within 10,000 ft of the edge of any active runway is not recommended; and (3) wildlife control activities in wetlands near the airport would conflict with wetland habitat mitigation goals. However, the hydrologic functions the wetlands perform would be replaced at the airport site with the proposed storm water management facilities, and relocation of the drainage channels, and relocation of affected portions of Miller Creek.

In addition, the Port performed a follow-up review of the west side of the airfield to determine if raptors (such as the red-tailed Hawk) were nesting in the area. This survey indicated that no nests are occurring, but that raptors forage in the airport area.

Floodplains

Construction and operation of the proposed Master Plan Update actions could significantly reduce the 100-year floodplain area and flood storage capacity, increase volumes of stormwater runoff and peak flows, and increase flooding potential in downstream areas on both Miller and Des Moines Creeks. However, flow modeling results using detention requirements for the new development show that the actions will not increase peak flows or potential flooding in downstream areas of Miller or Des Moines Creek.

Mitigation will include adherence to floodplain development standards and floodway management requirements of the FAA and Washington State Department of Ecology. Compensatory mitigation is required by state law for any proposed filling of 100-year floodplain so as to achieve no net loss in flood storage capacity and to prevent an increased risk of loss of human life or property damage.

Compensatory mitigation for floodplain impacts near the northwest corner of the proposed new parallel runway has been incorporated into the stream relocation design. The stream mitigation design, which was developed in cooperation with several resources agencies, including the U.S. Army Corps of Engineers, would create an equivalent amount of floodplain storage - so no net loss of flood storage capacity or increased risk of loss of human life or property damage would result.

Surface transportation

Continued regional population growth will impact the surface transportation system in the vicinity of Sea-Tac Airport regardless of the improvements undertaken at the Airport. The surface transportation analysis, using the new forecast shows the following:

- Total Airport traffic is expected to increase from approximately 72,500 vehicles per day in 1994, to approximately 114,000 vehicles per day for the Do-Nothing Alternative (Alternative 1) or approximately 113,300 vehicles per day for the Preferred Alternative (Alternative 3) in the year 2010. The differences between the Do-Nothing and the Preferred Alternative traffic volumes relate to the availability of on-site parking under each alternative and how the availability of parking affects vehicular access to the Airport.

- No significant surface transportation impacts have been identified for the Preferred Alternative in comparison to the Do-Nothing Alternative for any of the evaluated intersections and freeway ramp junctions.

- The Preferred Alternative would generate an additional 95 PM peak hour trips in the year 2010 over the Do-Nothing Alternative.

- Impacts associated with Alternative 2 (Central Terminal) and Alternative 4 (South Unit Terminal) were also considered and showed that the surface transportation impacts of these alternatives would be the same as the Preferred Alternative.

The transportation improvement project that would have the greatest impact on conditions in the Airport area is the construction of the State Route 509 Extension and South Access.

Plants and animals (biotic communities)

Construction and operation of the dependent parallel runway would have some adverse effects on fishery and aquatic resources of Miller and Des Moines Creeks and Puget Sound. About 3,700 feet of Miller Creek and its tributaries would require realignment and relocation to complete the runway. About 200 feet of Des Moines Creek would require relocation due to the 600 ft extension of Runway 34R. About 2,200 feet of open channel on Des Moines Creek would require relocation due to the South Aviation Support Area (SASA). The 200-foot section of Des Moines Creek that would be affected by the extension of Runway 34R is within the area that would be realigned as mitigation for SASA. Proposed mitigation would reduce potential impacts on the hydrology, water quality, and aquatic habitat and biota of the two creeks and Puget Sound.

Endangered species of flora and fauna

No significant impacts on threatened and endangered species are expected as a result of the proposed Master Plan Update Alternatives.

Public services and utilities

Public services and utilities would require minor changes based on the residences, businesses, and facilities displaced by development. Major utilities that would be relocated or protected in-place are the Southwest Suburban Sewer District, Miller Creek Interceptor, Seattle Water Department trunk line, Puget Power third electrical service metering point, and US West trunk lines entering at S. 176th Street. A variety of existing utility services, both on the Airport and off the Airport, would be abandoned.

Earth

Project construction and operation (including clearing, grading, excavation, and fill placement) are evaluated and potential mitigation measures identified. The Master Plan Update alternatives would require the placement of the following quantities of earth:

Alternative	Million Cubic Yards of Fill
Alternative 1 (Do-Nothing)	2.4
Alternative 2	23
Alternative 3	23
Alternative 4	23

Note: Transported fill volumes would be about 15% greater than the figures shown above to account for shrinkage during fill placement. Alternatives 2, 3 and 4 assume a new parallel runway with a length up to 8,500 feet, located 2,500 ft west of Runway 16L/34R. The Do-Nothing includes the development of the South Aviation Support Area (SASA) and Des Moines Creek Technology Campus.

Of the 23 million cubic yards of fill needed, about 17.25 million cubic yards would be needed for an 8,500-foot new parallel runway. Preliminary investigations indicate that all of the required fill could be obtained from a combination of Port of Seattle-owned property and off-site borrow sources.

Two seismic hazard areas have been identified by the City of SeaTac on the site of the proposed new parallel runway. They are small areas of shallow, loose sediment that likely would liquefy during a seismic event. During construction this sediment would be removed and replaced with compacted fill.

Erosion of exposed soils in areas of excavation, fill, and stockpile would occur during construction. The amount of erosion would depend on the design and implementation of an Erosion and Sedimentation Control Plan.

Solid waste

Solid waste is composed of solid and semi-solid waste, including such things as garbage, rubbish, metal, paper, plastic, and wood. Based on the analysis of solid waste conditions, and the impacts of the Master Plan Update alternatives, no significant impacts on solid waste generation and disposal are expected.

Hazardous waste

Operations at the Airport by the Port and airport tenants involve the storage and use of hazardous materials and the generation of hazardous wastes. Fifty-one potential or known hazardous substance sites exist on the Airport property and in the vicinity of the Sea-Tac Airport. Eleven of those sites are located in the area where a new parallel runway would be completed, and one is located in the proposed SASA Area. Sites located west of the Airport, and those located on Port of Seattle (POS) property, have the potential to be most affected by the Master Plan Update alternatives.

Mitigation for potential construction-related hazards include developing a Spill Prevention, Control, and Countermeasures Plan (SPCCP) outlining procedures for transport, storage, and handling of hazardous materials, and a Hazardous Substances Management and Contingency Plan outlining procedures for removal, storage, transportation, and disposal of hazardous wastes. All federal, state, and applicable local rules and guidelines for handling and disposal of hazardous substances would be followed.

Energy supply and natural resources

The proposed "With Project" alternatives (Alternative 2, 3 and 4) are expected to increase in annual energy usage seven to nine percent over the Do-Nothing (Alternative 1). All suppliers of these natural resources have indicated the capability of serving the increased demand.

Construction

As discussed in the Final Master Plan Update EIS (Chapter IV, Section 23), the transport of fill material to the airport could have adverse environmental impacts, e.g., impacts on surface transportation and impacts on properties near the construction sites. In an effort to mitigate such impacts, a Construction and Earthwork Management Plan would be prepared to govern the acquisition and placement of fill material for Master Plan Update development actions. The Plan should address the methods selected for acquiring and transporting fill material to the airport development sites including a process for designating preferred haul routes and specific conditions such as hours of operation, traffic control, and route mitigation. The Plan's contents will depend on the methods ultimately selected and may include such topics as construction of temporary access ramps and roads, shoreline dock facilities, conveyor systems, and/or rail facilities.

Because of the social disruption that would occur in the general vicinity of the proposed new runway construction, construction mitigation acquisition will be considered. This acquisition could include about 70 residential and commercial properties located east of Des Moines Memorial Drive between SR 509 and SR 518.

To minimize the fugitive dust transport, unpaved roads and inactive portions of the construction site will be watered (achieving a 50 percent reduction in dust) or chemically stabilized (achieving an 80 percent reduction) during dry periods.

Construction impacts are short-term and temporary. Provisions of FAA Advisory Circular 150/5370-10, "Standards for Specifying Construction of Airports," will be incorporated into construction specifications.

Aesthetics and urban design

The proposed "With Project" alternative will change the visual character of the area. Adherence to applicable design and landscaping standards can ensure that this impact would not be adverse.

Assumptions regarding airport activity levels with and without the new runway

It was assumed in the Master Plan Update EISs that, until the number of aircraft operations reaches approximately 460,000 operations per year, the number of passengers and flight operations would be the same regardless of whether the new runway is built. It was also assumed that, when the number of operations reaches approximately 460,000 operations per year, the number of operations would not increase under the "Do Nothing" scenario but the number of passengers would continue to increase within the foreseeable future as demand increases. Some commentors on the Draft EIS and Draft SEIS questioned these assumptions, suggesting that increasing delay at the airport will result in slower growth in flight operations than would occur with the development of the new runway. These commentors argued that the EISs are inadequate because they compared the potential impacts of the new runway to a "Do Nothing" alternative that was not accurate. The FAA and Port responded to these questions/arguments in two ways.

First, the relationship between increasing delay and the forecast demand was reviewed and discussed in the Final EIS and Final SEIS. When the aviation demand forecast model was developed for the Master Plan Update, an effort was made to create a model that would explain the past changes in air travel demand. The model demonstrated that changes in origin and destination (O&D)

enplanements at the airport are a result of changes in regional population, income, and average air fares. Regional forecasts for the Puget Sound area, prepared by the Puget Sound Regional Council and others, project that population and income in the Region will increase during the planning period. Average air fares are not expected to increase to an extent significant enough to dampen substantially the anticipated increase in aviation demand. Therefore, the forecasts predict that aviation demand will increase in the future.

The Flight Plan study concluded that the annual service volume of the existing airfield at Sea-Tac is about 380,000 annual operations, based on acceptable levels of aircraft delay. (In 1996, there were about 395,000 operations at Sea-Tac.) However, the study also concluded that it is possible for more than 380,000 operations to occur at Sea-Tac in a year, by expanding operations into the late evening and early morning hours and by accepting increased average delay, up to a theoretical capacity of 460,000 operations per year. For a number of reasons, it is the professional judgment of the FAA, the Port and its technical consultants that the increasing delay will not result in an overall level of aviation activity significantly different from that which would occur with the new runway until operations reach approximately 460,000 (forecast for the year 2008). Even without the new runway, the increases in regional population and income will result in increased operations at Sea-Tac because, among other reasons, there are no acceptable alternatives.

However, in the event this forecast is inaccurate, an analysis was conducted for the Final EIS that considered the potential differences in impacts if the increasing congestion and delay results in reduced aviation demand. As described on pages R-5 through R-18 in Appendix R, a scenario was considered in which aviation demand grows at rates 15% lower than that predicted in the Master Plan Update forecast. This analysis demonstrated that the impacts of this Do-Nothing scenario would be different from (and in most areas would be less than or occur later than) the impacts of the With Project alternatives. In the Draft and Final SEIS, this analysis was updated in light of the new forecast. The updated analysis is set forth in Appendix D and summarized at Table D-2 of the Final SEIS.

This analysis showed that fewer residences would be included in the DNL 65 noise contours and the quantity of air pollutants would be less, which is the logical result of fewer flight operations and less surface transportation to and from the airport. Impacts in other areas, including wetlands, stream relocations, floodplain impacts, property acquisitions, socio-economic impacts, and earth/fill material, would be delayed or non-existent as the construction of the new runway is delayed or abandoned. These differences provide a basis for comparison with the proposed action and have been considered by the Commission in reaching its decision to adopt Resolution No. 3245. Even if the impacts of the "Do Nothing" alternative are less, the Commission has concluded that approval of the Master Plan Update and development of the new runway is necessary and appropriate.

5. **The Commission's Decisions: A Balancing of Multiple Considerations.**

On August 1, 1996, the Port Commission adopted Resolution No. 3212, as Amended, which among other actions included adoption of the Airport Master Plan Update for Sea-Tac Airport, found that the Airport Master Plan EIS met the requirements of the State Environmental Policy Act (SEPA), and granted approval to develop the third runway. As discussed earlier in this Attachment to Resolution No. 3245, an update to the Master Plan forecasts was prepared subsequent to adoption of Resolution No. 3212, as Amended. Those updated forecasts indicated higher levels of air passengers and aircraft operations than anticipated by the Airport Master Plan. As a result, a Supplemental EIS was prepared to assess the impacts of the Master Plan Update improvements relative to the anticipated higher levels of air travel demand. Through Resolution No. 3245, the Commission re-affirms its findings and approvals granted in Resolution No. 3212, as Amended, and takes action with respect to the Supplemental EIS.

In reaching the decisions embodied in Resolution No. 3245, the Port Commission has considered a wide range of issues including, among others: (i) the need for improvements to meet the Region's growing aviation demand; (ii) the alternatives for meeting this demand including supplemental and replacement airports, demand/system management, high speed ground transportation, new air navigation and airplane technologies, and alternative configurations of a new runway and other new facilities at Sea-Tac airport; (iii) the environmental impacts of the various alternatives as documented in the Flight Plan and Master Plan Update EISs and Master Plan Update SEIS; and (iv) costs and related financial issues.

The Port has considered the potential environmental impacts of the alternative courses of action and the possible mitigating measures available to lessen or eliminate such impacts. In most cases, it is possible to mitigate potential environmental impacts to an acceptable level. For example, construction of the new runway will require filling of wetlands and relocation of a creek. But through careful planning, replacement wetlands and a relocated creek will be developed in a manner that replaces most if not all the important attributes of the affected areas. In some instances, however, there are unavoidable impacts that cannot be completely mitigated, requiring the Port Commission to balance the need for improvements and other considerations against the potential environmental impacts. The environmental impacts of a proposal, as documented in an EIS, represent one of many factors that must be considered and balanced by the decisionmakers. This balancing judgment is recognized as necessary and appropriate in the state SEPA regulations which provide as follows:

> SEPA contemplates that the general welfare, social, economic, and other requirements and essential considerations of state policy will be taken into account in weighing and balancing alternatives and in making final decisions. ... [T]he environmental impact statement is not required to evaluate and document all of the possible effects and considerations of a decision or to contain the balancing judgments that must ultimately be made by the decisionmakers. Rather, an environmental impact statement analyzes *environmental* impacts and must be used by agency decisionmakers, along with other relevant considerations or documents, in making final decisions on a proposal. The EIS provides a basis upon which the responsible agency and officials can make the balancing judgment mandated by SEPA ...

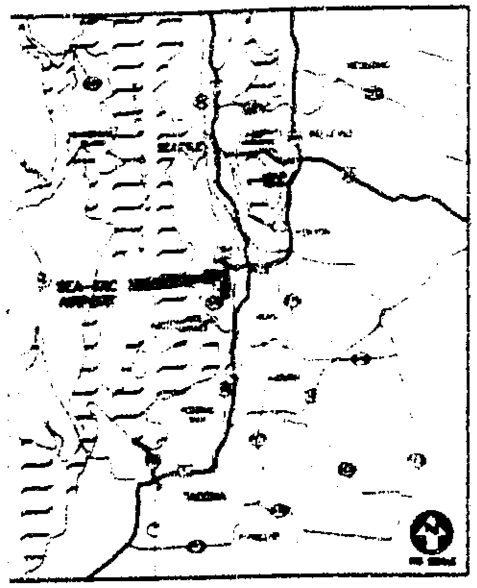
WAC 197-11-448 (1). In enacting Resolution No. 3245, the Commission has determined, on balance, that the adoption of the Master Plan Update and the development of a new dependent air carrier runway is a necessary and reasonable decision in the best interests of the Puget Sound Region.

SEATTLE – TACOMA INTERNATIONAL AIRPORT

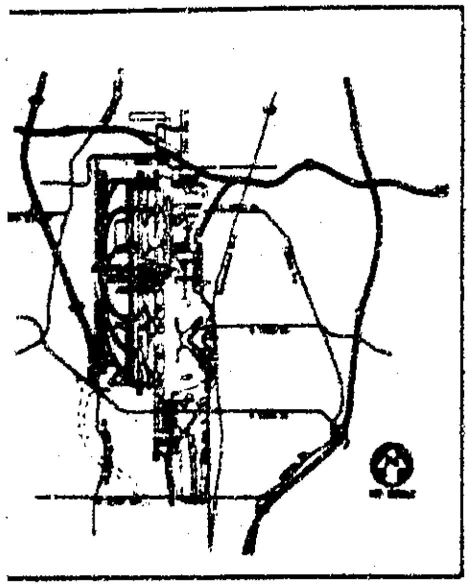
Attachment C
to Port Resolution 3245

AIRPORT MASTER PLAN

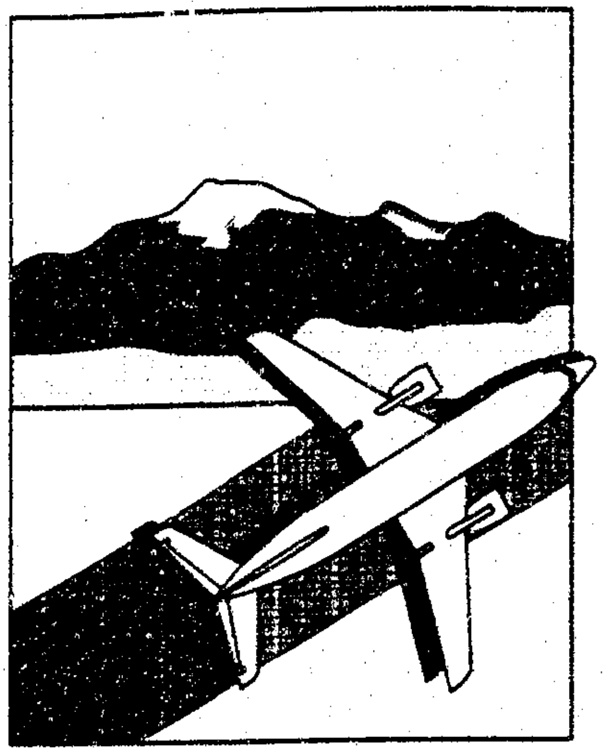
(8,500' OPTION FOR RUNWAY 16X–34X)



LOCATION MAP



VICINITY MAP



INDEX OF DRAWINGS

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3.	Terminal Area Plan
4.	Airport Land Use Plan – Existing Land Uses
5.	Airport Land Use Plan – Future Land Uses
6.	Airport Airspace Plan
7.	Approach Zone Profiles – Runway 16L – 34R
8.	Approach Zone Profiles – Runway 16R – 34L
9.	Approach Zone Profiles – Runway 16X – 34X
10.	Runway Protection Zone Plan and Profiles – Runway 16L – 34R
11.	Runway Protection Zone Plan and Profiles – Runway 16R – 34L
12.	Runway Protection Zone Plan and Profiles – Runway 16X – 34X

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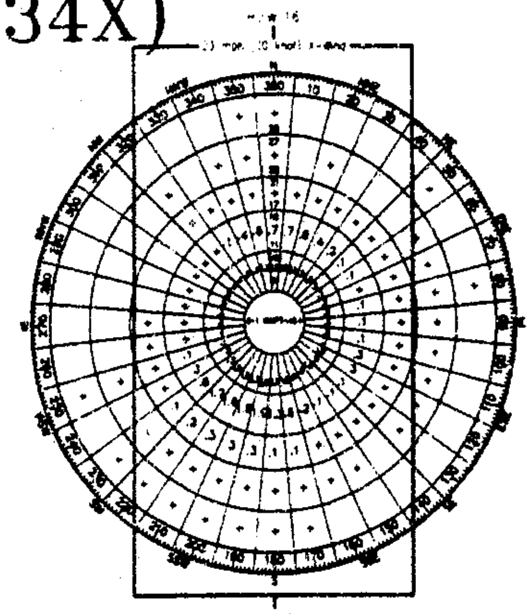

WIND COVERAGE:
99.97 %

ALL–WEATHER
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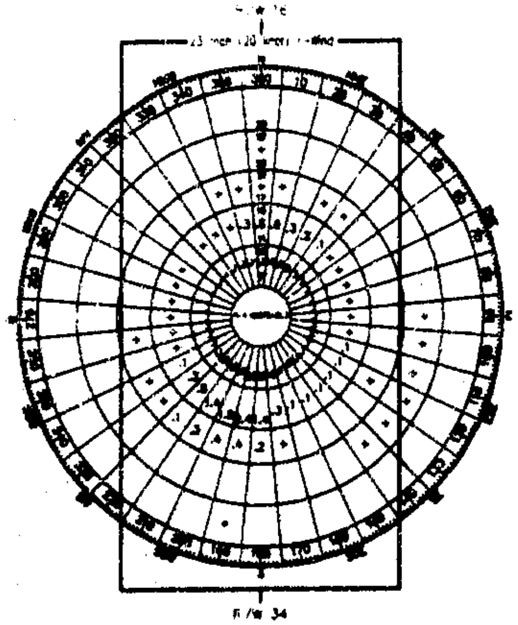
SOURCE: BASED ON 90,550 OBSERVATIONS TAKEN AT SEATTLE–TACOMA INTERNATIONAL AIRPORT FOR THE YEARS 1948–1978. NATIONAL CLIMATIC DATA CENTER.



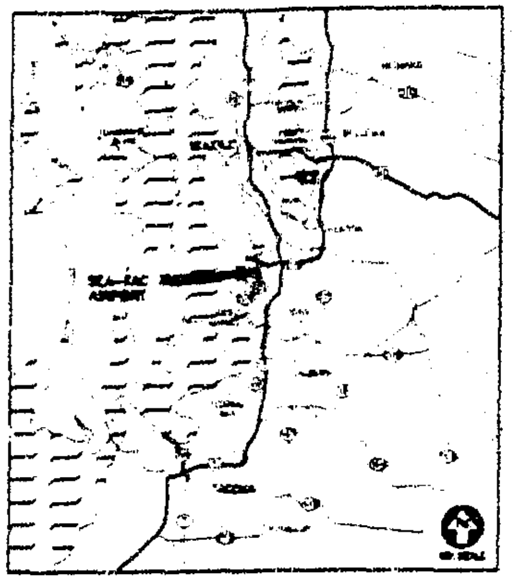
WIND COVERAGE:
100.00 %

IFR
WIND ROSE

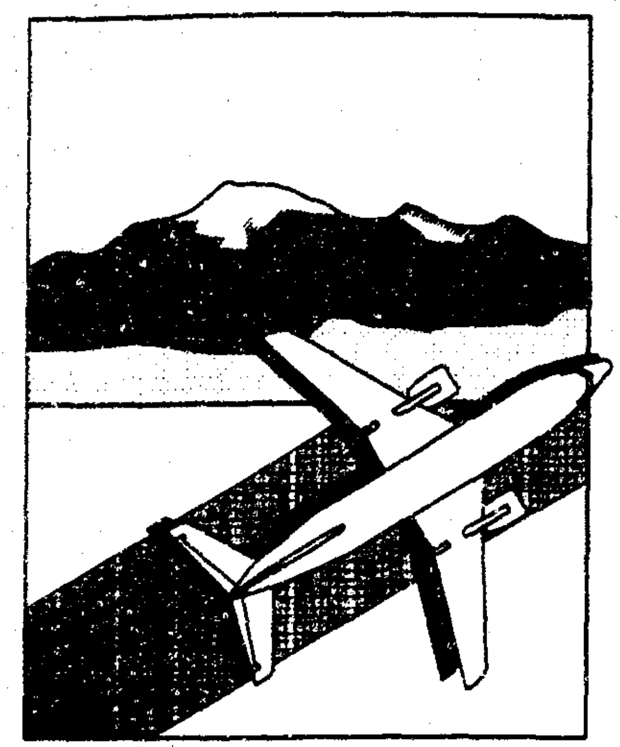
Attachment C
to Port Resolution 3

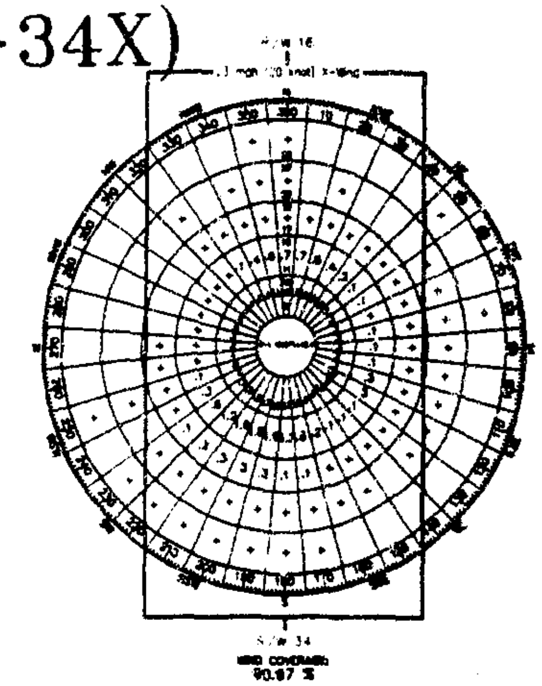
SEATTLE – TACOMA INTERNATIONAL AIRPORT

AIRPORT MASTER PLAN
(8,500' OPTION FOR RUNWAY 16X–34X)



LOCATION MAP





ALL-WEATHER WIND ROSE

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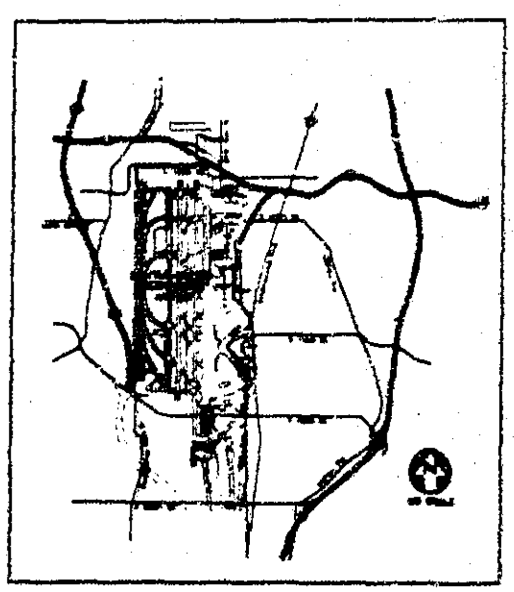

VICINITY MAP

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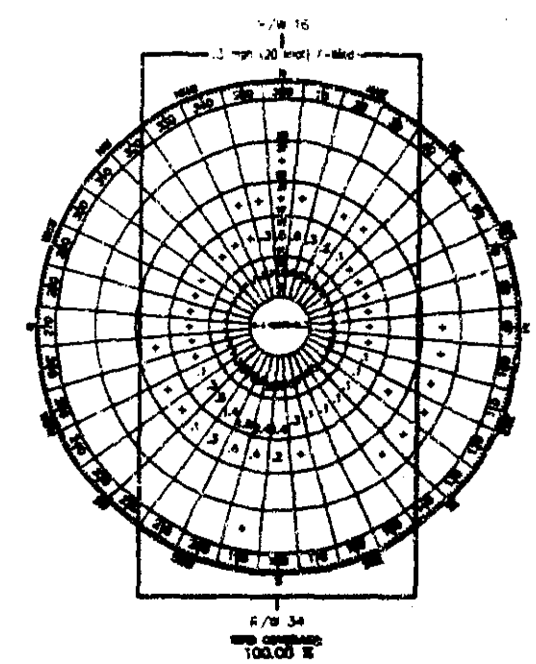
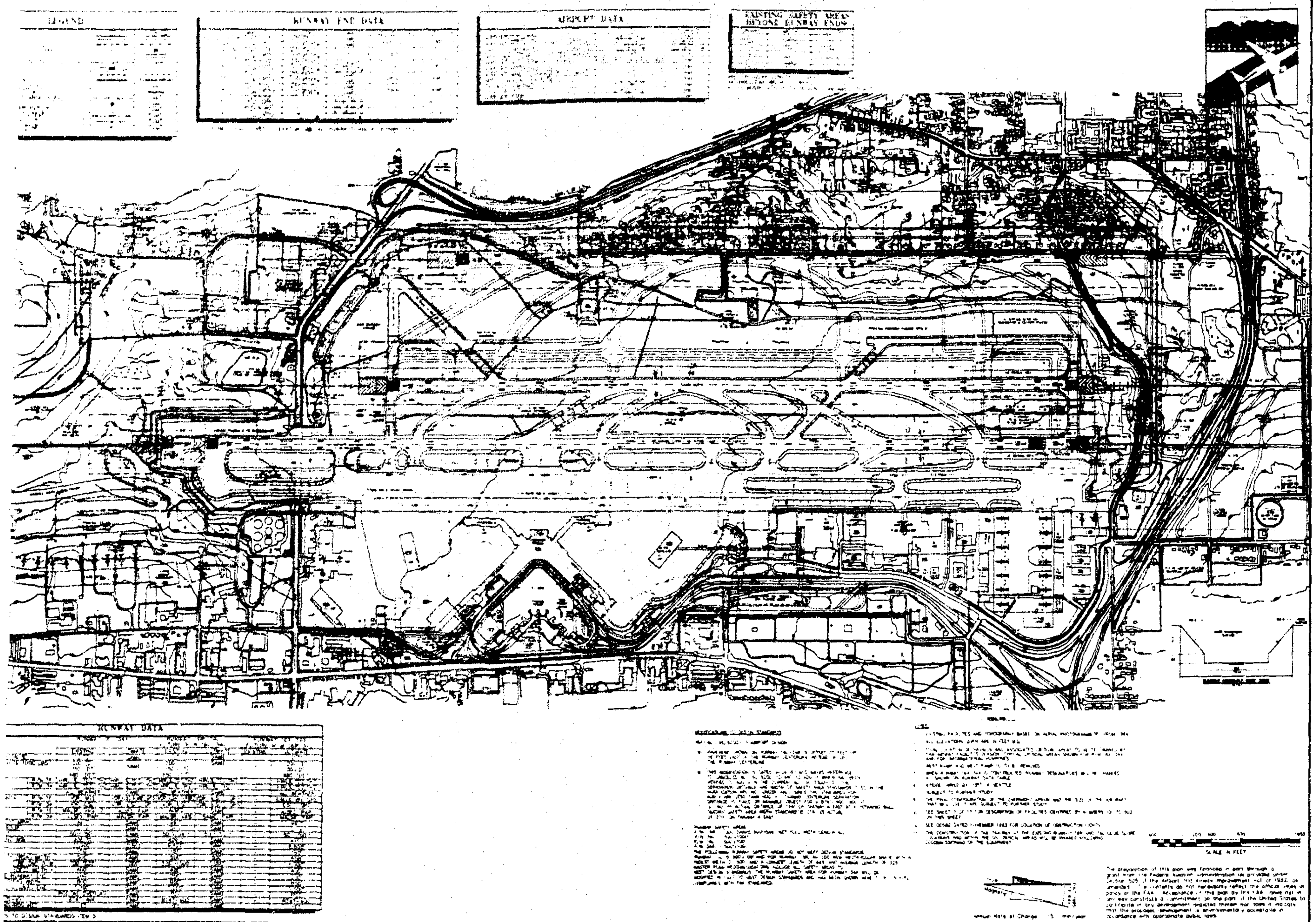


IFR WIND ROSE

P?D Aviation



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AIRPORT LAYOUT PLAN

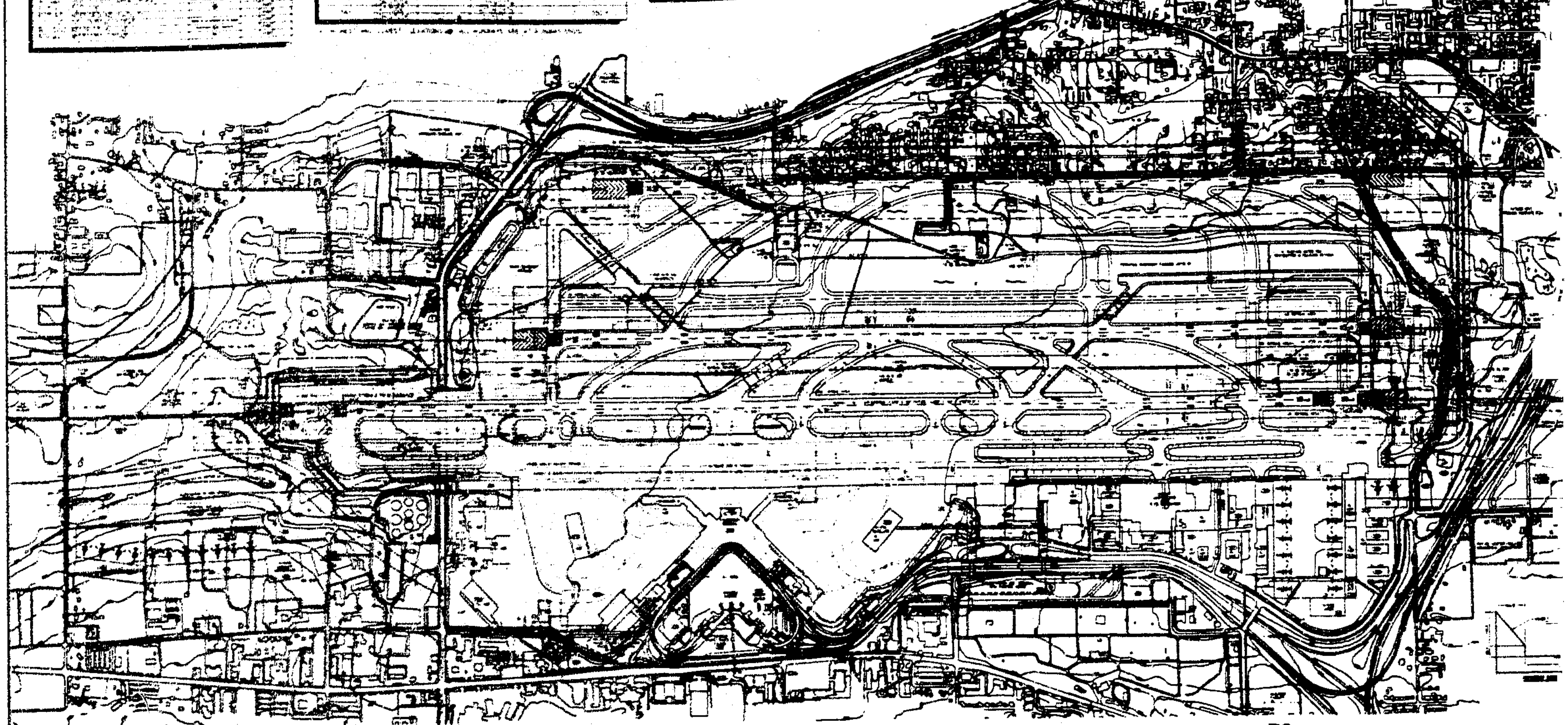
SHEET 2 OF 12

LEGEND

RUNWAY END DATA

AIRPORT DATA

EXISTING SAFETY AREAS BEYOND RUNWAY ENDS



RUNWAY DATA

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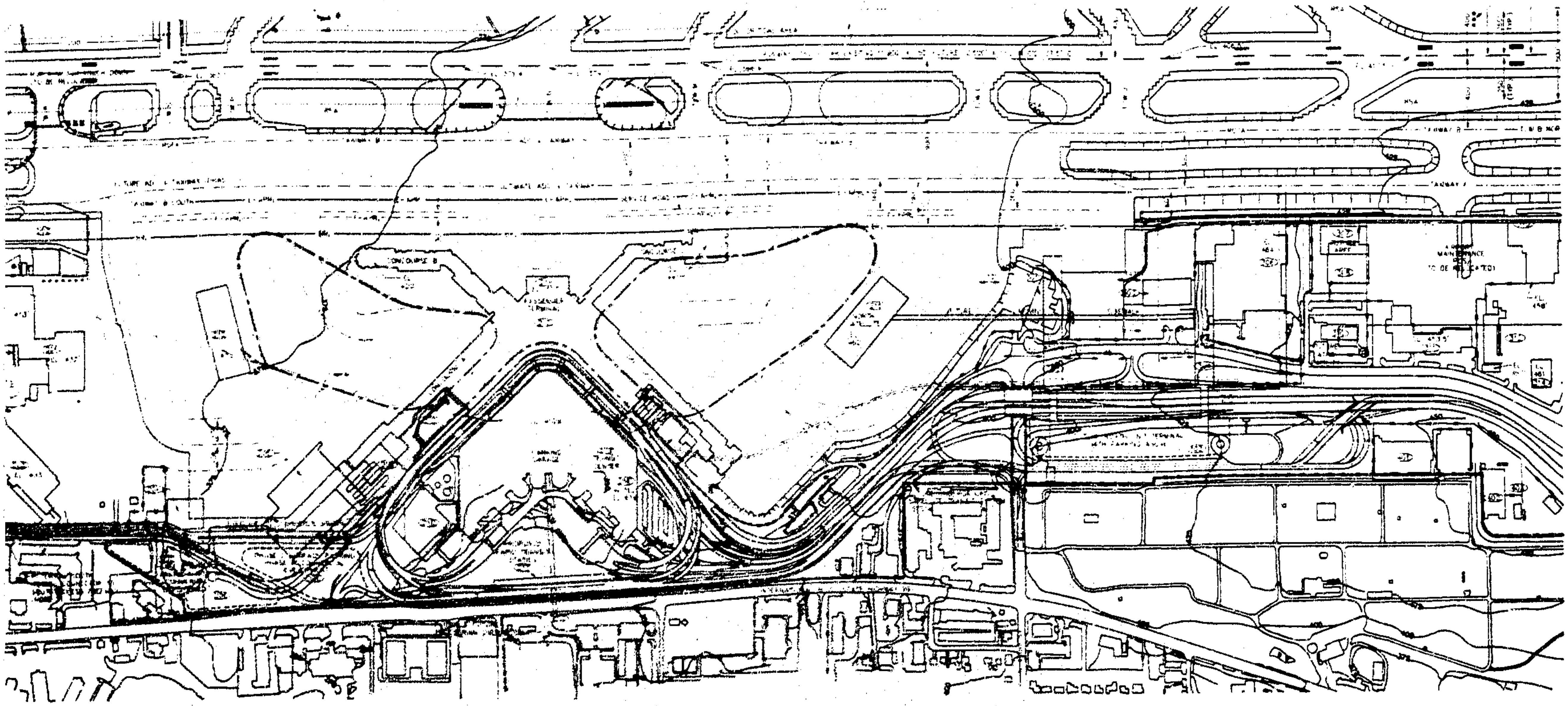
AIRPORT LAYOUT PLAN

SHEET 2 OF 1



BUILDING DATA TABLE

LEGEND

Aviation

PORT OF SEATTLE

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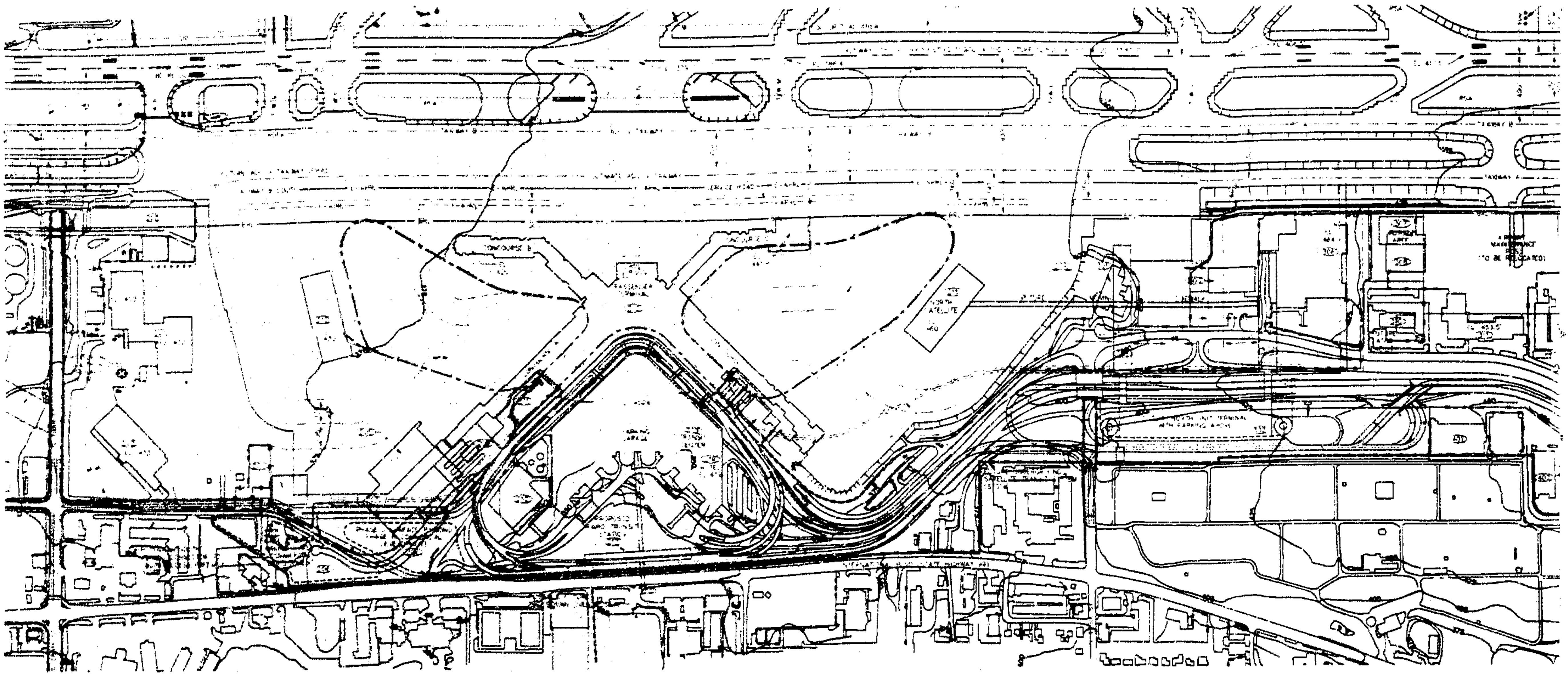
SEA-TAC INTERNATIONAL AIRPORT

TERMINAL AREA PLAN

SHEET 3 OF 12



BUILDING DATA TABLE

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108	[illegible]	[illegible]	[illegible] (Phase [illegible])	308	[illegible] Air Cargo	[illegible]	[illegible]
201	[illegible]	[illegible]	Same	309	[illegible]	[illegible]	[illegible]
202	[illegible]	[illegible]	To Be Removed / Relocated (Phase [illegible])	310	[illegible]	[illegible]	[illegible]
203	[illegible]	[illegible]	Same	311	[illegible]	[illegible]	[illegible]
204	[illegible]	[illegible]	To Be Removed / Relocated (Phase [illegible])	312	Air [illegible]	[illegible]	[illegible]
205	[illegible]	[illegible]	To Be Removed / Relocated (Phase [illegible])	313	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NOTES

1. Existing facilities and topography based on aerial photogrammetry from 1994.
2. All elevations given are in feet MSL.
3. Final location of relocated navaids to be determined by FAA Airway Facilities Division.
4. Property to be obtained by Port of Seattle in trade.
5. See sheet 2 of 12 for location of facilities 101 to 108, 315 to 321 and 404 to 503.

LEGEND

	EXISTING	ULTIMATE
[illegible]	[illegible]	[illegible]

SCALE IN FEET

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TERMINAL AREA PLAN

SHEET 3 OF 12

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AIRPORT LAND USE PLAN
EXISTING LAND USES

SHEET 4 OF 12

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EXISTING LAND USES

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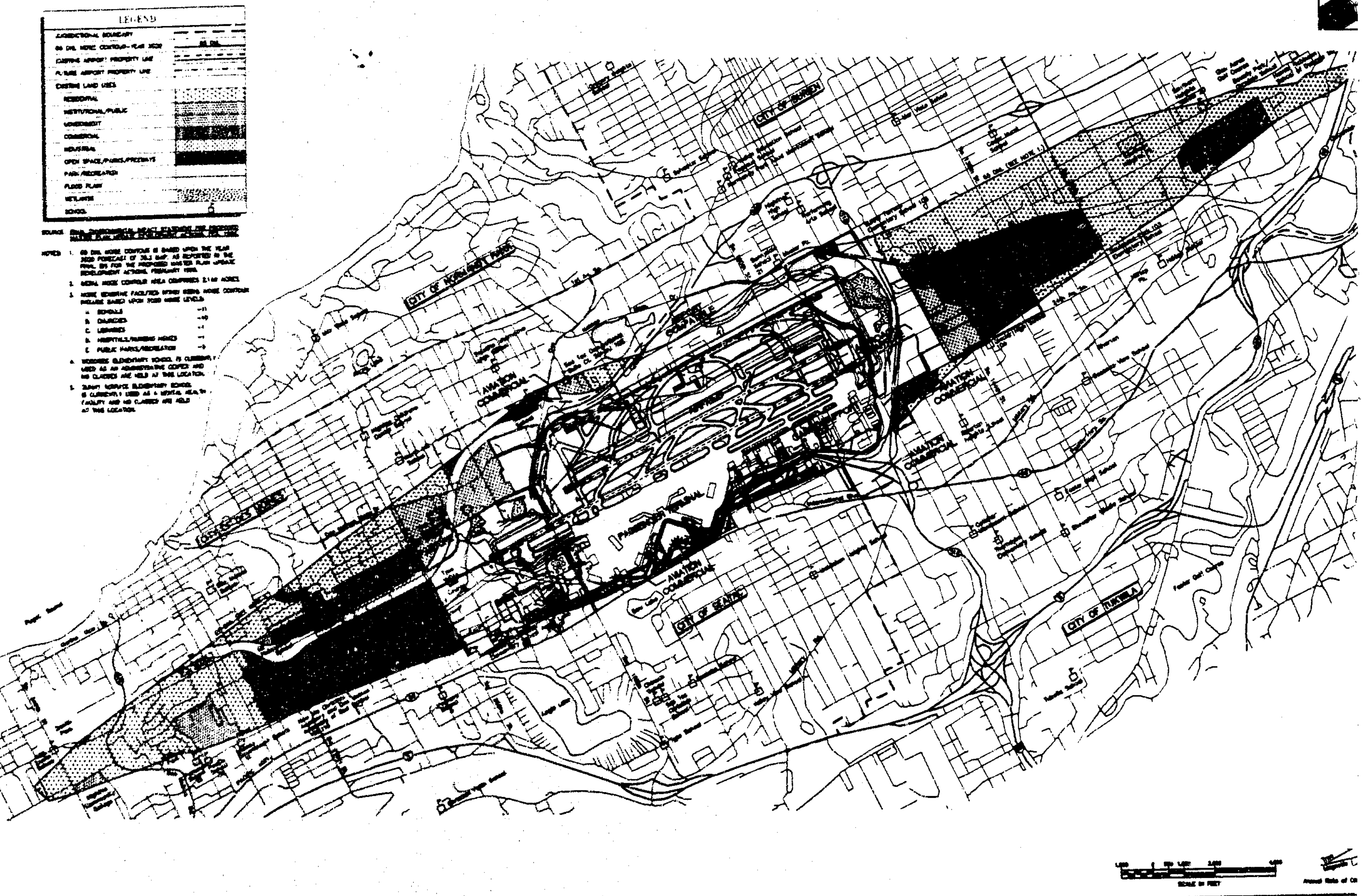
AIRPORT LAND USE PLAN
FUTURE LAND USES
SHEET 5 OF 12



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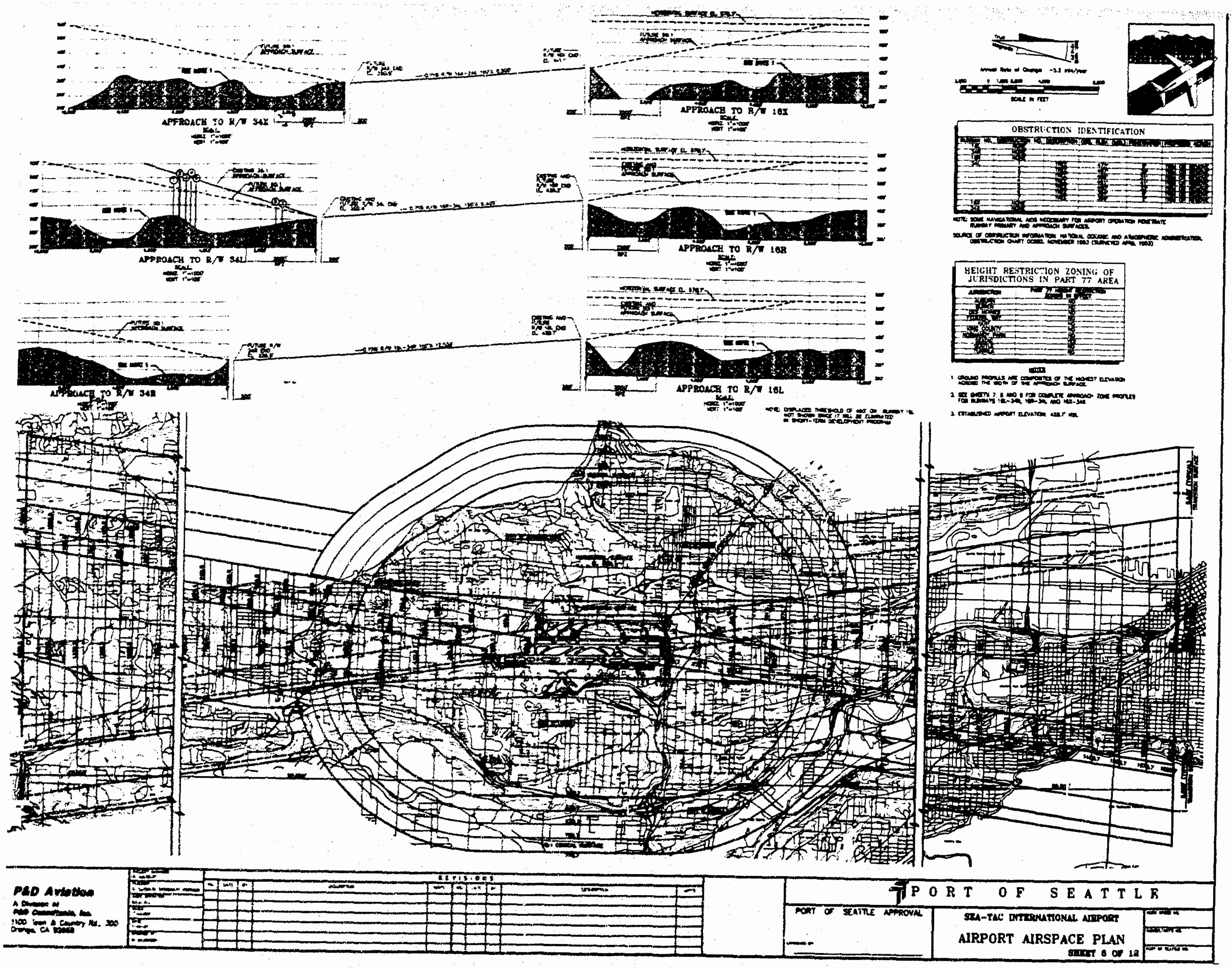
FUTURE LAND USES

SHEET 5 OF 1


APPROACH TO R/W 34X
APPROACH TO R/W 16X
APPROACH TO R/W 34L
APPROACH TO R/W 16R
APPROACH TO R/W 34R
APPROACH TO R/W 16L
OBSTRUCTION IDENTIFICATION
NOTE: SOME NAVIGATIONAL AIDS NECESSARY FOR AIRPORT OPERATION PENETRATE RUNWAY PRIMARY AND APPROACH SURFACES.
SOURCE OF OBSTRUCTION INFORMATION: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, OBSTRUCTION CHART OC882, NOVEMBER 1983 (SURVEYED APRIL 1983)
HEIGHT RESTRICTION ZONING OF JURISDICTIONS IN PART 77 AREA
NOTES
1. GROUND PROFILES ARE COMPOSITES OF THE HIGHEST ELEVATION ACROSS THE WIDTH OF THE APPROACH SURFACE.
2. SEE SHEETS 7, 8 AND 9 FOR COMPLETE APPROACH ZONE PROFILES FOR RUNWAYS 16L-34R, 16R-34L AND 16X-34X
3. ESTABLISHED AIRPORT ELEVATION: 429.7' MSL
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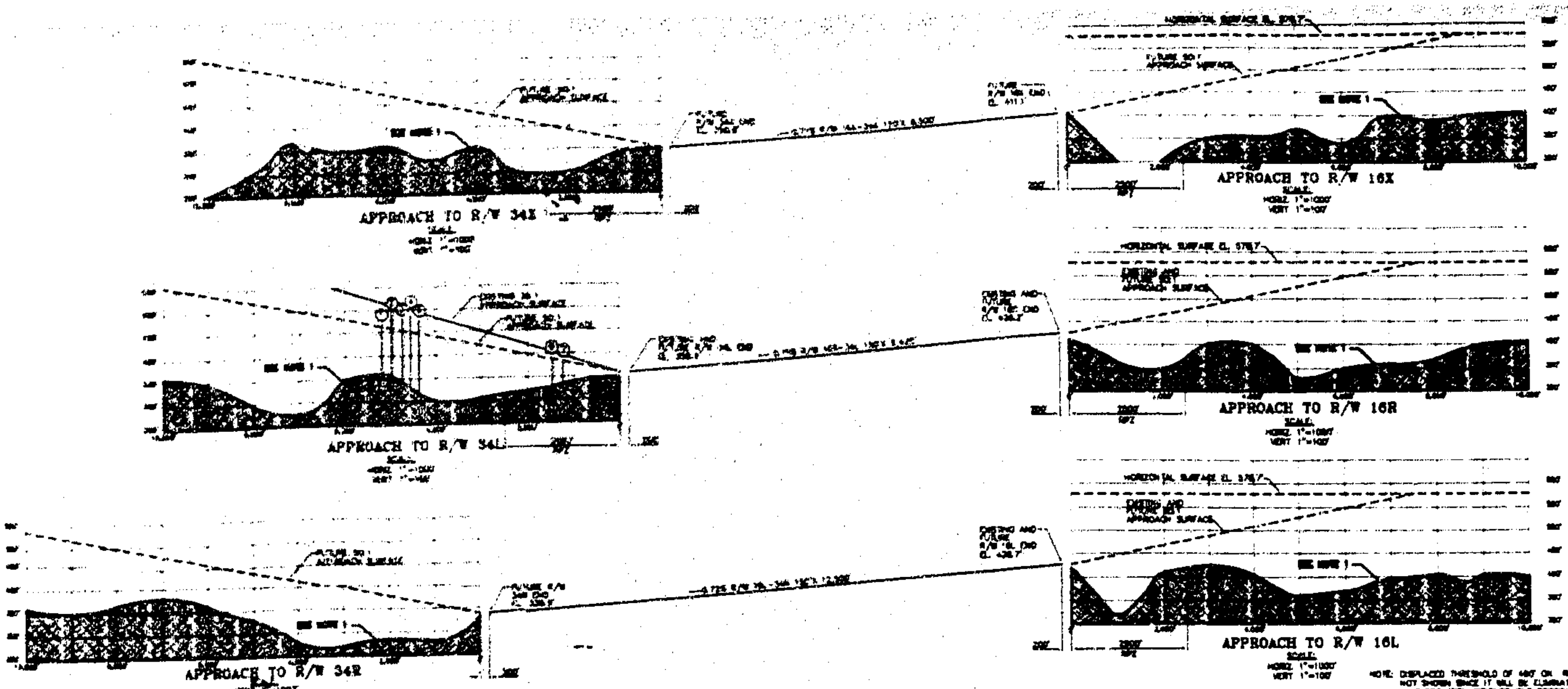
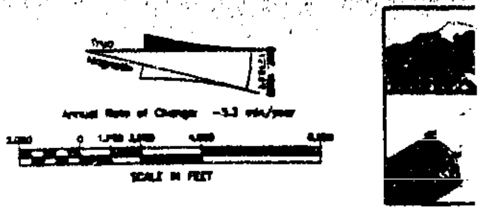
SEA-TAC INTERNATIONAL AIRPORT
AIRPORT AIRSPACE PLAN
SHEET 6 OF 12





OBSTRUCTION IDENTIFICATION

NOTE: SOME NAVIGATIONAL AIDS NECESSARY FOR AIRPORT OPERATION PENETRATE RUNWAY PRIMARY AND APPROACH SURFACES.

SOURCE OF OBSTRUCTION INFORMATION: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION OBSTRUCTION CHART OC660, NOVEMBER 1990 (SURVEYED APRIL 1990)

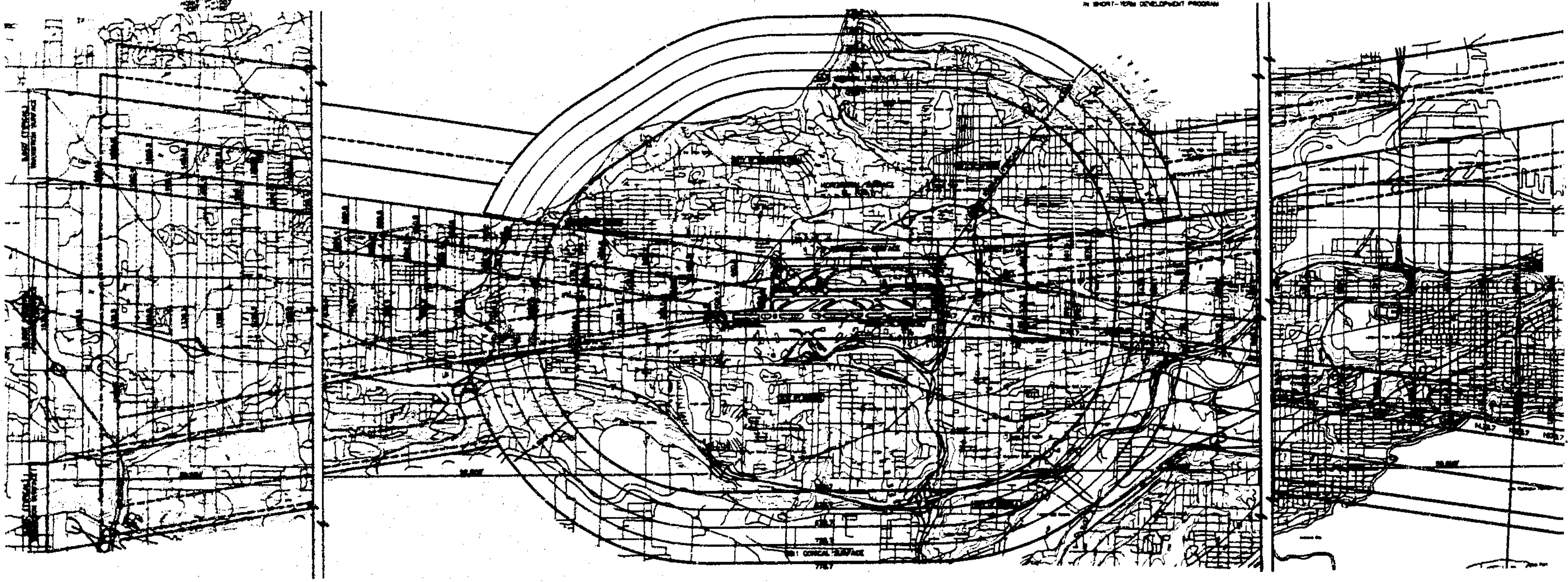
HEIGHT RESTRICTION ZONING OF JURISDICTIONS IN PART 77 AREA

JURISDICTION	PART 77 HEIGHT RESTRICTION ZONING IN EFFECT
AUBURN	[illegible]
BURIEN	[illegible]
DES MOINES	[illegible]
FEDERAL WAY	[illegible]
KENT	[illegible]
KING COUNTY	[illegible]
NORMANDY PARK	[illegible]
SEATAC	[illegible]
SEATTLE	[illegible]
TUKWILA	[illegible]

NOTES

1. GROUND PROFILES ARE COMPOSITES OF THE HIGHEST ELEVATION ACROSS THE WIDTH OF THE APPROACH SURFACE.
2. SEE SHEETS 7, 8 AND 9 FOR COMPLETE APPROACH ZONE PROFILES FOR RUNWAYS 16L-34R, 16R-34L AND 16X-34X
3. ESTABLISHED AIRPORT ELEVATION: 428.7' MSL

NOTE: DISPLACED THRESHOLD OF 460' ON RUNWAY 16L NOT SHOWN SINCE IT WILL BE ELIMINATED IN SHORT-TERM DEVELOPMENT PROGRAM



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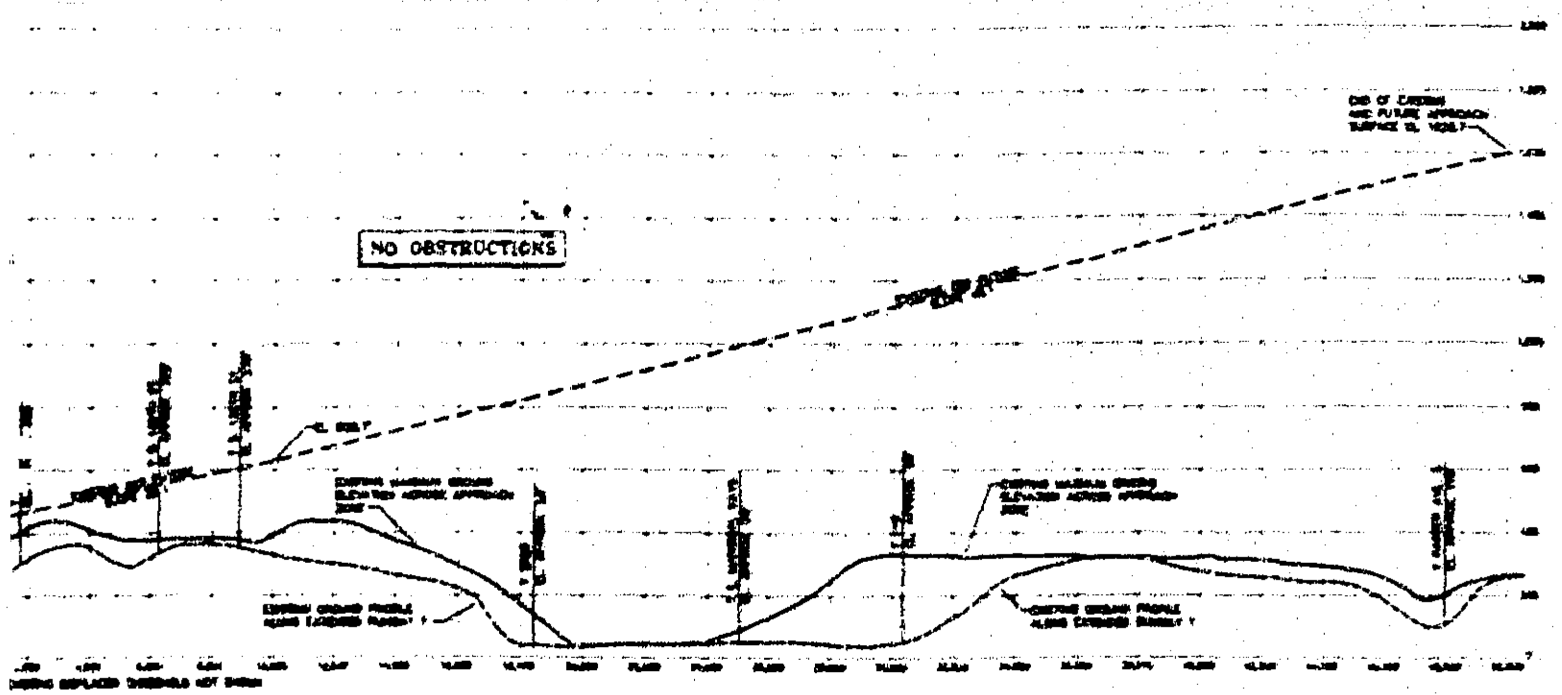
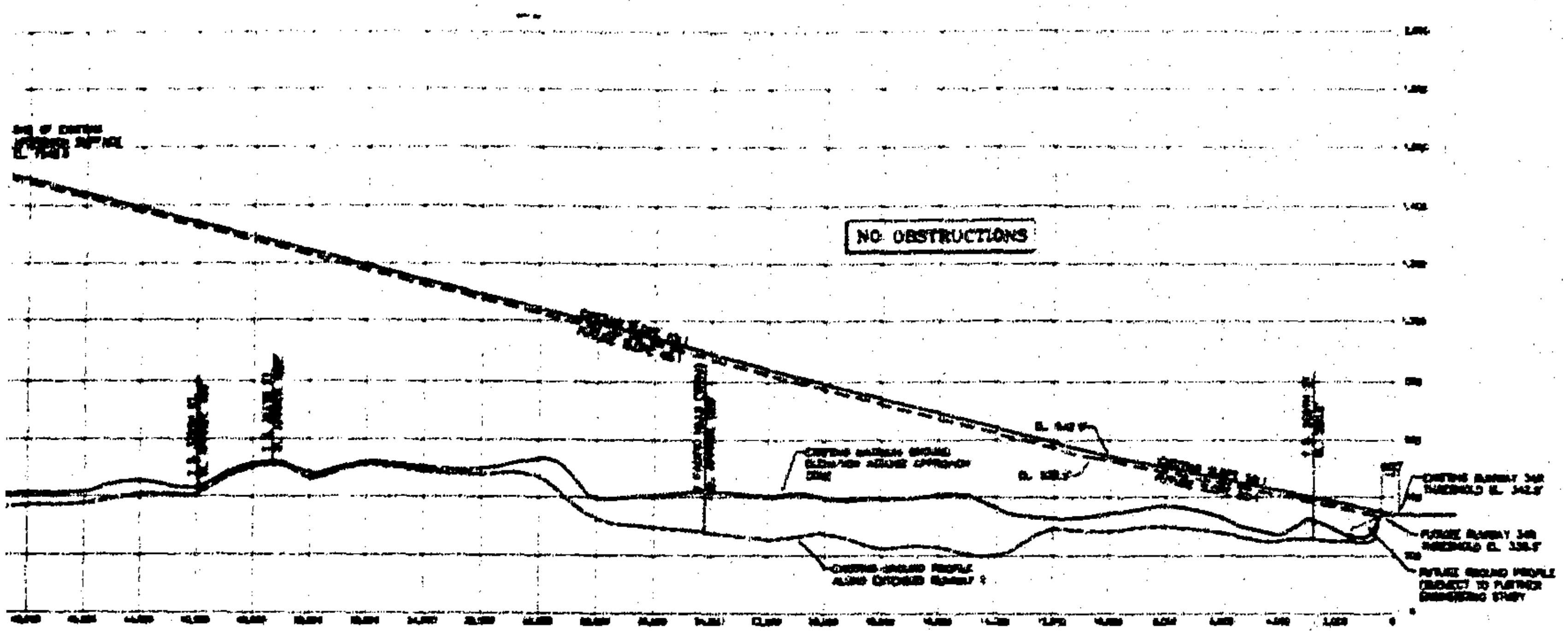
AIRPORT AIRSPACE PLAN

SHEET 6 OF 12



RUNWAY 16L APPROACH ZONE PROFILE



RUNWAY 34R APPROACH ZONE PROFILE

OBSTRUCTION IDENTIFICATION

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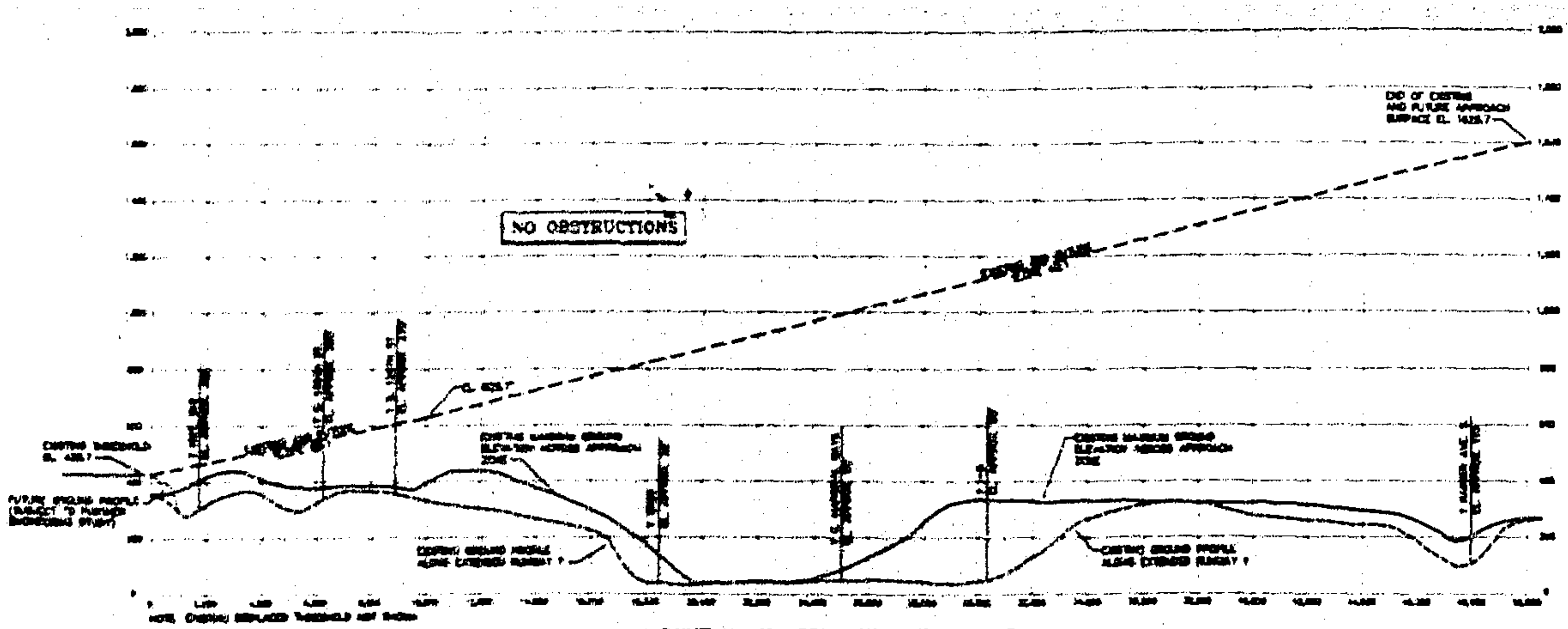
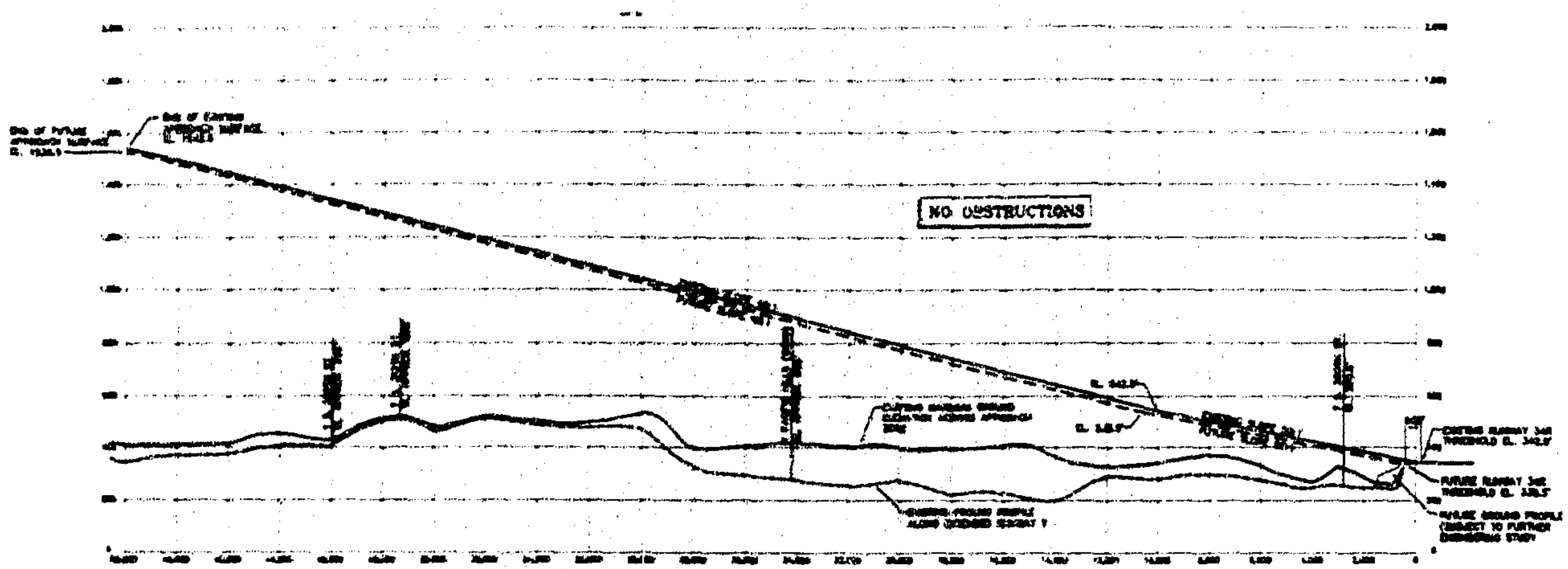
APPROACH ZONE PROFILES
RUNWAY 16L - 34R
SHEET 7 OF 12



RUNWAY 16L APPROACH ZONE PROFILE



RUNWAY 34R APPROACH ZONE PROFILE

OBSTRUCTION IDENTIFICATION

RUNWAY NO.	OBSTRUCTION NO.	DESCRIPTION	OBS. ELEV. (MSL)	PENETRATION	PROPOSED ACTION
16L	NONE				
34R	NONE				

NOTE: SOME NAVIGATIONAL AIDS NECESSARY FOR AIRPORT OPERATION PENETRATE RUNWAY PRIMARY AND APPROACH SURFACES.

SOURCE OF OBSTRUCTION INFORMATION: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, OBSTRUCTION CHART OC562, NOVEMBER 1983 (SURVEYED APRIL 1983) AND UPDATED INFORMATION FROM SEA-TAC AIRPORT.

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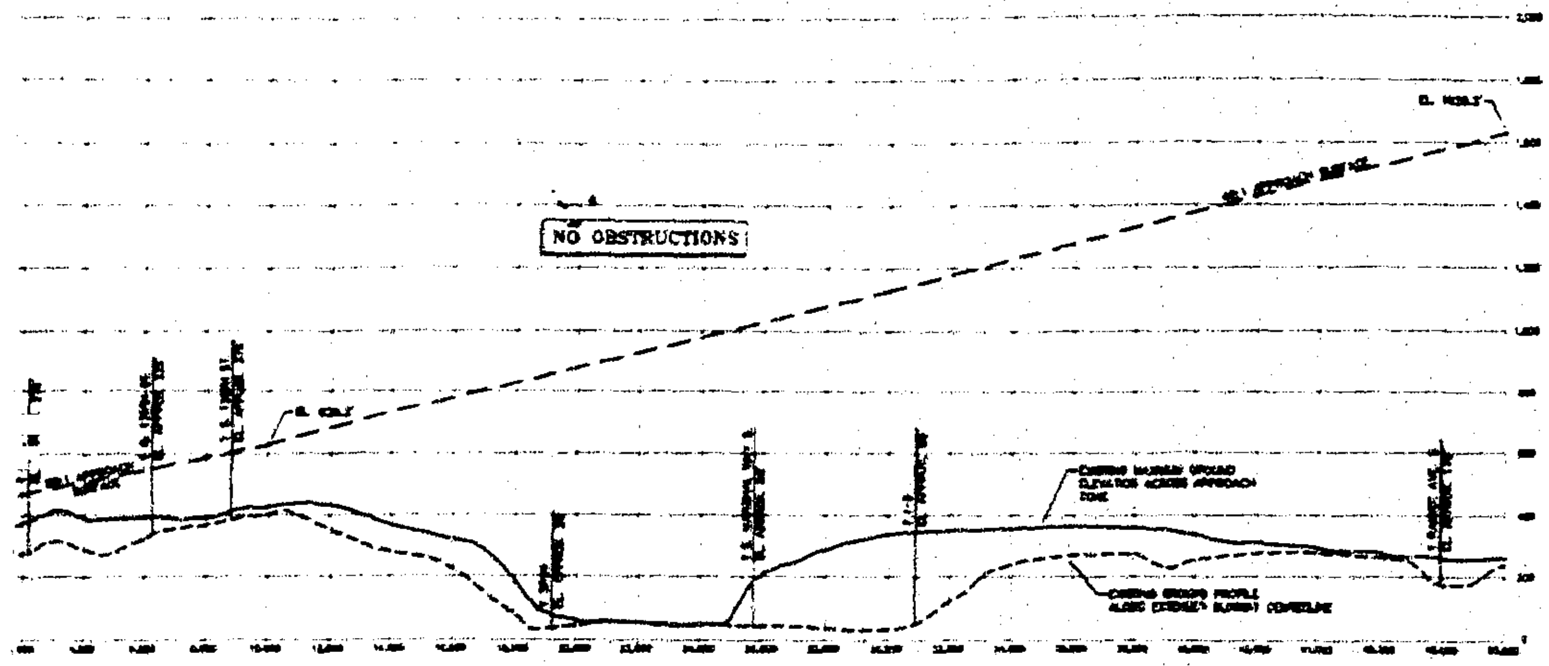
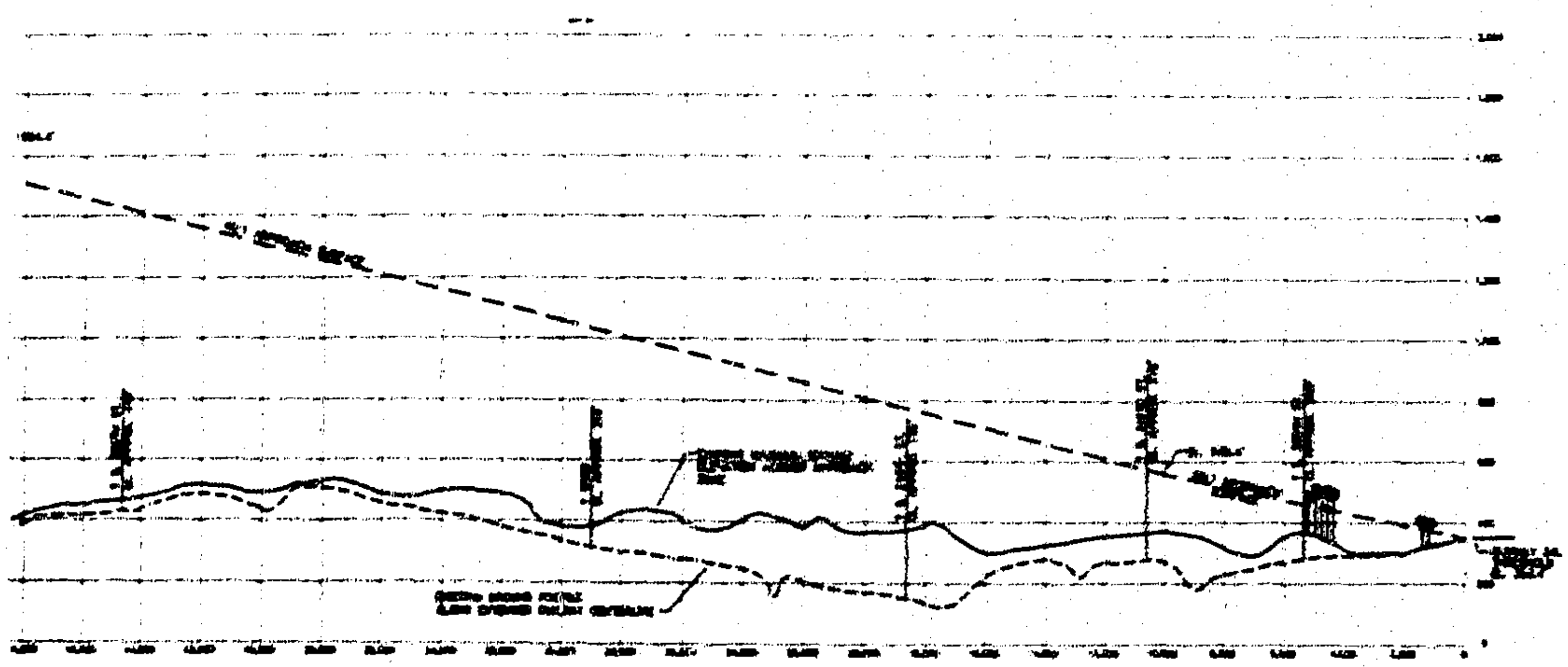
APPROACH ZONE PROFILES
RUNWAY 16L - 34R
SHEET 7 OF 1



RUNWAY 16R APPROACH ZONE PROFILE



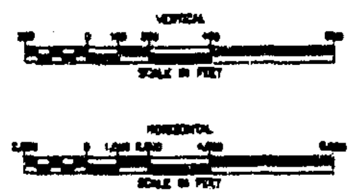
RUNWAY 34L APPROACH ZONE PROFILE

OBSTRUCTION IDENTIFICATION

RUNWAY NO.	OBSTRUCTION NO.	DESCRIPTION	GR. ELEV. (MSL)	PENETRATION	PROPOSED ACTION
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SCHEDULED FOR REMOVAL 1997
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SCHEDULED FOR REMOVAL 1997
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SCHEDULED FOR REMOVAL 1997
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SCHEDULED FOR REMOVAL 1997
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SCHEDULED FOR REMOVAL 1997
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SCHEDULED FOR REMOVAL 1997
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SCHEDULED FOR REMOVAL 1997

NOTE: SOME NAVIGATIONAL AIDS NECESSARY FOR AIRPORT OPERATION PENETRATE RUNWAY PRIMARY AND APPROACH SURFACES.

SOURCE OF OBSTRUCTION INFORMATION: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, OBSTRUCTION CHART [illegible], NOVEMBER 1993 (SURVEYED APRIL 1993)



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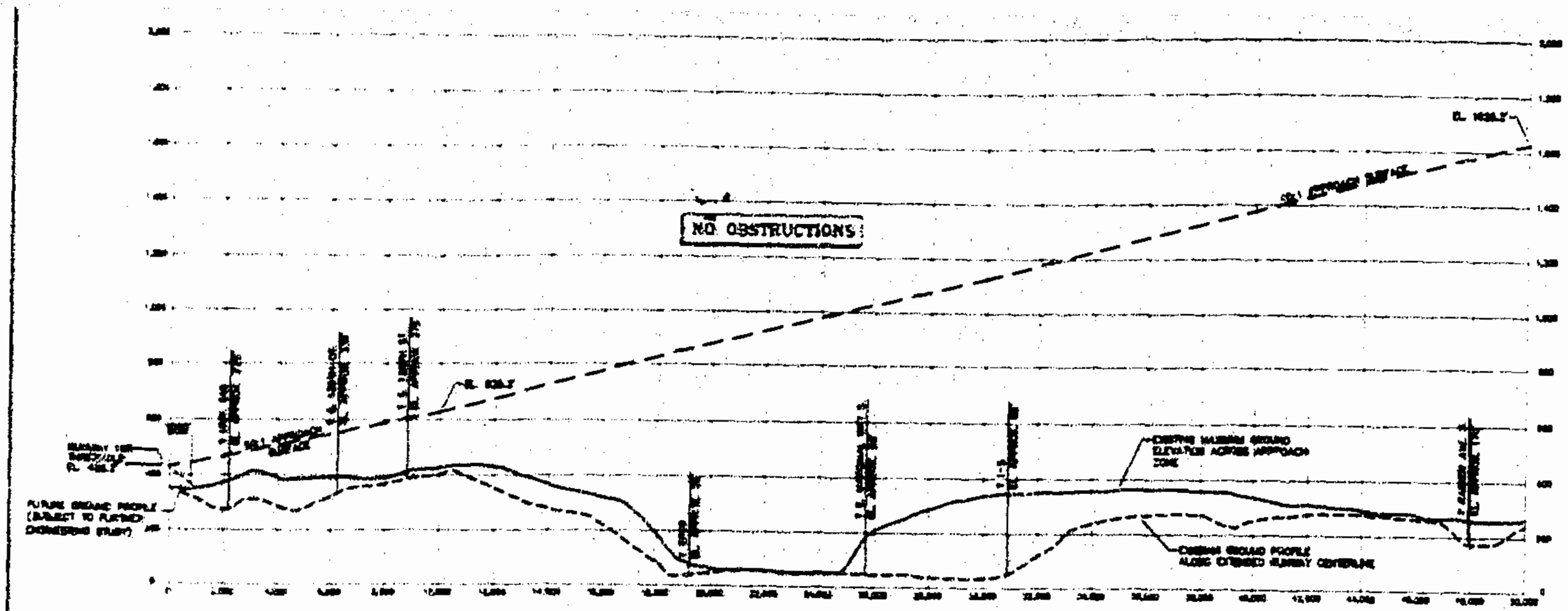
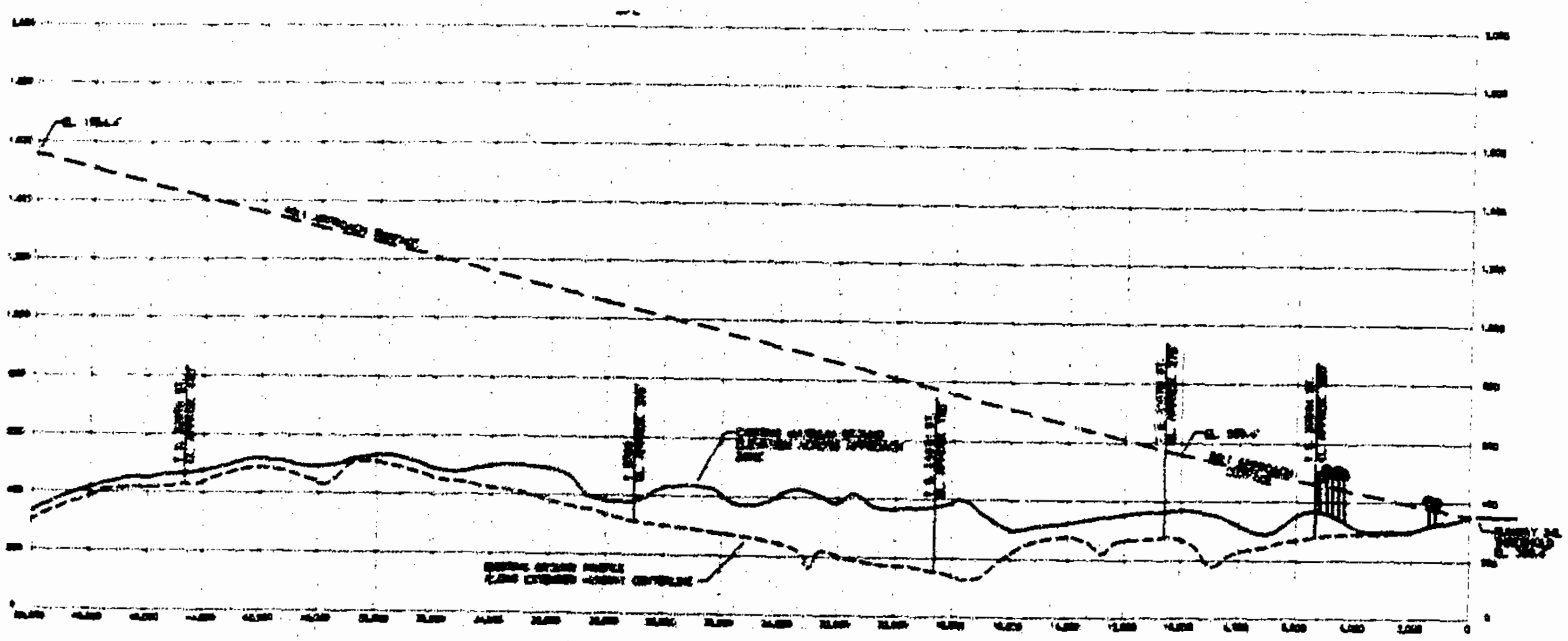
RUNWAY 16R - 34L

SHEET 6 OF 12



RUNWAY 16R APPROACH ZONE PROFILE



RUNWAY 34L APPROACH ZONE PROFILE

OBSTRUCTION IDENTIFICATION

[illegible]

NOTE: SOME NAVIGATIONAL AIDS NECESSARY FOR AIRPORT OPERATION PENETRATE RUNWAY PRIMARY AND APPROACH SURFACES.

SOURCE OF OBSTRUCTION INFORMATION: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, OBSTRUCTION CHART [illegible], NOVEMBER 1993 (SURVEYED APRIL 1993)

VERTICAL

SCALE IN FEET

HORIZONTAL

SCALE IN FEET

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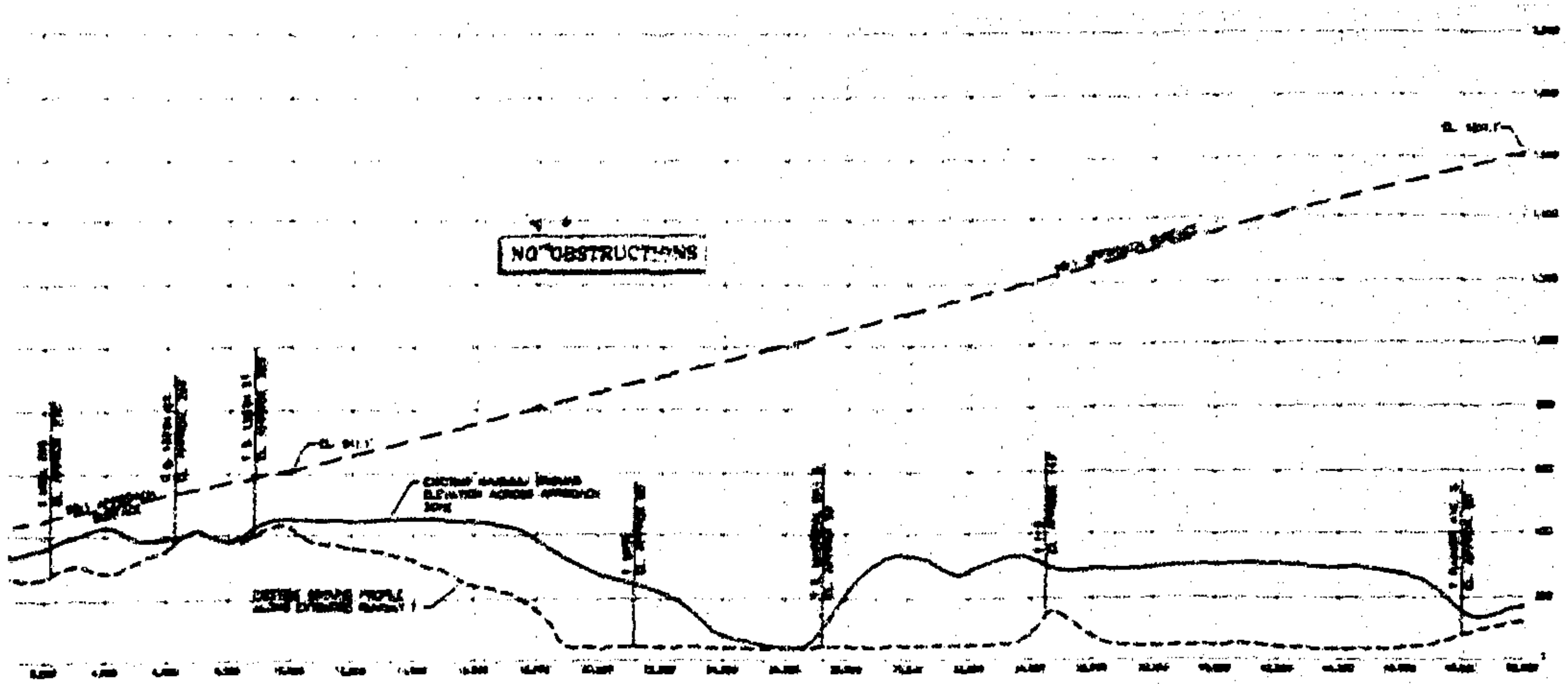
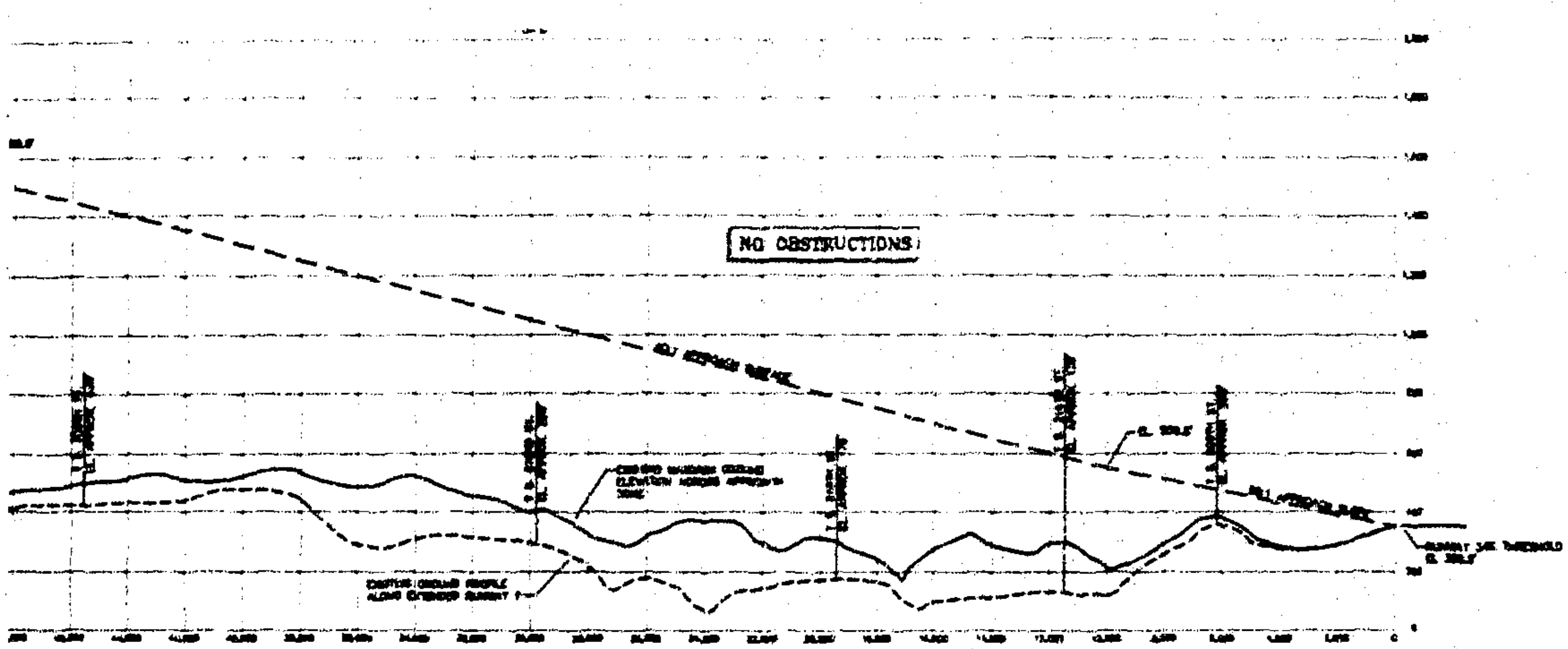


RUNWAY 16X APPROACH ZONE PROFILE



RUNWAY 34X APPROACH ZONE PROFILE

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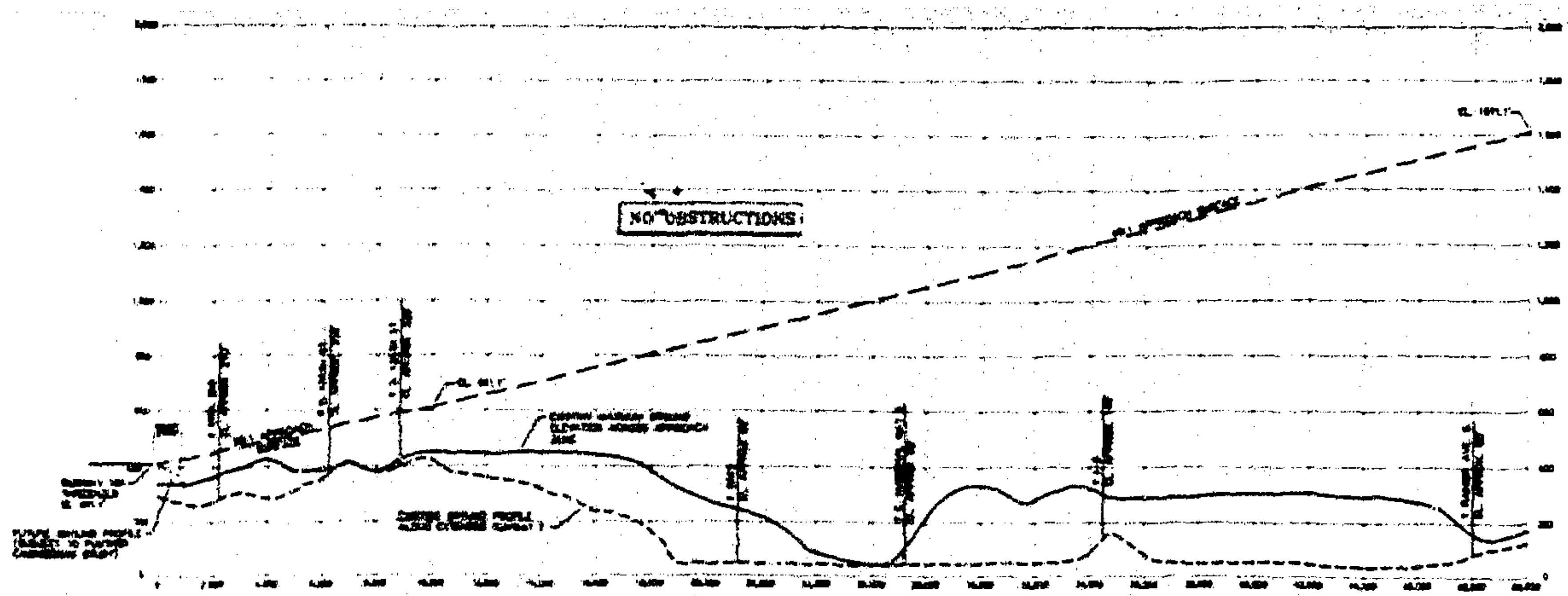
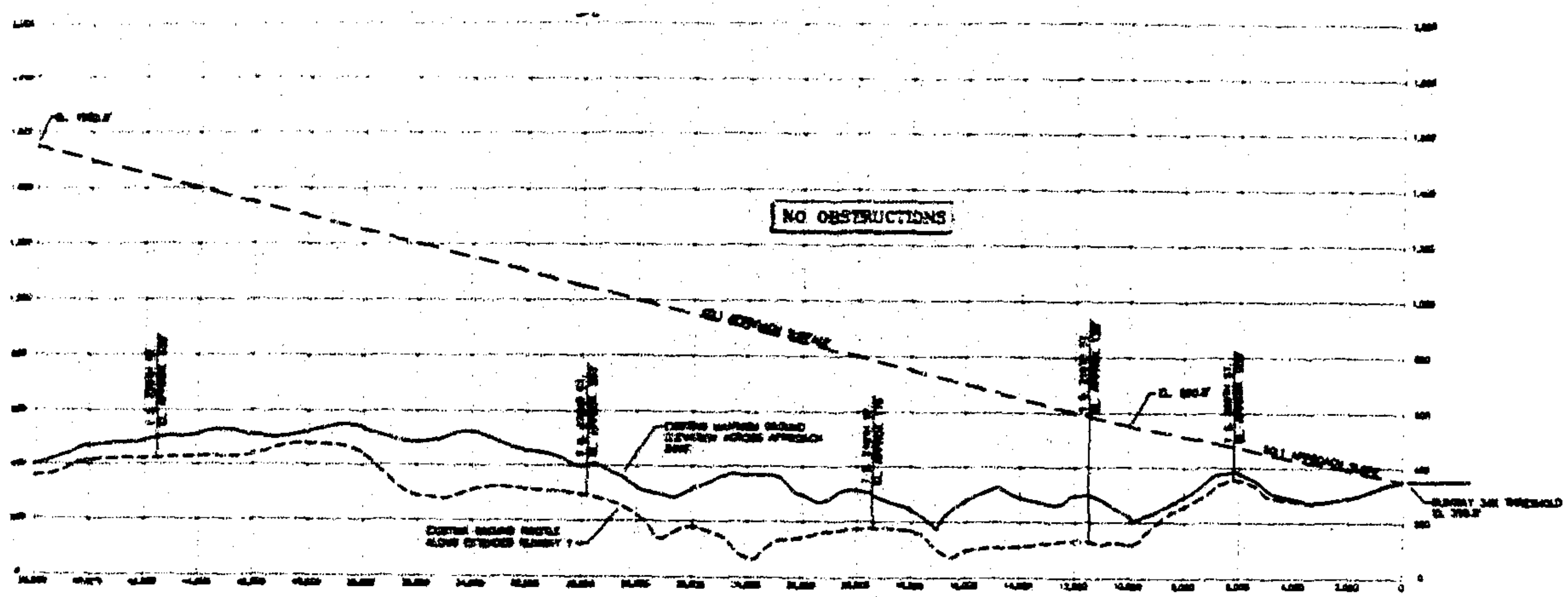
RUNWAY 16X - 34X

SHEET 9 OF 12



RUNWAY 16X APPROACH ZONE PROFILE



RUNWAY 34X APPROACH ZONE PROFILE

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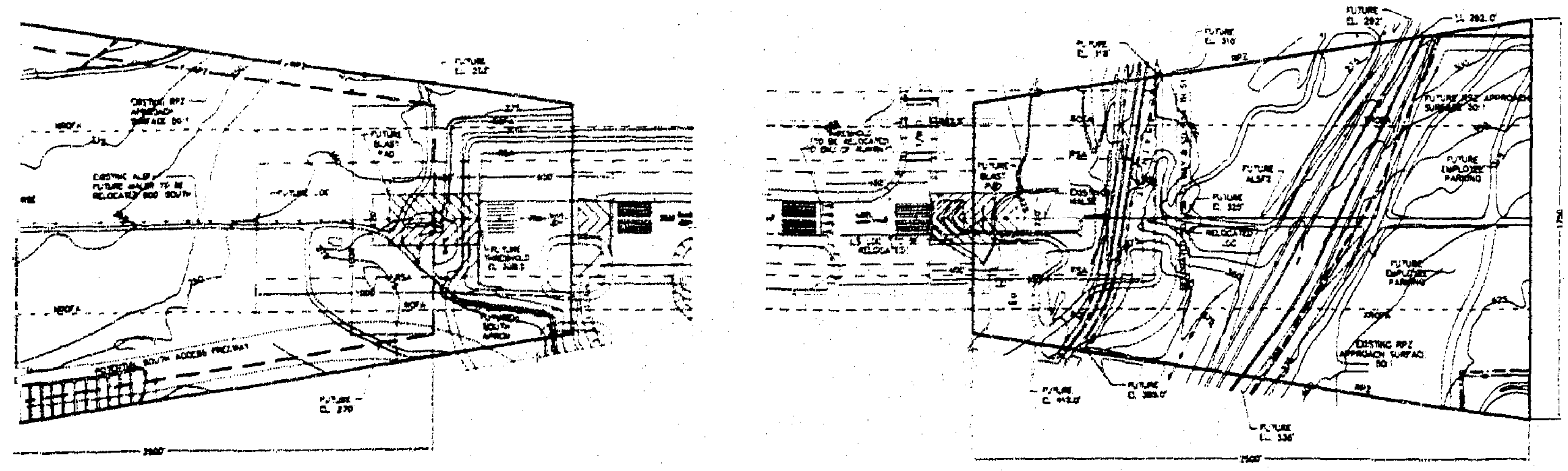
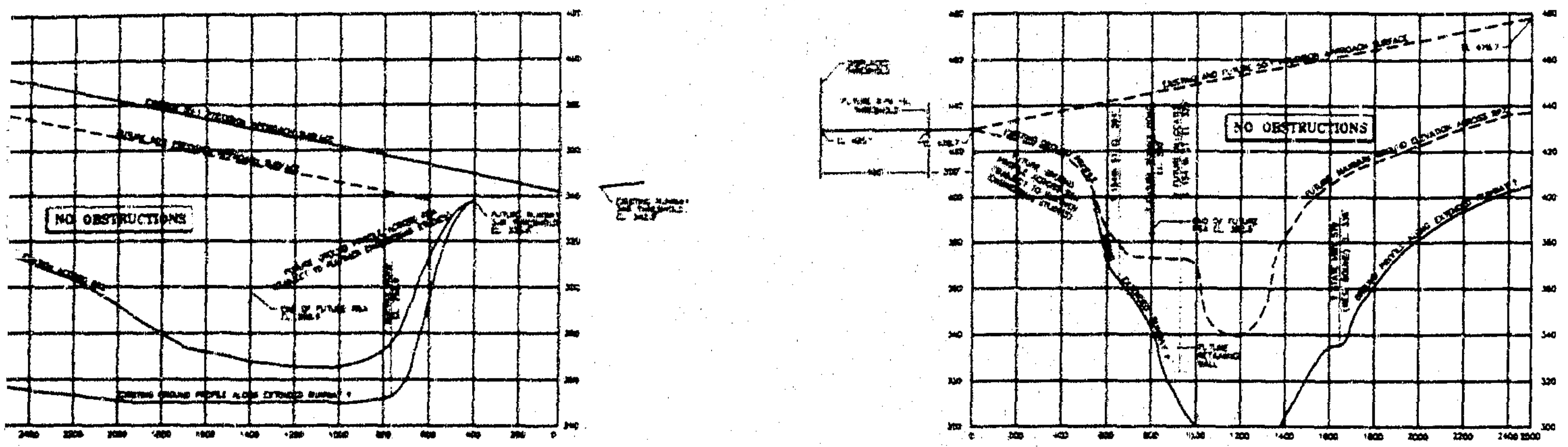
SHEET 9 OF 12



NOTES: 1) DISPLACED THRESHOLD TO BE RELOCATED TO EXISTING RUNWAY END AFTER FULL LENGTH RUNWAY SAFETY AREA IS COMPLETED. SEE SHEET 7 FOR OBSTRUCTIONS IN RPZ

2) RPZ DIMENSIONS BASED UPON AC 150/5300-13 CH 4 TABLE 2-4. APPROACH VISIBILITY - LOWER THAN 3/4 MILE (1200 M) AND EXPECTED TO SERVE - ALL AIRCRAFT

RUNWAY PROTECTION ZONE PLANS



RUNWAY PROTECTION ZONE APPROACH PROFILES

SCALE IN FEET

SCALE IN FEET

ABBREVIATIONS

ALSF	Approach Lighting System With Sequenced Flashing Lights
CL	Centerline
GS	Glide Slope
LOC	Localizer
MALSF	Medium Intensity ALSF
MSL	Mean Sea Level
OFA	Object Free Area
OFZ	Object Free Zone
ROFA	Runway Object Free Area
EROFA	Extended ROFA
RPZ	Runway Protection Zone
RSA	Runway Safety Area

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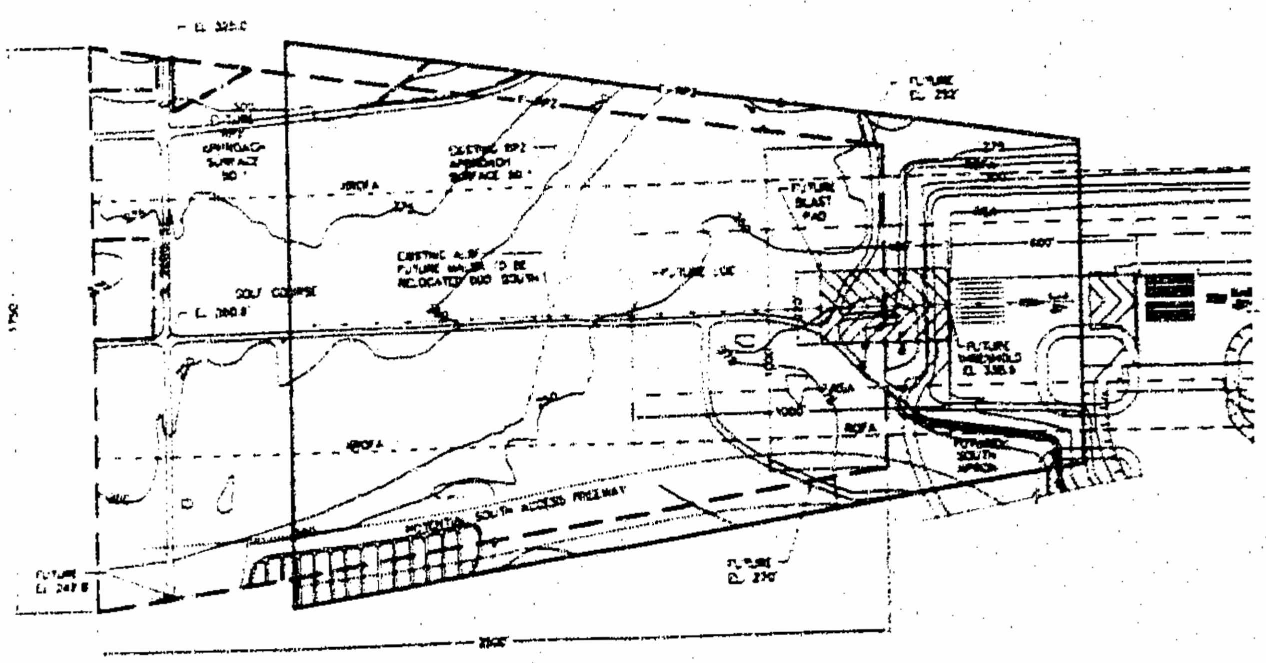
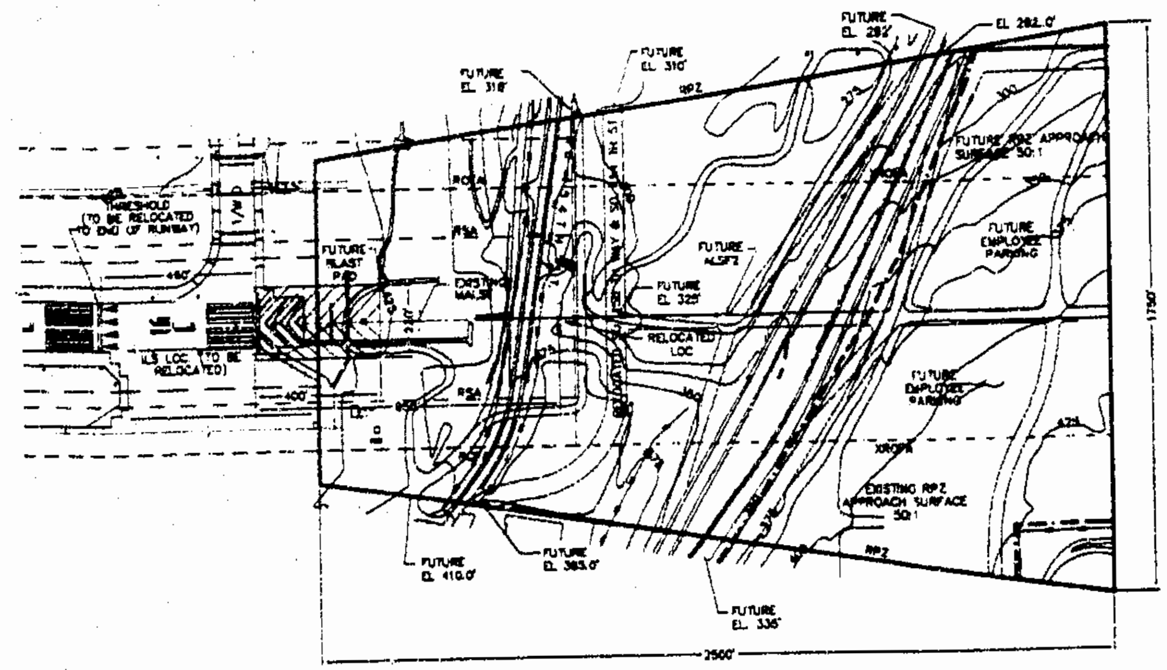
RUNWAY PROTECTION ZONE PLANS AND PROFILES

RUNWAY 16L - 34R

SHEET 10 OF 12

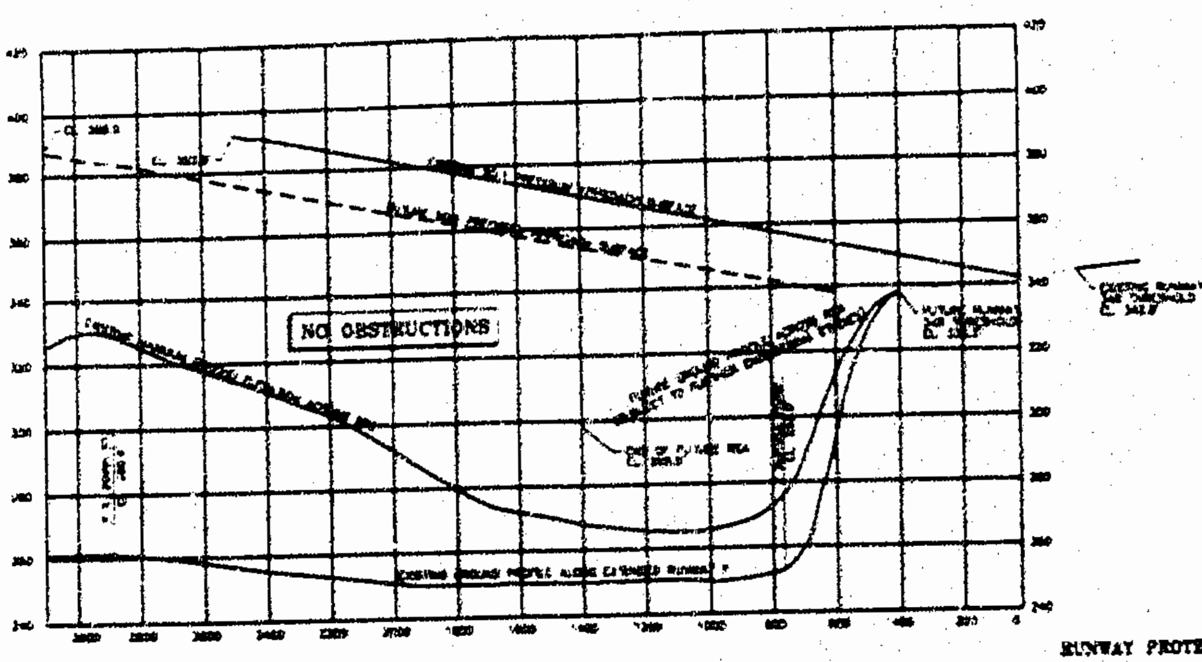


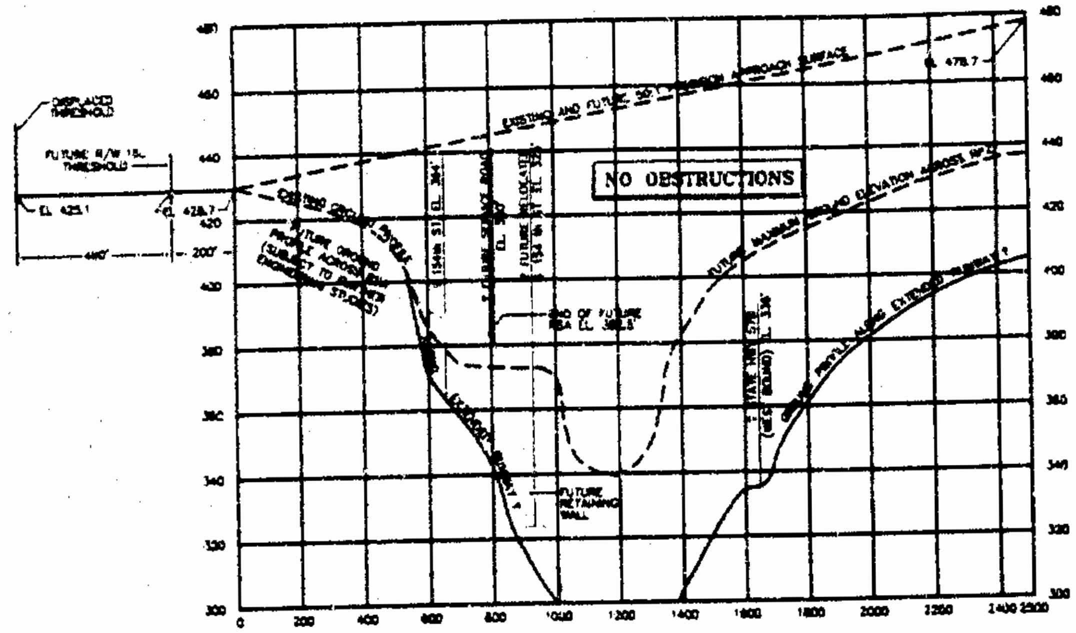


NOTES: 1) DISPLACED THRESHOLD TO BE RELOCATED TO EXISTING RUNWAY END AFTER FULL LENGTH RUNWAY SAFETY AREA IS COMPLETED. SEE SHEET 7 FOR OBSTRUCTIONS IN RPZ

2) RPZ DIMENSIONS BASED UPON AC 150/5300-13 CH 4, TABLE 2-4, APPROACH VISIBILITY - LOWER THAN 3/4 MILE (1200 M) AND EXPECTED TO SERVE - ALL AIRCRAFT.

RUNWAY PROTECTION ZONE PLANS





RUNWAY PROTECTION ZONE APPROACH PROFILES

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RUNWAY 16L - 34R
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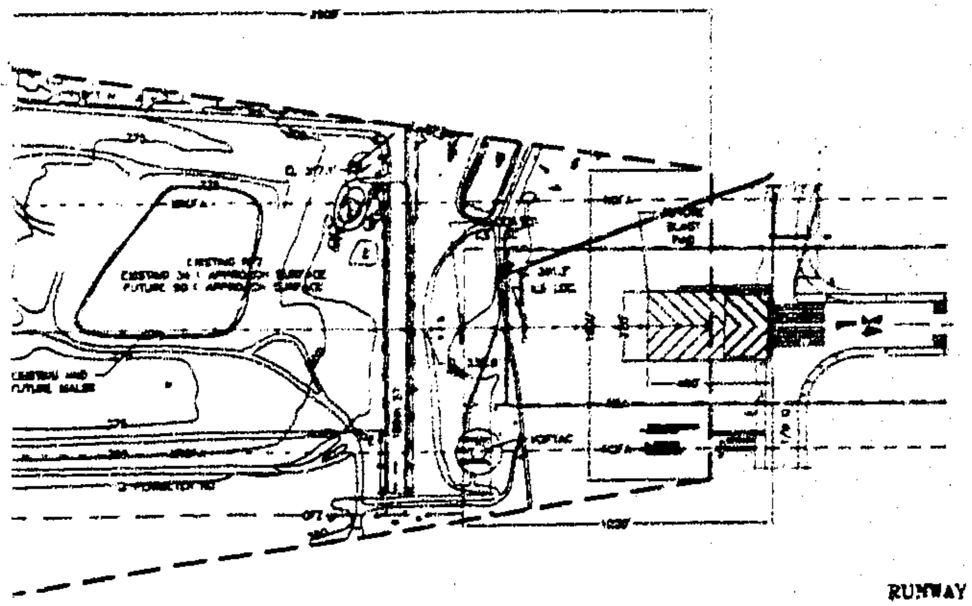
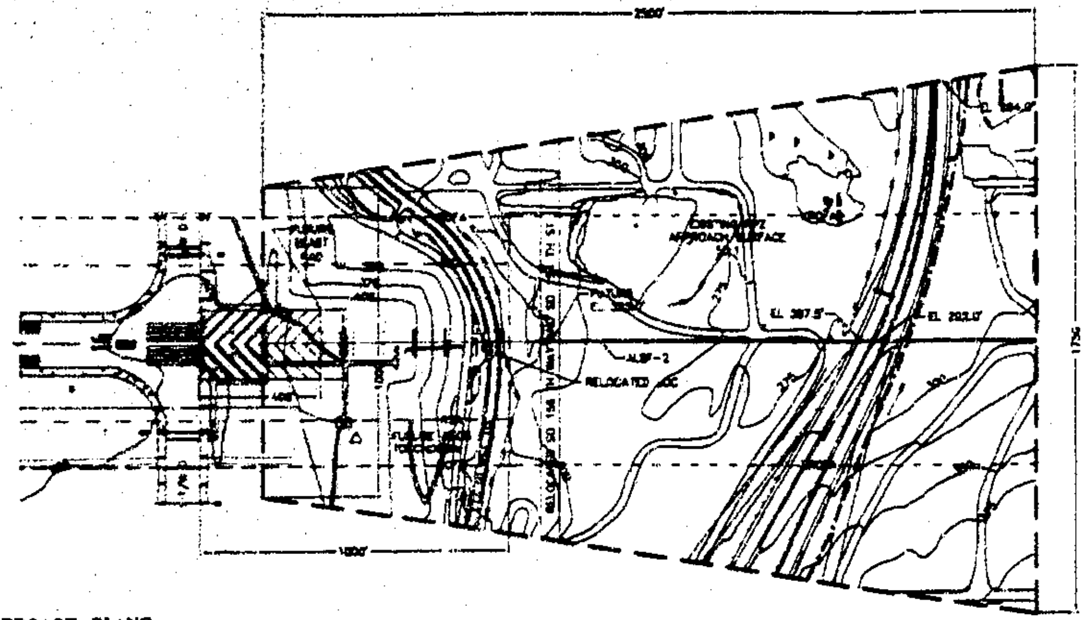
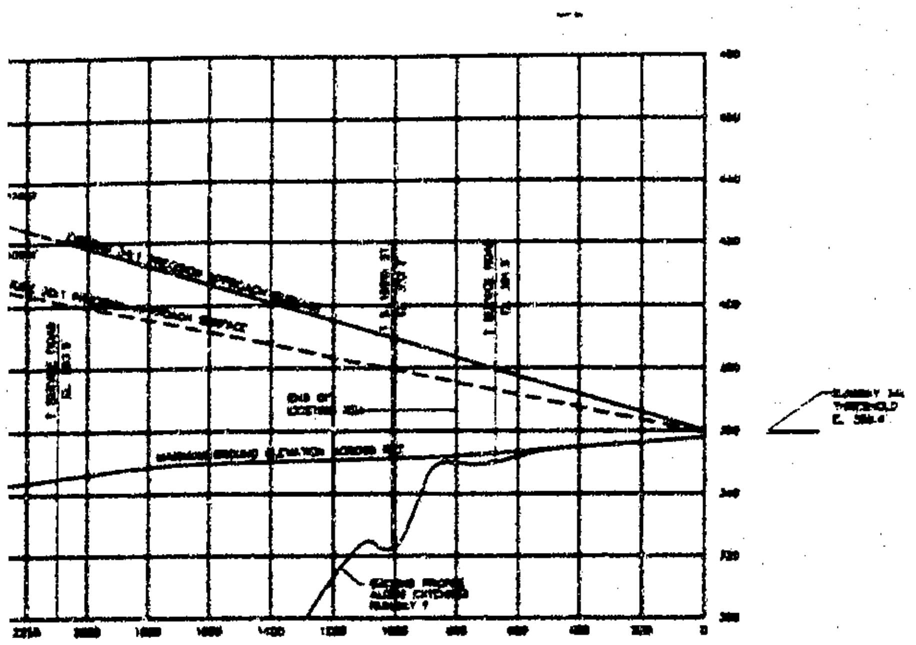
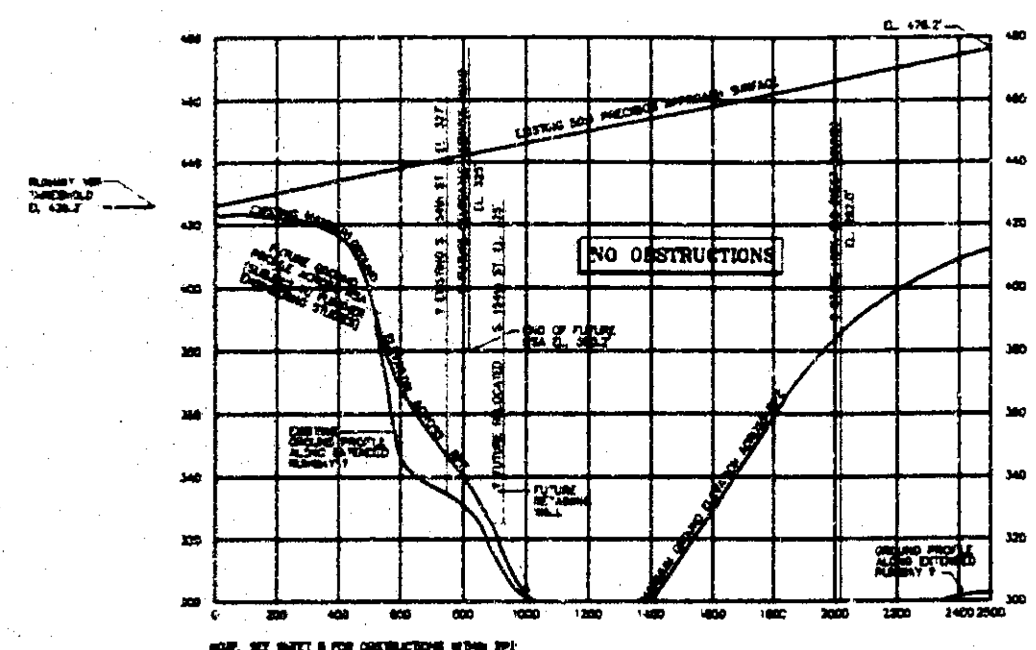




RUNWAY PROTECTION ZONE APPROACH PLANS

NOTE: RPZ DIMENSIONS BASED UPON AC 150/5300-13 CHG 4, TABLE 2-4, APPROACH VISIBILITY - LESS THAN 3/4 MILE (1200 M) AND EXPECTED TO SERVE ALL AIRCRAFT.





RUNWAY PROTECTION ZONE APPROACH PROFILES

NOTE: SEE SHEET 8 FOR OBSTRUCTIONS WITHIN RPZ

LEGEND

ABBREVIATIONS

ALSF Approach Lighting System With Sequenced Flashing Lights
℄ Centerline
LOC Localizer
OFA Object Free Area
OFZ Object Free Zone
ROFA Runway Object Free Area
EROFA Extended ROFA
RPZ Runway Protection Zone
RSA Runway Safety Area

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RUNWAY PROTECTION ZONE
PLANS AND PROFILES

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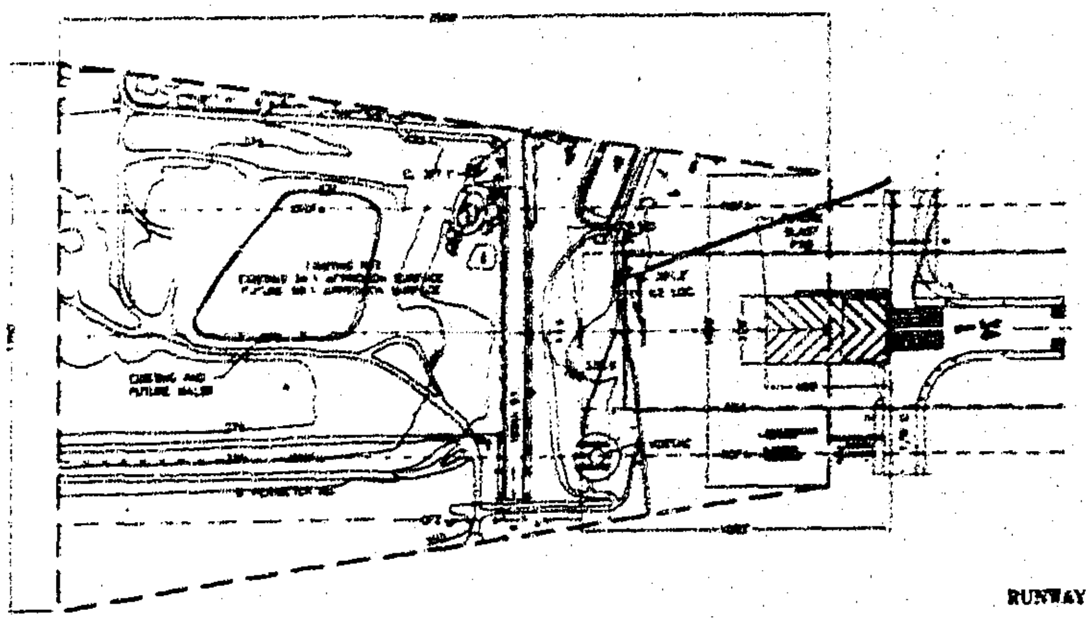
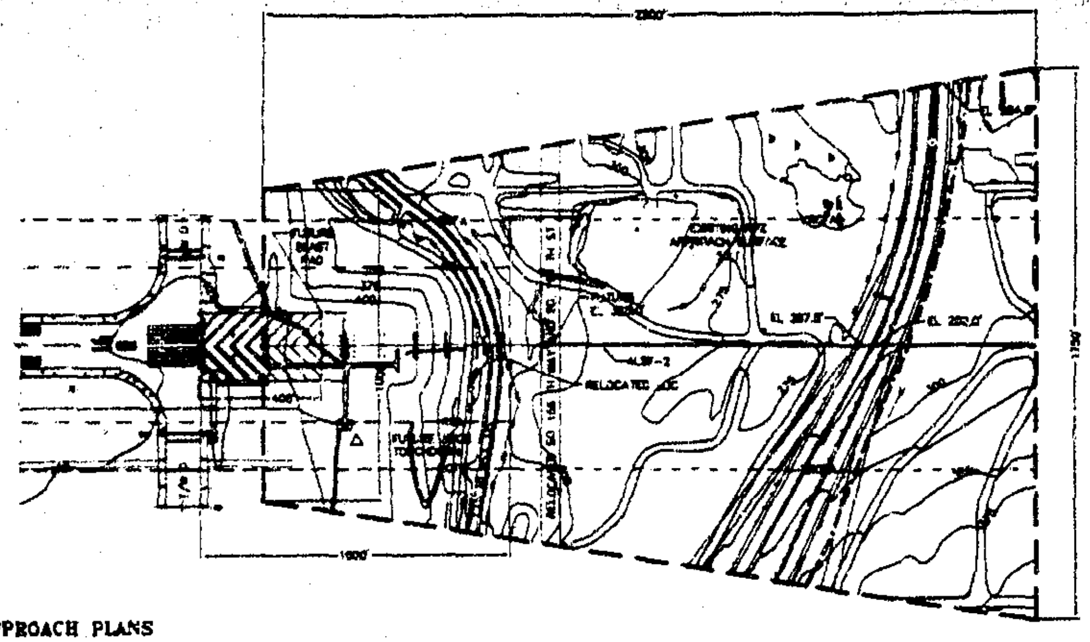
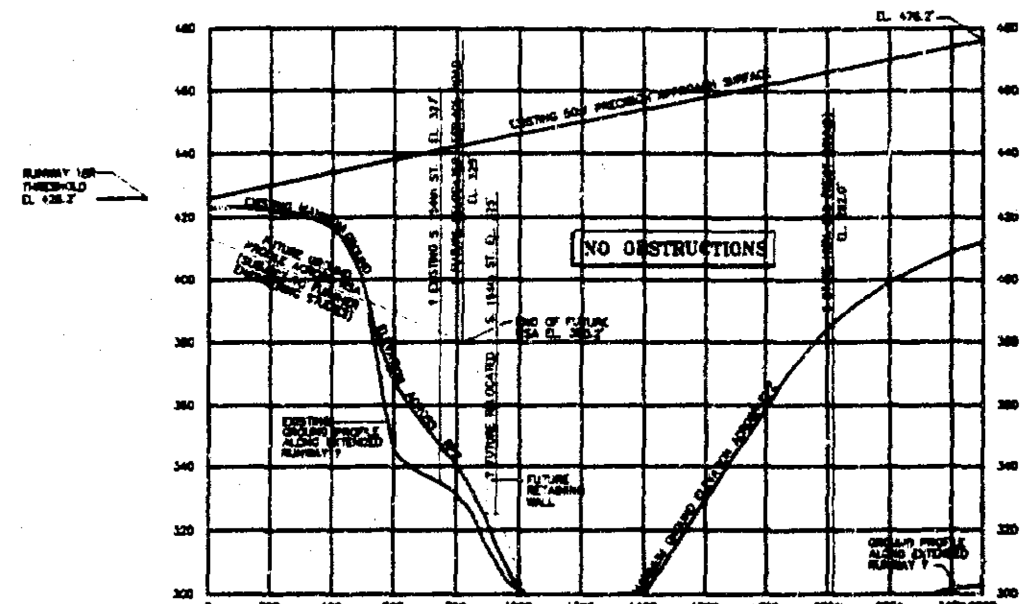
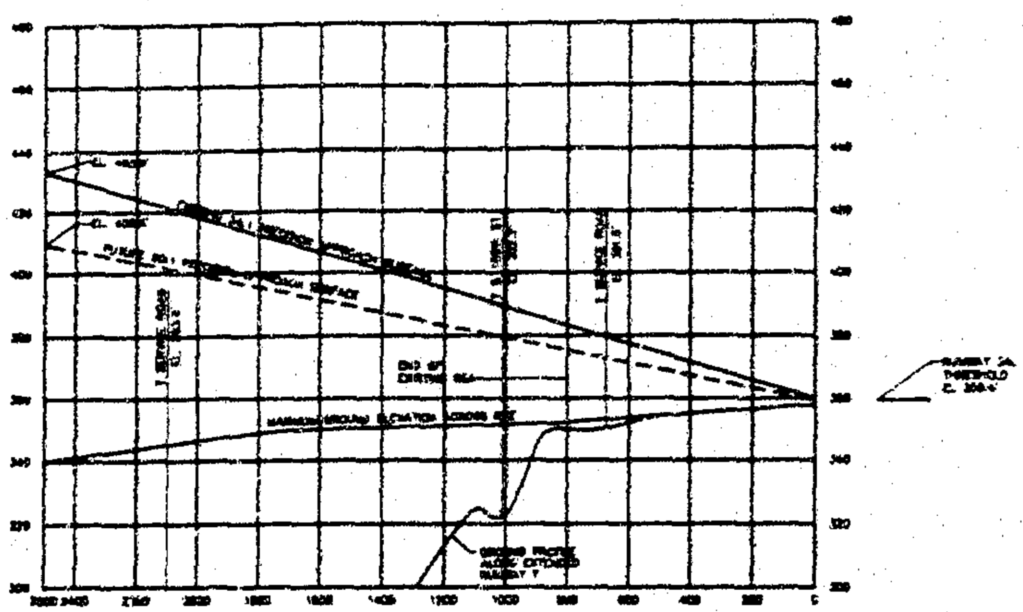




RUNWAY PROTECTION ZONE APPROACH PLANS

NOTE: RPZ DIMENSIONS BASED UPON AC 150/5300-13 CHG 4, TABLE 2-4, APPROACH VISIBILITY - LESS THAN 3/4 MILE (1200 M) AND EXPECTED TO SERVE ALL AIRCRAFT.





RUNWAY PROTECTION ZONE APPROACH PROFILES

NOTE: SEE SHEET 8 FOR OBSTRUCTIONS WITHIN RPZ

LEGEND

ABBREVIATIONS

ALSF Approach Lighting System With Sequenced Flashing Lights
℄ Centerline
GS Glide Slope
LOC Localizer
MALSF Medium Intensity ALSF
MSL Mean Sea Level
OFA Object Free Area
OFZ Object Free Zone
ROFA Runway Object Free Area
ROFA Extended ROFA
RPZ Runway Protection Zone
RSA Runway Safety Area

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NO.	DATE	BY	DESCRIPTION	APP'D	NO.	DATE	BY	DESCRIPTION	APP'D

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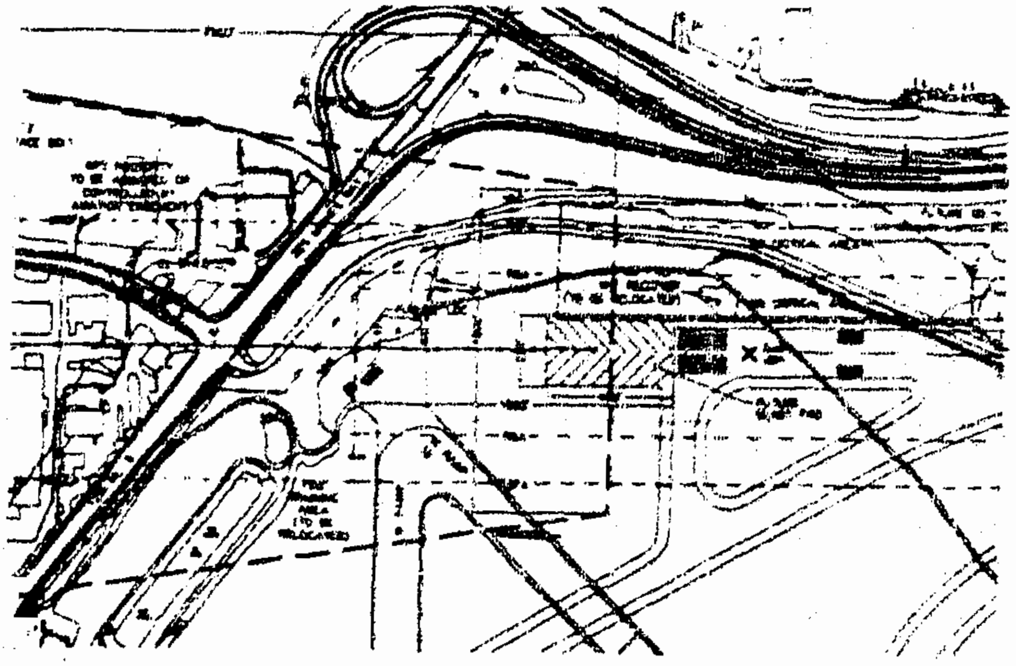
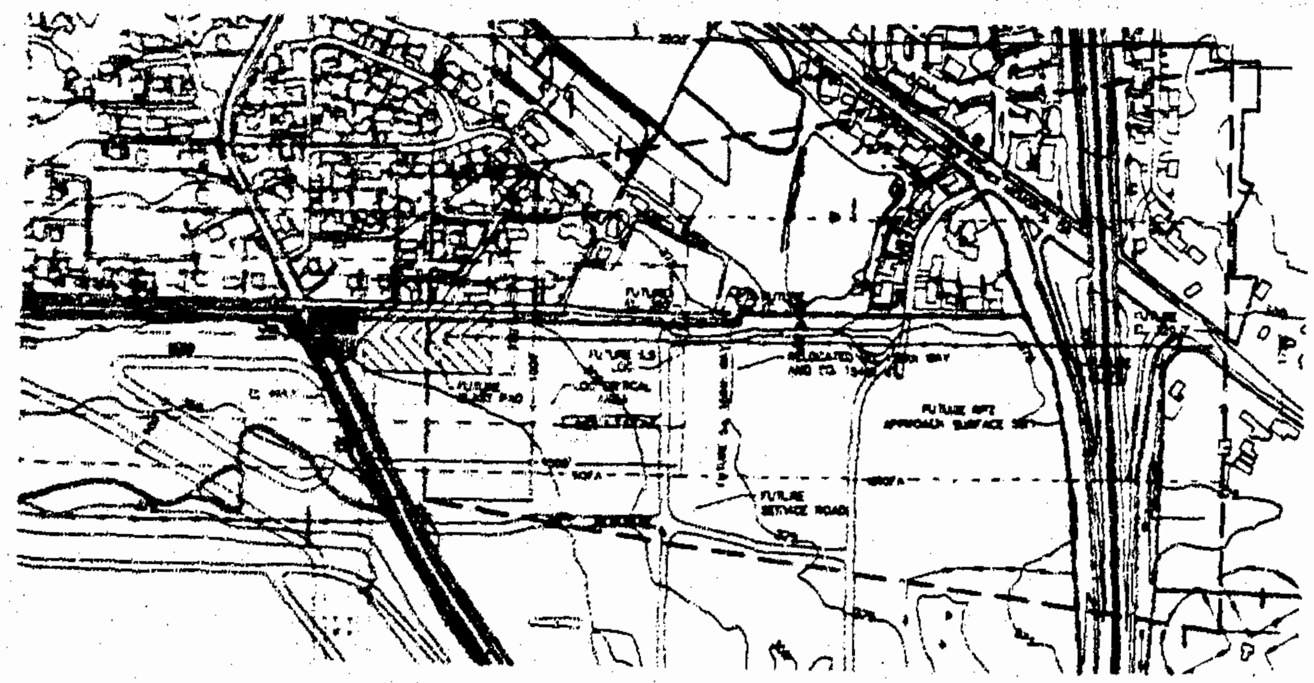
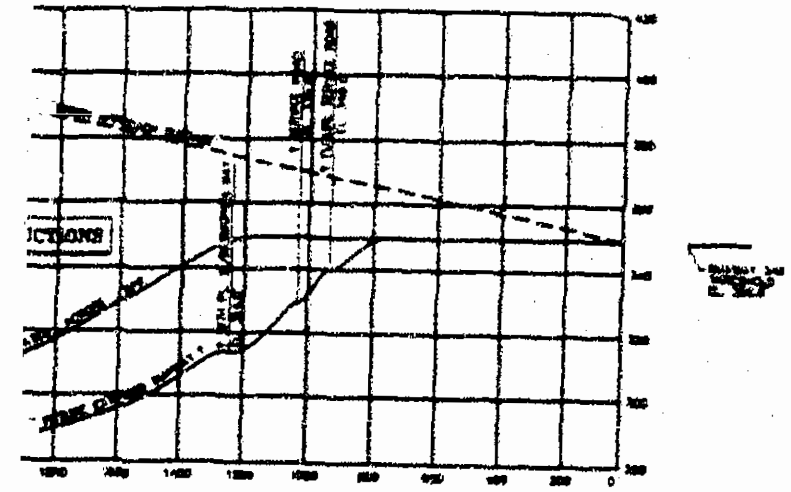
SEA-TAC INTERNATIONAL AIRPORT
RUNWAY PROTECTION ZONE
PLANS AND PROFILES
RUNWAY 16R - 34L
SHEET 11 OF 1

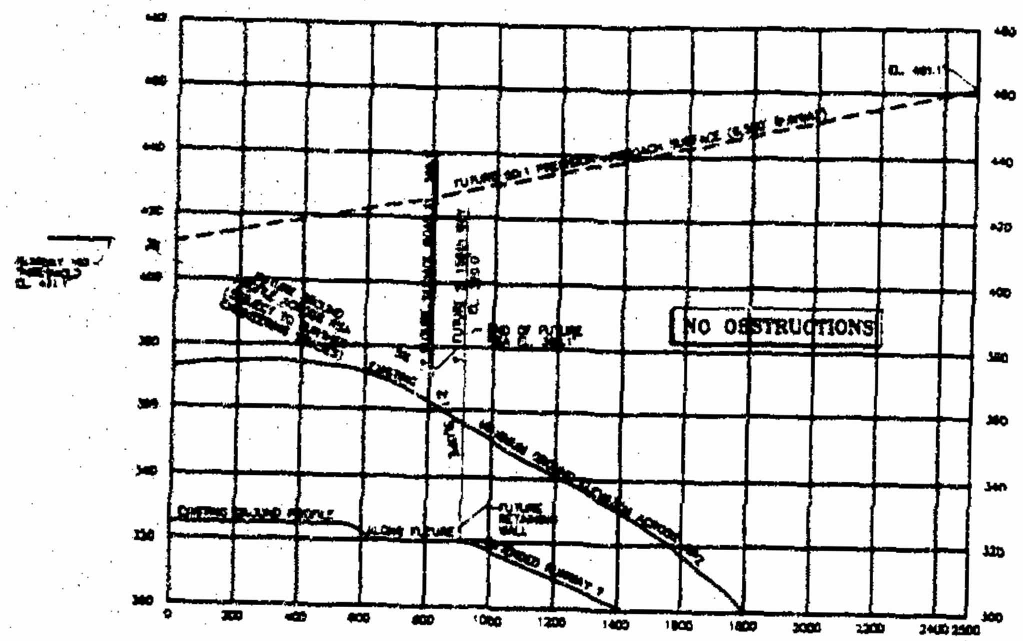




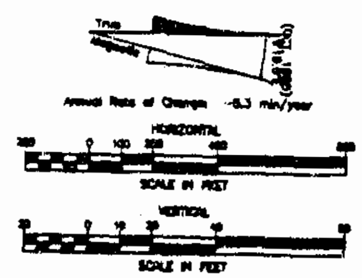
RUNWAY PROTECTION ZONE PLANS

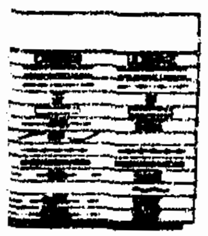
NOTE: RPZ DIMENSIONS BASED UPON A/C 150/5300-13 ... TABLE 2-4, APPROACH VISIBILITY - LOWER THAN 3/4 MILE (1200 m) AND EXPECTED TO SERVE ALL AIRCRAFT





RUNWAY PROTECTION ZONE APPROACH PROFILES





ABBREVIATIONS

- ALSF Approach Lighting System With Sequenced Flashing Lights
- MALSF Medium Intensity ALSF
- MSL Mean Sea Level
- OFA Object Free Area
- OFZ Object Free Zone
- ROFA Runway Object Free Area
- EROFA Extended ROFA
- RPZ Runway Protection Zone
- RSA Runway Safety Area
- R/W Runway
- T/W Taxiway

The preparation of this plan was financed in part through a grant from the Federal Aviation Administration as provided under Section 505 of the Airport and Airway Improvement Act of 1982, as amended. The contents do not necessarily reflect the official views or policy of the FAA. Acceptance of this plan by the FAA does not in any way constitute a commitment on the part of the United States to participate in any development depicted therein nor does it indicate that the proposed development is environmentally acceptable in accordance with appropriate public laws.

REVISIONS

NO.	DATE	BY	DESCRIPTION	APP'D	NO.	DATE	BY	DESCRIPTION	APP'D

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... Country Rd., 300

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PORT OF SEATTLE APPROVAL

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RUNWAY PROTECTION ZONE
PLANS AND PROFILES
RUNWAY 16X - 34X
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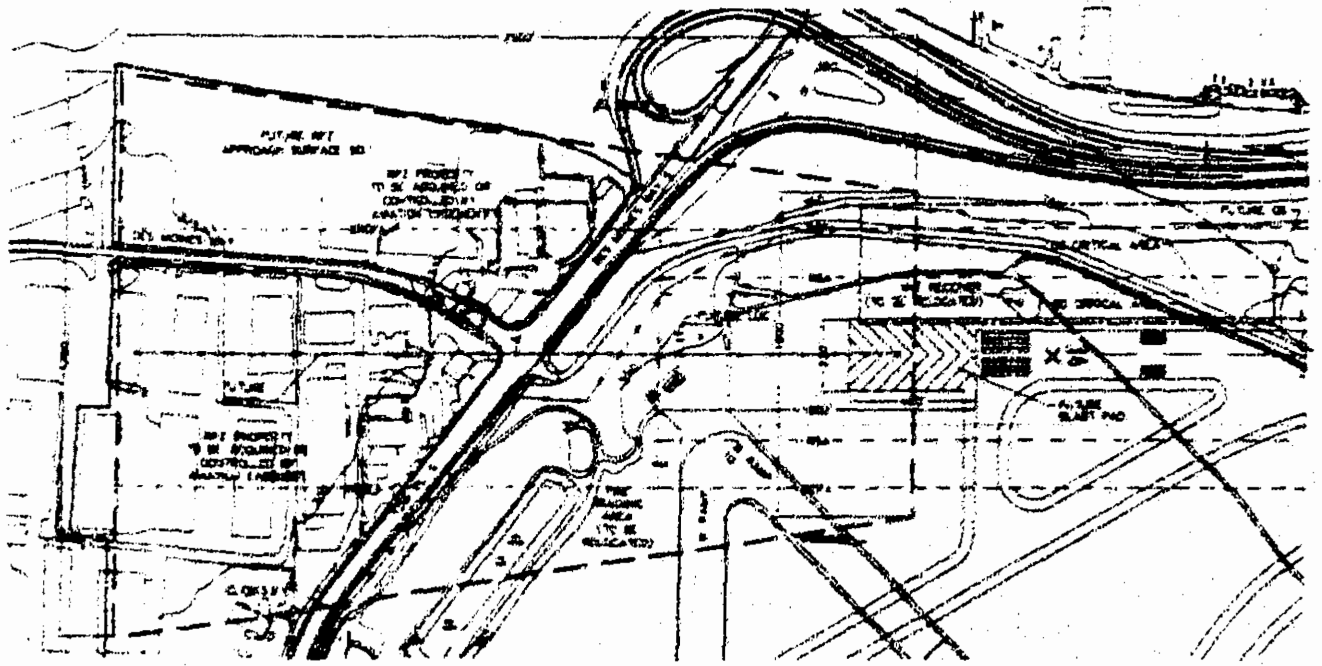
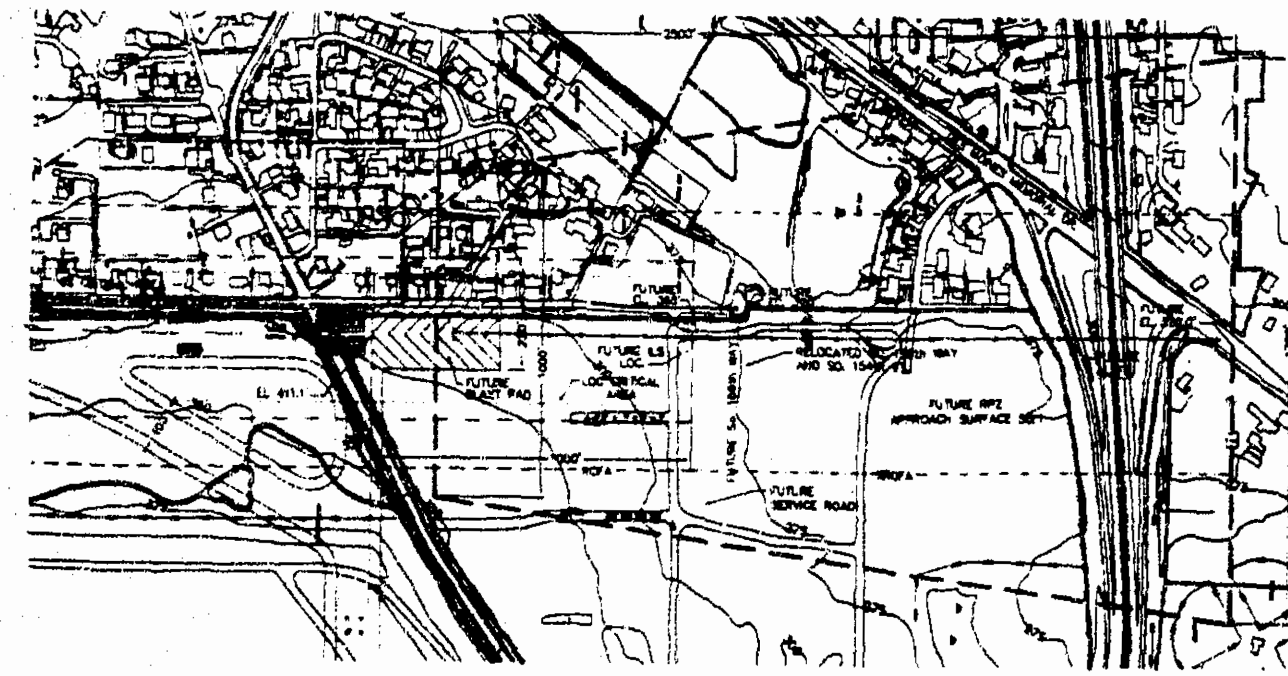
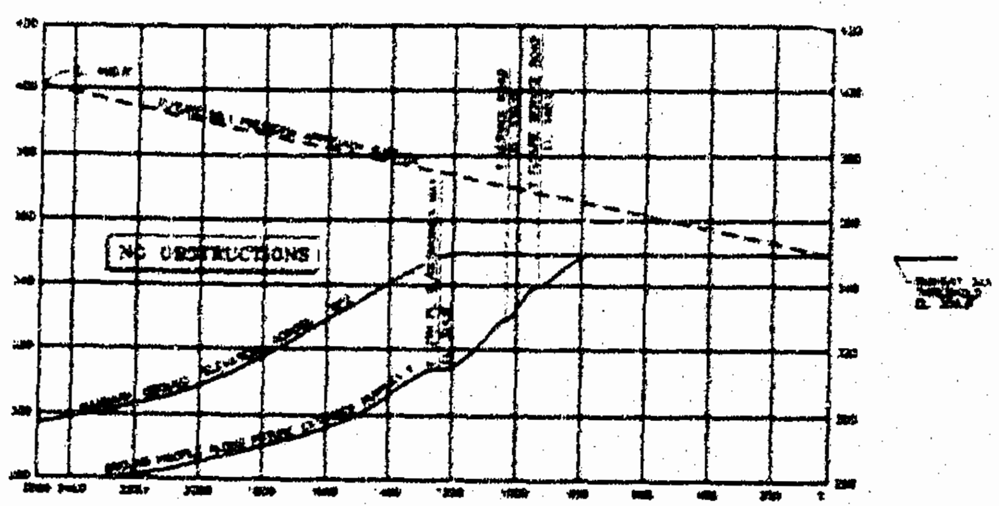
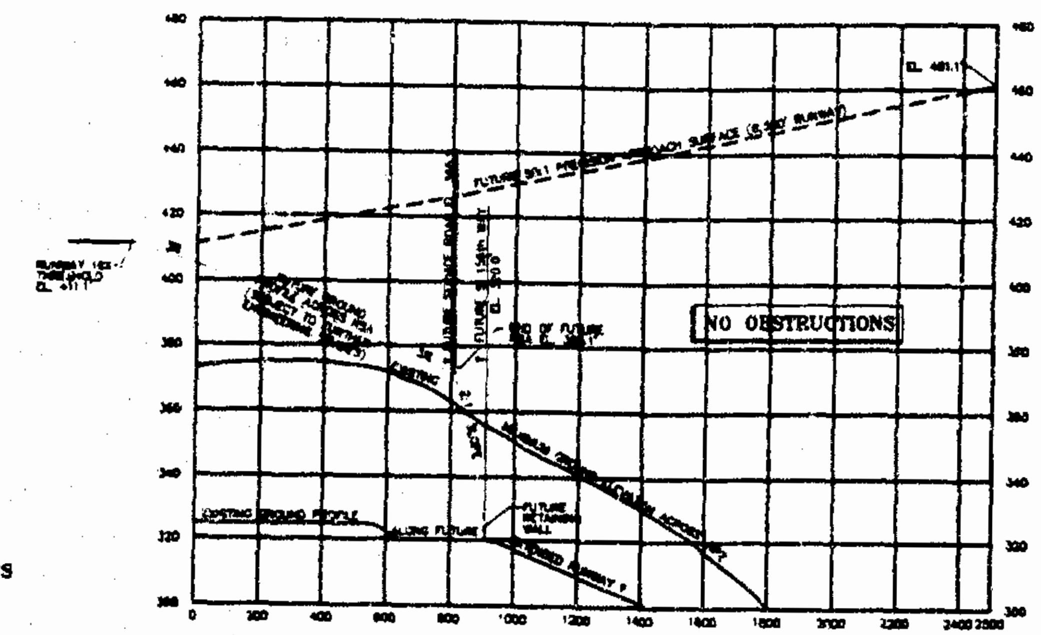




RUNWAY PROTECTION ZONE PLANS

NOTE: RPZ DIMENSIONS BASED UPON A/C 150/5300-13 CHG 4, TABLE 2-4, APPROACH VISIBILITY - LOWER THAN 3/4 MILE (1200 ft) AND EXPECTED TO SERVE ALL AIRCRAFT.





RUNWAY PROTECTION ZONE APPROACH PROFILES

LEGEND

ABBREVIATIONS

ALSF	Approach Lighting System with Sequenced Flashing Lights
LOC	Localizer
OFA	Object Free Area
OFZ	Object Free Zone
ROFA	Runway Object Free Area
RPZ	Runway Protection Zone
RSA	Runway Safety Area
R/W	Runway
T/W	Taxiway

SCALE IN FEET

SCALE IN FEET

P&D Aviation
A Division of
P&D Consultants, Inc.
1100 Town & Country Rd., 300
Orange, CA 92868

REVISIONS

PORT OF SEATTLE

PORT OF SEATTLE APPROVAL

SEA-TAC INTERNATIONAL AIRPORT
RUNWAY PROTECTION ZONE PLANS AND PROFILES
RUNWAY 16X - 34X
SHEET 12 OF 12

ATTACHMENT E TO PORT COMMISSION RESOLUTION NO. 3245

Puget Sound Regional Council (PSRC) Metropolitan Transportation Plan (MTP), Appendix G - Air Transportation Noise Reduction Measures and Implementing and Monitoring Steps

I. The Port of Seattle

The Port of Seattle will pass a Port Commission resolution affirming that it agrees to:

A. Evaluate and upgrade its existing noise monitoring system to include the use of approximately 25 noise monitors, develop a schedule for completion by the end of 1998, and thereafter disseminate regular reports to the public using data from the new noise monitoring system to include DNL, SEL and Time Above metrics.

B. Work with the FAA and/or airlines to:

1. Analyze the potential for reducing the use of thrust reversers.

2. Voluntarily minimize the number of flights in the middle of the night (1:30-5:30 a.m.).

3. Continue to enforce Airport Rules and Regulations to minimize the number of variances for the Nighttime Limitations Program.

4. Work with foreign air carriers to gain cooperation in ensuring that Stage 3 aircraft continue to be used for nighttime international flights.

5. Work with the owners/operators of Stage 2 aircraft under 75,000 pounds to voluntarily limit or eliminate their use.

6. Continue to work to enforce Airport Rules and Regulations to minimize nighttime engine run-ups.

C. Modify its existing contract with noise experts to specifically include the need to review methods of mitigating the impacts of low frequency noise and vibration, and to supply such information to the Port.

D. Design and implement a noise compatible land use plan for Port properties within its current acquisition zone.

E. Complete the "sensitive use" public buildings insulation pilot studies.

F. Seek a public commitment from FAA to evaluate actions needed to prevent apparent violations of the North Flow Nighttime Departure Noise Abatement Procedures to the extent that safety and efficiency allow.

G. In carrying out the Part 150 Study:

1. The Port of Seattle will invite the Regional Council, the FAA, and affected parties to participate, and ensure that they are able to participate actively and constructively, in the Port's upcoming Part 150 study, which will commence in the fall of 1996 and is expected to take two to three years.

2. Part 150 Study participants will be invited to take part in developing the scope of the study, consultant selection, and in all other milestones and products of the project, such as development of noise exposure maps; development of noise reduction and land use compatibility measures; and Port consideration and approval of the program.

3. Items to be considered in developing the scope of the Part 150 Study will include but not necessarily be limited to:

   a. Relocation of run-up areas where daytime engine run-ups occur, to reduce ground-related noise.
   b. Evaluating the potential net benefits of preferential runway use during low activity periods.
   c. Evaluating benefits and impacts of changes to departure climb profiles.
   d. Analysis of need to adjust Noise Remedy Program boundaries to include those in 65 DNL by the year 2000, provided that the Port will not reduce its established Noise Remedy Program boundaries for currently eligible properties.
   e. Evaluating scope, boundaries and funding for public use and multi-family buildings.

4. If, as a result of the Part 150 Study, a proposed noise reduction strategy results in a net improvement but causes a transfer of noise impacts to other communities, the Port of Seattle, Regional Council, FAA and communities affected by airport noise will seek agreement on guidelines or other equitable procedures for dealing fairly with conflicting views and needs of different communities.

5. The Port of Seattle will ask the FAA to include within its Record of Decision on the Master Plan Update Final Environmental Impact Statement the requirement to conduct a Part 150 Study with the goal of assessing needed additional noise abatement and mitigation.

H. School Insulation

1. The Port of Seattle will commit up to $50 million for school insulation.

2. The Port of Seattle will meet with the Highline School District to try to reach agreement on a plan for insulating the District's schools. If direct talks between the District and Port fail to produce agreement on a noise insulation program for the District's schools, the Port may request that the PSRC assist the parties in selecting an independent mediator.

3. The Port will initiate the Highline School District school insulation program consistent with an agreement reached by the District and Port.

4. Once the Port of Seattle completes the sound insulation program for schools affected by aircraft noise exposure of 65 DNL from Sea-Tac International Airport, it will investigate feasibility and funding for insulating schools affected by then current 60-65 DNL aircraft noise exposure from Sea-Tac. Sound insulation must comply with FAA eligibility criteria to achieve measurable noise benefit.

I. Deliver to the Regional Council on or before September 5, 1996, a detailed timetable for carrying out the steps specified in subsections A through H of this section, including (a) defined milestones against which the Port's progress toward completion of those steps may be measured, and (b) a schedule for progress on planning, design, and construction of a third runway at Sea-Tac Airport.

II. Highline School District

The Highline School District will:

A. Meet with the Port of Seattle to try to reach agreement on a plan for insulating the District's schools. If direct talks between the District and the Port fail to produce agreement on a noise insulation program for the District's schools, the District may request that the PSRC assist the parties in selecting an independent mediator.

B. Initiate its school insulation program, consistent with an agreement reached with the Port of Seattle.

III. Puget Sound Regional Council

The Puget Sound Regional Council will:

A. Seek funding to (a) actively participate in the Port's upcoming Part 150 Study; (b) undertake a study to evaluate a financing mechanism for the acquisition of incompatible uses as noted in III-G, below; and (c) conduct surveys as noted in III-H, below.

B. As part of its Policy and Plan Review process, the PSRC will:

1. Conduct an initial review of land use plans for areas that are within the 65 Ldn contour, and provide annual review of future changes;

2. Offer assistance to jurisdictions in finding ways to minimize the introduction of incompatible land uses;

3. Provide facilitation services, if requested by the Port of Seattle and jurisdictions in the vicinity of Sea-Tac Airport, to reach agreement on ways to redevelop currently incompatible land uses.

C. Upon receipt of a Resolution approved by the Port of Seattle that contains all the items noted under Port of Seattle Resolution, above, the Executive Director of the PSRC will notify the Executive Board that the Metropolitan Transportation Plan amendment including a third runway at Sea-Tac Airport has taken effect.

D. Encourage King County to continue its efforts to eliminate the two nighttime Alaska Airlines Stage 2 flights from Boeing Field.

E. Seek support for state legislation for state policies regarding land use compatibility around commercial airports, and will seek support for federal legislation to allow use of federally approved funding for insulation and acquisition programs beyond the current federal constraints.

F. Annually convene representatives of the Port of Seattle, FAA, communities affected by airport noise, and other interested parties, to coordinate efforts by all parties to alleviate issues that are undercutting the effectiveness of current noise reduction efforts and eliminate roadblocks to resolving issues, then report on progress to the Executive Board.

G. Undertake a study which evaluates use of a state-financed revolving fund, or other financing mechanism (such as a public/private partnership) for the acquisition of incompatible uses within the 65 DNL to the 75 DNL contour, for conversion to noise compatible non-residential uses. Any such funding mechanism must demonstrate a balance between long-term costs and revenues. The results of the study should be presented to the Executive Board by June 30, 1997.

H. Conduct statistically valid surveys, during and after construction of the third runway, to assess Sea-Tac Airport's effects on such items as noise, transportation/circulation, and land uses in the surrounding communities.

I. Recommend that the State, in cooperation with appropriate local jurisdictions and regional transportation planing organizations, implement a comprehensive process for evaluating all options to meet the State of Washington's long-term air travel and inter-regional ground transportation needs, including high speed rail.

IV. Washington State Department of Transportation and Transportation Commission

The Washington State Department of Transportation and Transportation Commission will:

A. Seek funding for acceleration of efforts to provide improved higher speed rail service in the I-5 Corridor.

B. Seek legislation similar to what was approved for general aviation airports during the 1996 session, to provide state policies for land use compatibility around commercial airports.

V. Monitoring Compliance

To ensure that measures contained in this Appendix G to the 1995 Metropolitan Transportation Plan are implemented as described, several mechanisms for tracking success and assuring accountability will be implemented. They include:

A. The Port of Seattle will report to the Regional Council twice yearly on progress toward all the efforts encompassed in this action, and

B. King County will report to the Regional Council Executive Board every six months on progress toward eliminating nighttime Stage 2 flights at King County International Airport, and

C. Regional Council staff will report annually to the Executive Board on its participation in the Part 150 Study and, based on its Policy and Plan Review Process, on progress toward minimizing the introduction of incompatible land uses within the 65 Ldn contour.

ATTACHMENT D TO PORT COMMISSION RESOLUTION NO. 3245

Mitigating Measures Relating to
Port Commission Resolution No. 3245, As Amended

Set forth below is a list of mitigating measures that shall be implemented in conjunction with the actions authorized in Port Commission Resolution No. 3245. This list is limited to mitigating measures related to Resolution No. 3245, and does not include a complete list of all mitigating measures that could be required for implementation of the Master Plan Update. As the Port Commission continues to consider and approve actions to implement the Master Plan Update, additional mitigating measures may be required. A more complete list of possible mitigating measures is included in the Final EIS and Supplemental EIS for Proposed Master Plan Update Development Actions and are summarized in Attachment A to Resolution No. 3245. The mitigating measures set forth below are subject to further refinement and revision as plans are finalized and permitting processes are completed.

The noise and land use mitigation items discussed below are in addition to, or complement, the noise reduction measures called for by the Puget Sound Regional Council (PSRC) in the Metropolitan Transportation Plan. The noise measures called for by PSRC are included as Attachment E to Commission Resolution No. 3245.

(1) **Noise and Land Use**.

• Continue implementation of sound insulation programs as described in Port Commission Resolution No. 3125, As Amended, Section 1 (c), including: (1) acoustical insulation of eligible single family residences on the waiting list as of December 31, 1993, before commencing construction of the new runway; (2) acoustical insulation of remaining eligible single family residences on the waiting list, prior to operation of the new runway; (3) acoustical insulation of all single family residences that become eligible as a result of actions taken based on the Master Plan Update EIS and SEIS and are on the waiting list as of December 31, 1997, prior to operation of the new runway; and (4) amendment of the acoustical insulation program to include multi-family residences, schools, and other institutional uses.

• Continue implementation of the existing Noise Abatement and Noise Remedy Programs, including but not limited to the Noise Budget, Nighttime Stage 2 Aircraft Limitations, Ground Noise Control, Flight Corridor Noise Abatement Procedures, and Flight Track and Noise Monitoring. Expand the Noise Abatement and

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Noise Remedy Programs to include the following additional elements:

• Initiate acoustical insulation for appropriate noise level compatibility of the long-term future use for the nine significantly noise impacted buildings identified in Chapter V, Section 6(i)(E) of the Supplemental EIS, if the owners consent.

• Initiate sound audits of certain residences located west of the current flight tracks and provide additional directional soundproofing if appropriate.

• Update the Airport's FAR Part 150 Noise Compatibility Plan to consider potential improvements and to evaluate potential residential acquisition in the Approach Transitional Zones of the new runway and sound insulate residences that would be affected by 65 DNL with the third runway.

• Continue to work with local jurisdictions to communicate land use and planning information and to support local zoning and construction controls that promote compatible development.

(2) **Water Quality**.

a. Construction Erosion and Sedimentation Control Plan. Prepare a construction erosion and sedimentation control plan for the construction of the new runway. The plan shall require use of Best Management Practices (BMPs) including but not limited to the following:

• Erosion control measures such as use of mulching, silt fencing, sediment basins, and check dams that are properly applied, installed, and maintained pursuant to agreements with contractors.

• Spill containment areas to capture and contain spills at construction sites and prevent their entry into surface or ground waters. Install proper temporary fuel storage areas and maintenance areas to reduce the potential for spills and contamination.

• Phasing of construction activities to minimize the amount of area that is disturbed and exposed at any one time.

- Where feasible, use of temporary and permanent terraces for fillslopes and cutslopes to reduce sheet and rill erosion and reduce transport of eroded materials from the construction site.

- Install gravel and wheel wash facilities on construction equipment access roads and encourage covering of loads to minimize sediment transport onto nearby roads.

b. Stormwater Management Plan. Prepare a stormwater management plan for the new runway that includes the following:

- Detention criteria should be based upon Department of Ecology standards limiting 2-year peak flow rates from the developed portions of the site to 50% of the existing 2-year rate, limiting the developed 10-year rate to the existing 10-year rate, and limiting the developed 100-year flow rate to the existing 100-year rate. Stormwater detention should comply with the requirements of the *King County Surface Water Design Manual*.

- Design stormwater facility outlets to reduce channel scouring, sedimentation and erosion, and improve water quality. Where possible, flow dispersion and outlets compatible with stream mitigation should be incorporated into engineering designs.

- Maintain existing and proposed new stormwater facilities. Stormwater management facilities should be maintained according to procedures specified in the operations manuals of the facilities.

c. NPDES Permit Requirements. Comply with the requirements of the National Pollution Discharge Elimination System permit for the airport dated June 30, 1994, as may be revised from time to time.

d. Ground Water. Because of concerns with possible ground water/aquifer contamination, the Port will continue to coordinate with the Seattle Public Utilities concerning the development of the north employee parking lot north of SR 518. Construction and operational BMPs will be used to address concerns voiced by the Utility. These include:

- Prohibiting fuel or bulk material storage on the parking lot unless it is strictly inert material

- Prohibit vehicle washing and maintenance activities on the parking lot

- Carefully design sealing methods for all joints and pipe connections, and establish quality assurance check during construction to confirm that sealing has been accomplished in accordance with project specifications

- Design bioswales for optimum petroleum hydrocarbon degradation

- Control agriculture chemical (landscaping fertilizer) application, particularly during the initial planting

- Regular maintenance of the drainage system, focusing on the removal of sediments from catch basins and detention vaults and oil from oil/water separators

- Require contractor to prepare and implement a construction spill response plan

- Require the contractor to centralize equipment fueling and repair operations and to construct on-site spill containment measures for the operations area

- Establish fill placement specifications which lower fill permeability to the greatest degree practicable

In addition, it is expected that a guard will be available in the parking lot to ensure that activities are not conducted in the lot or adjoining area that could result in contamination. The Port will also place signage in the lot to notify users that the lot is in near proximity to the Utilities wellhead. Because of the presence of the wellhead in this area, the Port and Seattle Public Utilities are expected to continue coordination to ensure that contamination does not occur.

(3) **Wetlands**.

- Avoid potential impacts to wetlands by transporting fill from other on-site borrow sources or off-site borrow sources rather than using fill from on-site Borrow Site No. 8 (as identified in the FEIS) which will avoid potential impacts to approximately 16 acres of wetlands at Borrow Site No. 8.

- Continue coordination with the U.S. Army Corps of Engineers and other appropriate agencies concerning all necessary permits and approvals to fill wetlands associated with the Master Plan Update projects.

(4) **Plants and Animals**. In cooperation with the state Department of Fish and Wildlife, finalize and implement plans for the relocation of those portions of Miller Creek and its tributaries necessary for construction of the new runway.

(5) **Earth**.

- The FEIS identifies two seismic hazard areas on the site of the new runway, referred to as "relatively small areas of loose shallow sediment". Removal of the sediment and replacement with compacted fill, or other appropriate engineering approach to stabilizing these areas, should be included in the final engineering plans.

- Prepare a landscaping plan for the new runway area, including plans for seeding and planting of vegetation to stabilize areas of fill that will not be covered by impervious surface.

(6) **Construction Impact Mitigation**.

- Prepare a Construction and Earthwork Management Plan to govern the acquisition and placement of fill material for Master Plan Update development actions. The Plan should address the methods selected for acquiring and transporting fill material to the airport development sites, including designation of preferred haul routes, hours of operation, traffic control, and route mitigation. The Plan's contents will depend on the methods ultimately selected and may include such topics as construction of temporary access ramps and roads, shoreline dock facilities, conveyor systems, and/or rail facilities.

- Prepare a construction acquisition plan, to mitigate the disruption that could occur in the general vicinity of the proposed new runway construction. This acquisition plan should consider inclusion of about 70 residential and commercial properties located east of Des Moines Memorial Drive between SR 509 and SR 518.

- Issue bid specifications reflecting the construction BMPs identified in the Final Supplemental EIS.

Attachment B

to Commission Resolution No. 3245

Attachment B to Commission Resolution No. 3245 consists of the following technical reports prepared for the Airport Master Plan Update:

- Technical Report #1: Final Work Scope
- Technical Report #2: Public Involvement Program Development Report
- Technical Report #3: Planning History & Study Relationships
- Technical Report #4: Facilities Inventory
- Technical Report #5: Final Forecast Report
- Technical Report #6: Airside Options Evaluation
- Technical Report #7A: Terminal Options Evaluation
- Technical Report #7B: Other Facilities Requirements & Options
- Technical Report #8: Master Plan Update Final Report

Attachment B
to Port Resolution 3245

TECHNICAL REPORT NO. 1
SCOPE OF WORK

AIRPORT MASTER PLAN UPDATE

AIRPORT MASTER PLAN UPDATE

FOR

SEATTLE-TACOMA
INTERNATIONAL AIRPORT

P&D Aviation

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Section 1
SCOPE OF WORK

SECTION 1

SCOPE OF WORK

TASK 1 PROJECT MANAGEMENT/COORDINATION

TASK 1.1 DEVELOP DETAILED WORK PROGRAM

Objective: To develop a master plan update detailed work program which meets all Port objectives and which clearly states consultant responsibilities and expected work products.

Methodology: Upon notification of selection, the detailed project scope and schedule will be developed. Refinements will be based upon discussions with the Port staff and others as directed by the Port.

Schedule: Detailed work program and schedule.

Product: The output of this task will be Technical Report No. 1, *Final Work Scope* (10 copies of draft and 40 copies of final). This will be a comprehensive document which clearly describes the consultant's scope of work, and schedule. This document will serve as an attachment to the contractual agreement, and as the Port's guide in determining the consultant's progress on the study.

TASK 1.2 MONTHLY PROGRESS REPORTS

Objective: To provide a comprehensive monthly status report update to the Port, and others as directed by the Port.

Methodology: A written report will be prepared to describe the present status of each aspect of the work; any problems encountered; recommendations for modifications to the plan of study; changes in personnel, methodology or schedules for completion; and hours and costs spent and hours and costs remaining on each work element. A monthly Affidavit of Amounts Paid to MBEs/WBEs will also be prepared.

Schedule: Monthly for twenty four months.

Product: The product of this task will be monthly written progress reports (3 to 4 pages in length) supplemented with oral briefings during the weekly Program Management meetings.

TASK 1.3 SUBCONSULTANT MANAGEMENT

Objective: To provide necessary management of the work efforts of the subconsultants who are participating in the Master Plan Update Study.

Methodology: In this task, P&D will manage the contracts, work schedules and progress, invoices and payments, and work products of each of the subconsultants. Contracts will be prepared for the subconsultants to ensure that their terms and work scopes are consistent with the project requirements. Adherence to the contract terms, including work schedules will be monitored. Monthly progress reports from subconsultants will be received and evaluated against the overall project schedule. Critical path work elements of each subconsultant will be carefully monitored. Subconsultant invoices will be reviewed and approved by the P&D Project Manager.

The work products of the subconsultants will be monitored and reviewed for overall consistency with other project elements. All work products of the study, including report text and graphics, will be produced in a standardized format. To accomplish this, P&D will be responsible for the final word processing, proof-reading, editing and production of all reports. P&D will develop standards for graphics and text for all project deliverables.

Monthly coordination discussions will be held to ensure consistency of analysis, to avoid duplication of efforts, to maintain quality control, and to formulate ideas and discuss project strategy.

Schedule: This task will continue from the date of Notice to Proceed until all subcontractor contractual obligations are fulfilled and final payment is made to each subcontractor. Duration is limited to twenty four months.

Product: This task will result in the execution of contracts between P&D and each subconsultant and will ensure the fulfillment of their obligations, including the quality control of their work products.

TASK 1.4 PROGRAM COORDINATION

Objective: To keep Port Project Management Staff coordinated with the progress of the study.

Methodology: Regular briefings will be provided by the consultant to the Port Project Management Staff and as directed by airport management. As a part of this task P&D Aviation will develop a composite master program schedule and update this schedule with the assistance of Port staff.

Schedule: Staff coordination meetings of this type will be limited to 60 meetings. This includes 48 during the first twelve months and twelve during the second twelve months. Budget is limited to 3 hours of Project Manager's time per meeting.

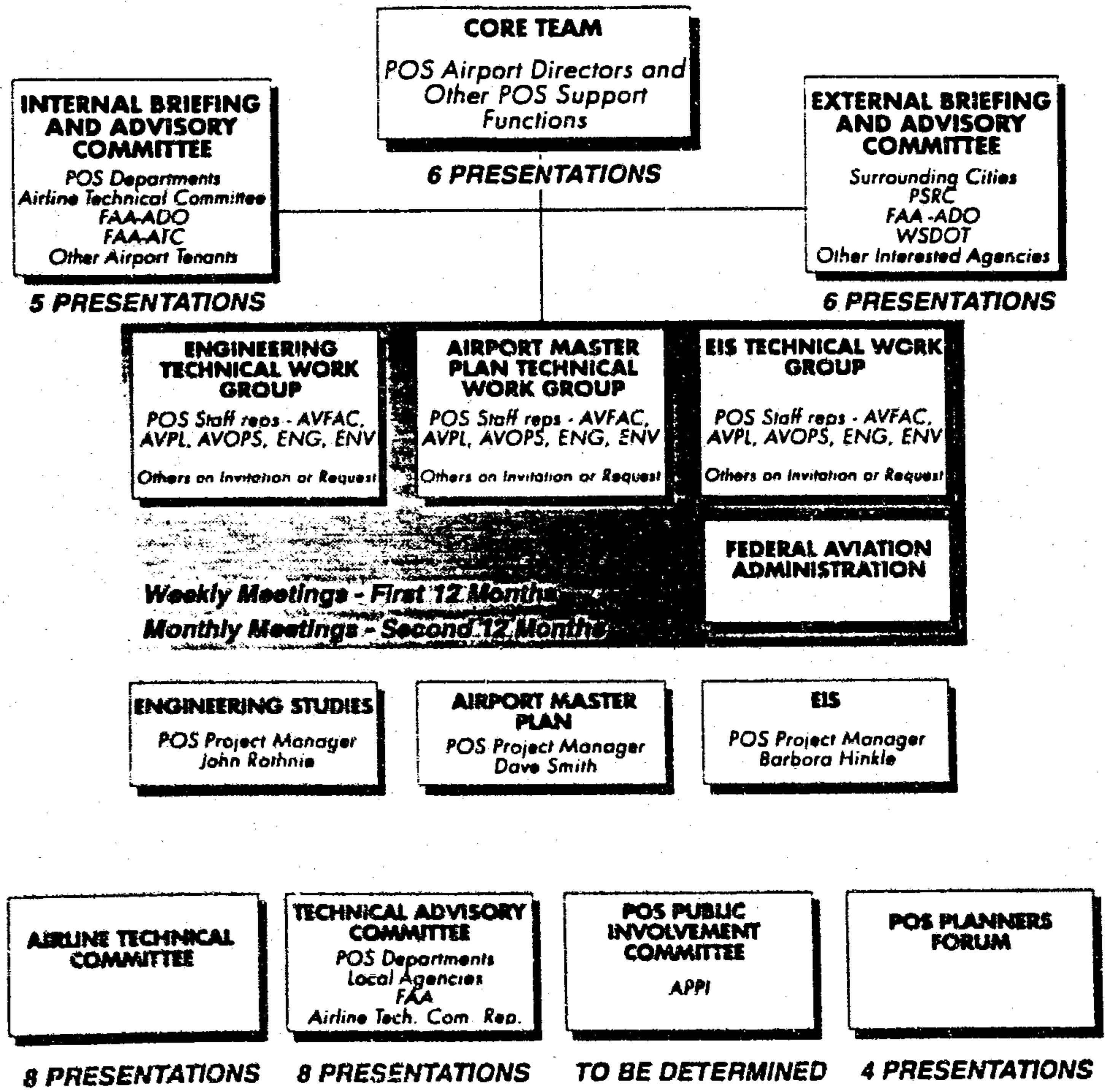
Product: Weekly briefings during first twelve months and monthly briefings during second twelve months to Port Program Management Staff. Composite master program schedule updated monthly. Schedule will show relationships and progress of Engineering, FAA Task Force, Planning, and EIS activities. This task also includes general non-task specific coordination which is limited to 1 hour per week during the 24 month period.

TASK 1.5 OTHER PRESENTATIONS AND MEETINGS

Objective: To present master plan update study results to the groups illustrated in the figure on the following page.

MASTER PLAN UPDATE ORGANIZATION STRUCTURE

P&D Aviation Coordination and Presentation Requirements



OTHER MEETINGS

- FAA Capacity Enhancement Task Force - 9 Meetings
- FAA Airport District Office Meetings - 5 Meetings
- PSRC Demand Management Presentations - 3 Presentations
- PSRC Noise Compliance Presentations - 6 Presentations

Methodology: Presentations will be made to these groups at key milestone points.

Schedule: Presentations are limited to the frequency indicated on the following page. Roughly half of these presentations are planned during the second year of the project. Budget is limited to 5 hours of Project Manager's time per presentation.

Product: Briefings will be made using presentation handouts and visual aids. Presentation graphics will consist of overhead transparencies. Port staff will assist in the preparation of the overhead transparencies.

TASK 1.6 FAR PART 150 COORDINATION

Objective: The objective of this task is to ensure consistency, economy of work effort and cost effectiveness in the preparation of the Airport Master Plan Update and the Environmental Impact Statement as these projects relate to the future update of the FAR Part 150 Program which will be required subsequent to the completion of the Airport Master Plan Update and EIS. The recently completed 1993 Noise Exposure Maps and Noise Compatibility Program did not include the development or implementation of the third runway, nor did it consider any of the land use/noise affects of the project. The third runway could require additional amendments to the Noise Compatibility Program and an updating of both the existing and future Noise Exposure Maps. Work elements being prepared under the Master Plan Update and EIS should be coordinated such that sufficient information is generated that can be utilized during the Part 150 Update, thus reducing work effort, ensuring consistency of all Port planning documents and avoiding duplication of tasks. In addition, the commitments, requirements and limitations developed in the Noise Mediation Agreement and the 1993 Part 150 Amendments must be considered in the Master Planning process.

Methodology: The Consultant will review specific work scopes for those items in both the Airport Master Plan Update and EIS that would be applicable to the Part 150 Update and recommend any additions or changes that would be required to ensure use in the Part 150 Update and be consistent with the conditions developed in the Noise Mediation Agreement. The Consultant would also attend appropriate work meetings, public meetings and other coordination meetings to ensure that all work efforts lead toward the final production of the FAR Part 150 Update and that the Part 150 Update reflects the efforts and be consistent with the Airport Master Plan Update and EIS. This may also include meeting with local units of government or the Planners Forum to discuss Airport Master Plan Update and EIS implications for the Part 150 Update. The main areas of concern are Forecasts Update, Landside and Airside Facilities Development, Options Development, Noise Analysis, Land Use Inventory and Analysis, and overall jurisdictional/public coordination.

Product: The product of this task will be to ensure the integration and consistency of the Airport Master Plan Update, the EIS and the future Part 150 Update, along with the Noise Mediation Agreement and the 1993 FAR Part 150 Amendments. A written report will be prepared at appropriate intervals to explain inconsistencies and to recommend corrective action.

Schedule: The task will be on-going throughout the development of the Master Plan Update and the EIS. Meetings will be coordinated with and held in conjunction with other tasks throughout the planning process. A total of 8 trips to Seattle are planned during the 24 month period. Four of these are planned during the first 12 months.

TASK 2 PUBLIC INVOLVEMENT PROGRAM

TASK 2.1 MARKET RESEARCH

Objective: The consultant will conduct market research in coordination with the Port's Public Involvement Committee using a variety of mechanisms to determine issues, identify key publics, and clarify citizen opinions. The data collected through this research will provide the basis for the public involvement plan.

Methodology:

A telephone survey and approximately 20 interviews with "key influentials" will be conducted for the market research phase of the project.

Survey. The survey will consist of a 600-sample in the area immediately around Sea-Tac, and a 400-sample in greater King County. The 600-sample will be a twelve-minute phone interview, consisting of three or four open-ended questions. The 400-sample will be a very brief three-question survey, and will be designed to validate existing survey data.

Interviews. Between 18-25 individuals will be interviewed.

Questions will focus upon the nature and significance of issues surrounding airport activities, the significance of these concerns in the broader context of all issues affecting such groups, ways the Port can improve the airport to better serve the group in question, and ways to actively engage each group in the planning process.

Schedule: The market research will be conducted during the first month of the project, with published results distributed in month 2.

Product: A published summary of the research results, Technical Report No. 2, *Market Research Results*, will be distributed to airport staff and project team members. Included in this document will be a summary of the interview results, a list of key issues, a list of key publics, and an analysis of the market research findings.

TASK 2.2 PUBLIC INVOLVEMENT PROGRAM DEVELOPMENT

Objective: To provide the framework for public involvement activities throughout the project.

Methodology: After the completion of Task 2.1, analysis of the issues will be performed and the public involvement plan will be written and submitted to the Port staff for review.

Schedule: The public involvement program development will be completed in month 3 approximately 2 weeks after the market research results are compiled.

Product: The documentation for this task will be included in Technical Report No. 2, *Market Research Results*.

TASK 2.3 PUBLIC INVOLVEMENT PROGRAM IMPLEMENTATION

Task deferred pending completion of Task 2.1 Market Research. This task may include: small "issue" work groups, newsletters, brochures and other printed materials, presentations to existing groups, media outreach, and video presentations. Funds included in budget are set aside for this task subject to finalization of work program.

TASK 2.4 EIS SCOPING MEETINGS

Objective: To assist and participate in EIS scoping meetings.

Methodology: The consultant will participate in two scoping meetings being conducted for the EIS on the Master Plan Update. This effort will be accomplished in conjunction with the Port and FAA. The purpose of the meetings will be to identify the range of probable significant environmental impacts, mitigation measures, and reasonable options to be addressed in the EIS. The EIS scoping meetings will be organized and led by the EIS consultant. A maximum of 8 hours is budgeted for O'Neill and Company for this task.

Schedule: To be determined by the Port.

Product: Participation in two EIS scoping meetings.

TASK 2.5 PROJECT BROCHURE

Objective: To prepare a project brochure.

Methodology: A four panel brochure will be developed which explains the Master Plan and EIS process. The brochure will be of professional graphic quality, non-technical in nature, and will be distributed to the public and other interested parties. Funds included in budget are set aside for this task subject to finalization of work program.

Schedule: Month 1 of project.

Product: Project brochure (10 copies of draft and 1,000 of final), 4 panels in size.

TASK 3 INVENTORY

TASK 3.1 REVIEW PLANNING HISTORY

Objective: To assemble and review a complete library of previous studies relevant to the Sea-Tac Master Plan Update.

Methodology: Review and document Sea-Tac Airport planning history. Prepare a working paper summarizing the chronology and outcomes of major planning efforts at Sea-Tac over the last several decades. The paper shall also discuss major Port policy directions arising from past planning and shall address the major airline industry changes and regional socio-economic changes since the last Airport Master Plan Update was prepared. The purpose of this task is to provide background and context information for the Master Plan Update. Documents which must be reviewed include the list of reports in the Master Plan Update RFP. Port staff will assist with this task.

Schedule: Month 1 of project.

Product: Technical Report Number 3, *Planning History and Study Relationships* (10 copies of draft and 40 copies of final). The report will provide a complete inventory of previous airport planning studies that assesses continuity of their assumptions, methodologies, and conclusions. Report will be co-authored by P&D and Port staff.

TASK 3.2 STUDY RELATIONSHIPS

Objective: To examine the relationship of the Airport Master Plan Update to other relevant land use and transportation plans.

Methodology: A working paper shall be developed which analyzes the linkages between the Airport Master Plan Update and the Regional Airport System Plan (RASP) prepared by the Puget Sound Regional Council (PSRC), the City of Sea-Tac Comprehensive Plan, and other local, state, and federal transportation and land use plans (including regional and local rail transit system studies). The interrelationships of these plans especially should be discussed in the context of the Washington State Growth Management Act (GMA). Port staff will assist with this task.

Schedule: Month 1 of project.

Product: Technical Report No. 3, *Planning, History and Study Relationships* (10 copies draft and 40 copies of final). This section of the report will focus on relationships between the Master Plan Update and other land use and transportation plans. Recommendations will be developed for coordination. Report will be co-authored by P&D and Port staff.

TASK 3.3 REVIEW SEA-TAC GROUND ACCESS AIRPORT FACILITY PLANS AND STUDIES

Objective: The objective of this task is to utilize recent plans and studies to form the baseline of existing and near-term ground access conditions and future options. A further objective is to identify on-going planning efforts which will need to be coordinated with the Airport Master Plan Update.

Methodology: This task will involve examining proposed transportation improvement projects in the vicinity of the airport (such as the South Access/SR 509 Extension Studies, 28th/24th Avenue South Arterial EIS, and Regional Transit Plan documents) to identify likely additions to transportation capacity in the pre-2000, 2000-2010, and 2011-2020 timeframes. This task will also identify on-going projects which will need to be coordinated with the Airport Master Plan Update. Port staff will assist with this task by providing reports and up-to-date studies from other agencies.

Schedule: This task will be accomplished during the last half of month 1 of the project.

Product: The findings of this task will provide input into Technical Report No. 4 - *Facilities Inventory* (10 copies of draft and 40 copies of final).

TASK 3.4 INVENTORY FACILITIES

Objective: An inventory of existing airport facilities, airspace and navaids.

Methodology: A database of existing conditions is to be prepared using documents assembled in Task 3.1, the existing airport layout plan, on-site inspections, and other relevant sources. Facilities to be inventoried must include:

- Runways and taxiways (including safety areas and pavement condition)
- Apron and ramp areas (including pavement condition)
- Passenger terminal and offices
- Air cargo facilities
- General and corporate aviation facilities
- Maintenance facilities
- Crash, fire, and rescue facilities (including the possibility of developing a regional fire training facility at the airport or on Port property.)
- Hangars
- Fueling facilities
- Hotel/Office Expansion
- Utilities
- Airfield lighting
- Landing and navigational aids and instrumentation

- Other aviation support facilities (i.e., Air Traffic Control Tower, etc.)
- Runway Protection Zones, FAR Part 77 Surfaces, and obstructions
- Airspace conditions
- Airport property not contiguous with the primary airport property.
- Surrounding land uses off airport property (including industrial/commercial, racreation, and airport buffer uses)
- Drainage and stormwater control and treatment facilities
- Pollutant and hazardous material controls

In this task an existing Airport Base Map for the ALP will be prepared on CADD using digital data files in AutoCAD furnished by the Port covering all airport property including key on-site access roads and transportation facilities surrounding the airport, and the Preliminary Engineering Study. Port staff will assist with this task. Consultant CADD labor hours are limited to 100 hours.

Schedule: Months 1 and 2 of the project.

Product: Technical Report No. 4, *Facilities Inventory*. CADD Airport Base Map for the ALP.

TASK 3.5 INVENTORY EXISTING GROUND ACCESS SEA-TAC AIRPORT FACILITIES

Objective: The objective of this task is to prepare an inventory of existing airport ground access circulation and parking facilities and services.

Methodology: This task will involve preparing an inventory of existing ground access, circulation and on and off airport parking facilities and services, including taxis, rental car services, private bus and shuttle bus operations and public transit operations, and estimating the currently available ground access and internal circulation capacity by mode.

This work will also involve the collection of ground traffic and parking data including traffic count data, parking accumulation data and study reports. The data will include all available ADT and peak hour traffic counts, turn movements at intersections, parking accumulation data and classification counts of traffic on the circulation roadways. Port staff directed by P&D, will provide the following data.

- Typical daily parking pattern.
- ADT and peak-hour traffic for critical intersections and surface roads.
- Vehicle classification and occupancy ratios.
- A summary of taxi, rental car, shuttle and courtesy bus, van and public transit operations.

The data will be compiled by P&D for input into the ALPs model calibration and a technical report summarizing existing conditions, capacities, trends and programmed improvements.

Schedule: This task will be accomplished during month 2 of the project.

Product: The findings of this task will provide input into Technical Report No. 4 - *Facilities Inventory*, and the data base for calibrating the ALPS model.

TASK 4 ACTIVITY FORECASTS

TASK 4.1 EVALUATE AND REFINE FORECASTS

Objective: To prepare updated forecasts of future airport activity.

Methodology: A review and evaluation will be conducted of regional air travel forecasts generated for the Flight Plan Project, the Sea-Tac Air Cargo Study, and other efforts (i.e., Boeing, FAA, etc.). The consultant will prepare updated forecasts of future aircraft operations and passengers for Sea-Tac (both unconstrained and constrained activity levels), within the project scope and budget, and submit to the FAA for approval. Forecasts shall be based on short- (1994 - 2000), medium- (2001 - 2010) and long-term (2011 - 2020) time frames. For each time frame, low, medium, and high estimates of passengers, aircraft operations, and cargo shall be made.

Specific components of the forecasting effort must include:

- Air passengers (total, origin and destination, connecting, major air carrier, commuter air carrier, domestic destination, international destinations, Canadian destinations, peak hour, etc.)
- Aircraft operations (total, major air carrier, commuter air carrier, general aviation, military, international, Canadian destinations, cargo-only, peak hour, etc.)
- Air Cargo (total tons, all-cargo airlines versus passenger airline cargo, package express, national and international destinations, etc.)
- Aircraft size and fleet composition by aircraft type
- Average passengers per operation
- Air Travel Demand factors (including trends in Pacific Rim travel, evolution of global airlines, bilateral airline market agreements, etc.)

The effects of supplemental airports will be considered and coordinated with PSRC studies.

Schedule: Month 2 of project.

Product: Technical Report No. 5 - *Forecast Report.*

TASK 4.2 GROUND ACCESS FORECASTS

Objective: The objective of this task is to prepare future ground access and internal circulation demand for passengers, employees and freight that impact airport area transportation facilities.

Methodology: This task will review previous travel forecasts for the airport area completed for the Port, the regional planning council and other local agencies. This review will help determine the best target years for forecast analysis in the following periods: Pre-2000, 2000-

2010, 2011-2020. Forecasting methodology will consider modes, daily and peak-period parameters set for Sea-Tac forecasts to ensure consistency with various planning components (i.e. routes, auto occupancy, parking demand, modes, percentage distributions, etc.) within the regional forecasting methodology. Existing data collected in Task 3 -- will be important to calibrate the model. Forecasts will be made for average daily and peak period conditions to be assigned to future transportation systems.

P&D will use the "Airport Landside Planning System," model to examine on-site and immediate area conditions. The model will be calibrated to reflect current conditions for which suitable data exists (1992 or 1993). This calibrated model of existing conditions will allow comparison with future alternatives to be developed. Transit modes will be tabulated separately, to the degree possible.

Data for future travel growth in the immediate area of the airport will have to be provided by Port Staff for the target years (to be determined as described above) to include land use pattern desired, as well as assumptions about off-site parking or changes in parking supply and location, car rentals, transit connections, on-site employment, mode split, facility sizes and capacities, and other related information will be needed for each model run for each target year forecast.

P&D proposes to complete ALPS assignments for the following: 1) Calibration for current year; 2) A late 1990's forecast; 3) and 4) Forecasts for the same year in the 2000-2010 period but with different background assumptions; 5) and 6) Forecasts for the same year in the 2011-2020 period but with different background assumptions; and, 7) A final run of a long-range plan.

These forecasts will build upon the data supplied by Port Staff for the airport area for the target years and conditions, while developing airport related transportation data to overlay regional conditions. An overview of regional and airport related transportation conditions will be identified. Model output will include trip generation, trip distribution on the roadway system, level of service, parking accumulations, key weaving movements, parking access and egress, as well as curbside analysis, to the degree possible.

Schedule: The model will be calibrated within the first two months of the project; Assignments 2-6 will be made in months 3-4 of the study. The final assignment will be made near the completion of the analysis phase.

Product: The product will be included in Technical Report No. 5 *Forecast Report*. These results will provide input into the evaluation of capacity and demand in Task 5.

TASK 5 FACILITY ANALYSIS

TASK 5.1 AIRSIDE FACILITY ANALYSIS

Objective: To develop airside delay analysis for range of new runway options and optimize necessary taxiway connections.

Methodology: A range of runway options will be prepared and are described as follows:

1. Existing Conditions - existing 11,900' and 9,425' lengths, 800' separation
2. Commuter - 5,000' length, 1,500' separation
3. Commuter - Dependent - 5,000' length 2,500' separation
4. Dependent ("Programmatic Baseline") - 7,000' length, 2,500' separation
5. Dependent - Maximum Length - about 8,500' (to be determined by engineer)
6. Independent - Maximum Length - about 8,500' length, 3,300' separation

The FAA's Airfield Capacity Model (for microcomputers) will be used for this task. This analytical model has been extensively validated by the FAA and will provide results sufficient for a comparative analysis of the proposed options. The analytical analysis will support and be consistent with the simulation analysis to be conducted by the FAA using the Airport and Airspace Simulation Model (SIMMOD), which provides more detailed results.

Each option will be defined in terms of physical and operating characteristics, flow direction, weather condition, and forecast demand level. These characteristics will be developed in close coordination with the Airport, FAA, and other relevant parties.

Prepare Assumptions. Given the option descriptions identified above, inputs and assumptions for each case will be prepared, which include the following:

- Physical and operational inputs, including the physical airspace structure and airfield characteristics, ATC rules and procedures, aircraft operating characteristics, and aircraft separations in the airspace and on the ground.
- Demand schedule inputs, including aircraft operations schedule for selected forecast demand levels.

The first of these inputs will be developed based on the results of the airspace configuration analysis, and the second will be based on the evaluation of forecasts. The inputs and assumptions developed in this task will be reviewed with the FAA and others, as appropriate.

Perform Capacity and Delay Analysis of Options. A capacity and delay analysis will be performed for each case defined above. The results of the analysis will be summarized in terms of average annual aircraft delays.

The average annual aircraft delay estimates will be used to develop demand versus delay relationships for the six airfield/airspace options specified above. These demand/delay curves will be compared with the baseline case and the resulting increase/decrease in aircraft delays will provide relative measure of airside capacity for each option.

The requirements for new and relocated navaids will be determined, as well as the need for modifications/improvements to runway safety areas and the need for additional taxiways.

Schedule: Months 1 through 4 of project.

Product: Airside facility requirements analysis to be included in Technical Report No. 6 - *Demand, Capacity, Requirements.*

TASK 5.2 GROUND ACCESS FACILITY ANALYSIS

Objective: The objective of this task is to compare current and forecast airport landside activity levels to the operational capacity of the various landside components and to identify capacity surpluses and deficiencies.

Methodology: This task will involve comparing forecast ground access demand and capacity, average daily and peak hour(s), for the pre-2000, 2001-2010 and 2011-2020 timeframes. Capacity deficiencies and excess capacity will be identified, both for access to the airport and internal travel within the airport. Person travel demand and capacity will be compared on both a mode-specific and all-mode basis, to determine if mode shifts can balance demand and capacity.

Schedule: This task will be completed during month 4 of the project.

Product: The findings of this task will provide input into Technical Report No. 6 - *Demand, Capacity, Requirements* (10 copies of draft and 40 copies of final).

TASK 5.3 TERMINAL DATA COLLECTION

Objective: The primary objective of this task is to produce the diverse data necessary for determining the terminal facility requirements. This data must be terminal specific as well as operationally detailed to permit the forecast demand to be translated into meaningful capacity requirements.

Methodology: Existing data sources and studies such as the recently completed Terminal Development Program will be relied upon, but revisited in light of updated forecasts, operational changes, or other developments which may have occurred. Certain data elements such as airline/OAG schedules will be updated automatically focussing on peak hour activity which is fundamental to terminal programming. Supplementary data collection in the form of observations may also be necessary. Port staff will assist with this task.

Supplementary data collection will include existing gate assignment schedules, tenant lease areas and terms, plans of any recent or anticipated modifications to terminal areas, and any documentation of Port leasing or operational policy which might have a bearing on the demand for, and use of, terminal facilities in the future. On-site observations may include determination of passenger processing rates at security screening and check-in areas, as well as passenger occupancies of areas such as concessions, holdrooms, and baggage claim at peak periods of the day where existing information is insufficient to determine use of these facilities.

Schedule: The bulk of the data collection effort is expected to occur within a three week period; however, additional periodic data collection may be necessary to support specific tasks or analysis throughout the study.

Product: The results of this task will be incorporated as supporting information to the demand/capacity analysis and terminal program sections of Technical Report No. 6, *Demand, Capacity, Requirements*.

TASK 5.4 TERMINAL PROGRAMMING

Objective: A comprehensive, implementable, prioritized, and phased terminal program is the primary objective of this task. This program will be coordinated with landside and airside capacities for the long range forecast period as well as for individual stages of the terminal development.

Methodology: The terminal programming methodology will begin with an examination of updated peak period airline and airport forecasts which form the basis for terminal facility requirements. Forecasts will be reviewed for completeness of data, underlying assumptions, and period of forecast. Adjustments will be made and verified as necessary with individual carriers. Activity levels in terms of passengers, baggage, aircraft operations, etc. will be disaggregated to show both design day and peak hour activity levels, and broken down by type of operation (airline and aircraft type) to provide the level of detail which is essential to the effective sizing of gates, holdrooms, baggage space, and other major terminal components. The terminal area facilities inventory found in the Terminal Development Study will be revisited and adjusted to conform to changes which may have occurred. This information will be used to compare the existing capacity of the terminal complex with the anticipated demand. The resulting deficiencies (or surpluses) will form the basis for the updated terminal program.

Both public and tenant facilities will be dis-aggregated by type of use and organized by functional location within the terminal and location within either the secure, non-secure or sterile (FIS) areas.

Schedule: The terminal programming task is expected to take approximately four weeks to complete, but this effort will run concurrently with other elements of the Master Plan Update, and therefore will fall within its overall time table. Because the terminal programming task is dependent upon updated forecast material, it will not be initiated until the updated forecasts for Sea-Tac are available. An initial draft of the program will be available for review approximately two weeks after the availability of the forecasts. This will be used to initiate the development of terminal options. The complete program will be revised and finalized as terminal options are developed.

Product: Documentation of this task will be included in Technical Report No. 6, *Demand Capacity, Requirements*. Revisions based upon comments received will be incorporated into a final Master Plan Update document.

TASK 5.5 CARGO FACILITY ANALYSIS

Objective: To update the Sea-Tac cargo facility requirements analysis.

Methodology: The facility requirements developed in the 1992 Sea-Tac Air Cargo Study will be reviewed and updated as required. Components included are air freight, air mail and small package service.

Schedule: Month 4 of project.

Product: Sea-Tac cargo facility requirements analysis, to be included in Technical Report No. 6 - *Demand, Capacity, Requirements.*

TASK 5.6 OTHER AIRPORT ELEMENTS

Objective: The objective of this task will be to develop facility requirements for remaining airport facilities not addressed in Tasks 5.1 through 5.5 for the pre-2000, 2000-2010 and 2011-2020 timeframes.

Methodology: Facility and/or space requirements will be developed for each of the following:

- General and corporate aviation facilities
- Maintenance area
- Crash, fire and rescue facilities
- Fueling facilities
- Drainage and stormwater control and treatment facilities
- Pollutant and hazardous material control facilities
- Other airport tenants
- Airport operations, maintenance and administration
- Air traffic control tower
- Flight kitchen

Potential uses for non-contiguous airport property will be discussed.

Schedule: Month 4 of project.

Product: Facility requirements for airport support facilities and other airport related activities, to be included in Technical Report No. 6 - *Demand, Capacity, Requirements.*

TASK 6 CONCEPT ANALYSIS

TASK 6.1 DEVELOP CRITERIA

Objective: To develop and describe evaluation criteria to be used in the evaluation of options.

Methodology: Criteria to be applied to the option evaluations must include the operational, economic, and environmental considerations. The options will be evaluated in terms of their flexibility and adaptability to changing conditions in the airline and airport business.

Schedule: Month 3 of project.

Product: Definition of evaluation criteria to be used in evaluation of options. Number of options to be evaluated in Task 6 is limited to sixteen. (Four for airside, terminal, landside and other).

TASK 6.2 AIRSIDE OPTIONS ANALYSIS

Objective: To evaluate and select the preferred airside options.

Methodology: The airside options analysis will be conducted in a two step approach to ensure the results of the new runway analysis are completed by April 1994. Initially the options described in Task 6.1 will be screened to determine a smaller set of options (maximum of 4) to be evaluated in greater detail. Parameters to be evaluated shall include Sea-Tac future delays, Boeing Field future delays, amount of imported fill material required, construction sequence considerations, physical impact area, other environmental considerations, construction costs, delay costs, and mitigation costs.

Other airside issues will be considered to include navaids, runway safety areas, taxiways, airspace considerations, and instrument approach procedures.

Schedule: To be completed during month 4 of the project.

Product: The product of the airside studies will be a two tier analysis with the final conclusions documented in the form of working paper by early March 1994. This information will also be incorporated in Technical Report No. 7, *Evaluation Report* (10 copies of draft and 40 copies of final).

TASK 6.3 MULTI-MODAL AIRPORT LANDSIDE OPTIONS ANALYSIS AND EVALUATION

Objective: The objective of this task is to identify and evaluate multi-modal airport ground access and internal circulation options.

Methodology: This task will involve identifying options for improving ground access and internal circulation capacity to meet expected demand. These options may include roadway and parking improvements; transit facility improvements; traffic, parking and transit operational and service improvements; transportation system management options to encourage mode shifts of person travel to, from and within the airport; and transportation demand management options to discourage vehicular traffic to, from and within the airport at peak times. Concept designs of options will be prepared, where appropriate, including concept-level cost estimates. The facility, operational and management improvement options identified will be evaluated and components will be recommended for inclusion in the preferred Master Plan Update package.

Schedule: These tasks will be completed during month 7 of the project.

Product: The findings of these tasks will provide input into Technical Report No. 7 - *Options Evaluation Report*. An airport access plan, showing recommended improvements, will be prepared on a separate sheet on AutoCAD if necessary.

TASK 6.4 DEVELOPMENT OF TERMINAL OPTIONS

Objective: The identification of three terminal development options will provide a basis for revisiting the findings of the Terminal Development Study and adjusting these as necessary to fit the program for the Master Plan Update. These are envisioned as options which will make the terminal compatible with landside or airside planning rather than complete redevelopments of the terminal itself. Options may also focus upon operational improvements or architectural modifications to the existing terminal to make the terminal function better. It should be noted that the Terminal Development Program completed in 1991 was envisioned as a "living" planning document and intended to be revisited from time to time.

Methodology: An updated terminal facilities inventory and options developed in the Terminal Development Program will form the basis for the terminal analysis task. The development planning criteria will also be re-examined in conjunction with POS designated staff, airlines, and other terminal users' requirements to determine whether changes or adjustments which would influence the plans are warranted. Terminal plans which address both interim/short range and projected long range requirements will be developed for evaluation. The terminal options themselves will be coordinated in regularly scheduled meetings with POS staff, airlines, other designated parties and terminal users in concert with other elements of the Master Plan Update.

Schedule: The terminal options development task itself is expected to take approximately four weeks to complete. This will be followed by a two week evaluation period as defined in the next task. Both efforts will be accomplished in concert with airside and landside elements of the Master plan Update.

Product: The product of this task will be in two components: (1) drawings or other exhibits suitable for presentation and review, and (2) a narrative accompanied by graphics, describing the terminal development options. Typically, this information is distributed for review along with the terminal evaluations and refinement process. All drawings in this task will be prepared at a scale of either 1" = 200' or 1" = 100' depending on the terminal component(s) being considered and the level of detail desired.

TASK 6.5 EVALUATION OF TERMINAL OPTIONS

Objective: The confirmation of a recommended terminal plan for the Master Plan Update is the main objective for the options evaluation process. This process must be carried out in an objective manner to ensure that all factors are compared equally and fairly.

Methodology: The evaluation criteria defined in the Terminal Development Program will be revisited with POS designated staff to determine continued applicability. Adjustments will be made as necessary including redefining or modifying criteria as appropriate. An evaluation matrix or other form of evaluation process will be identified as the frame work to be used for evaluation. The benefits and deficiencies of each terminal option will be identified and compared. An important component of the evaluation should be the ability of an option to adjust to the phases of airside and landside capacity increases which are contemplated for the Master Plan Update.

Schedule: The terminal options evaluation process is expected to take approximately two weeks to complete including reviews. It immediately follows the terminal options development task.

Product: Both the evaluation criteria and the process leading to a recommended plan will be defined in exhibits suitable for presentation as well as a narrative to be included in Technical Report No. 7, *Options Evaluation Report*. The narrative will be developed initially in draft form and submitted for review along with the terminal options development narrative.

TASK 6.6 REFINEMENT OF TERMINAL OPTIONS

Objective: The results of the terminal options evaluation process may produce a need for certain adjustments to the plan, or the incorporation of elements of other plans. It is the objective of this task to provide an opportunity for this to occur, and this is referred to as the refinement process.

Methodology: Following the terminal development and evaluation process, the recommended terminal plan may need to be further refined to incorporate additional information or elements of other plans which would improve it. This process will also integrate additional program findings concerning major site elements, including airside, terminal, access and parking plans developed concurrently which may have an influence on the plan. The scale and functional relationships of major terminal components may also undergo some modification. Coordination with appropriate parties, including airlines and other terminal users, regarding their input and review will also be completed during the refinement process.

Schedule: The terminal refinement process is expected to take approximately four weeks including the preparation of a recommended terminal plan. This effort will run concurrently with other tasks of the Master Plan Update and is not expected to lengthen the overall planning process.

Product: Exhibits suitable for presentation as well as a narrative explaining any changes made during the refinement process will be produced and incorporated, following appropriate reviews, into Technical Report No. 7, *Options Evaluation Report*. All drawings in this task will be prepared at a scale of either 1" = 32', 1" = 50' or 1" = 100' depending on the terminal component(s) being considered and the level of detail desired.

TASK 6.7 TERMINAL DOCUMENTATION

Objective: It is the objective of Task 6.7 to summarize the recommended terminal plan for inclusion in the Master Plan Update for Sea-Tac International Airport. This final recommended plan must not only serve the specific needs and forecast requirements of the terminal area, it must be coordinated and compatible with the recommended plans for airside and landside development including balanced capacities during various phases of implementation.

Methodology: Because many of the prior tasks focus upon terminal-specific solutions, the recommended plan must address its relationship to the other major components of the Master Plan Update. To some extent this will have been carried out through other prior tasks; however, the documentation of the results will be produced in Task 6.7. This requires careful coordination with other disciplines and may result in some further adjustments or refinements. Results will be documented both in narrative and graphic form for inclusion in the Master Plan Update report.

Schedule: Month 24

Product: The recommended terminal development plan for the Master Plan Update will be produced in AutoCAD suitable for use in producing the Terminal Area Plan sheet and final presentations, and appropriately rendered in color. An accompanying narrative summarizing the plan will also be prepared and incorporated into final documentation. Thompson Consultants International staff will be available to participate in a maximum of three presentations to Port Executive Staff and the public.

TASK 6.8 SITE BEAUTIFICATION OPTIONS

Objective: To identify opportunities for improving airport boundary condition conflicts and to improve overall appearance of the airport.

Methodology: Existing conditions will be analyzed, concept options will be developed and final beautification measures will be developed.

Schedule: To be completed during month 10 of the project.

Product: A photo documentation board of key areas will be presented as well as a site analysis and development recommendations based on existing conditions and opportunities (i.e. sun, wind, soils vegetation, views, urban surroundings, and access). Concept beautification options will be presented as well as a final plan of beautification measures.

TASK 6.9 CARGO OPTIONS

Objective: To review the 1992 Air Cargo Study and develop and evaluate cargo expansion options.

Methodology: The results of the 1992 Sea-Tac Air Cargo Study will be used to the maximum extent possible. Discussions will be conducted with the Port and the Airlines to determine if additional evaluation and selection of cargo facility layout options is necessary at this time.

Schedule: To be completed during month 9 of the project.

Product: Cargo Facilities Recommended Improvement Program, to be included in Technical Report No. 7 - *Options Evaluation Report*.

TASK 6.10 OTHER AIRPORT ELEMENT OPTIONS

Objective: To identify and evaluate options for each of the other elements listed in Task 5.6.

Methodology: Due to the varied nature of facilities included in the "other" category, no single consistent methodology will be used to evaluate these options. Generally however, operational, economic, and environmental considerations will be evaluated to determine the preferred option. Facility elements in the "other" category will be evaluated in various levels of detail, according to the importance to the Airport Master Plan Update. For example, storm water runoff and retention ponds will be evaluated in greater detail.

Schedule: To be completed during month 10 of the project.

Product: Preferred options for "other" airport elements, to be included in Technical Report No. 7 - *Options Evaluation Report*.

TASK 6.11 EVALUATE "PACKAGES"

Objective: To develop and evaluate a complete and integrated system of options.

Methodology: A maximum of four "packages" of options will be generated and evaluated which combine the elements evaluated in Tasks 6.2 through 6.10. Packages will be defined which seek to optimize the use of existing facilities and land. Land acquisition needed to implement the options will be identified and the rationale behind such acquisition will be explained. The need for relocation of existing facilities shall be examined. Each option shall include a general sequence and timing (or activity level trigger) for implementation of each of the element options (i.e., phasing of facility developments.)

Schedule: Months 14 through 22 of the project.

Product: Evaluation results of "package" option studies. Technical Report No. 8, ***"Package" Evaluations Report***. Number of packages to be evaluated are limited to four.

TASK 6.12 PREFERRED PACKAGE

Objective: To select and document the preferred package.

Methodology: Results of the evaluations will be presented and discussed with Port staff and others as directed by the Port. A preferred package will be selected based on these discussions. The preferred package will be fully documented as described in Task 9.

Schedule: Month 23.

Product: Selection of a preferred package.

TASK 7 FINANCIAL PLAN

TASK 7.1 COST ESTIMATES

Objective: To develop capital cost estimates for the recommended plan.

Methodology: Developing optimum solutions for the concepts will require repeated cost comparisons and analyses of airfield facilities, terminal facilities, vehicular road systems, public and employee parking, air cargo facilities and general aviation facilities, including any temporary construction required to implement the concepts. Estimators will work with the planners throughout the evaluations to develop cost comparisons to assist in the evaluating options. For the recommended plan, detailed cost estimates and schedules will be developed for each phase of the projects.

Schedule: To be completed in month 22 of project.

Product: Preliminary and final capital cost estimates.

TASK 7.2 PHASING PLAN

Objective: To develop a master plan phasing schedule.

Methodology: Based on the forecasts and cost estimates, a proposed master plan construction phasing schedule will be developed. The phasing plan will include the estimated capital costs and development time frames for the preferred Master Plan Update and runway option. The plan will correspond to the forecasting periods identified in Task 4. The financing plan to be developed by the Port will be reviewed and the phasing plan adjusted if necessary to achieve a financially feasible plan.

Schedule: To be completed in month 22 of the project.

Product: Master Plan Update Phasing Program.

TASK 7.3 OPERATING AND MAINTENANCE (O&M) FORECASTS

Objective: To provide technical assistance to Port staff in preparing the financial plan for the Master Plan Update.

Methodology: Review and provide input into the capital financial analysis for each of the options. Provide assistance in performing financial analysis of the options. Provide technical assistance in identifying O&M costs associated with each option. Review staff work on the O&M financial analysis.

Schedule: To be completed in month 22 of the project.

Product: Assistance to the Port in the development of inputs for financial modeling.

TASK 8 PSRC IMPLEMENTATION STUDIES

TASK 8.1 PSRC DEMAND MANAGEMENT/SYSTEM MANAGEMENT ANALYSIS

Objective: To estimate the potential impact on the passenger and operations forecasts which could result from various demand management/system management techniques.

Methodology: Demand Management/System Management options which are reasonable from an operational standpoint will be described and evaluated. These options will include pricing mechanisms, gate controls, and high speed rail. Options will be analyzed to determine feasibility, considering the reasonableness of methods and assumptions, the time frame for implementation and the likely extent of the impact on future operations at Sea-Tac. Also considered will be issues such as long term regional goals, existing contractual obligations and legal constraints, safety, operational efficiency, and expense. Included in this task are three (3) presentations to the PSRC Expert Arbitration Panel.

Schedule: To be completed in month 10 of the project.

Product: Separate chapter of Technical Report No. 6, *Demand, Capacity, Requirements* titled Feasibility Study of Demand Management Strategies. Three (3) presentations to the PSRC Expert Arbitration Panel.

TASK 8.2 DIVERSION TO GROUND MODE

Objective: The objective of this task is to assist in the preparation of air travel forecasts by forecasting the likely diversion of inter-city travel to a high speed ground transportation mode.

Methodology: This task will use data from the Washington State High Speed Ground Transportation Study to provide an estimate of the realistic diversion of short distance air passenger trips to high speed rail, in the pre-2010, 2011-2020 and post-2020 timeframes. Information prepared by Washington Department of Transportation will be used to the maximum extent possible.

Schedule: This task will be accomplished in month 2 of the project.

Product: The product of this task will be a technical memorandum which will provide input to the overall air travel forecasting effort.

TASK 8.3 PSRC NOISE PERFORMANCE ANALYSIS

Objective: To provide acoustic services to meet the requirements of the PSRC Noise Reduction Performance Objectives as set forth in PSRC Resolution A-93-03. The services will include the development of a noise measurement validation program and provide the required ongoing reporting and presentation requirements as specified in the Resolution.

Methodology: The following tasks will be performed to meet the requirements of Section II of the PSRC Resolution:

1. The noise methodology used to evaluate the noise reduction will be developed. The methodology will correlate the noise reduction goals specified in the Noise Budget to the measured aircraft DNL noise levels in the community.

2. The number and location of the existing noise monitoring sites that will be used for the location of the monitoring program will be specified. Provisions for removal of data from any failed site will be allowed for.

3. The reference base year noise level will be specified. It will be defined relative to the time period of the Mediation Agreement.

4. The noise reduction level that must be achieved will be determined. The noise reductions must be based upon the noise reduction goals established through the Mediation Program. These reductions in noise shall be consistent with the reductions that have been predicted through the 1996 Part 150 noise study.

5. Prepare document that specifies the calibration requirements that must be achieved concerning the Permanent Noise Monitoring System.

6. Prepare documents that presents the methodology. The consultant will work with Port and PSRC staff in the development of the methodology. It is assumed that these tasks will include two Seattle trips.

7. Present the methodology to Expert Panel. Task includes preparation and one trip to Seattle.

8. Prepare simi-annual reports on the status of the measurement program and the level of compliance with these measures. This assumes 4 reports over the two year time frame.

9. Present results of the status of the measurement to the PSRC Executive Council. This task assumes 4 presentations over the two year time frame. Task includes one trip to Seattle.

10. Present final results to expert panel during the late 1995 time frame.

11. Present a verification that the Port is achieving the objectives of the Acoustical Insulation Program. Prepare simi-annual summarizes to present to the Executive Council.

Schedule: The following is the proposed schedule for completing this assigned tasks:

- The Independent Validation Plan:

Draft	December 31, 1993
Final	January 31, 1994

- Expert Panel Presentations:

  First 1st Quarter 1994
  Final 4th Quarter 1995

- Simi-Annual Reports:

  First 2nd Quarter 1994
  Second 4th Quarter 1994
  Third 2nd Quarter 1995
  Fourth 4th Quarter 1995

- Executive Board Presentations:

  First 2nd Quarter 1994
  Second 4th Quarter 1994
  Third 2nd Quarter 1995
  Fourth 4th Quarter 1995

Product: The following services and products will be provided as part of this task.

- Development of Independent Validation Plan
- Simi-Annual Reports (2 years -- 4 reports)
- Simi-Annual Presentations to Executive Board (2 years -- 4 presentations)
- Two Presentations to Expert Arbitration Panel

TASK 9 DOCUMENTATION

TASK 9.1 UPDATE ALP

Objective: To prepare and update the Airport Layout Plan (ALP).

Methodology: An updated ALP, including the obstruction drawing and the Runway Protection Zone (RPZ) drawing, will be prepared to FAA guidelines. The ALP shall be prepared using AutoCAD software, with the final ALP files to be provided to the Port. The ALP will be coordinated with preliminary engineering and shall include all items specified on the FAA ALP checklist. The number of CADD labor hours available for this task is limited to 330 hours.

The ALP plan set will consist of the following sheets:

- Airport Layout Plan
- Obstruction and Runway Protection Zone Plan
- Terminal Area Plan
- Airport Access Plan, if necessary
- On-Airport Land Use Plan

Schedule: Preliminary ALP to be completed in month 11. Final updated ALP to be completed in month 23.

Product: ALP plan set plus AutoCAD files.

TASK 9.2 DRAFT FINAL REPORT

Objective: To prepare a final Master Plan Update Project Report.

Methodology: The Final Report will be the primary document in which the entire airport Master Plan Update, methodologies, findings, and recommendations are presented. It will be based on the technical reports generated for the previous tasks, but will be formatted and organized to work as a stand-alone document (i.e., it will be more than a compendium of the working papers and will include a technical executive summary, introduction, transition, and conclusion sections). The Final Report will include a role statement for Sea-Tac Airport; recommendation for future studies which should be conducted as a result of the Master Planning effort; and all relevant data, maps and discussions included in the technical reports. A general map of the preferred Master Plan Update option will be included.

Schedule: Month 23.

Product: Draft of the Master Plan Update Final Report. 50 copies. (Technical Report No. 9, *Draft of Master Plan Update Final Report*)

TASK 9.3 FINAL REPORT

Objective: To revise and finalize the Master Plan Update Final Report.

Methodology: Results of comments will be incorporated into the Final Report as directed by the Port.

Schedule: Month 24.

Product: Master Plan Update Final Report. 400 copies plus camera-ready originals, computer data files for text, spreadsheets, and graphics.

The following Technical Reports will be prepared during this study:

Technical Report No. 1 - *Final Work Scope*

Technical Report No. 2 - *Market Research Results*

Technical Report No. 3 - *Planning History and Study Relationships*

Technical Report No. 4 - *Facilities Inventory*

Technical Report No. 5 - *Forecast Report*

Technical Report No. 6 - *Demand, Capacity, Requirements*

Technical Report No. 7 - *Options Evaluation Report*

Technical Report No. 8 - *"Package" Evaluations Report*

Technical Report No. 9 - *Draft of Master Plan Update Final Report*

Attachment B
to Port Resolution 3245

ATTACHMENT B
TECHNICAL REPORT NO. 2
PUBLIC INVOLVEMENT PROGRAM
MARCH 1994 - DECEMBER 1995

AIRPORT MASTER PLAN UPDATE
FOR
SEATTLE - TACOMA INTERNATIONAL AIRPORT

Prepared by:

O'NEILL & COMPANY

Prepared for:

The Port of Seattle
SEATTLE - TACOMA INTERNATIONAL AIRPORT

APRIL 28, 1994

The P&D Aviation Team

P&D Aviation • Barnard Dunkelberg & Company • Berk & Associates
Mestre Greve Associates • Murase Associates • O'Neill & Company
Parsons Brinckerhoff • Thompson Consultants International

TABLE OF CONTENTS

INTRODUCTION

This document details a public involvement program designed to support the engineering and environmental analysis that will occur through the Port of Seattle's Master Plan Update. The public involvement program encompasses a broad range of strategies designed to inform and involve as many individuals as possible in the two-year planning effort.

The plan begins with a situational analysis which briefly describes the general public atmosphere within which this Master Plan Update effort will be conducted. This analysis was developed with background information on previous Port processes, as well as on the basis of interviews with 27 key opinion leaders in the Sea-Tac area.

Strategic goals and messages are described in the next sections of the document, followed by a description of the key audiences that are important to focus on and include throughout the process.

The Environmental Impact Statement and the Master Plan Update are being conducted simultaneously. The FAA has hired consultants to carry out the environmental studies and the public will have the opportunity to comment in the spring of 1995. The Port of Seattle is conducting the Master Plan, a comprehensive engineering and planning study that will determine how Sea-Tac can best accommodate the growing number of passenger and cargo volumes of the future. Public involvement will be ongoing through the end of 1995.

The actual strategies that form the basis of the plan are described in three sections. The first, **"1994-95 Region-wide Strategies,"** describes those efforts intended to reach as broad a constituency as possible. They form a network of communication that enables interested individuals to gain information and comment on the work underway without actually having to attend meetings.

The **"Sea-Tac University"** is a new approach to engaging directly with the public on virtually all of the components of the Master Plan. Major topic areas of the plan have been divided and worked into a series of public meetings.

Finally, there is a compilation of 1995 strategies, these are designed to allow for public comment on the completed draft Master Plan.

Each of the strategies is described, then highlighted with supporting information. This includes a rationale for the strategy, as well as a description of the roles and responsibilities for implementing that strategy.

The document ends with a graph depicting the timeframe for implementation of the public involvement effort.

SITUATIONAL ANALYSIS

Clearly the possible expansion of Sea-Tac International Airport represents a challenging regional decision. Seldom does any one issue become the subject of such vitriolic community debate and opposition. Unfortunately, there are clear lines already drawn in the sand. Substantial opposition exists among those neighborhoods in closest proximity to Sea-Tac, and that opposition threatens to be reinforced through the legal system. Neighborhood opposition forces are joined by residents from other King County areas who fear greater noise impacts from increased airplane traffic. Although those areas are impacted more by the four-post plan than a possible third runway, some organized groups in these areas are opposed to expansion because they believe it will increase the number of noisy flights over their homes.

Yet, in a recent survey conducted throughout King County, 69% of respondents said that they supported construction of a third runway at SeaTac. It is incumbent upon the Port to analyze and plan for the third runway as a viable contingency for the region's future. If the Port did not embark upon this planning effort, it would be irresponsible and in conflict with mandates from its enabling legislation.

As the Port moves into the comprehensive Master Plan Update process, it is clear that public involvement will play a vital role in the ultimate success of the effort. No matter how thorough the planning and environmental work is, unless the public understands the process and the results and unless there are significant opportunities for all affected communities to comment on and be involved in that process, it will ultimately fail. There is a need to make a sincere effort at public involvement so that regional governments, and indeed the Port Commission itself, will be more inclined to approve the Master Plan.

While the controversy surrounding the third runway is daunting, it is only one example of the kinds of controversies likely to be present throughout the region in the foreseeable future. It epitomizes the dilemmas facing our area: how much should one community hold sway over a decision that is likely to benefit the entire region -- even the entire state? Likewise, how far do we go in requesting a single geographic area to bear the burden of regional growth?

Ultimately decisions about Sea-Tac will come down to this inevitable tug of war between the needs of one community versus the needs of the region as a whole. It is this difficult balancing act with which the Port must struggle over the next two years. This public involvement plan is designed to inform and involve all of the Port's constituencies in the complex decisions that will create the Sea-Tac Airport of the 21st Century.

PUBLIC INVOLVEMENT GOALS

The public involvement plan will work to achieve the following goals:

- **Ensure that the program captures a wide diversity of opinions and public direction.**

A core audience will attend public meetings to make their views known. This program is designed to elicit opinion from these groups on specific issues. In addition, however, it provides encouragement and ample opportunity for those who would not normally attend meetings to express their opinions on the master planning process.

- **Build confidence for the Port Commission.**

As the Commission prepares to make the tough, final decisions on the third runway, it is important they have confidence that the public involvement effort has been genuine and comprehensive. This program is designed to instill that level of confidence.

- **Develop opportunities for involvement on a broad range of issues -- not just the third runway.**

The third runway has obviously captured media and public attention, due to the vehement opposition of some groups. The master plan, however, has a scope that goes far beyond the third runway decision. It is important to develop a public dialogue on this broad range of issues without allowing the third runway to completely dominate all proceedings.

- **Work to create new, more positive, long-term relationships.**

While Flight Plan offered significant opportunities for public feedback on a broad range of airport options, this is the first time since 1985 that the Master Plan itself has been updated. This represents a tremendous opportunity for the Port to create new partnerships with both the surrounding community and the region as a whole. It is a chance to express an attitude that emphasizes a strong, genuine working relationship between the Port of Seattle and its constituencies.

STRATEGIC MESSAGES

The following themes will be reiterated throughout the public involvement process:

- **Overall operations at Sea-Tac are rated far above other governmental agencies.**

In a recent opinion poll, 56% of the respondents rated the airport far higher than King County, Metro, or the State Legislature. On average, residents make eleven trips to the airport every year. It is important to maintain this positive perception of the airport. The Master Plan is designed to continue to make it as easy as possible to travel to the airport, park, and get to the gate.

- **This is a *regional* decision.**

While the communities that are geographically linked to Sea-Tac Airport stand opposed to any airport expansion, the decision of whether or not to build a third runway has a tremendous, far-reaching impact on the entire region. The decision will be incorporated into other ongoing work, including the PSRC's search for a major supplemental airport. While the Port is responsible for the Master Plan and the public involvement program to support it, we need to continue to stress that this is a decision that affects the Commission's *entire constituency*.

- **Virtually all governmental agencies are planning for growth. The Port must do the same.**

The Port is mandated, by law, to provide infrastructure that serves the regional economy. It would be a serious disservice to the region if the Port did not fully anticipate regional growth and evaluate whether or not it can effectively be handled through an expansion at Sea-Tac. This is a concept that is often lost in the debate over the third runway.

- **The Port supports the parallel process searching for a new regional airport.**

Again, the Port is fulfilling its own mandate, but cannot mandate all decisions for the region as a whole. The Port intends to carry out its own planning process, but it is also supportive of the Regional Council's search for a supplemental airport.

- **The Port Commission has directed an open, iterative planning process with *meaningful* public involvement.**

The public involvement program has been designed to be accessible and widespread. It also provides for significant opportunities for public comment on all of the components in the Master Plan. These comments will be considered and included wherever possible and a commitment will be made to explain what is incorporated, what isn't incorporated, and why.

DESCRIPTION OF KEY AUDIENCES

This public involvement plan employs strategies designed to inform and involve the following groups:

LOCAL COMMUNITIES: ELECTEDS, STAFF AND RESIDENTS

Of all the identified audiences, it will require the most effort to strengthen lines of communication and build trust with individuals in the local cities surrounding Sea-Tac. Major changes at Sea-Tac Airport will have direct impacts on transportation and land use decisions being made by local governments in the region -- most notably King County and the local jurisdictions of SeaTac, Normandy Park, Federal Way, Des Moines, Tukwila, and Burien. The plan has been designed to allow these entities to receive frequent, up-to-date communications regarding the Master Plan, as well as opportunities for them to express their opinions throughout the process before reports are issued or decisions are made.

There are three subdivisions within this broader audience: elected officials, staff, and the residents themselves. It is important to understand the differences between them. Many of the elected officials won office on an anti-runway platform. They are unlikely to back off this stance, even in light of solid technical analysis and no other regional alternatives. It is important to work proactively with these individuals to keep them informed about the Master Plan. More importantly, however, it may be desirable for Port Commissioners to interact with this audience as "electeds talking to electeds."

The planning staff within each local community is absolutely crucial to the Master Plan process. It is at this operational level that most positive interactive dialogue can take place. Bi-monthly meetings have been scheduled with these individuals in order to provide this opportunity.

Finally, there are the residents themselves. While many may be opposed to the third runway, there are a substantial number who have not become directly involved in commenting on any proposed expansion at the airport. This plan actively reaches out and engages as many local citizens as possible in the Master Plan process.

BUSINESS
The area's business community has a significant interest in Sea-Tac Airport, and has traditionally been a strong ally to the Port. Business leaders are not likely to attend public meetings, but they are responsive to presentations at organized groups (e.g. Rotary, Chamber) and may also take the time to respond with a phone call or in writing. Specific strategies have been delineated in this plan to allow for such feedback. Businesses that rely on excellent air service such as Boeing, Microsoft, the biotech industry, and agribusiness, will also be given direct opportunities to participate in the process.

STATE LEGISLATORS
While changes from this legislative session will have been enacted and/or defeated early in the Master Plan process, it is important that key legislators continue to be kept briefed about that process and about the results of the public involvement effort. These briefings will further serve the Port by providing Master Plan details prior to the 1995 and 1996 sessions.

ANTI-AIRPORT GROUPS
It may seem that no progress can be made with people so bitterly opposed to the flow of travel at Sea-Tac Airport, but it is important to engage these groups as honestly as possible, and with the best, most timely information the Port can provide. Obviously, these groups will be demanding this information, but the Port will set the agenda by providing personal presentations and continually offering a hand for these groups to share in the process.

LABOR
Organized labor groups in the region will want to be kept informed about possible expansion, since it directly relates to both job creation and retention. Labor leaders will be briefed throughout the process and presentations will also be made to organized groups.

MEDIA
This is a regional issue and reporters from all over the state will be interested in the Master Plan process. While the print media can cover complicated air transportation issues in depth, electronic media has a historical weakness in this area. Non-traditional media, such as talk shows and public affairs programs, will be approached with the intent to provide more in-depth electronic media coverage to reach out to a much broader regional audience. The Plan has been structured to strive for in-depth, intelligent discussion of the issues. Efforts will be made to educate key reporters, columnists, and editors.

ENVIRONMENTAL GROUPS
The Washington Environmental Council was involved in the Flight Plan Process, and will undoubtedly be close observers of the Master Plan and PSRC process. They may begin to express concerns and/or support about the variety of options being considered. They will be kept in the loop and up-to-date regarding the Master Plan.

AIRLINES AND OTHER TENANTS
These are your customers, and they need to be in the loop on the process. The public involvement plan has been designed to actively ask for their opinions, specifically in the areas that will be of most concern to them.

AIRLINE TRAVELERS
Those who use the airport frequently will undoubtedly be interested in any proposed plans for terminal and parking improvements. Efforts have been made in this plan to present options to travelers and solicit their opinions on those options.

FEDERAL AVIATION ADMINISTRATION
Clearly, communication will be ongoing with this agency because they are the lead on the EIS. Timely communications and coordinating sessions with key staff will help to keep the two processes aligned.

PUGET SOUND REGIONAL COUNCIL
The PSRC is leading the search for a supplemental airport within the region. It will be important to continue to keep staff and key members informed about the progress of the Master Plan. Port staff will undoubtedly be briefing these individuals on the Plan; written materials produced for the project can also be used to provide the PSRC with regular, up-to-date information.

KING COUNTY RESIDENTS
Port Commissioners are ultimately responsible to the voters of King County, and it is important that this very broad set of voices be heard throughout the process. It will be difficult to get large numbers of the general populace to attend public meetings per se, but the plan has been designed to allow individuals to comment through a wide variety of mechanisms. Every effort will be made to provide easy opportunities for a diversity of opinions to be heard throughout the Master Plan process.

COORDINATION WITH THE PSRC PROCESS

PSRC AIRPORT SEARCH

At this point the public involvement strategy for the PSRC process remains undefined, but coordination can occur with this effort as well. The primary points of this coordination will occur between Port and PSRC staff. If appropriate, the Port will provide Master Plan information at any general PSRC workshops, and likewise, PSRC staff may be invited to present updates at Master Plan workshops. When appropriate, the Master Plan newsletter will also provide an update on the PSRC process, with key contacts for more information.

PUBLIC INVOLVEMENT STRATEGIES

♦ 1994-1995 Region-Wide Strategies

STRATEGY: ***Frequent updates of the Forum newsletter.***

The "Sea-Tac Forum" will be expanded as needed to include information on the Master Plan. It will be important to allow for 2-4 pages of information each time, in order to fully inform readers about the process, results, and opportunities for involvement. Master Plan information will be highlighted with its own masthead, which will remain constant throughout the project. The "Sea-Tac Forum" will issue a special edition dedicated to the Master Plan on a quarterly basis.

Each special edition will include a form readers can use to provide written comments back to the Port.

RATIONALE
A short, to-the-point printed piece allows a broad audience to stay current on the progress of the project. At the same time, it provides frequent opportunities for comment from those who might not otherwise attend meetings and/or be involved in the process.

ROLES AND RESPONSIBILITIES
- O'Neill & Company staff will write initial drafts of the newsletter as appropriate. These will be provided to Forum writers for review, approval, and inclusion in the newsletter.

- Port staff will provide all oversight for printing and distribution of the newsletter.

TIMEFRAME
The first update will be issued in April 1994 and as needed thereafter for the life of the project.

STRATEGY: ***Master Plan Hotline***

RATIONALE

A hotline will be established that will enable callers to answer key questions about, and express their opinions on, the Master Plan Update. A hotline will be one means of making this easy for a broad range of people to do.

It is important to note that the hotline will be designed to elicit responses to a *direct question* rather than generally to the Plan. Actual questions from the Port of Seattle will be asked via voice mail and gathered through this system. For example, when the traffic analysis has been completed and there are options on the table, we will use the newsletter to describe the options, ask a question about those options, and give people the opportunity to respond via the hotline.

ROLES AND RESPONSIBILITIES

- O'Neill & Company will set up a 1-800 number through a local phone system. Callers will be able to leave messages on the line, which will be monitored daily.

- O'Neill & Company will advertise the number in all printed pieces and mention it at all public gatherings.

- O'Neill & Company staff will monitor the calls on a daily basis, and respond immediately to easy questions. More complicated issues will be referred to Port staff the same day.

- It may be possible to devote one of the Port's existing lines to the Master Plan. This would dramatically reduce the budget.

TIMEFRAME

The planning hotline will be instituted in April 1994 and will be active for the life of the project.

STRATEGY: ***"E-Mail" Feedback***

RATIONALE

A computer e-mail system will be established to allow another opportunity for feedback. With home and office computer use rapidly expanding, interactive computer technology offers the opportunity for those who would not normally attend public meetings to express their opinions.

As described on the previous page, E-Mail respondents will be encouraged to share their opinions related to a specific component or question regarding the Master Plan Update.

ROLES AND RESPONSIBILITIES

- A line will be set up at O'Neill & Company. It will be monitored regularly, with responses recorded and forwarded to the Port.
- O'Neill & Company will advertise this option in all printed pieces and will include the information on the same display board as the planning hotline number.

TIMEFRAME

The E-mail system will be established in April 1994 and in place for the duration of the project.

STRATEGY: ***Presentations to Organized Groups***

RATIONALE

Presentations on the Master Plan will be made to a wide variety of organized groups throughout the region. We have found that most people won't come to a public meeting unless it is about an issue that directly affects them. So, to bring more people into the process, we will develop interactive presentations designed for a wide range of business, civic, labor, airline, environmental, and community groups.

ROLES AND RESPONSIBILITIES

- O'Neill & Company will develop the presentations with overhead or slide graphics, perhaps video, with approval from the Port.

- O'Neill & Company staff will develop a "hit-list" of key groups to choose from, consult with Port staff, and develop a schedule for those groups.

- Key Port staff will deliver the presentations.

- All presentations will be recorded on an evaluation sheet that details the group, key questions and comments, and any necessary follow-up. The presentation will then be recorded on a matrix that will provide a historical record of interaction with these key groups.

TIMEFRAME

Presentations will begin in May 1994 and continue throughout the life of the project.

STRATEGY: ***Bi-Monthly Work Sessions with Local Governments and Appropriate Resource Agencies***

RATIONALE

The Port will hold bi-monthly meetings with key staff in both the surrounding city governments and key county/state resource agencies. Any decisions made in the Master Plan will obviously have substantial impact on the land use and transportation decisions being made by King County and the cities adjacent to the airport. While airport staff are already conducting regular meetings with local government planning staff, it is important that these meetings be expanded and organized to create an ongoing dialogue with these governments on every phase of the Master Plan Update. No other single activity is as important as this one.

City staff have said in the preliminary interviews that they very much resent being handed large, complicated documents and then given only a very short time to review them. One of the most effective outreach strategies the Port could employ would be to establish a schedule in advance with the planners, and make component studies of the Master Plan available for review *prior* to their assembly into a final document.

This will serve two important functions. First, it will provide the Port and consultant staff with early warning of significant areas of dispute in the technical work. Secondly, it will provide an organized, substantive mechanism for local government interaction throughout the planning process.

When/where appropriate, state resource agencies such as fisheries, DOE, and PSAPCA, should be invited to participate.

The schedule/outline of documents that could be made available for the public might consist of the following:

- Forecasting
- Traffic
- Airside requirements/options
- Landside requirements/options
- Role of demand management
- Picture of full range of options

A schedule for document review and discussion will be printed in advance and distributed to the city planners. They will also be given advance copies of the "Sea-Tac University" brochure to understand the nature and number of community meetings that will be held throughout the process.

Roles and Responsibilities

- Port and/or consultant staff will transmit the studies, make presentations, and conduct discussion sessions with local city staff.

Timeframe

Presentations will be scheduled on a bi-monthly basis throughout 1994-1995.

STRATEGY: ***Ongoing Briefings to Washington State Legislators***

RATIONALE

While there are many members of the state legislature who fully support the Port of Seattle and expansion at Sea-Tac, there are others with constituencies demanding changes. These state legislators hear from their voters regarding noise insulation, opposition to the third runway, traffic congestion, and a range of other issues. In light of this interest, it is important to keep these officials informed about the Master Plan itself as well as the results from the ongoing public involvement effort. They need to be in a good position to understand the planning process in order to be able respond to constituent concerns.

ROLES AND RESPONSIBILITIES

- Port lobbyists will handle individual briefings. When appropriate, O'Neill & Company can support the effort with brief fact sheets and/or other informational materials.

TIMEFRAME

Briefings will occur throughout the life of the project.

STRATEGY: ***Ongoing Media Outreach***

RATIONALE

There has been substantial print coverage regarding the third runway process. The Master Plan will be new for the media, and we recommend a different approach. Non-traditional media, though less predictable, tends to be more thorough in its coverage of an issue. This issue is one of the most important decisions facing this region - more important than any public project in the last decade - and it deserves substantial, thorough airing and coverage. Normal media outreach will still be maintained, special efforts will also be made to air the Master Plan on KCTS or other appropriate channels/programs.

ROLES AND RESPONSIBILITIES

- Port media staff will take the lead in determining where and how stories should be pitched, and will handle all media outreach.

TIMEFRAME

Throughout the life of the project. The level of activity will vary according to need and interest.

STRATEGY: ***Fact Sheets***

RATIONALE
In addition to the newsletter, quick, easy-to-read fact sheets on key components of the Master Plan will be an important information tool to use throughout the process. These will be used at public meetings and workshops, as well as in virtually every presentation and/or briefing. Fact sheets should be developed on the forecast, airside options, terminal design, traffic analysis, multi-modal options, and demand management.

ROLES AND RESPONSIBILITIES
- O'Neill & Company will draft the fact sheets and submit them to Port staff for review and approval.

- O'Neill will oversee design, printing, and distribution.

TIMEFRAME
Fact sheets will be developed as Plan components are completed.

STRATEGY: ***Broadcasts on Community Cable Access Channels***

RATIONALE
The City of Des Moines is just establishing regular broadcasts on a community access channel. King County is developing a wide-ranging cable access network, as is the City of Seattle. While at one time these channels were relegated to character-generated weather reports, they are now gaining popularity as a way to stay in touch and involved in government affairs.

Sea-Tac University meetings may be broadcast on the following channels:

In Seattle:

Public Access:	Viacom and TCI are involved.
Government Access:	TCI Cable does all scheduling.
Educational Access:	Cable Learn -- through the UW.

In Bellevue:

Educational Channel:	Run through BCC. Primarily educational courses, but interested in the Port of Seattle Master Plan.

In Tacoma:

Government Access:	Tacoma Municipal Television
Viacom Cable:	This is an option for extended showing of the video.

In Everett:

Government Access:	Everett Municipal Television
Public Access:	Run via Viacom in Seattle.

The hotline/fax/E-mail numbers will be flashed on the screen at the appropriate point to invite viewers to share their opinions on the issues under consideration in the plan.

ROLES AND RESPONSIBILITIES
O'Neill & Company will film the meetings, perform any necessary editing, and distribute the film for broadcast.

Port and consultant staff will review broadcasts before they are aired and will participate in the broadcasts through public presentations and/or other forums where appropriate.

TIMEFRAME

Most broadcasts will be made during the Sea-Tac University, between May and December 1994.

STRATEGY: ***Newspaper Ad Campaign / Surveys***

RATIONALE

SeaTac Airport serves the region and the entire state, and there needs to be a way for people from the entire region to comment. In particular, King County residents must have the opportunity to comment on each phase of the plan - whether or not they attend meetings. To do this, a 1/4 page ad will be placed on a weekday in the *Seattle Times/PI.* We will also place the ad in the *Highline Times*.

Ad will say:

> *"In a recent survey, King County residents said they make an average of eleven trips per year to Sea-Tac, and 56% gave Sea-Tac higher performance ratings than most other governments in the region.*
>
> *We want to make certain Sea-Tac performs according to the expectations of its customers. To do that, we've started a new Master Plan process to look at the options for keeping Sea-Tac a great airport in the twenty-first century.*
>
> *Your comments are needed! We'd like you to participate in ongoing public comment on each phase of the Master Plan. If you return the form below, we will send you three packets between now and January 1995. Each packet will contain information on the Master Plan, along with a brief survey you can use to record your reactions to the information presented.*
>
> *We'd like to hear from you! Please return the form today!"*

In addition to the responses received from the newspaper ad, we will ask those who gave us their name/number in the Sea-Tac area survey to participate with us in this ongoing survey.

ROLES AND RESPONSIBILITIES

- O'Neill & Company will draft the ad and submit it to Port/PSRC staff for approval.
- O'Neill & Company will produce the informational fact sheets that will serve as the package for the survey work.
- O'Neill & Company will subcontract with a research firm to compile all results from the surveys.

TIMEFRAME
The ad will be placed in June 1994.

♦ STRATEGY: Sea-Tac University

The "Sea-Tac University" program comprises the public meetings that will take place for the Master Plan Update. They are meetings scheduled around a wide range of issues that will be analyzed and developed for the plan. They will be facilitated sessions, with a "technical leader" assigned for the main presentation of information. Each session will then be opened to questions and comments from the audience. These questions will be facilitated and moderated.

The following document outlines the university program. Specific dates have been given for the meetings. Each topic area has a specified number of meetings, and consultant staff have been assigned where possible and appropriate.
All meetings will be held at Highline Community College. They will begin at 6:30 p.m. and end at 9:00 p.m. In general, the meetings will include a 45-60 minute presentation and a 60 - 90 minute period for questions.

ORIENTATION SESSION: WHAT IS THIS MASTER PLAN PROCESS ALL ABOUT, ANYWAY?

Tuesday, May 17
Technical leader: Ron Ahlfeldt
Facilitator: Margaret Norton-Arnold

Ron will present a broad overview of the Master Plan process. This will include a description of the three areas for airport planning -- landside, airside, and gates. Ron will also discuss the most recent forecasts for anticipated passenger growth, and will provide a context for the planning effort: Here's what we're faced with if we don't build a runway, and here's what we're faced with if we do build a runway. Ron will also talk about airport financing in general, and how any airport expansion might be financed at SeaTac. He will also detail the Master Plan studies, timeframe, and schedule for future decisions.

Questions and Answers: Attendees will be invited to ask questions and provide comments on the plan.

MARKETPLACE REALITIES: DEMAND AND DEMAND MANAGEMENT

Thursday, May 26
Technical Leaders: Ron Ahlfeldt and an airline executive
Facilitator: Margaret Norton-Arnold

Airports have to respond to the market demands of airlines. At the same time, airlines respond with service levels that will best make them profitable. Ron will present an overview of how airlines have managed more passengers with fewer flights over the past two years. He will also outline how airlines will regulate their flights in the future -- be they upward or downward. The airline executive will present, the trends and factors they take into consideration when planning for future flight schedules.
Ron will explain the role demand management will play in the Master Plan process, and will provide an overview of how the analysis of potential demand management will be presented in the plan.The PSRC has requested the Port to fully examine demand management in the Master Plan. This will give participants the chance to better understand the marketplace realities that dictate demand management practices, both positively and negatively, for the Port.

Questions and Answers: A question and answer period will follow the presentation.

AN INSIDER'S VIEW OF THE AIRFIELD: WHAT'S HAPPENING NOW?

Series of two seminars - Wednesday, June 8 and Thursday, June 16
Technical Leader: Ron Ahlfeldt
Facilitator: Margaret Norton-Arnold

This set of two seminars will be designed to present the kinds of analysis that has been performed to determine if a new runway is needed, why it is needed, and how, if it is needed, it will look. Ron Ahlfeldt will discuss the parameters of his analysis for the Port, including the federal requirements for airport operation and design, as well as the pros and cons of all the options that have been considered in the preliminary analysis.

Seminar One. The Options on the Table
Wednesday, June 8
At this meeting Ron will present an overview of what will happen at Sea-Tac if no runway is built. He will also present the runway designs that have been presented as options in the master plan.

Questions and Answers: Participants will be invited to ask Ron questions about his analysis.

Seminar Two. Costs and Quantities
Thursday, June 16
Given the options as they have been presented, how much will they cost? How many truckloads of dirt are we really talking about? What are the costs/benefits of each of the proposed alternatives?

Questions and Answers: Participants will be invited to ask questions.

ON THE ROAD AGAIN: HANDLING TRAFFIC OPTIONS UNDER THE MASTER PLAN

Two Seminars - Wednesday, June 22 and Tuesday, July 12
Panel Discussion
Facilitator: Margaret Norton-Arnold

Seminar One. Analysis, Analysis, and more Analysis
Wednesday, June 22
This meeting will feature a panel of speakers from WSDOT, METRO, the Port, and other appropriate agencies. This will provide an overview of the planning activities, analyses, and resulting recommendations regarding traffic control that have been conducted over the past several years. The Master Plan traffic analysis will also be presented, and will be placed in context of the preceding work.

Questions and Answers: A question and answer session will follow the panel presentation.

Seminar Two. Draft Alternatives
Tuesday, July 12
Facilitator: Margaret Norton-Arnold

Consultant team staff will present their draft alternatives for traffic flow and parking at the airport.

Questions and Answers: A question and answer session will follow the presentation.

TRAINS, AND BOATS, AND PLANES...
A LOOK AT DIFFERENT WAYS OF TRAVELING

Wednesday, September 21
Panel Discussion: Transportation Consultants
Facilitator: Margaret Norton-Arnold

Many people are interested in the potential for a better multi-modal transportation system, ranging from the possibilities of "light rail" throughout the region to "people movers" inside the airport. At this meeting, appropriate consultant staff will review the kinds of options that have been part of the preliminary analysis of the Master Plan. This will include a review of all appropriate transportation modes and potential links throughout the Puget Sound region. Consultant staff will discuss the realities of what appears possible in the Sea-Tac area, including technology, costs, and other factors governing final transportation investment decisions.

Questions and Answers: Questions and answers will follow the presentation.

SO WHAT ABOUT ALL THAT OTHER LAND? A DISCUSSION OF POTENTIAL DEVELOPMENT AROUND THE AIRPORT

Tuesday, October 4

Technical Leader: Karl Myers, Director of Aviation, Business, and Property Mgmt.
Facilitator: Margaret Norton-Arnold

This seminar will address the other parcels of land around Sea-Tac Airport that have the potential to be developed in a number of ways. The meeting will focus on land use, the possibilities for new development, and the decision-making process related to those parcels of land.

A TIME FOR REVIEW: COMMUNITY OPEN HOUSE

Thursday, October 20
Facilitator: Margaret Norton-Arnold
Featured Speaker: Gina-Marie Lindsey, Managing Director

By this time, the community will have been actively engaged with the Port on a variety of issues related to the Master Plan. At this meeting Airport Director Gina-Marie Lindsey will outline the kinds of comments that have been received throughout the process. She will review the steps that have been taken to address community issues, concerns, and perspectives, and will provide an overview of "next steps" in the Master Plan process. This will effectively end the Airport University for 1994.
General questions and answers will follow. The presentation will be supported with a workshop during which participants can look at informational boards and talk informally to Port and consultant staff.

A LOOK AT THE PLAN AS A WHOLE: COMMUNITY WORKSHOPS ON THE MASTER PLAN

Two Workshops
May 1995

Two workshops will be held on the draft plan. The workshops will contain a variety of public kiosk displays, with each display focused on a specific component of the plan. Port and/or consultant staff will be available at each kiosk to explain and answer questions about the draft plan. People will have the opportunity to leave written comments on the draft Master Plan Update at the workshop.

Written Comments. The public will also be invited to submit written comments on the draft plan. The newsletter will summarize the plan, and interested individuals will be invited to request the Executive Summary and/or full plan if they desire. They may submit comments in writing directly to the Port.

Mall Displays. In addition to the scheduled community workshops, a display featuring key findings of the draft Plan will be set up at area shopping malls, including Sea-Tac, Southcenter and Federal Way. The free-standing display will not require staffing, but will be equipped with a postage-paid comment card by which viewers can record their reactions to the elements proposed in the Master Plan.

♦ OUTREACH WITH SPECIALIZED AUDIENCES

Some of the components of the Master Plan do not lend themselves to generalized public debate, but could benefit from the opinions of the groups most affected by decisions in that area. Most notable among these components is the work related to terminal improvements. The Port's customers - the airlines - will want to be able to participate in planning decisions related to the terminals. It will also be important to hear from travelers regarding their needs, opinions, and perspectives on terminal design.

BRIEFINGS WITH KEY AIRLINE STAFF

Port and consultant staff will meet as frequently as appropriate to brief airline staff about any proposed terminal improvements and overall design features. It is anticipated that airline staff will be able to share their perspectives and concerns related to the proposals, engaging directly with Port and consultant staff on key issues.

DISPLAY FOR AIRLINE AND AIRPORT EMPLOYEES

A visual display on a standing kiosk will also be created for airline/airport employees. In a graphically pleasing way, this display will feature preliminary drawings, suggested improvements, general direction of the terminal design, etc. A survey will be provided along with the display asking these employees their opinions about preliminary options. This will provide a significant amount of information from the individuals who actually work in the airport every day.

SURVEYS AND INTERVIEWS WITH PASSENGERS / PASSENGER DISPLAYS-KIOSKS

Every year the Port commissions a survey with passengers. In 1994 and/or 1995, whatever is deemed appropriate by the Port, the survey will include questions related to the Master Plan. Port staff will determine the best questions to ask, and the most appropriate timeframe for doing so. In addition, kiosk displays will be set up in key terminals. They will contain information about the Master Plan and brief response cards passengers can use to register their opinions on the Master Plan.

ROLES AND RESPONSIBILITIES

- O'Neill & Company will organize the displays, and will compile the results of the employee survey.

- Port staff will develop all briefings with airline staff and will determine the most appropriate timeframe and questions for the passenger surveys.

TIMEFRAME

Briefings with the airlines will occur as necessary throughout the project. The kiosk display and passenger survey will occur between September 1994 and February 1995.

Attachment B
to Port Resolution 3245

TECHNICAL REPORT NO. 3
SEA-TAC AIRPORT PLANNING HISTORY AND STUDY RELATIONSHIPS

AIRPORT MASTER PLAN UPDATE

FOR

SEATTLE-TACOMA INTERNATIONAL AIRPORT

P&D Aviation

TECHNICAL REPORT NO. 3
SEA-TAC AIRPORT
PLANNING HISTORY AND
STUDY RELATIONSHIPS

AIRPORT MASTER PLAN UPDATE
FOR
SEATTLE - TACOMA INTERNATIONAL AIRPORT

Prepared by:

The Port of Seattle
SEATTLE - TACOMA INTERNATIONAL AIRPORT

May 5, 1994

The P&D Aviation Team

P&D Aviation • Barnard Dunkelberg & Company • Berk & Associates
Mestre Greve Associates • Murase Associates • O'Neill & Company
Parsons Brinckerhoff • Thompson Consultants International

TECHNICAL REPORT NO. 3
SEA-TAC AIRPORT PLANNING HISTORY
AND STUDY RELATIONSHIPS

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INTRODUCTION

BACKGROUND

The genesis of the Seattle-Tacoma International Airport (Sea-Tac) Master Plan Update was the "Comprehensive Planning Review" conducted in 1988. This ten month program evaluated the 1985 Airport Master Plan as well as several other related planning studies. The conclusions of this analysis, as well as the results of the Puget Sound Regional Council's 1988 Regional Airport System Plan, led the Port of Seattle Commissioners to formally acknowledge that Sea-Tac would reach runway saturation near the turn of the century. In response to this challenge, the Commissioners, and the Puget Sound Council of Governments (now Puget Sound Regional Council), entered into a three-year planning effort known as the "Flight Plan" project.

The purpose of Flight Plan was to develop a regional airport system, that would meet the aeronautical needs of the region to the year 2020 and beyond. In the third phase of Flight Plan, alternative airport systems were evaluated. In the end, the 39-member Puget Sound Regional Air Transportation Committee (PSATC) chose as its preferred alternative the construction of a new runway at Sea-Tac and development of two reliever satellite airports. This ultimately led to the adoption by the Port of Resolution No. 3125, which directed that a new runway for Sea-Tac be examined in detail. Subsequently, a planning team led by P&D Aviation was selected for an Airport Master Plan Update and began work on December 3, 1993.

PROJECT OBJECTIVES

The overall objective of this project is to "prepare a comprehensive Airport Master Plan [Update] for the airside, terminal, and landside facilities needed at Sea-Tac to meet air travel demand to the year 2020 and beyond." Specifically, the master plan update study must fulfill each of the relevant objectives stated in Port Resolution 3125. These are as follows:

- Design a mechanism and process to promote [land use and community] compatibility through improved coordination, communication and involvement.
- In addition to the third runway studies, include a reconsideration of a fast rail system together with diversion of all cargo carriers.
- Fully explore the impacts of peak period pricing and other demand management techniques.
- Explore land acquisition and redevelopment to compatible uses.
- Attenuate airport noise through the use of berms and barriers.
- Promote aggressive on-airport emission reductions.
- Promote regional transit and reduction in use of automobiles.
- Improve the aesthetic appearance of the airport boundary.
- Develop a comprehensive stormwater management plan.

SCOPE OF STUDY

The first assignment of the Airport Master Plan Update study was the development of a detailed scope of work designed to fulfill the project objectives. The final scope of work, prepared on December 2, 1993, contains forty-five work tasks (Table 1-1). The detailed scope of work is contained in Technical Report No. 1, Scope of Work.

The primary issues addressed in the scope of work include:

- ***Forecasts.*** The master plan update and related Environmental Impact Statement and FAA Part 150 Study must be based on a reliable and generally accepted set of forecasts.

- ***Airside Evaluations.*** An important component of the study is the analysis of a new dependent parallel (minimum runway separation of 2,500 feet) runway. The Airspace Update Study and the FAA Airport Capacity Enhancement Task Force both determined that a substantial capacity improvement can be achieved by constructing a new parallel dependent runway.

- ***Terminal Evaluations.*** A key issue in the terminal development is to achieve a balance between added terminal capacity and additions to airside and landside capacity. Curb frontage, roadway and automobile parking are critical components.

- ***Multi-Modal Evaluations.*** There is considerable interest at the Federal, State and local levels of government to development inter-modal transportation systems that are economically efficient and improve air quality and reduce airport congestion.

- ***Financial Planning.*** A comprehensive financial plan and implementation strategy must be developed to maximize the Port's ability to fund needed capital improvement projects.

- ***Part 150 Issues.*** The Noise Mediation Agreement resulted in substantial noise reduction programs, now being implemented. This agreement plays a vital role in existing and future planning efforts at the airport and has been incorporated into the recently completed FAR Part 150 Study 1993 Amendments. However, those amendments did not consider the implementation of a third runway, and thus the Noise Exposure Maps that were generated in the study will require updating to consider the third runway option.

- ***Process.*** Public involvement in the planning process is an important element of the Airport Master Plan Update. The public involvement program developed for the study will allow for better understanding of the sentiments in the surrounding communities and constructively involve the public in focused workshops for the project. Elements of the public involvement program include workshops, public opinion surveys, and dissemination of project information through newsletters and technical reports prepared during the study.

STUDY SCHEDULE AND DOCUMENTATION

The Airport Master Plan Update is scheduled to be completed in December 1995. During 1994, forecasts will be prepared, facility requirements will be developed and individual options for accommodating projected needs will be evaluated. In 1995, option "packages" will be developed and evaluated and concurrently an Environmental Impact Statement will be prepared.

The following documents are scheduled to be delivered to the Port during the course of the project:

- Technical Report No. 1, Final Work Scope
- Project Brochure
- Technical Report No. 2, Public Involvement Program Development Report
- Technical Report No. 3, Planning History and Study Relationships
- Technical Report No. 4, Facilities Inventory
- Technical Report No. 5A, Preliminary Forecast Report
- Technical Report No. 5B, Final Forecast Report
- Technical Report No. 6A, Preliminary Airside Report
- Technical Report No. 6B, Demand, Capacity Requirements
- Technical Report No. 7, Options Evaluation Report
- Demand Management Report
- Technical Report No. 8, "Package" Evaluations Report
- Technical Report No. 9, Draft of Master Plan Update Final Report
- Airport Layout Plan Set
- Final Report

PLANNING TEAM COMPOSITION

The Master Planning Team led by P&D Aviation consists of eight firms which are listed below with their key responsibilities:

- ***P&D Aviation*** - Project Management, Forecasts and Facility Requirements, Airside Planning, Ground Access Planning, Overall Airport Master Planning and Coordination
- ***O'Neill & Company*** - Public Involvement
- ***Parsons Brinckerhoff*** - Multi-Modal Transportation Evaluations
- ***Thompson Consultants International*** - Terminal Planning
- ***Barnard Dunkelberg & Company*** - Part 150 Integration
- ***Berk & Associates*** - Financial Planning
- ***Murase Associates*** - Airport Beautification, Landscape Architecture
- ***Mestre Greve Associates*** - Aircraft Noise Impacts

CONTENTS OF THIS REPORT

Section 2 of this report contains summaries of recent planning studies related to Sea-Tac Airport and the surrounding communities. An understanding of the findings and recommendations of these past studies and how each relates to the development of future plans for Sea-Tac is important for the preparation of the Airport Master Plan Update.

SECTION 2
PLANNING HISTORY AND STUDY RELATIONSHIPS

SECTION 2
PLANNING HISTORY AND STUDY RELATIONSHIP

PURPOSE

Technical Report No. 3, *Sea-Tac Airport Planning History and Study Relationships*, summarizes recent Port of Seattle plans and studies related to the Seattle-Tacoma International Airport Master Plan Update. It also discusses related local, regional, and state transportation and land use plans. The purpose of Report No. 3 is to document studies which will serve as inputs to the Master Plan Update and to define the planning and community context in which the airport operates.

The Airport Master Plan Update will combine existing airport plans with new planning work to create a comprehensive picture of the future of Sea-Tac Airport. It will provide the Port with a framework for developing Sea-Tac to the year 2020 and will facilitate continued land use compatibility planning efforts of airport communities and the airport.

BACKGROUND OF AIRPORT DEVELOPMENTS

Seattle-Tacoma International Airport (Sea-Tac) is the primary air transportation hub of Washington State and the Northwest United States. Located 12 miles south of downtown Seattle, Sea-Tac is the only airport with scheduled airline service in the Central Puget Sound Region (King, Pierce, Snohomish, and Kitsap Counties). Figure 1 shows the airport location.

In 1942, the Port of Seattle Commission voted to assume responsibility for a new major airport to serve the residents of the Central Puget Sound Region. The Port acquired nine-hundred and six acres and in 1943 officially broke ground for what was then called the Bow Lake Airport. Limited operations began in 1944 and by 1948, Northwest Orient Airlines and Western Airlines offered regular commercial service. On opening day, the airport had four runways. The main runway was oriented north/south and cross-wind runways were oriented east/west, southeast/northwest, and southwest/northeast. The original passenger terminal was completed in 1949.

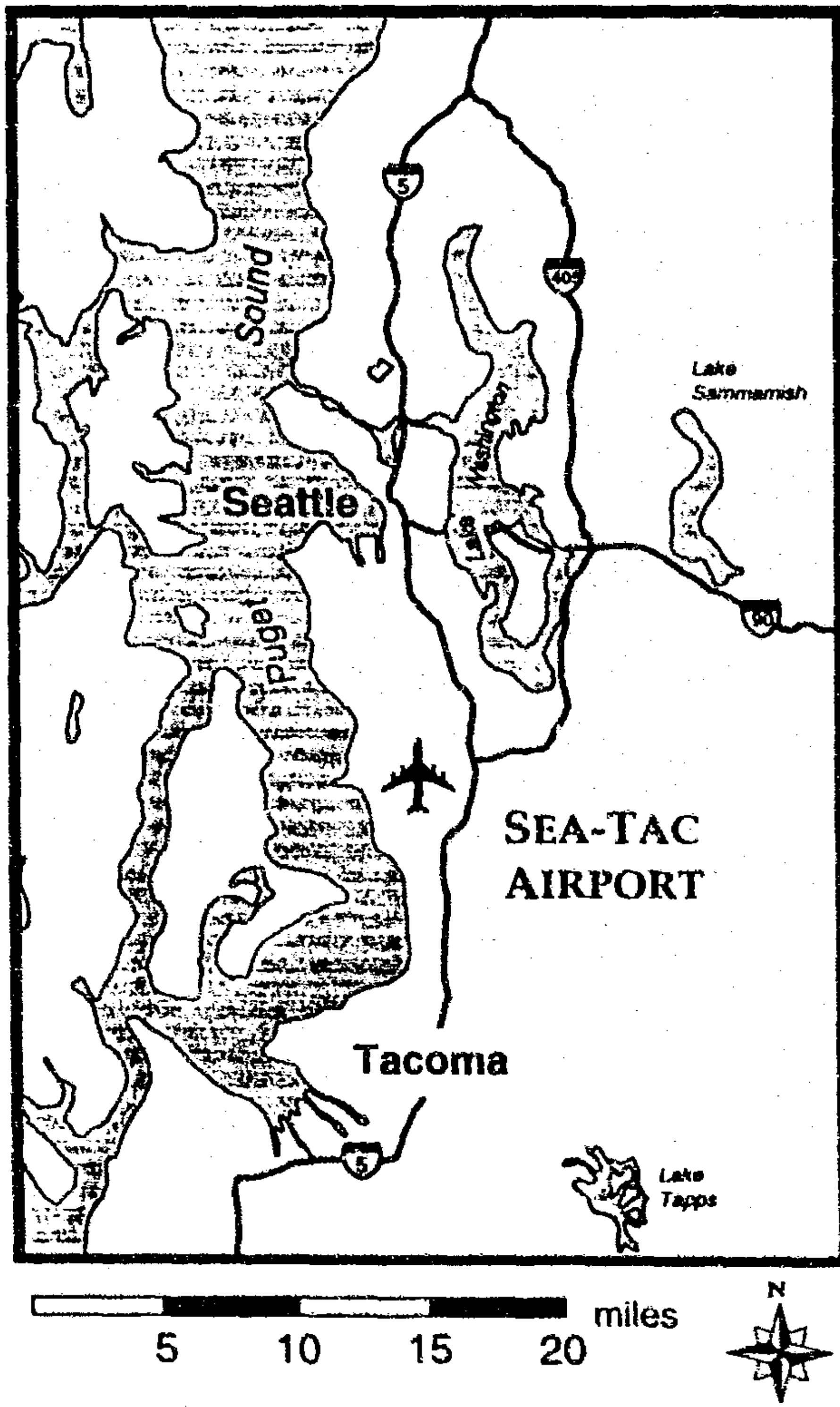
Over time, numerous improvements were made to Sea-Tac Airport and the facility grew to more than 2,500 acres. Improvements included lengthening of the main runway and construction of a second north-south parallel runway, new taxiways, and additional navigation aids. Cargo, maintenance, and fire facilities were also built. A chronology of airport developments is included in Appendix A. A brief discussion of airport developments follows.

Between 1959 and 1970, extensive additions and improvements were made to the passenger terminal. Included were four new concourses and improvements to the lobby, restaurant, shops, and cocktail lounge.

From 1967 to 1973, Sea-Tac underwent a major enhancement. Additions included the second parallel runway, north and south satellite terminals, a passenger subway to link the satellites to the main terminal, the north airport access freeway, and an eight-story parking garage. During this time, the airport terminal drives were separated into upper and lower levels for departing and arriving passengers.

In 1976, the Port of Seattle and King County adopted the Sea-Tac Communities Plan to guide

FIGURE 1
Sea-Tac Airport Location



development of the airport and the surrounding neighborhoods. Several community and airport compatibility studies have been completed since then.

Following federal deregulation of the airlines in 1978, the number of airlines using Sea-Tac doubled. This lead to increased demand for ticketing counters, baggage claim space, and aircraft gates. International flights also increased and the Federal Inspection Services (customs) facilities in the South Satellite were upgraded in 1983.

In 1992, the airport "First Class Upgrade" was completed. Included were major passenger concourse renovations which added six new aircraft gates, expansion of the parking garage from 4,500 to 8,000 spaces, new short-term metered parking, and a pick-up/drop-off plaza in the garage.

AIRPORT MASTER PLAN UPDATE PROGRAM

The last Master Plan Update for Seattle-Tacoma International Airport was finished in September 1985. In the following years, Sea-Tac experienced greater-than-anticipated growth in aircraft operations. The Master Plan forecasted 295,500 aircraft operations for the year 2005. This level was reached by 1988, and in 1993, Sea-Tac served 339,000 operations. Recent studies indicate continued strong increases in air travel at Sea-Tac over the next thirty years and have identified an existing bad weather capacity shortfall for the airfield. In response, the Port of Seattle has participated in regional airport planning efforts and conducted specific planning for many areas of the airport including the passenger terminal, airfield, cargo facilities, ground access system, and other support facilities.

The purpose of the Airport Master Plan Update Program is to update existing plans and to conduct new planning for key areas of the airport. Plans will be assembled into a comprehensive picture of the range of facilities needed to keep Sea-Tac Airport operating efficiently to the year 2020. A main goal of the Master Plan Update is to balance the airside, landside, and ground access facilities and to ensure a logical overall development of the airport. A primary component of the work is to identify and evaluate options for adding a new runway. In addition, the study will examine improvements that would be needed whether a new runway is built or not.

Two additional studies are being prepared as part of the Master Plan Update Program. These are: 1) Preliminary Engineering for a New Dependent Runway, and 2) an Environmental Impact Statement (EIS) on the Master Plan.

The Preliminary Engineering Study is being conducted by the Port of Seattle to develop baseline concepts for a new runway at Sea-Tac Airport. HNTB Corporation is the lead consultant. The Study will provide background technical data for the development of airfield options in the Airport Master Plan Update. It will also provide the necessary background information needed to analyze the impacts of a new runway in the EIS. Included will be development of conceptual airfield layouts, assessment of general on and off-site construction impacts, identification of fill material quantities and potential sources, identification of property acquisition requirements, and preparation of a conceptual construction schedule and order-of-magnitude cost estimates. The study will be completed in 1994. More-detailed engineering studies will be needed before a runway could be built.

The Federal Aviation Administration (FAA) has the lead in preparing the Environmental Impact Statement (EIS) for the Airport Master Plan

Update. The Port of Seattle will administer the consultant contract and provide day-to-day project management services. A Memorandum of Understanding (MOU) between the two agencies outlines their roles and responsibilities. Landrum and Brown is the lead consultant.

The EIS will evaluate the cumulative range of impacts for the conceptual plans developed in the Airport Master Plan. It will also identify a comprehensive approach for mitigating those impacts. In addition, the EIS will evaluate in detail the specific impacts and potential mitigation measures for a new runway. The Final EIS is scheduled to be available at the end of 1995 prior to the adoption of a final Airport Master Plan.

PLANS AND PROJECTS RELATED TO THE AIRPORT MASTER PLAN UPDATE

Recent plans prepared for Sea-Tac Airport will form the foundation for the Airport Master Plan Update. Following is a discussion of major planning efforts by the Port of Seattle and others to be considered in the Update. They are organized by the following categories: 1) Airfield and Airspace; 2) Terminal, Cargo, and Maintenance Facilities; 3) Ground Access and Land Use; and 4) Noise and Other Environment. Studies are presented chronologically within each category. Local, regional, and state plans are discussed in a later section. Earlier Planning Studies are listed in Appendix B.

Airfield and Airspace

Airport Master Plan Update, 1985
Port of Seattle (Peat Marwick and TRA), September, 1985

The underlying premise of the 1985 Sea-Tac Airport Master Plan Update was that "the primary role of the Airport is to serve the traveling public and to promote trade by accommodating the air transportation needs of the region." The Update was prepared to guide development of the airport over a twenty-year planning horizon based on a forecast of 21 million annual passengers and 295,000 aircraft operations by the year 2003. A key assumption of the plan was that the existing two runways would be able to accommodate this demand and that new runways would not be needed during the 20-year planning horizon.

The Update focused on accommodating passenger terminal and air cargo facility needs. It included recommendations to extend Concourse A and the North and South Satellites to provide for up to 94 total aircraft gate positions. These extensions would require relocation of the aircraft line maintenance hangars south of the terminal complex. The plan identified the west side of the airfield and the existing northeast cargo area as potential locations for future cargo and maintenance facilities. To improve passenger circulation, the plan recommended widening both concourses B and C. Further recommendations included adding lanes to the upper and lower automobile access drives, adding north and south wings to the parking garage, and constructing a shuttle bus plaza on the third floor of the garage.

Comprehensive Planning Review and Airspace Update Study
Port of Seattle (P&D Technologies), December, 1988

The purpose of the Planning Review Study was to assess the validity of previous plans developed for Sea-Tac in light of air travel growth levels not previously anticipated and other changing conditions at the airport. The results of the assessments were used to develop a strategy for preparing a comprehensive plan for the airport. The Airspace Update Study was prepared at the same time and provided technical data on airside capacity and demand forecasts for use in the Comprehensive Planning Review.

The Planning Review concluded that Sea-Tac plans were adequate for current and near-future requirements, except in the area of airfield capacity. Previous plans, including the 1985 Master Plan Update, had not indicated a need for new runway capacity. The Planning Review, however, identified that passenger and aircraft operations growth had exceeded previous forecasts and that the existing runways would not be adequate to meet demand past the year 2000.

In addition to increasing airfield capacity, the Planning Review recommended expansion of the passenger terminal and implementation of the 1987 Landside Access Program to improve automobile access to the airport. Continued study of a south access roadway to the airport was also identified as a high priority. In a departure from the 1985 Master Plan Update, the Planning Review recommended that airline hangars and other facilities that would be impacted by passenger terminal expansion be moved to a new development south of the airport rather than to the west side of the airfield. To deal with increasing community concerns with aircraft noise, The Planning Review also recommended that the Port of Seattle proceed with a mediation process for managing aircraft noise at Sea-Tac.

Air Space Study (Four-Post Plan): Seattle Arrival and Departure Routes; Simulation, Analysis, and Recommendations
Federal Aviation Administration, Seattle-Tacoma Tower, 1989

The objective of the study was to identify ways to reduce aircraft delays at Sea-Tac Airport caused by airspace constraints (constraints other than the actual capacity of the airfield). The problem was that in periods of high demand, as weather conditions improved, the high-altitude route structure and holding airspace was configured in such a way that the Seattle Air Route Traffic Control Center (ARTCC) could not increase the aircraft arrival rate in a timely and efficient fashion. It could take up to thirty minutes for the ARTCC to substantially increase the metered arrival rate, resulting in up to 20 lost arrival opportunities. The study examined the efficiency and safety of thirteen alternative airspace and arrival/ departure procedure plans. The recommended plan involved routing arriving aircraft over one of four fixed points (generally southeast, southwest, northwest, and northeast). This solution, commonly called the Four-Post Plan, provided symmetrical arrival capacity (56 - 60 landings) regardless of the direction of landing and allowed for the filling of every arrival opportunity or slot with an aircraft. The Four-Post Plan was put into operation in April, 1990.

Airport Capacity Enhancement Plan
Federal Aviation Administration and Port of Seattle, June, 1991

The Capacity Enhancement Plan was a technical evaluation of options for improving airfield capacity and reducing operational delay at Sea-Tac Airport. Options examined included improved taxiways, additional or upgraded navigation aids, a new commuter runway, a new dependent runway, a new independent runway, and demand management. The hourly and annual capacity constraints of the existing airfield and the aircraft delay savings from implementing each of the options were also studied. Capacity with a delay of four minutes per aircraft was identified as 61 arrivals per hour.

Total aircraft delay was analyzed for a baseline of 320,000 aircraft operations per year and for future operations of 390,000 and 425,000 per year. The Airfield Delay Simulation Model (ADSIM) and Runway Delay Simulation Model (RDSIM) were used in the analysis.

The Plan identified an existing bad weather arrival capacity problem at Sea-Tac. Weather conditions over the course of a typical year were identified as follows:

VFR 1 (56% of the time): Ceiling at least 5,000 feet and visibility at least 5 miles
VFR 2 (19% of the time): Ceiling between 2,500 - 4,999 feet and visibility more than 3 miles
IFR 1 (18% of the time): Ceiling between 650 and 2,499 feet and visibility more than 1,800 feet runway visual range (RVR)
IFR 2 (5% of the time): Ceiling below 650 feet and visibility more than 1,200 feet runway visual range (RVR)
IFR 3 (2% of the time): Ceiling zero, visibility less than 1,200 feet runway visual range (RVR)

In VFR 1 (good weather), the airport is able to handle two arrival streams of traffic. However, in bad weather, only one arrival stream is possible because of the close spacing of the runways. The result is a significant reduction in airfield capacity.

The Plan found that in 1989, 48,000 hours of aircraft delay at a cost of about $69 million (1989 dollars) to the airlines were incurred at Sea-Tac. With no capacity improvements, delay was projected to rise to 241,000 hours at a cost of $347 million when annual aircraft operations reach 425,000.

The Plan concluded that a new parallel runway capable of accommodating jet aircraft would provide the greatest amount of delay savings.

The Federal Aviation Administration (FAA) is currently preparing an update to the Sea-Tac Capacity Enhancement Plan. FAA will use the Terminal Airspace Model (SIMMOD) to study capacity and delay of a range of airfield and airspace improvements including reassessment of the findings of the 1991 Enhancement Plan. The Update is scheduled to be completed by fall of 1994 and will provide useful detailed information for evaluating airfield options developed in the Airport Master Plan Update.

Flight Plan Project (Puget Sound Air Transportation Committee)
Port of Seattle and Puget Sound Regional Council (P&D Technologies, Apogee Research, and Peat Marwick), October, 1992

Both the Sea-Tac Airport Comprehensive Planning Review and the Puget Sound Council of Governments (PSCOG) 1988 Regional Airport System Plan (RASP) identified that the existing two Sea-Tac runways would not be adequate to meet regional air travel needs beyond the year 2000. As a result, the Port of Seattle and the PSCOG (now Puget Sound Regional Council, PSRC) signed an interlocal agreement in 1989 to conduct a planning study to recommend a long-term air travel system for the region. The two agencies assembled a steering committee of citizens, elected officials, business people, airline representatives, and environmentalists known as the "Puget Sound Air Transportation Committee" (PSATC). The PSATC's study was called the Flight Plan Project.

Forecasts developed for Flight Plan showed that commercial air travel demand in the Puget Sound Region could reach 45 million annual passengers and 524,000 annual aircraft operations by the year 2020. A range of options including Sea-Tac expansion, supplemental airports, a replacement airport, high-speed rail, demand management, and new aircraft and navigation technologies were analyzed. Sites throughout the Puget Sound Region were examined. Major elements of the analysis were capacity and delay, airspace, airport accessibility, environmental impacts, economic impacts, cost and funding, and institutional issues. Draft and final environmental impact statements were prepared.

The PSATC chose a multiple airport system with a new runway at Sea-Tac Airport as its preferred alternative. The PSATC recommended two supplemental airports: Paine Field in Snohomish County, and another airport to be located somewhere in Pierce County (possibly joint-use of McChord Air Force Base). The recommendation was developed to balance the region's air travel needs with environmental and economic concerns. It was designed to maximize accessibility of airports to travelers given the linear nature of the Puget Sound Region, to minimize noise and air emissions, and to be consistent with regional land use plans.

Based on Flight Plan, the Port of Seattle Commission passed a resolution (No. 3125) in November, 1992 that directed the Port staff to study a new runway in detail and to prepare a project-level environmental impact statement (EIS) in cooperation with the Federal Aviation Administration (FAA). The resolution also called for an increase in the number of homes insulated each month under the Port's Noise Remedy Program and for an extension of the Program to include apartments, schools, churches, and other institutional buildings.

Also based on Flight Plan, the Puget Sound Regional Council (PSRC) adopted a resolution (No. A-93-03) in April, 1993 which called for a feasibility assessment of a major supplemental airport to accommodate commercial airline service. The resolution also called for the Port of Seattle to proceed with detailed plans for a new runway at Sea-Tac. The new runway would be authorized by April 1, 1996 if certain demand management and noise reduction objectives were met.

Microwave Landing System (MLS) Demonstration Program
Federal Aviation Administration, June, 1992

As part of its national test program for the Microwave Landing System (MLS) technology, the Federal Aviation Administration (FAA) is proposing to install an MLS at Sea-Tac Airport and to develop an instrument approach procedure to Runway 16L using the new equipment. The purpose of the MLS is to increase efficiency of airport flight operations for MLS-equipped commuter aircraft landing to the south during some limited poor weather conditions.

The proposed location for the necessary azimuth (compass heading), altitude, and precision distance measuring equipment is north of the airport employee parking lot near International Boulevard on South 160th Street. This is approximately 4,500 feet east of the Runway 16L centerline and 700 feet south of that runway's threshold.

The new equipment would allow for simultaneous ILS/MLS approaches to Runways 16R and 16L. The ILS approach to Runway 16R is an existing instrument procedure. The approach path for the Runway 16L MLS would be approximately 4,500 feet east of and parallel to the Runway 16R ILS approach and would include a fly visual side-step maneuver to Runway 16L once the aircraft broke out of the clouds. The proposed MLS procedure would be useable when there is at least 3 statute miles of visibility and the cloud-cover ceiling is at least 3,000 feet above the ground. The relatively steep angle of descent (4.2 degrees) associated with the approach procedure means that it can only be used by smaller aircraft such as the De

Havilland Dash 7s and 8s and Dorniers. The MLS could only be used by aircraft that have the proper signal receiving equipment on-board.

The Sea-Tac MLS is anticipated to be operational sometime during 1994.

Runway Safety Area Expansions

Runway 16R-34L Safety Area Expansion Study, Port of Seattle (HNTB), March, 1992
Runway 16L-34R Safety Area Expansions, Port of Seattle, December, 1992
Runway 34R Safety Area Expansion, Port of Seattle (Reid Middleton), August, 1993

A runway safety area (RSA) is a surface surrounding a runway to reduce the risk of damage to aircraft in the event of an overshoot or undershoot. Federal Aviation Administration (FAA) standards require RSAs at Sea-Tac to be 500 feet wide and 1,000 feet long off the runway ends. The existing RSAs do not meet these standards. The Port of Seattle has prepared several studies on RSA expansions needed to meet the standards.

Runway 34R (the eastern runway) would require a safety area extension of 465 feet on the south end. Approximately 600,000 cubic yards of fill would be needed. Most of the extension area is on the Tyee Valley Golf Course. The toe of the slope of the extended runway safety area could potentially compete with the proposed South Aviation Support Area (SASA) and South Access roadway because of the size of the fill involved. To assure that all projects have adequate space, the Port of Seattle could use sidewall-retained sections where required (as opposed to normally-sloped fill).

The north RSA on Runway 16L was partially expanded in 1993. The RSA is now 500 feet wide and 700 feet long.

The Preliminary Engineering Study for Runway Safety Area Expansion of Runway 16R-34L examined a range of options for meeting the RSA requirements on the north and south ends of that runway. Options included a wide range of RSA expansions and runway threshold relocations. The existing north RSA is 500 feet wide out to 230 feet, 350 feet wide for an additional 320 feet, and 110 feet wide for an additional 95 feet (total length = 645 feet). The south RSA is 500 feet wide out to 775 feet from the runway end. Further engineering of the Runway 34L RSA will be completed in 1994 with construction scheduled for 1995. Extension of the other three RSAs is on hold pending completion of the Airport Master Plan Update.

PSRC Regional Airport System Plan Update and Major Supplemental Airport Feasibility Study

Puget Sound Regional Council (PSRC), April, 1993, 1994 - 1996

In response to the Flight Plan Project conducted jointly by the PSRC and the Port of Seattle, the PSRC General Assembly adopted a Resolution (No. A-93-03) in April 1993 to amend the Regional Airport System Plan (RASP). The Resolution called for a feasibility assessment of a major supplemental airport and for the Port of Seattle to conduct detailed studies for adding a third runway at Sea-Tac Airport. A third runway would be authorized by April 1, 1996 unless it could be shown through financial and market feasibility studies that a supplemental airport would eliminate the need for a new runway. In addition, demand management/system management programs and noise reduction objectives would need to be pursued and achieved before a new runway was authorized. The Resolution also requested that the Federal Aviation Administration consider modifications to the Four-Post-Plan of arrivals and departures at Sea-Tac Airport.

The PSRC is conducting the feasibility studies for the major supplemental airport. The studies will include an environmental assessment, financial and market feasibility, and institutional factors analysis. The study is not intended to provide the necessary detail for final airport siting, but rather to determine the general feasibility of a supplemental airport. Several work tasks of the Sea-Tac Airport Master Plan Update relate to the Supplemental Airport Feasibility Studies. These include the air travel demand forecasts, air traffic demand management, diversion of air passengers to other modes, and the noise reduction objectives called for in the PSRC Resolution. These are all identified in the Airport Master Plan Update scope of work.

Terminal, Cargo, and Maintenance Facilities

Terminal Development Program

Port of Seattle (Thompson Consultants International), April, 1992

The Terminal Development Program (TDP) refines the recommended passenger terminal plan presented in the 1985 Master Plan Update. The underlying philosophy of the TDP was that all future terminal development must be as flexible as possible to meet changes in the airline industry and other conditions which may develop. In addition, future facilities must be capable of meeting the needs of both hubbing and non-hubbing airlines. The TDP presented a range of options to be considered by the Port of Seattle in developing the terminal during the pre-2000 and post-2000 timeframes. It was intended to be a "living" document which could be adjusted as needed.

Options developed in the plan were based on the passenger and aircraft operations forecasts developed for the Flight Plan Project. Before the year 2000, the terminal would need to handle a maximum of 380,000 annual aircraft operations and 20 million annual passengers. Beyond 2000, the maximum demand level was assumed to be 480,000 aircraft operations and 39 million annual passengers.

The recommended plan for pre-2000 was to: expand the main terminal for additional ticketing and baggage claim; expand and refurbish Concourse A for additional aircraft gates; expand the South Satellite for additional lobby space; prepare to relocate the international arrival facilities (including customs) from the South Satellite to Concourse A; and possibly add an office building and hotel adjacent to Concourse D.

Post-2000, the TDP examined conceptual development options which were based on a range of possible passenger and aircraft operations. These were: 1) Sea-Tac absorbs none of the projected regional passenger growth and would handle a maximum of 380,000 operations per year, 2) Sea-Tac absorbs a portion of the projected regional passenger growth with approximately 410,000 operations per year, and 3) Sea-Tac absorbs most of the projected regional passenger growth with a maximum of 480,000 operations per year.

Three option packages were developed to identify the facilities needed for each of the possible post-2000 demand levels. Under the maximum development scenario, Concourse A could be extended to the southeast and then to the south; Concourse D could be extended; the North and South Satellites could be extended parallel to the runways; and additional in-fill space could be added to the central terminal area. International arrival facilities would be relocated from the South Satellite to Concourse A. Extension of Concourse A and the South Satellite would require relocation of the aircraft line maintenance hangars currently south of the terminal complex.

Air Cargo Study
Port of Seattle (HNTB), June, 1993

The goal of the Air Cargo Study was to provide a framework for future master planning of air cargo facilities at Sea-Tac Airport. Its objectives were to identify the market forces which influence air cargo demand at Sea-Tac, to determine the projected level of future cargo activity, and to develop facility alternatives to meet those needs.

The Study reported that the air cargo outlook for Sea-Tac was favorable, although modest, compared to past performance. Total air cargo volumes were projected to increase from 347,666 metric tons in 1991 to 639,350 metric tons by 2020 (an annual growth rate of 3.5 percent). Japan is anticipated to remain the most important Asian market for the Pacific Northwest, but Southeast Asia, the Russian Far East and China offer important trading opportunities. Asian cargo imported via the Seattle harbor and bound for Europe by air has been important at Sea-Tac, but is projected to remain flat because of competition from other West Coast airports. Latin and South American markets also hold promise. For the US domestic market, the Study anticipates increased imports and continued export growth, although at a slower rate than during the 1980s.

The Study recommended that the Port provide facilities that would accommodate airline growth, include some area for air cargo handling, and preserve some space for expansion. To meet these goals, cargo warehouse requirements were projected to increase from 808,156 square feet in 1991 to 1,120,000 square feet by 2020. Hardstand requirements were projected to increase from 21 to 27 over the same time period.

The Study called for the current Airport Master Plan Update to further analyze cargo facility options, costs, financial feasibility, and timing. Some near-term improvements that could provide adequate facilities through the year 2000 include: conversion of the existing north employee parking lots to allow expansion of the ramp area between the Federal Express and Transiplex buildings; development of a ground service equipment staging area; conversion of Air Cargo Building #2 from the airport maintenance building back to a cargo building; and reconstruction of the hardstand next to Air Cargo Building #2. A new location for the maintenance building would need to be identified. Feasibility studies also were recommended for long-term facilities such as a Foreign Trade Zone, a Port-owned and operated perishables center, livestock pens and loading ramps, and improvements to increase the efficiency of the Transiplex/AVIA cargo area.

Market/Economic Feasibility and Space Planning for a Hotel and Office Building Development
Port of Seattle (The Chambers Group), January, 1993

The Study analyzed the feasibility of a possible hotel/office development at the northeast end of the passenger terminal on the site of the existing United Airlines office building. This was discussed in the 1992 Terminal Development Program.

The Study was intended to provide a baseline for future development of detailed alternatives. It concluded that a 300 - 325 room hotel would be feasible in 1995. The planning concept was for a common base structure with a 12 - 14 story hotel tower and a 3 story office building. The hotel included 310 guest rooms, 5,000 - 5,500 square feet of meeting space, a 125 - 150 seat restaurant, a 100 seat lounge, and a health facility. The office building was estimated at 55,000 gross square feet. In addition, the Study analyzed traffic and parking options, utility capabilities, and economic feasibility.

South Aviation Support Area (SASA)
Federal Aviation Administration and Port of Seattle (TRA, et al), March, 1994

Extending Concourse A and the South Satellite as envisioned in the 1992 Terminal Development Program and 1985 Airport Master Plan Update would require that the existing aircraft line maintenance hangars south of the terminal complex be relocated. In addition, there is need for future line maintenance facilities and possibly major base maintenance facilities at Sea-Tac Airport. The Port of Seattle is proposing to locate these facilities on a new development southeast of the existing airfield. The project is known as the South Aviation Support Area (SASA).

The SASA Environmental Impact Statement (EIS) analyzes three "build" alternatives and the required No-Action Alternative. The three build alternatives consider varying levels and types of aircraft maintenance. Development of these alternatives takes into account the alignments of the proposed south access roadway and the proposed 28th/24th Avenue South Arterial. The Port would grade, pave, and extend utilities to the site and the airlines that lease the space would construct the maintenance facilities. The preferred alternative includes approximately 60 acres for aircraft line maintenance facilities as well as a base maintenance complex. About 20 additional acres could be used for non-aviation development. A direct taxiway link to the airfield would be provided. SASA development would occur in the area generally bounded by South 192nd Street, 28th Avenue South, South 200th Street, and the Tyee Golf Course.

The EIS also considered alternative locations for maintenance facilities, including the northeast and west portions of the airfield as envisioned in the 1985 Master Plan Update. However, the northeast area has been extensively developed for air cargo. The west side of the airfield was determined not to be feasible because of the increase in airfield congestion it would cause and because of inadequate safety clearances from the existing runways. Development immediately north of the airport is limited by steep slopes and the existing State Route 518. The east side of the airport is a heavily developed commercial area and the southwest is constrained by topography, wetlands, and the Runway 16R-34L safety area.

SASA is listed in the airport Capital Improvement Program and the initial construction phase is estimated to begin in about two years.

Ground Access and Land Use

Sea-Tac Vicinity Development Potential Study
Port of Seattle (TRA and ERA), March, 1986

The purpose of the study was to evaluate the development potential of 22 parcels of land totaling 830 acres in the vicinity of Sea-Tac Airport. The land was largely acquired as part of the Port of Seattle's Noise Remedy Program.

The study estimated the following land demand for the period between 1985 and 2000 based in part on the 1985 Airport Master Plan passenger forecasts: Parking (passenger, rental car storage, and employee) = 68 to 102 acres; Office = 46 acres; Industrial = 65 acres; and Hotel = 400 acres (200 rooms per acre).

The study also examined three conceptual options for developing the land and provided an economic evaluation of the options in terms of return to the Port, level of investment, tax revenue, and employment generated. The three options were: 1) emphasize commercial and industrial development; 2) balance commercial and industrial uses with public uses; and 3) emphasize public uses, including a military cemetery and regional park. Alternative 3 was found to provide the highest level of return per dollar invested.

Landside Access Program
Port of Seattle (CH2M Hill), October, 1987

The Landside Access Program identified a comprehensive implementation plan for automobile access facilities on the airport to serve a level of 25 million annual passengers. The primary findings of the study were that the curbside capacity for arriving and departing passengers, as well as private vehicle parking capacity, needed to be expanded. Connections to the regional highway system and the ramps to the arriving and departing drives were found to require little or no additional capacity. Although the Program did not address a south access roadway link to Interstate 5, it was designed to be compatible with a south access.

The recommended Program was to: build the north and south wing additions to the parking garage, as well as a 9th floor; provide easy-access, short-term metered parking and a vehicle loading and unloading plaza in the garage; locate the rental car operations on the second floor of the garage; develop remote public parking with 3,000 spaces and remote employee parking with 2,500 spaces; and provide a new taxi holding lot at South 160th Street.

Parking Facilities Expansion, Sea-Tac Airport
Port of Seattle (CH2M Hill, KJS, The Parry Co.), December, 1988

The purpose of the project was to meet existing and near-term growth in parking demand at the airport and to reduce congestion on the terminal drive system. Air passengers were predicted to reach 20 million by 1993 and 25 million by 1999. An environmental impact statement (EIS) examined the following options: 1) Partial garage expansion and remote lots at the airport, 2) Remote lots on and off-airport, 3) remote lots or garages located far from the airport, with shuttle service, 4) full garage expansion, 5) remote mixed-use lots or garages (joint use with shopping malls or other facilities), and 6) no action. The preferred alternative was partial garage expansion and remote lots at the airport. Under this scenario, future airport parking demand would primarily be met by the Port of Seattle. The Port would add north and south wings to the existing airport garage, increasing the total parking from 4,500 spaces to approximately 8,000 spaces. To help relieve congestion on the drives, a passenger loading and unloading plaza would be established on the third floor of the garage. In addition, approximately 1,000 public parking spaces would be developed in the vicinity of South 160th Street and International Boulevard (Pacific Highway South). In addition, a 1,300-vehicle remote employee parking lot would be built along 24th Avenue South north of State Route 518 and a taxi/bus holding and staging facility would be built in the vicinity of South 160th Street and Host Road. Based on the study, the Port completed each of these projects, with the exception of the remote employee lot north of SR 518.

Airport Vicinity Land Use Inventory Project

Port of Seattle (Shapiro & Associates), April, 1994

The Land Use Inventory Project was undertaken to provide background information on existing and historical land use types and patterns near the airport, as well as socio-economic data for the surrounding communities. The study documents changes in land use since 1948 and includes information on population, age, race, housing units, owner occupancy of housing units, median home values, median rent, median income, and building permit activity. Included is a detailed database of population and type of housing units (single family vs. multi-family) at the census block level. The study also includes a preliminary examination of property values for homes subjected to aircraft noise versus homes outside of noise areas. Major past land use planning efforts are discussed. Possible future land uses in light of city comprehensive plans being conducted under the State Growth Management Act are also discussed.

State Route 509 Extension and South Access Roadway Studies
Washington State Department of Transportation and others

The Washington State Department of Transportation (WSDOT), Port of Seattle, City of SeaTac, City of Des Moines, Metro/King County, and property owners are studying an extension of SR 509 from its current terminus at South 188th Street. The extension would run through the City of Sea-Tac and possibly farther south through Des Moines and eventually link with Interstate 5. Within the City of SeaTac, the extension would likely use existing WSDOT right-of-way to the southwest and south of the airport and possibly may use Port of Seattle property south of South 200 Street. The extension would be a limited access divided highway similar to the existing SR 509.

The parties are also studying a south access roadway to link the south end of the airport with Interstate 5. The three main types of traffic expected to be served by the proposed south access are: 1) airport traffic oriented to the south, 2) trips generated by a proposed business park south of South 188th Street, and 3) traffic into and out of the Cities of Des Moines and Sea-Tac which now accesses I-5 by way of the South 188th and South 200th Street interchanges.

Historically, it is estimated that approximately 40% of airport-related traffic is oriented to the south. Direct freeway access to the airport is available from the north, but not from the south. South-oriented airport traffic is handled by Pacific Highway South (International Boulevard) and by the I-5 interchanges at South 188th and South 200 Streets.

A 1990 study of the south access roadway by Entranco Engineers analyzed several conceptual roadway alignments and options for interchanges with the airport terminal drives system, I-5, and the proposed State Route 509 extension. Without an SR 509 extension, South Access would need to link directly to the regional highway system. Traffic flows on the proposed South Access roadway and surrounding roads were analyzed over a 20 year planning horizon (year 2010) using King County Transportation Planning and Puget Sound Council of Governments projections. The two main assumptions in the traffic analysis were for 33 million annual air passengers in the year 2010 and for 6 million gross square feet of development in the proposed business park. The business park was anticipated to include mostly office buildings (82%) with some industrial park/light manufacturing (12%) and hotels/convention centers/trade centers (6%).

A corridor-level environmental analysis of both the State Route 509 extension and the south access roadway has been underway since 1992. A Draft Environmental Impact Statement (DEIS) is anticipated by mid 1995. The EIS will examine the no action alternative and three alternative locations for the SR-509 extension to link with I-5. These are in the vicinity of: 1) South 210th Street, 2) SR-516 (Kent/Des Moines Road), or 3) South 272nd Street. In each case, the South Access Roadway and

SR 509 extension would intersect in the vicinity of South 200th Street. The EIS will be based upon the assumption that the roadways would be operational in the year 2003. It will also include evaluation of impacts out to the year 2020. Significant new land developments south of the airport will be assumed, but less than in the previous Entranco study.

Extension of the roadways have possible implications for storm water detention facilities near the airport. The South Aviation Support Area (SASA) DEIS mentioned the possibility of accommodating a portion of the SR 509 extension runoff detention on Port of Seattle property in conjunction with runoff facilities for the SASA project or other potential sub-regional detention facilities.

28th/24th Avenue South Arterial Project Draft Environmental Impact Statement
Cities of SeaTac and Des Moines (Ficklin Environmental), November, 1992

A consortium of the Cities of SeaTac and Des Moines, the Port of Seattle, King County, and land owners is studying alternative alignments for an arterial to serve existing and expected local access traffic generated by proposed business park developments in the Cities of SeaTac and Des Moines.

The Draft EIS for the project examines 3 "build" alternatives and the required No Action alternative. Each of the three alternatives would follow 28th Avenue South from South 188th Street to the vicinity of South 196th Place. Alternative #2 would continue along 28th to the intersection with International Boulevard (it would be a southbound one-way road with two lanes south of South 200th Street). Alternative #3 would step to the west and follow 26th Avenue South to the vicinity of South 208th Street and then step further to the west and continue along 24th Avenue South and terminate at South 216th Street. Alternative #5 would move west and generally be aligned between 28th and 26th Avenues South to the vicinity of South 202nd Street. It would then proceed further west and follow 24th Avenue South from the vicinity of South 204th Street to South 216th.

A Final EIS on the project was completed in May 1993. The preferred alternative was a combination of alternatives #3 and #5 above. Engineering and design work is still needed and subject to funding availability, construction could begin in about two - three years.

Personal Rapid Transit System (Sea-Tac People Mover Study)

Personal Rapid Transit (PRT) is an alternative mode of transportation under consideration by the City of Sea-Tac. It would consist of 3 - 4 person-sized, computer-controlled vehicles operating on an elevated guideway between business developments within the city, hotels, remote parking, and the airport.

In the spring of 1991, the City, in cooperation with Metro, King County, and the Port of Seattle, completed a feasibility study of a such a people mover system. The study concluded that if the technology develops, that such a system could potentially be used to help reduce automobile congestion in the city.

Regional Transit Project

A Regional Transit Authority (RTA) was recently formed to address future transit needs for the Puget Sound Area. The RTA is examining options for major expansion of existing bus service, additional bus and carpool facilities, and possibly a high-capacity light rail transit (HCT) system. The HCT would link Seattle, Tacoma, and communities on the eastside of Lake Washington.

One of the HCT alignments under consideration is along Pacific Highway South adjacent to Sea-Tac Airport. The City of SeaTac is developing land use plans for a potential HCT station in the vicinity of the airport terminal as part of its International Boulevard Center Plans.

Noise and Other Environment

Noise Exposure Update
Port of Seattle, June, 1982

The 1982 Noise Exposure Update was an update to the noise analysis presented in the Sea-Tac Communities Plan. Revised noise exposure maps were deemed necessary because of the growth in commuter operations and the growth in the number of individual carriers serving the airport. The study examined existing noise for 1980 and forecasted noise for 1985, 1990, and 2000. The noise projections were an input into the Noise Remedy Program Background Studies (see below).

Noise Remedy Program Background Studies
Port of Seattle (Peat Marwick Mitchell & Co.), January, 1985

The objective of the Noise Remedy Program Background Studies was to evaluate and update the schedule and scope of the aircraft noise remedy program contained in the Sea—Tac Communities Plan. It addressed the noise projections presented in the 1982 Sea-Tac Noise Exposure Update Study and the extent of the progress made toward implementing the original noise remedy program. The study was completed in accordance with the FAR Part 150 guidelines.

The study recommended a noise remedy program which included aircraft operational noise abatement procedures, purchase of noise-impacted homes, a sound insulation program, residential real estate sales assistance, and acquisition of avigation easements by the Port of Seattle. The Port of Seattle Commission unanimously adopted an Updated Noise Remedy Program on January 8, 1985 based on the results of the study.

Airport Noise Mediation Agreement
Noise Mediation Committee (Mestre Greve & Associates), March, 1990

Sea-Tac Airport was the first and only airport in the United States to bring together all parties affected by aircraft noise to work out a consensus-based solution. Citizens from communities throughout the Puget Sound Area, the airlines, Federal Aviation Administration, and the Port of Seattle developed a Noise Mediation Agreement that outlines specific measures to reduce overall airport noise by half by 2001. The agreement went into effect in 1991. It established a noise budget that guarantees that Sea-Tac will move steadily toward a quieter, all Stage 3 aircraft fleet by reducing the amount of noise airlines are allowed to make each year. In 1992, 73% of the aircraft at Sea-Tac were Stage III compared to 59% nationally. A nighttime limitations program to phase out noisier Stage 2 aircraft during nighttime hours was also enacted. In 1990, twenty-two scheduled Stage 2 flights were allowed to operate between midnight and 6 a.m. As of October 1993, no scheduled Stage 2 flights operate between 11:00 p.m. and 6:30 a.m. By October 1995, the agreement calls for the elimination of all scheduled Stage 2 flights between 10 p.m. and 7 a.m.

In addition, the Mediated Noise Agreement called for an increase in the rate of sound insulation for noise-impacted homes, extended full Port/FAA payment of sound insulation to all areas within the Noise Remedy Program area, improved nighttime flight corridors, established better enforcement of ground noise restrictions, and set-up a state-of-the-art flight track monitoring system. These actions have been implemented and further refinements continue.

FAR Part 150 Airport Noise Exposure Map Update, 1991
Port of Seattle (Barnard Dunkleberg & Co. and Parametrix), April, 1993

The Noise Exposure Map Update is a technical analysis of the noise impacts of 1991 actual aircraft operations and 1996 forecasted operations. Prior Part 150 noise exposure maps were prepared in 1989, 1985 (*Noise Remedy Program Background Studies*), and 1982.

Sea-Tac's Noise Exposure Maps serve several purposes: 1) as a basis for continued Federal Aviation Administration funding of the Port of Seattle's noise mitigation programs; 2) as an assessment of the current and future noise impact of the airport, including the effects of noise mitigation measures proposed in the 1990 Noise Mediation Agreement; and 3) as an aid in future planning for airport noise remedy and abatement programs.

Future aircraft operations were projected to be 403,500 per year in 1996 as derived from the Flight Plan Project forecasts. 75% of the jets in 1996 were assumed to be Stage 3.

The noise contours are predicted to continue shrinking toward the airport. The total number of residents living within the 65 Ldn contour will likely decrease from 67,000 in 1991 to 44,000 in 1996. Acres of non-compatible land uses within 65 Ldn or greater are projected to decrease from 6,920 to 3,761 over the same period.

Airport Ground Noise Study
Port of Seattle (Mestre Greve & Associates), 1994

The Ground Noise Study is intended to provide recommendations for improving the identification, monitoring, and mitigation of ground noise sources at the airport, with a focus on nighttime noise. It will also serve as background information for the Environmental Impact Statement (EIS) on the Airport Master Plan. The study draft report identified the following considerations related to the Airport Master Plan Update: locating taxiways to minimize aircraft noise; possible use of fixed electrical power and pre-conditioned air systems at the gates instead of aircraft auxiliary power units (APUs); possible hushing facilities; and consideration of noise berms. The study is scheduled to be completed in the first half of 1994.

Airport Air Quality Inventory
Port of Seattle (MFG Consultants), 1994

The Air Quality Inventory will provide baseline data on existing air quality conditions in the airport vicinity and will be used to help design detailed air quality analysis in the Environmental Impact Statement (EIS) on the Airport Master Plan. The study is scheduled to be completed during the first half of 1994.

LOCAL, REGIONAL AND STATE PLANS

Seattle-Tacoma International Airport influences and is influenced by the surrounding communities and the greater Puget Sound Region. Facility options for the Airport Master Plan Update will consider local, regional, and state land use and transportation plans. Following is a discussion of relevant off-airport plans and policies.

Washington State Air Transportation Commission (AIRTRAC)

The Air Transportation Commission (AIRTRAC) was created by the State

Legislature in 1990 to recommend statewide air transportation policies. The Commission's mandate was: "to recommend ways to promote a statewide multi-modal transportation system that includes air, stimulate economic development through air transportation, mitigate negative impacts of aviation activities on communities, and to advance the State's competitive position in national and international trade through air transportation." The Commission's final report was made to the Legislature in December 1993.

The Commission noted that Sea-Tac Airport is approaching its airfield capacity and found the demand forecasts developed for the Flight Plan Project to be valid. Alternative modes of travel such as high-speed rail were found to be important, but would not solve air capacity problems. The recommended policies called for: ensuring that existing airport capacity is preserved and that new capacity needs are addressed; pursuing multi-modal alternatives and demand management; reducing future noise impacts and ensuring mitigation of noise impacts; improving the performance of the air transportation infrastructure to support economic development goals; and improving surface access to airports.

A Commission minority report was also prepared which concurred with the majority report, with the exception of calling for a greater State role in air transportation planning and development.

Washington State Growth Management Act (GMA)

King County and the cities within it (along with certain other counties) are required by the State of Washington Growth Management Act to prepare and adopt comprehensive plans. The primary goals of GMA include: 1) reduce sprawl by encouraging development in urban areas; 2) preserve open space and resource lands; 3) encourage multi-modal transportation systems; and 4) encourage economic development. Plans must address land use, transportation, utilities, capital facilities, and housing. The Act further stipulates that city and county comprehensive plans must be coordinated with one another and provide for siting of essential public facilities (including airports). Comprehensive plans are required to be completed by July 1, 1994. Regulations to implement the plans must then be adopted by December 31, 1994. Extensions of these deadlines have been granted in certain cases.

Airport-Vicinity Comprehensive Plans Prepared by King County

Development of communities in the airport area has been guided by several major County planning efforts in addition to comprehensive plans prepared by individual cities. Following is a discussion of plans prepared by King County over the last twenty years. A later section of this report discusses existing city comprehensive plans and updates being conducted under the State Growth Management Act (GMA).

Sea-Tac Communities Plan, 1976

The Sea-Tac Communities Plan was produced jointly by King County and the Port of Seattle. It covered an area of about forty-four square miles around Sea-Tac Airport and addressed the airport's relationship to surrounding communities. A major goal was to achieve land use compatibility. The Plan recommended a comprehensive Airport Noise Remedy Program for residential areas including acquisition or sound insulation of noise-impacted homes. A general land use concept for the airport and immediate vicinity was also developed.

Highline Community Plan, 1977

The Highline Community Plan and subsequent

Highline Community Plan Area Zoning (1981) served to implement the policies and land use concept developed in the Sea-Tac Communities Plan. In addition to the area covered by the Sea-Tac Communities Plan, the Highline Community Plan included the Cities of Des Moines and Burien. Important land use concepts in the Plan included designations for airport-related businesses, highway-oriented commercial uses, and airport open use.

Sea-Tac Area Update and Area Zoning, 1989

The Sea-Tac Area Update and Area Zoning amended portions of the Sea-Tac Communities Plan to further deal with land use compatibility in the immediate vicinity of the airport. It also supplemented and amended policies developed in the Highline Community Plan. The Sea-Tac Area Update planning area was much smaller than either of the two community planning studies and was focused on the area immediately around Sea-Tac Airport. The Update proposed no new residential land and recommended conversion of 200 acres north of the airport from residential designation to airport open use and a 200-acre business park south of the airport in the vicinity of 28th Avenue South.

City Comprehensive Plans

The cities in the airport vicinity are in the process of preparing and adopting updated comprehensive plans in accordance with the State Growth Management Act (GMA). The GMA requires adoption of comprehensive plans by July 1, 1994 with enactment of zoning controls by December 1, 1994. Some extensions have been granted to these deadlines.

Following is a discussion of the existing planning and zoning of the cities near the airport and anticipated land use changes under the new comprehensive plans. Much of this information is derived from the Port of Seattle's 1994 Sea-Tac Airport Vicinity Land Use Inventory Project.

Figure 2 is a map of the airport vicinity communities.

City of Sea-Tac

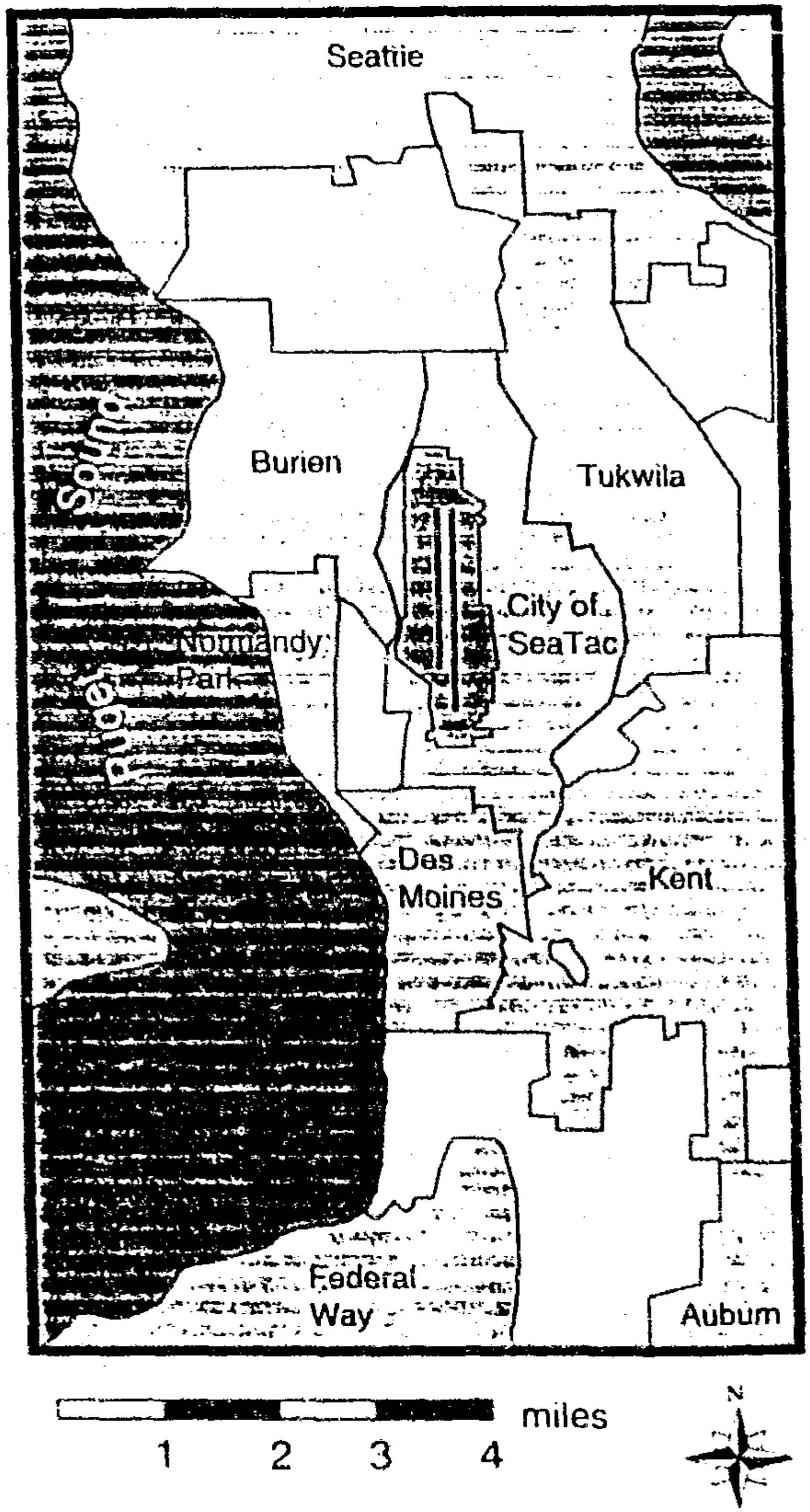
The City, which incorporated in 1990, surrounds Seattle-Tacoma International Airport on all sides. The City adopted the 1985 King County Comprehensive Plan, the 1977 Highline Community Plan, and the 1989 Sea-Tac Area Update and Area Zoning to provide policies and codes until a city comprehensive plan could be prepared.

Over two thirds of the land within the City of Sea-Tac is devoted to either airport-related uses or to single family housing. The airport itself and the airport-related areas are zoned "Industrial" and the single-family areas are primarily zoned "Urban Low." Most of the commercial uses and multi-family housing are located along International Boulevard (Pacific Highway South). These are primarily classified as "Community Business," "Urban Medium," or "Urban High." In addition, the City has adopted an "Airport Use" category which permits economic uses and development of areas affected by the airport. South of the airport, a major business park is planned in an area zoned as "Aviation and Business Center." The open space north of the airport is zoned as "Park" for the proposed North SeaTac Park.

The City is preparing a Comprehensive Plan which is scheduled to be adopted by the end of July 1994. Subarea planning efforts for the International Boulevard area east and south of the airport and the Westside subarea west of the airport will be integrated into the Comprehensive Plan.

The draft International Boulevard Center (IBC) plan calls for the location of an urban center in

FIGURE 2
Airport Vicinity Communities



the area east of the airport. Urban centers are regionally-designated areas which would absorb a large portion of the additional population and employment growth of the Puget Sound Region. They are a major portion of the Regional Transportation and Land Use Plan (Vision 2020) and the King County County-Wide Planning Policies. If the International Boulevard area is designated as an urban center, substantial increases in population and employment density would be anticipated. The City is conducting further planning of the IBC area in a study known as the Transit-Supportive Land Use Master Plan.

In the Westside Subarea Plan, the City is evaluating the possibility of converting the residential neighborhood west of the airport to a light industrial park. This is the area in which the proposed new runway at Sea-Tac Airport would be located.

North of the airport, the City is developing the North SeaTac Park on property leased from the Port of Seattle.

Des Moines
The City of Des Moines is located south of the airport, adjacent to the City of SeaTac. Most of the land in Des Moines is developed as single-family residential. Multi-family housing and commercial uses are located in the downtown/marina area and along Pacific Highway South. The City adopted the Greater Des Moines Comprehensive Plan in 1981 and adopted a revised land use element in 1991. Partially in response to the large growth in multi-family units within the City, the element contains a policy to limit the amount of new multi-family housing. The City's 1991 North Central Neighborhood Plan calls for developing a major business park south of the airport in conjunction with the City of SeaTac. The area is generally bounded by 16th and 24th Avenues South, and South 220th and South 208th Streets. A portion of the area is within the Port of Seattle Noise Remedy Program acquisition area.

Each of the elements of the comprehensive plan are being updated one-by-one. All updates are expected to be completed by the July 1, 1994 GMA deadline. Subsequently, the elements will be assembled and adopted as the City comprehensive plan.

Tukwila
Tukwila lies to the northeast of Sea-Tac Airport adjacent to the City of SeaTac. The City adopted the Tukwila Comprehensive Land Use Policy Plan in 1982. The plan promotes "mutual cooperation between governmental jurisdictions regarding land use decisions to maintain the livability of viable residential areas both inside and outside the Tukwila planning area." The airport is addressed under the Transportation and Utilities policies. This element encourages "an efficient system of air transport which serves both the people and industries of the planning area" while promoting "a harmonious relationship between airports and surrounding land uses."

Tukwila is preparing a comprehensive plan update which is expected to be completed during the first part of 1995. The plan is expected to include a new mixed use area along Pacific Highway South between South 160th and South 128th Streets. Additional multi-family housing and commercial uses are anticipated and would increase the existing development density in this portion of the city.

Seattle
The Seattle city limit is located several miles due north of Sea-Tac Airport. Currently, the City is not operating under a formal comprehensive plan, but rather under a set of policies and a land use/zoning code. The portions of the City which are closest to the airport are along the Duwamish Waterway.

This area is primarily classified as industrial. The City completed a draft Comprehensive Plan and Draft Environmental Impact Statement in 1993 and is in the process of preparing a final plan. Adoption is anticipated in July 1994 with the capital facilities element likely to be deferred until fall. The plan is focusing on concentrating future development into "urban villages." A manufacturing/industrial center is proposed for the Duwamish Area.

Kent
Kent lies several miles southeast of Sea-Tac Airport. The majority of the City is located in the Green River Valley and Kent East Hill away from the airport. The portion of the City closest to the airport is located along Pacific Highway South and is known as the West Hill. The City adopted the West Hill Plan in 1984 as part of its overall comprehensive plan. Most of the area is designated as either "Community Retail," "Limited Commercial/Office," or "Multi-family."

Kent is preparing the land use element of the new comprehensive plan. The land use element will be adopted in early 1994. The City expects that the most significant change in the West Hill area will be encouragement of mixed-use development and thus additional multi-family housing, and potentially a higher housing density along Pacific Highway South.

Federal Way
Federal Way is located approximately several miles south-southwest of Sea-Tac Airport, south of the City of Des Moines. Significant amounts of the western portions of the city are residential. Commercial developments are concentrated along Pacific Highway South and along South 320th Street in the vicinity of Sea-Tac Mall. Following incorporation in 1990, a comprehensive plan was prepared for the new city. The plan is being updated in accordance with the Growth Management Act. One of the land use alternatives being considered in the plan is development of an urban center along South 320th Street west of Interstate 5. A draft of the plan is scheduled to be available by June 1994.

Burien
Burien is located to the northwest of Sea-Tac Airport adjacent to the City of SeaTac. Due to its recent incorporation in 1992, City plans are very preliminary and are just beginning to develop. Burien adopted the land use and circulation element map of the Highline Community Plan as its interim comprehensive plan. None of the policies of the original Highline Community Plan have been adopted. The City comprehensive plan is anticipated to take several years to complete.

Normandy Park
Normandy Park is a primarily residential community located on Puget Sound west-southwest of Sea-Tac Airport adjacent to the City of SeaTac. The City's revised comprehensive plan, adopted in 1987, designates most of the city as low-density single family residential. Small concentrations of commercial and high-density multi-family uses are designated in the vicinity of Southwest Normandy Way and Southwest 200th Street at First Avenue South.

The City is preparing a comprehensive plan update under the Growth Management Act. The City is expected to remain primarily single-family residential with only minor new residential and commercial development in the future. Some additional high-density multi-family housing is planned for the area along First Avenue South described above. The comprehensive plan is scheduled to be adopted in August 1994.

Normandy Park has been considering annexing the unincorporated North Hill area west of the airport and adjacent to the City of SeaTac. The City of SeaTac has also considered annexing this area.

CONCLUSIONS

A review of past plans prepared for Seattle-Tacoma International Airport indicates a consistent overall concept of the airport's role as a major air carrier airport which provides for needed regional air travel growth while maintaining and enhancing compatibility with the surrounding communities. Maximizing airport efficiency and balancing the airside, landside, and ground access facility needs has also been a common theme. The Airport Master Plan Update will continue these planning philosophies and will rely upon information and results from many of the recent airport and community planning efforts.

The Master Plan Update will provide the Port of Seattle with a framework for future developments at Sea-Tac and will provide neighboring communities and citizens with a clear picture of the airport's future. It will allow communities to anticipate and plan for upcoming changes at the airport. It will also help facilitate continued cooperative land use compatibility planning efforts of communities and the Port.

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BIBLIOGRAPHY

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APPENDIX A

SEA-TAC AIRPORT DEVELOPMENT CHRONOLOGY

APPENDIX A

SEA-TAC AIRPORT DEVELOPMENT CHRONOLOGY

1942	Port of Seattle Commission votes to build and operate a regional commercial service airport to serve the Puget Sound Region
1944	Seattle-Tacoma International Airport opens
1949	Passenger Terminal / Administration Building dedicated
1959	North Concourse (now Concourse D) extension completed
1961	South Concourse (now Concourse A) extension completed
	Main runway extended to 11,900 feet
1964	Concourse B completed
1966	Concourse C completed
1967	Extension of Concourse B completed
1968	Construction begins on 9,450-foot second parallel runway
	Work starts on initial phase of $90 million expansion program
	Expansion of Concourse D completed
1970	North Airport Freeway road link to State Route 518 / Interstate 5 is completed
1971	Second parallel runway (Runway 16R / 34L) completed
1973	New Main Terminal, North and South Satellite terminals, and Satellite Transit System completed
	Upper and lower drive system and parking garage completed
1976	Port of Seattle Commission and King County Council adopt Sea-Tac Communities Plan
1983	South Satellite expansion completed (in-transit lounge and four new international arrival gates)

1985 Updated Port of Seattle Noise Remedy Program adopted

1987 Main Terminal expansion completed (north-end ticket counters, public waiting, baggage handling, and concessions)

1990 Sea-Tac Noise Mediation Agreement reached

1992 "First Class Upgrade" program completed (addition of north and south parking garage wings for an additional 3,500 parking stalls, new short-term parking area and pick-up / drop-off plaza, major concourse renovation including six new aircraft gates)

1993 Puget Sound Regional Council adopts a plan calling for a third runway at Sea-Tac and a new major supplemental airport

APPENDIX B

SEA-TAC AIRPORT HISTORICAL PLANNING STUDIES

APPENDIX B

SEA-TAC AIRPORT HISTORICAL PLANNING STUDIES

1969 ***Practical Annual Aircraft Handling Capacity of the Proposed Runway Configuration at the Seattle-Tacoma International Airport 1970 - 1985***, Port of Seattle, March 1969. This study analyzed the projected capacity and delay of the airfield with two close-spaced parallel runways (the current configuration). It also contemplated a third runway 3,000' long on the northwest part of the airfield to be used by general aviation aircraft.

1968 ***Future Traffic and Parking Requirements and Parking Financial Analysis***, Port of Seattle, April 1968. The study discussed existing and projected ground travel demand at the airport and discussed plans for constructing a parking garage (the current garage) in two phases.

1968 ***Air Transportation System Advance Plan, Technical Report No. 1***, Puget Sound Governmental Conference, August 1968. Recommended a new supplemental airport on the Kitsap Peninsula.

1967 ***Airport Comprehensive Plan***, Port of Seattle, March 1967. Included passenger terminal expansion, terminal and access roadways, parking facilities, and runway construction.

1962 ***Seattle-Tacoma International Airport 100% Land Use and Development***, Port of Seattle, September 1962. Subsequent to the *Expansion and Improvement Study 1958 - 1967*, this study was intended to be a concept master plan for all airfield facilities. Particularly, it sought to balance cargo facility needs with passenger terminal development and included a plan concept for the north and south satellite terminals. It also discussed the possibility of adding a second parallel runway to help meet air traffic needs into the 1970's.

1961 ***Sea-Tac Airport Expansion and Improvement Study 1958 - 1967***, Port of Seattle, June 1961. The study served as a master plan for the development of the passenger terminal during the 1960's. It guided extensions of the North and South concourses (now Concourses A & D) and extension of the South Central Concourse (now Concourse B) as well as enhancements of the main terminal area and the airport drives.

Attachment B
to Port Resolution 3245

TECHNICAL REPORT NO. 4
FACILITIES INVENTORY

AIRPORT MASTER PLAN UPDATE

FOR

SEATTLE-TACOMA INTERNATIONAL AIRPORT

P&D Aviation

TECHNICAL REPORT NO. 4
FACILITIES INVENTORY

AIRPORT MASTER PLAN UPDATE
FOR
SEATTLE - TACOMA INTERNATIONAL AIRPORT

Prepared by:

P&D AVIATION

Prepared for:

The Port of Seattle
SEATTLE - TACOMA INTERNATIONAL AIRPORT

OCTOBER 21, 1994

The P&D Aviation Team

P&D Aviation • Barnard Dunkelberg & Company • Berk & Associates
Mestre Greve Associates • Murase Associates • O'Neil & Company
Parsons Brinckerhoff • Thompson Consultants International
Landrum & Brown • Claire Barrett & Associates

TECHNICAL REPORT NO. 4
FACILITIES INVENTORY

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INTRODUCTION

SECTION 1
INTRODUCTION

BACKGROUND

The genesis of the Seattle-Tacoma International Airport (Sea-Tac) Master Plan Update was the "Comprehensive Planning Review" conducted in 1988. This ten month program evaluated the 1985 Airport Master Plan as well as several other related planning studies. The conclusions of this analysis, as well as the results of the Puget Sound Regional Council's 1988 Regional Airport System Plan, led the Port of Seattle Commissioners to formally acknowledge that Sea-Tac would reach runway saturation near the turn of the century. In response to this challenge, the Commissioners, and the Puget Sound Council of Governments (now Puget Sound Regional Council), entered into a three-year planning effort known as the "Flight Plan" project.

The purpose of Flight Plan was to develop a plan for a regional airport system that would meet the aeronautical needs of the region to the year 2020 and beyond. In the third phase of Flight Plan, alternative airport systems were evaluated. In the end, the 39-member Puget Sound Air Transportation Committee (PSATC) chose as its preferred alternative the construction of a new runway at Sea-Tac and development of two reliever satellite airports. This ultimately led to the adoption by the Port of Resolution No. 3125, which directed that a new runway for Sea-Tac be examined in detail. Subsequently, a planning team led by P&D Aviation was selected for an Airport Master Plan Update and began work on December 3, 1993.

PROJECT OBJECTIVES

The overall objective of this project is to "prepare a comprehensive Airport Master Plan [Update] for the airside, terminal, and landside facilities needed at Sea-Tac to meet air travel demand to the year 2020 and beyond." Specifically, the master plan update study must fulfill each of the relevant objectives stated in Port Resolution 3125. These are as follows:

- Design a mechanism and process to promote [land use and community] compatibility through improved coordination, communication and involvement.
- In addition to the third runway studies, include a reconsideration of a fast rail system together with diversion of all cargo carriers.
- Fully explore the impacts of peak period pricing and other demand management techniques.
- Explore land acquisition and redevelopment to compatible uses.
- Attenuate airport noise through the use of berms and barriers.
- Promote aggressive on-airport emission reductions.
- Promote regional transit and reduction in use of automobiles.
- Improve the aesthetic appearance of the airport boundary.
- Develop a comprehensive stormwater management plan.

SCOPE OF STUDY

The first assignment of the Airport Master Plan Update study was the development of a detailed scope of work designed to fulfill the project objectives. The final scope of work, prepared on December 2, 1993, contains forty-five work tasks. The detailed scope of work is contained in Technical Report No. 1, Scope of Work.

The primary issues addressed in the scope of work include:

- ***Forecasts.*** The master plan update and related Environmental Impact Statement and FAA Part 150 Study must be based on a reliable and generally accepted set of forecasts.
- ***Airside Evaluations.*** An important component of the study is the analysis of several runway options, including a new dependent parallel (minimum runway separation of 2,500 feet) runway. The 1988 Airspace Update Study and the 1991 FAA Airport Capacity Enhancement Task Force both determined that a substantial capacity improvement can be achieved by constructing a new parallel dependent runway.
- ***Terminal Evaluations.*** A key issue in the terminal development is to achieve a balance between added terminal capacity and additions to airside and landside capacity. Curb frontage, roadway and automobile parking are critical components.
- ***Multi-Modal Evaluations.*** There is considerable interest at the Federal, State and local levels of government to development inter-modal transportation systems that are economically efficient and improve air quality and reduce airport congestion.
- ***Financial Planning.*** A comprehensive financial plan and implementation strategy must be developed to maximize the Port's ability to fund needed capital improvement projects.
- ***Part 150 Issues.*** The Sea-Tac Airport Noise Mediation Agreement resulted in substantial noise reduction programs, now being implemented. This agreement plays a vital role in existing and future planning efforts at the airport and has been incorporated into the recently completed FAR Part 150 Land Use Compatibility Study 1993 Amendments. However, those amendments did not consider the implementation of a third runway, and thus the Noise Exposure Maps that were generated in the study will require updating if a third runway is approved.
- ***Process.*** Public involvement in the planning process is an important element of the Airport Master Plan Update. The public involvement program developed for the study will allow for better understanding of the sentiments in the surrounding communities and constructively involve the public in focused workshops for the project. Elements of the public involvement program include workshops, public opinion surveys, and dissemination of project information through newsletters and technical reports prepared during the study.

STUDY SCHEDULE AND DOCUMENTATION

The Airport Master Plan Update is scheduled to be completed in December 1995. During 1994, forecasts will be prepared, facility requirements will be developed and individual options for accommodating projected needs will be evaluated. In 1995, option "packages" will be developed and evaluated and concurrently an

Environmental Impact Statement will be prepared jointly by the FAA and the Port of Seattle.

The following documents are scheduled to be prepared during the course of the project:

- Technical Report No. 1, Final Work Scope
- Technical Report No. 2A, Market Research Results
- Project Brochure
- Technical Report No. 2B, Public Involvement Program Development Report
- Technical Report No. 3, Planning History and Study Relationships
- Technical Report No. 4, Facilities Inventory
- Technical Report No. 5A, Preliminary Forecast Report
- Technical Report No. 5B, Final Forecast Report
- Technical Report No. 6, Airside Options Evaluation
- Technical Report No. 7A, Terminal Options Evaluation Report
- Technical Report No. 7B, Evaluation of Other Facility Options
- Demand Management Report
- Technical Report No. 8, "Package" Evaluations Report
- Technical Report No. 9, Draft of Master Plan Update Final Report
- Airport Layout Plan Set
- Final Report

PLANNING TEAM COMPOSITION

The Master Planning Team led by P&D Aviation consists of eight firms which are listed below with their key responsibilities:

- ***P&D Aviation*** - Project Management, Forecasts and Facility Requirements, Airside Planning, Ground Access Planning, Overall Airport Master Planning and Coordination
- ***O'Neill & Company*** - Public Involvement
- ***Parsons Brinckerhoff*** - Multi-Modal Evaluations
- ***Thompson Consultants International*** - Terminal Planning
- ***Barnard Dunkelberg & Company*** - Part 150 Integration
- ***Berk & Associates*** - Financial Planning
- ***Murase Associates*** - Airport Beautification, Landscape Architecture
- ***Mestre Greve Associates*** - Aircraft Noise Impacts

CONTENTS OF THIS REPORT

This report documents the number, type and general condition of the existing facilities that comprise Seattle-Tacoma International Airport (Sea-Tac). It is a complete compilation of all systems, including airfield, terminal area, ground access, parking, navigational aids, pavement conditions, utilities and the physical characteristics of the airport site. As such, this report serves as a reference document for planning team members in the accomplishment of other master planning tasks.

In other phases of the work program, the facilities are assessed as to their capacity to accommodate future demand. By comparing the capacity of existing facilities with future demand (demand/ capacity analysis), capacity deficiencies can be determined. Once the deficiencies are identified, alternative expansion concepts (capable of accommodating future demand) can be formulated, evaluated and ultimately, a recommended development program will be formulated.

The remainder of this report is organized in the following sections:

- Section 2 Airside Facilities
- Section 3 Existing Airspace System
- Section 4 Landside Facilities
- Section 5 Ground Access Facilities
- Section 6 Existing Utilities

The existing airfield facilities are described in Section 2, including the runway/taxiway system and lighting. Meteorological conditions are also included. Section 3 addresses the regional airspace environment and air traffic control procedures for the Airport. Existing landside facilities, such as passenger and cargo terminals, are described in Section 4. Due to their importance, ground access facilities, while technically an element of the landside complex, are included in a separate section of the report (Section 5). Existing utility services are addressed in Section 6.

Section 2
AIRSIDE FACILITIES

SECTION 2
AIRSIDE FACILITIES

INTRODUCTION

This section documents the inventory of airside facilities. The term "airside" as used in this report and master plan relates principally to the airfield facilities, or landing area, and includes the runway and taxiway system, the runway approach areas and associated equipment such as airfield lighting and navigation aids. Aircraft parking aprons are considered a "landside" element rather than an airside component, because apron planning considerations are more closely associated with the passenger terminal. Meteorological considerations are also addressed in this discussion of airside facilities as they can significantly affect aircraft operations into and out of an airport. Airspace and air traffic control are the subject of a separate section in this report. The existing airside facilities as well as other major operating elements of the Airport are shown in Figure 2-1, Existing Airport.

RUNWAY/TAXIWAY SYSTEM

Seattle-Tacoma International Airport encompasses a total of approximately 2,500 acres and consists of two parallel runways oriented in a north-south direction. The Airport Reference Point (ARP) is located at 47° 26' 58" North latitude and 122° 18' 34" West longitude. The established airport elevation, defined as the highest point along any of the Airport's runways, is 429 feet above mean sea level (MSL) and is found at the Runway 16L threshold.

Runways

The Sea-Tac runways are designated as 16L/34R and 16R/34L. Runway 16L/34R is 11,900 feet long and Runway 16R/34L is 9,425 feet long. Both are 150 feet wide. The landing threshold of Runway 16L is displaced 490 feet. Originally, the displacement provided approach slope clearance above a tree which has since been removed. Since touchdown zone lighting is installed on the runway and the displaced threshold does serve in a noise abatement capacity, elimination of the displaced threshold has not been considered. The true bearings of the runways are true north (N 00°00'00"E).

Paved blast pads are located at each runway end. Blast pads are 150 wide and vary in length by runway end as follows: 16L - 130 feet; 16R - 220 feet; 34L - 150 feet; and, 34R - 150 feet. Blast pads are designed to protect areas beyond the runway ends from erosion due to jet blast.

The centerlines of the runways are separated by 800 feet. The 800 foot separation between the runways is important in that it allows both to be used simultaneously for takeoffs and landings in good weather including two arriving streams of traffic. However, during weather conditions when cloud ceilings descend and visibility is reduced, at least a 2,500 foot separation is required to meet FAA standards allowing the use of both runways simultaneously. Thus during these periods, the airport is limited to the use of one runway for landing, which greatly reduces its capacity.

Pavement Strength. Runway 16L/34R is asphalt paved and is grooved. Condition of the pavement is excellent due to a rehabilitation project in 1993. Runway 16R/34L is grooved concrete. A program is now underway to replace damaged concrete panels on the runway.

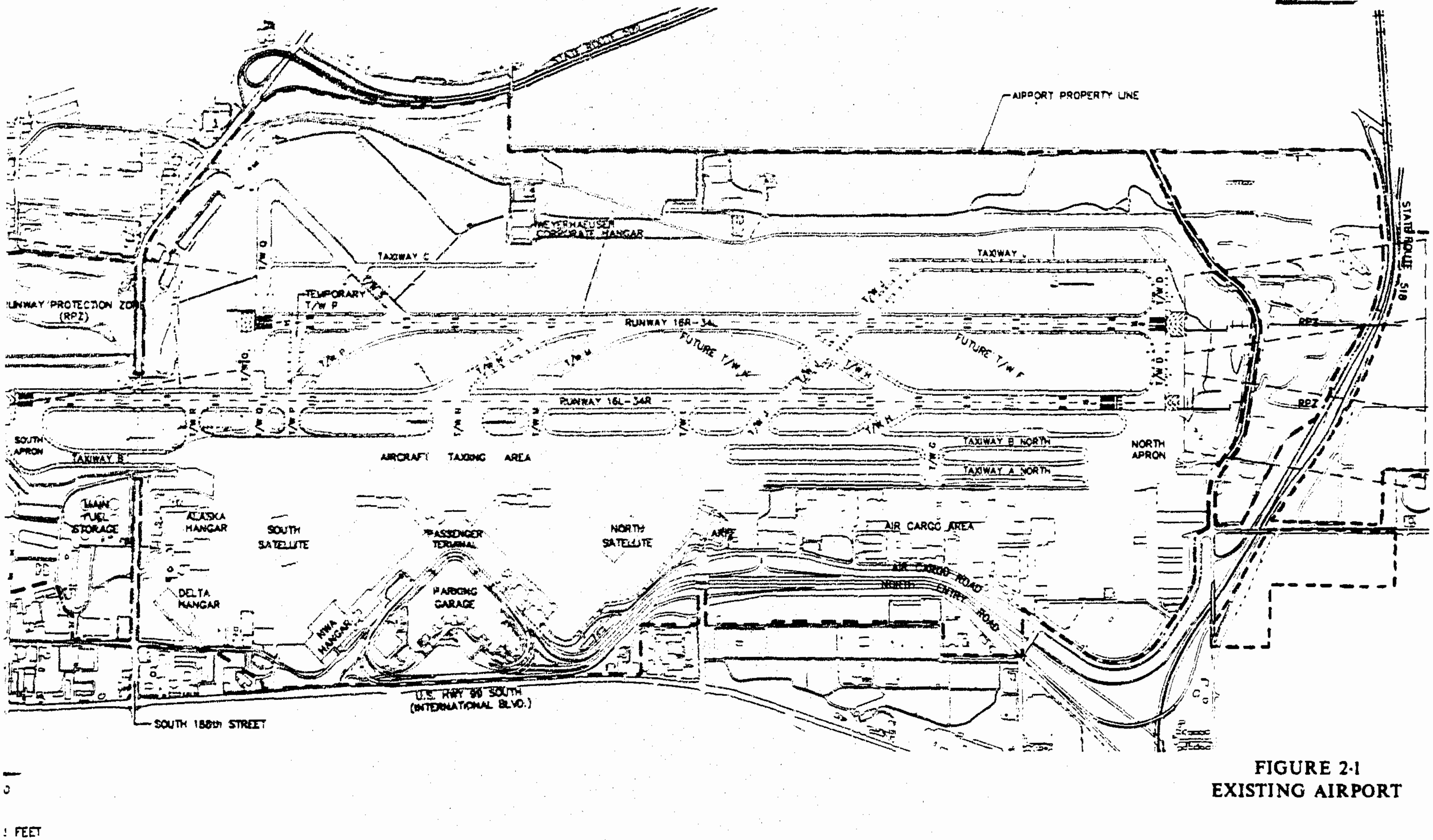


FIGURE 2-1
EXISTING AIRPORT

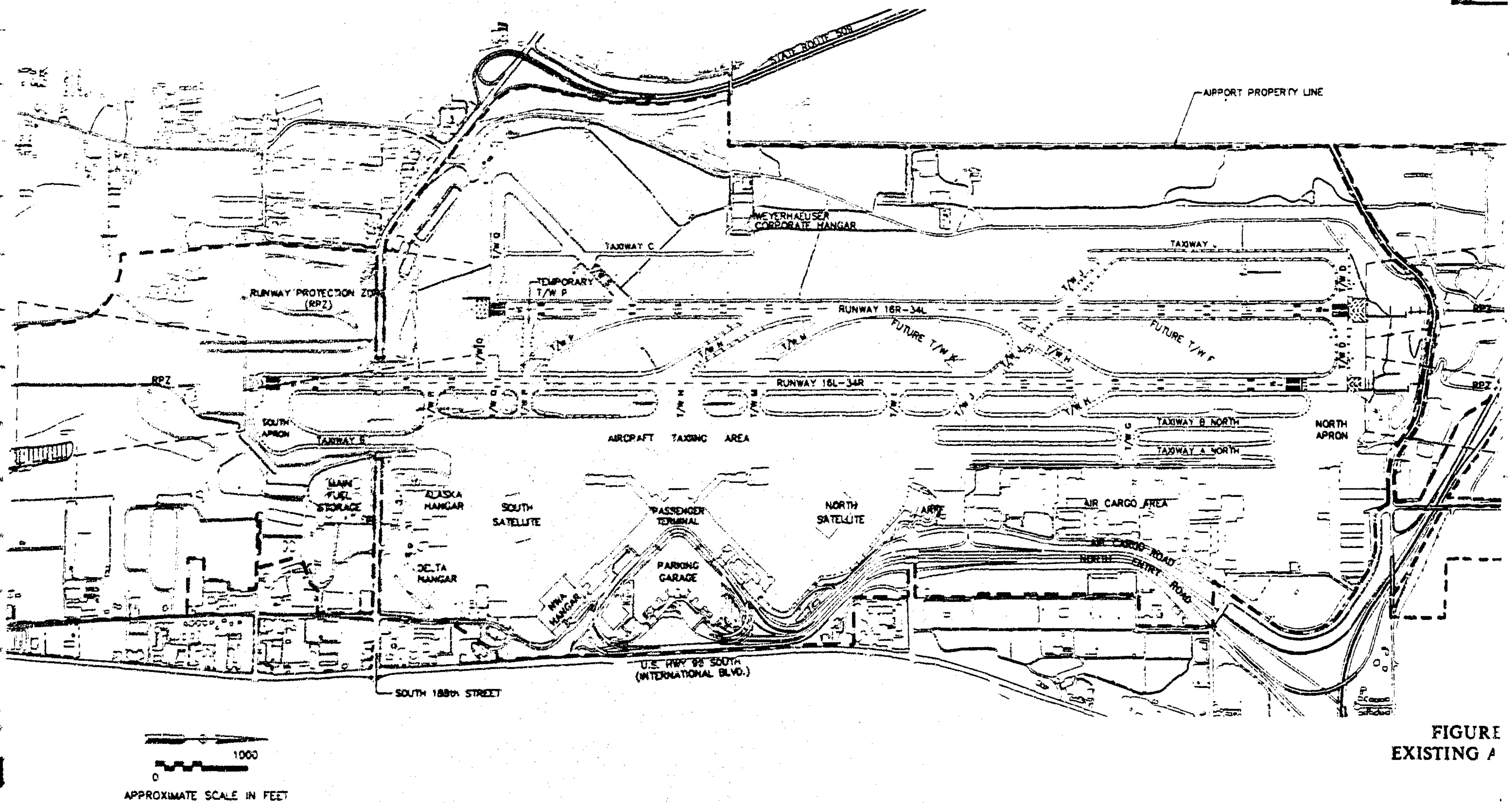


FIGURE
EXISTING A

The runway pavements are rated at the weight bearing capacities shown in Table 2-1.

Evaluations of each runway's pavement have been performed in recent studies. The following subsections extract from these studies and summarize the present pavement conditions.

- Runway 16L-34R. Runway 16L-34R was rehabilitated in 1993. A 5 inch asphalt overlay was constructed and designed to extend the life of the runway pavement 20 years. The pavement condition index (PCI) of the runway has now been increased to 100 due to the recent rehabilitation. The rehabilitation did not change the weight bearing capacity of the runway.

- Runway 16R-34L. A pavement evaluation as documented in a report entitled Preliminary Engineering Report Runway 16R-34L (Pavement Consultants Inc., August 1992), is the basis for the following description of runway pavements. For the purpose of the analysis, the runway was divided into eight longitudinal sections shown in Figure 2-2. PCI and pavement condition ratings (PCR) were derived for each section based on visual inspection conducted in conformance with FAA procedures. Results of the visual condition survey are shown in Table 2-2. The following excerpt from the above report generally describes the pavement condition.

  "The runway pavement is currently exhibiting load-related distresses, including: mid-panel cracking, corner cracking, shattered slabs, joint spalling and corner spalling. The joint sealant is no longer effective since it has debonded from the sides of the joints. At several places, joint material was found to be missing or broken into pieces. There was, however, no evidence of pumping which indicates that the subsurface drainage along the runway length is effective. There was one area where one corner of a broken slab has settled, indicating the present of voids under the pavement."

Runway Gradient. The runway pavement centerline profiles slope upward from south to north at a 0.7 percent longitudinal gradient. Pertinent runway end data are summarized in Table 2-3.

Runway Safety Areas. A runway safety area (RSA) is defined as a rectangular area centered about the runway that is cleared, drained, graded and usually turfed. Under normal conditions, this area should be capable of accommodating occasional aircraft that may veer off the runway, as well as fire fighting equipment. For Sea-Tac, the requirement (existing and future) for the runways is an area 500 feet wide centered on the runway centerline and extending 1,000 feet beyond each runway end. The existing runway safety areas do not fully meet current FAA criteria. The existing RSA for Runway 34R is 535 feet long and 500 feet wide. The Runway 16L RSA is 700 feet long and 500 feet wide. The RSA for Runway 34L is 775 feet long and 500 feet wide. The RSA for Runway 16R is 645 feet long with the width varying from 180 to 500 feet.

Taxiways

The taxiway system affects the ability of an airport to handle traffic. Capacity benefits can be obtained if aircraft can exit the runway quicker and taxi to and from the terminal efficiently. The existing taxiway system, shown in Figure 2-1, is comprised of a number of parallel and exit taxiways which facilitate the movement of aircraft while on the ground at Sea-Tac. This subsection describes the existing taxiway system and is largely based on

TABLE 2-1
EXISTING RUNWAY PAVEMENT STRENGTH
(Aircraft Weight)

Runway	Single Wheel Landing Gears	Dual Wheel Landing Gears	Dual Tandem Landing Gears	Double Dual Tandem Landing Gears
16L/34R	100,000 lbs.	200,000 lbs.	350,000 lbs.	825,000 lbs.
16R/34L	100,000 lbs.	200,000 lbs.	350,000 lbs.	800,000 lbs.

Source: U.S. Government Flight Information Publication Airport/Facility Directory.

TABLE 2-2
VISUAL CONDITION SURVEY RESULTS - RUNWAY 16R-34L
(Inspection conducted in November 1991)

Section	PCI (1971)	PCI (1991)	PCR (1991)	Percent Load-Related Distress	Percent Climate-Related Distress
1	86	59	Good	87.54	12.46
2	93	76	Very Good	76.19	23.81
3	90	82	Very Good	63.68	36.32
4	88	73	Very Good	83.73	16.27
5	90	77	Very Good	63.97	36.03
6	90	78	Very Good	74.35	25.65
7	84	68	Good	77.72	22.28
8	80	68	Good	62.82	37.18

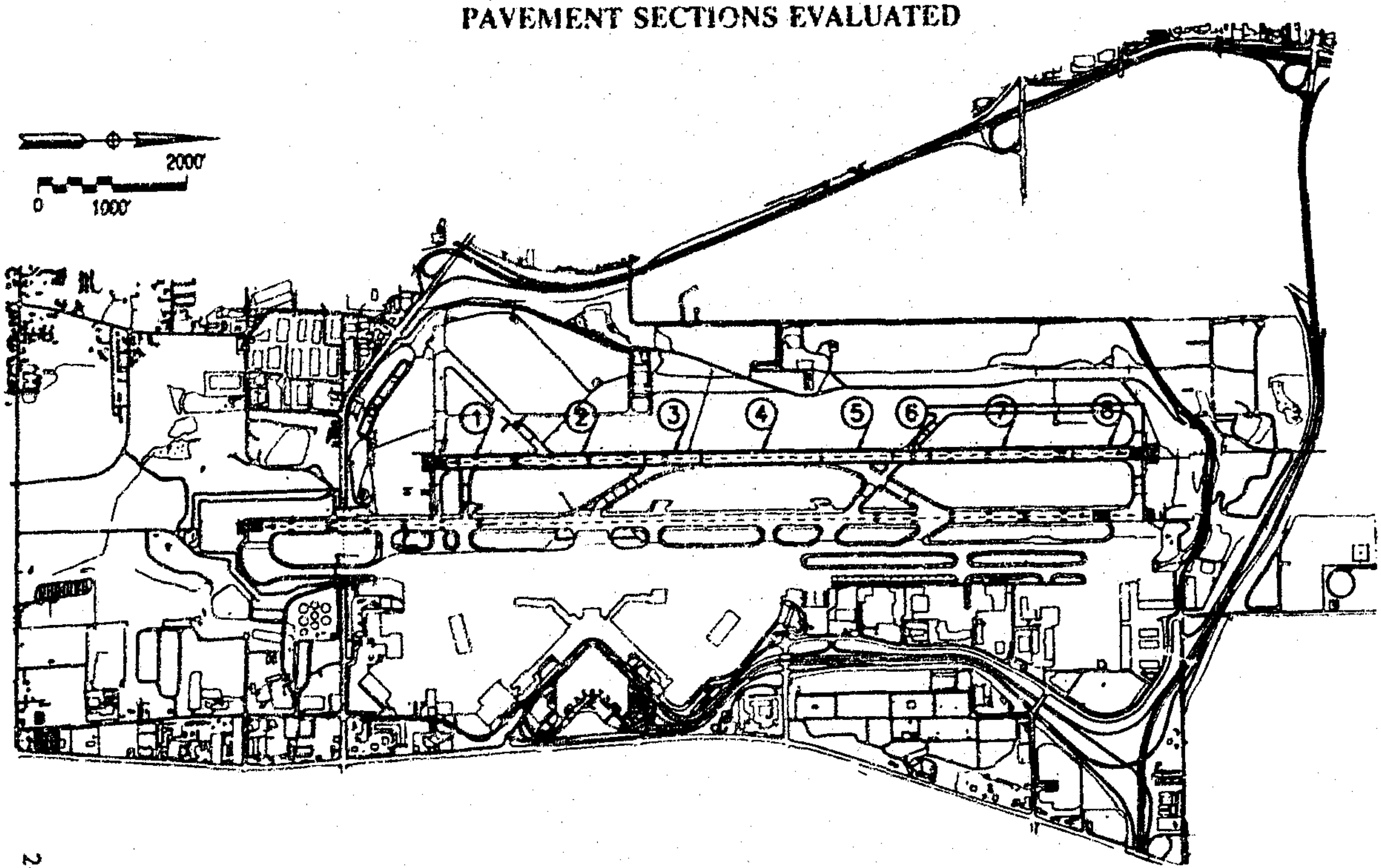
Source: Preliminary Engineering Report Runway 16R-34L. Pavement Consultants, Inc., August 1992.

TABLE 2-3
EXISTING RUNWAY END DATA

Runway End	Latitude	Longitude	Elevation
16L	N47°27'50"	W122°18'23"	429 ft.
34R	N47°25'53"	W122°18'25"	343 ft.
16R	N47°27'50"	W122°18'35"	426 ft.
34L	N47°26'17"	W122°18'36"	359 ft.

Source: Airport Obstruction Chart.

FIGURE 2-2
RUNWAY 16R-34L
PAVEMENT SECTIONS EVALUATED



information previously developed by the Port of Seattle and contained in a report entitled: Taxiway Improvements Study Seattle-Tacoma International Airport (September 1991).

Runway 16L/34R is served by a parallel taxiway, which on the north end includes a dual parallel taxiway. From the terminal apron Taxiways A and B (North) provide access to the 16L threshold. Both taxiways are 100 feet wide. Centerline-to-centerline separation between the runway and Taxiway B (the inboard taxiway) is 400 feet. The separation between Taxiways A and B (North) is 300 feet. The taxiways terminate at the North Apron. On the south end of the airfield, access from the passenger terminal area to the 34R threshold is provided by Taxiway B. The centerline-to-centerline separation between Runway 16L-34R and Taxiway B on the south end of the airfield is 600 feet.

A parallel taxiway between runways is not provided and Runway 16R/34L is not served by a parallel taxiway on the passenger terminal side (east side). Aircraft on 16R/34L must exit the runway and cross Runway 16L/34R and taxi on the above described Taxiways A and B. Runway 16R/34L is served by partial parallel taxiways on the west side. These are Taxiways J and C. Taxiway J serves little purpose as a taxi route and occasionally is used to clear the runway of aircraft quickly if needed. In this case, the taxiway serves as a turnaround and aircraft will taxi back, cross both runways and proceed to the terminal destination. Taxiway C serves as access for the Weyerhaeuser hangar and Flight Operations facility.

Runway 16L/34R has ten (including the entrance/exit taxiways at each runway end) exit taxiways, while Runway 16R/34L is served by three angled exits and three right angled exits that connect to Runway 16L/34R. The acute angled (high-speed exit) taxiways are designated as high speed turnoffs (up to 60 mph) but aircraft exiting Runway 16R/34L tend to turnoff at lower speeds (40-45 mph). The slower turnoff speed is needed for adequate braking distance to stop before the Runway 16L/34R holding line and to safely maneuver to cross the runway.

The exit taxiways are described below. Table 2-4 summarizes the present taxiway system at the airport.

Taxiway N. The 30-degree high speed taxiway is the primary exit for aircraft arriving on Runway 16R. It is located about 6,400 feet (1,950 m) from the threshold of Runway 16R. Several airfield surveys have indicated that about 86 percent of class 3 (medium and commuter aircraft) and 76 percent of class 4 (heavy aircraft) use Taxiway N to exit the runway. At high arrival periods with Taxiway N being occupied frequently, some aircraft landing on Runway 16R have to taxi to the end of the runway (Taxiway Q) to exit. Airfield surveys showed that the Runway Occupancy Time (ROT) for an aircraft taxiing to the end of Runway 16R is about twice the ROT for exiting at Taxiway N.

Taxiway J. The 45-degree exit off Runway 16R was originally constructed as a high speed exit for the south flow arrivals and to connect Runway 17/35 (now a parallel segment of Taxiway J) to the terminal area when the runway was in use. Since 1978, however, with the decline of General Aviation operations at the airport, the former runway is only being used as a parallel taxilane and aircraft parking area. Since the runway exit segment of Taxiway J is only 3,300 feet (915 m) from the Runway 16R threshold, only class 1 and 2 (single or twin turboprop) and some commuter aircraft have adequate braking distance to use the exit. Taxiway J continues across Runway 16L/34R and connects to taxiway B, thus serving as an

TABLE 2-4
EXISTING EXIT TAXIWAYS

Taxiway	Location [a] (feet)	Length (feet)	Width [b] (feet)	Exit Type/ Direction
Exits Serving Runway 16R/34L				
D	North end of 16R/34L	800	112.5	90-degree
J	3,300	1,140	75	45-degree SE
H	3,780	1,140	112.5	30-degree NE
N	6,398	1,555	112.5	30-degree SE
P	9,019	800	75	90-degree
Q	9,360	800	75	90-degree
Exits Serving Runway 16L/34R				
North Apron	North end of 16L/34R	335 radius	250	90-degree Apron
H	2,615	835	75	30-degree SE
J	4,000	585	100	45-degree SE
L	5,000	300	100	90-degree
M	5,810	300	100	90-degree
N	7,280	300	490	90-degree
P	9,042	415	139	90-degree
Q	9,360	415	75	90-degree
R	10,030	415	200	90-degree
South Apron	11,790	225 radius	375	90-degree Apron

[a] Location measured from the north end of Runways 16R/34L and 16L/34R.

[b] Excluding taxiway edge.

Source: Taxiway Improvement Study, Seattle-Tacoma International Airport, September 1991, updated by P&D to reflect current taxiway designations and recent taxiway construction.

exit for Runway 16L.

Taxiway H. The taxiway is the only high speed exit on Runway 34L for the north flow arrivals. At 6,345 feet (1,934 m) from the south end of Runway 34L, the majority of aircraft landing at Sea-Tac have adequate breaking distance to use the taxiway. Field observations showed that more than half of class 2 aircraft and 1/3 of commuters use the exit. Surveys have indicated that almost all aircraft using Taxiway H turn onto Taxiway J to reach the apron area. Pilots have a better view of arriving aircraft on Runway 34R when using Taxiway J than on Taxiway H. Turning onto Taxiway J also reduces taxiing distance to the terminal. However, aircraft tend to slow down considerably on Runway 16R to make the turn from H onto J and do not take the full advantage of the high speed exit. A segment of Taxiway H east of Runway 16L/34R connects to Taxiway B. This is a 30° exit for Runway 16L, but due to its location (2,615 feet from the runway threshold) serves only small, general aviation aircraft.

Taxiways D and Q. The two right-angle taxiways at each end of Runway 16R/34L are mostly used by class 3 and 4 aircraft. Field observations showed that in dry runway conditions about nine percent of heavy aircraft use the end taxiways, but the usage increases to about 20 percent in wet conditions. Aircraft using the right-angle exits have to stop and make a 90-degree turn, occupying the runway for a ling time. Also in the south flow direction, airlines having their gate at the South Satellite (Northwest and foreign-flag airlines) tend to use Taxiway Q frequently to reduce taxiing distance to the terminal. Since Taxiway Q connects to the terminal apron it also serves as a right-angle exit that is mainly used for aircraft taxiing to Runway 34L for north flow departures and for intersection departures on Runway 34R.

Taxiway N. Taxiway N (formerly called the Broad Ramp) is used frequently by aircraft arriving on Runway 16R. Due to its proximity to the terminal, commuter and general aviation aircraft also use Taxiway N for intersection departures.

Taxiway L. Taxiway L, a 45-degree exit, is the preferred exit for aircraft landing on Runway 34L. About 34 percent of aircraft arriving on Runway 34R use the taxiway. Small aircraft (classes 1, 2 and commuters) also use Taxiway L for intersection departures in the south flow direction.

Taxiway R. Taxiway R is a 200-foot wide right-angle taxiway that was reopened in 1990 for operations.

Since the completion of the Taxiway Improvements Study, some new taxiway construction has been accomplished. This includes reconfiguration (reducing the width) of Taxiway N, a temporary bypass entrance taxiway and associated connector to the apron (Taxiway P) for Runway 34L, and initial construction of angled exits for Runway 16R-34L (Taxiways M and P).

The throat of Taxiway N was reduced to a width of 490 feet. Taxiway construction projects to be completed by the end of 1994 include reconstruction of Taxiway Q and construction of Taxiways P and M. Taxiways P and M are acute angled taxiways serving Runway 16R and are located approximately 8,000 feet and 5,500 feet, respectively from the end of Runway 16R. As part of the Taxiway P project, a temporary right angled taxiway was constructed. The temporary taxiway was designed for a two year life and the pavement will probably be removed after construction of the permanent Taxiway P is completed.

Construction of Taxiways F and K are

scheduled for 1995. These will serve Runway 34L in a similar manner as Taxiways P and M, and are acute angled exit taxiways located approximately 7,035 feet (Taxiway F) and 4,220 feet from the landing end of the runway, i.e., the threshold of Runway 34L.

Approach Surfaces and Runway Protection Zones

The approach surface and the runway protection zone (formerly called clear zone) are important elements in the design of runways which help to ensure the safe operations of aircraft. A brief description of these two areas follows:

- ***The Approach Surface*** is an imaginary inclined plane beginning 200 feet beyond the end of the runway pavement and extending outward to distances up to 10 miles depending on runway use (i.e., instrument or visual approaches). The width and slope of the approach surface are also dependent on runway use. As the type of instrument approach to a runway becomes more precise, the approach surface increases in size and the required approach slope becomes more restrictive.

  The approach surface is one of five imaginary surfaces defined in FAR Part 77, with the other four being the horizontal, conical, primary and transitional surfaces. The approach surface begins at the end of the primary surface, is bounded by transitional surfaces along the side edges, and intercepts the horizontal and conical surfaces. Definitions of these Part 77 imaginary surfaces are contained in Appendix A.

  If objects extend above the approach surface they are classified as obstructions. Federal Aviation Regulations Part 77 indicates that the approach surface should be kept free of obstructions to permit the unrestricted flight of aircraft in the vicinity of the airport.

  The presence of obstructions in the approach surface can affect the decision height and visibility minimums for an instrument approach procedure.

- ***The Runway Protection Zone (Clear Zone)*** is a trapezodial area at ground level that provides for the unobstructed passage of landing aircraft through the airspace above. The runway protection zone begins 200 feet beyond the end of the runway area that is usable for takeoff or landing, and has a size which varies with the designated use of the runway.

  The runway protection zone is the most critical safety area under the approach path and should be kept free of all obstructions. No structure should be permitted nor the congregation of people allowed within the runway protection zone. Control of the runway protection zone by the airport owner is essential. It is desirable, therefore, that the airport owner acquire adequate property interests, preferably in fee title, in the runway protection zone to ensure compliance with the above.

As indicated above, the approach surface and runway protection zone dimensions are dependent on the type of approach being made to a runway. Runways 16R, 34L and 34R, are equipped with instrument landing systems (ILS) which permit precision instrument approaches. This type of instrument approach requires an RPZ that has an inner width of 1,000 feet, an outer width of 1,750 feet and length of 2,500 feet, and current RPZ's meet these requirements.

The standard FAR Part 77 approach surface slope for runways with precision instrument approach systems is 50 to 1. The available approach surface slope can be as steep as 34 to 1, with reduced approach minimums. The available approach slopes for the precision instrument runways are:

Runway	Approach Slope
16R	50:1
34L	34:1
34R	50:1

Runway 34L has approach minimums of 250 feet decision height and one mile visibility, rather than the standard of 200 feet and 1/2 mile, due to trees on high terrain south of the runway. This terrain could be lowered to provide an available 50:1 approach slope if it were used for construction of a third runway.

Runway 16L is presently the only runway without precision approach capability, but is categorized as a non-precision runway with a published non-precision approach (VOR). Note that a discussion on instrument approach categories is presented in a later subsection. The RPZ associated with the instrument approach to this runway calls for an area 1,700 feet long with an inner width of 1,000 feet and an outer width of 1,425 feet. The current Airport Layout Plan for Sea-Tac indicates an RPZ 2,500 feet long with a 1,000 foot inner width and 1,750 foot outer width beginning 200 feet from the displaced threshold of the runway. The available approach slope is currently 50 to 1 since obstruction (tree) removal has been accomplished.

The control tower is the only structure on-airport that is an obstruction, as defined by FAR Part 77. The control tower is lighted as an obstruction by red obstruction lights.

NAVIGATIONAL AIDS

The Airport is equipped with the navigational aids described below. These "navaids' provide pilots with electronic guidance to and from the Airport.

Airport Surveillance Radar (ASR)

The ASR is used by air traffic controllers in the Terminal Radar Approach Control Facility (TRACON) located at the Airport to sequence, separate, and provide navigational guidance to aircraft in the terminal area environment (i.e., within an approximate 30-nautical mile radius of the Airport). The radar at Sea-Tac is an ASR-9 which is the latest state-of-the-art surveillance radar.

Distance Measuring Equipment (DME)

The Seattle VORTAC, as well as the ILS approaches, are equipped with DME, which provides pilots with electronic distance information from the associated navigational aid.

Instrument Landing system (ILS)

Runways 16R, 34L, and 34R are equipped with ILS Category I approaches. An ILS consists of various components including a localizer transmitter which provide pilots with electronic horizontal guidance, and a glideslope transmitter which provide pilots with electronic horizontal guidance to the Airport. Runway 16R is also equipped with ILS CAT II and III approaches which provide lower landing minimums, but requires special aircrew and aircraft certification for use.

ILS approaches are categorized based on decision height and the horizontal visibility that a pilot has on the runway. The decision height is defined as the height at which a decision must be made during a precision instrument approach to either continue the approach or execute a missed approach. The horizontal visibility is referred to as ***runway visual range (RVR).*** The different classes are:

- Category I (CAT I) - provides approaches to a decision height down to 200 feet and an RVR down to 1,800 feet.
- Category II (CAT II) - provides approaches to a decision height down to 100 feet and an RVR down to 1,200 feet.
- Category IIIA (CAT IIIA) - provides approaches without a decision height (down to the ground) and an RVR down to 700 feet.
- Category IIIB (CAT IIIB) - provides approaches without a decision height and an RVR down to 150 feet.
- Category IIIC (CAT IIIC) - provides approaches without a decision height and without an RVR. This will permit landings in "0/0 conditions," that is weather conditions with no ceiling and visibility as during periods of heavy fog.

The CAT III approach at Sea-Tac permits landings with visibility as low as 300 feet RVR and 0 decision height, and is classified as Category IIIB.

Nondirectional (Radio) Beacon (NDB)

NDB's are collocated with the outer markers which are components of the ILS approaches to Runways 16 and 34. When used in conjunction with the ILS, the NDB's are referred to as "Outer Compass Locators (LOM)." The NDB's provide directional guidance to pilots and serve as tertiary instrument approach aids to Runways 16R and 34R.

Outer, Middle, and Inner Markers (OM, MM, and IM)

The markers are components of the ILS and provide pilots with an electronic indication of their specific location when they are overflown on the final approach course.

Transmissometer

Transmissometers, located near the runways, are components of the ILS which measure the visibility along the runways, referred to as the "Runway Visual Range (RVR)." The RVR facilities consist of a projector and receiver. For Category III runways, three RVRs are required at touchdown, midpoint and rollout locations along the runway. At Sea-Tac, three RVR installations ar located between the existing runways.

Very High Frequency Omnidirectional Range collocated with Tactical Air Navigation (VORTAC)

The Seattle VORTAC is located on the south end of the Airport between the runways. Along with other VORTAC in the national airspace system, the Seattle VORTAC provides enroute navigational guidance to pilots. The Seattle VORTAC also serves as a secondary instrument approach aid to Runways 16L/ 16R and 34L/34R.

Microwave Landing System (MLS)

An MLS is being constructed for an approach to Runway 16L to be used only by non-jet aircraft equipped with MLS receivers. The approach procedure is an offset approach with a 4.5° glide slope. Aircraft will fly an approach 3,500 feet east of the Runway 16L extended center-line. Aircraft will make a right then left "S" turn to land on Runway 16L.

Airport Surface Detection Equipment (ASDE)

The airport is equipped with ASDE which is a type of radar designed specifically to detect all principal features on the surface of the airport, including aircraft and ground vehicles, and present the entire image of the airport's various operational areas on a radar console located in the control tower. It is used to augment visual observations of aircraft and vehicles by controllers in the tower during periods of good visibility, and is a primary means of controlling ground traffic on the runway/ taxiway system during periods of low visibility. The system at Sea-Tac is an ASDE-3, which is the latest version in production.

AIRFIELD LIGHTING

Both runways are equipped with high intensity runway edge lights (HIRL). Runway 16R also has centerline lighting and touchdown zone lighting. Both runways are marked with standard precision instrument markings. These include centerline, designator (runway number), threshold and fixed distance markers, touchdown zone markings and side stripes.

The airport is equipped with the following approach lighting systems and visual aids. These are provided to assist pilots in locating the runway at night or during periods of reduced visibility.

- Medium Intensity Approach Lighting System with Sequenced Flashing Lights (MALSF) - Runway 16L is equipped with a MALSF, which is a 1,400 foot long medium intensity approach light system with sequenced flashing lights installed at the outer three light bars.

- High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF) - ALSF is a 2,400 foot long approach lighting system with sequenced flashing lights the outer 1,400 feet of the system. Runway 34R is equipped with an ALSF1 which is configured for a Category I ILS. Runway 16R is equipped with an ALSF2 which is configured for a Category II ILS. The difference in lighting systems is that the ALSF2 has additional light bars on each side of the approach light lane for the innermost 1,000 feet.

- Medium Intensity Approach Light System with Runway Alignment Indicator Lights (MALSR) - Runway 34L is equipped with MALSR which consist of a 2,400 foot approach lighting system. The first 1,400 feet consists of a standard 1,400 foot medium intensity approach lighting system. Runway alignment indicator lights (RAIL) extend for an additional 1,000 feet.

- The airport is equipped with a Surface Movement Guidance Control System which provides guidance and visual clearance verification to taxiing aircraft during periods of reduced visibility (when the Runway Visual Range (RVR) is less than 1,200 feet). As seen from the previous definitions of ILS categories, this RVR represents Category III conditions. The system consists primarily of taxiway centerline lights and stop bar lights. The stop bar lights function similar to traffic lights and control the flow of aircraft onto the runway. These are located at each hold position. The taxiway centerline lights are used during periods when RVR is less than 1,200 feet. When the RVR is less than 600 feet (which would represent Category IIIB conditions), all taxiway lights are turned off except for the low visibility taxi route to be used for aircraft manoeuvering. Low visibility taxiway centerline lighting is on Taxiways A, B, D, and Q.

The Airport is the only airport in the U.S. certified for operations down to RVR 300.

- Visual Approach Slope Indicator (VASI) - A VASI provides vertical visual glide path information to approaching pilots. Runways 16L and 34L are each equipped with a 6-box VASI set at a standard 3 degree glide path angle for all aircraft except high cockpit aircraft such as the B747. For high cockpit aircraft the VASI is set at 3.25 degrees to provide a sufficient threshold crossing height.

- Rotating Beacon - This visual aid indicates the location of an airport. Alternating white and green beams indicate an airport and the beacons are located either on or close to an airport. The beacon for Sea-Tac is located on top of the control tower and meets current FAA specifications.

METEOROLOGICAL CONSIDERATIONS

Meteorological considerations in this master plan focused on the review of various data obtained from the National Climatic Data Center (NCDC). Wind conditions mainly determine the directions of arrival and departure flows. For Sea-Tac, operations for the south flow have historically been estimated to occur approximately 65 to 70 percent of the time on an annual basis. An analysis of NCDC data for the period January 1, 1982 to March 31, 1992 indicated that wind conditions favored south traffic flows approximately 61 percent of the time on an annual basis. Since the capacity of an airport will vary depending on, among other factors, the weather conditions, the frequency of certain weather conditions is important. P&D also conducted an analysis of cloud ceiling and visibility for north and south traffic flows. The categories of weather conditions (ceiling and visibility) used are shown below. It should be noted that these are not FAA defined categories, but are used for planning purposes since they indicate how operations are conducted at Sea-Tac.

- VFR 1 - Ceiling (the height of clouds, smog, etc., above ground) is at least 5,000 feet, and visibility at least 5 miles. These conditions prevail approximately 56 percent of the time. During VFR 1, dual approach streams are possible. In weather conditions below VFR 1 the Airport is limited to a single arrival stream. Based on the weather analysis, it is concluded that the Airport is limited to a single arrival stream approximately 43 percent of the time.

- VFR 2 - Ceiling is between 2,500 and 4,999 feet, and the visibility more than 3 miles. These conditions occur approximately 20 percent of the time. During VFR 2 the Airport is limited to a single arrival stream.

- IFR 1 - Ceiling is between 800 and 2,499 feet, and visibility more than 2 miles. These conditions occur approximately 17 percent of the time and would be Category I ILS conditions. During IFR 1 the Airport is limited to a single arrival stream.

- IFR 2 - Ceiling is between 200 and 799 feet, and visibility between 1,800 feet RVR and 2 miles. These conditions occur approximately 5 percent of the time and would also be Category I ILS conditions. The airport capacity during IFR 2 is somewhat less than IFR 1 since the need to minimize interference with the glide slope signal slows the flow of departing aircraft.

- IFR 3 - Ceiling is less than 200 feet and visibility between 600 and 1,800 RVR. IFR 3 conditions occur approximately 1.5 percent of the time. These would include Category II, Category IIIA and some Category IIIB ILS conditions. During IFR 3

TABLE 2-5
SEA-TAC WEATHER CONDITIONS YEARLY AVERAGE

Weather	Ceiling	Visibility	South Flow	North Flow	Total
	Feet	Miles			
VFR1	5,000 or more	5 or more	26.7%	29.4%	56.1%
VFR2	2,500 - 4,999	3 or more	15.4%	4.3%	19.7%
IFR1	800 - 2,499	2 or more	14.4%	2.6%	17.0%
IFR2	200 - 799	1,800 RVR - 2 mi	3.4%	2.0%	5.4%
IFR3	Less than 200	600-1,800 RVR	0.7%	0.8%	1.5%
IFR4	Less than 200	Less than 600 RVR	0.1%	0.2%	0.3%
Total			60.7%	39.3%	100.0%

Source: P&D analysis of data obtained from the National Climatic Data Center for the period January 1, 1982 to March 31, 1992.

the Airport is limited to one arrival stream in south traffic flows. In north flows, the Airport cannot accept arrivals due to the lack of CAT II/III ILS on Runways 34L/R.

- IFR 4 - Ceiling is less than 200 feet and visibility is less than 600 feet RVR. These conditions occur approximately 0.3 percent of the time. These would include some Category IIIB and all Category IIIC conditions. As with IFR 3, during IFR 4 the Airport is limited to one arrival stream in south flows and cannot accept arrivals in north flows.

Table 2-5 summarizes the frequency of weather conditions based on aircraft traffic flows.

Other pertinent information obtained from NCDC which is germane to the planning and design of airport facilities is shown below. These represent another set of data from NCDC (Airport Climatological Summary) which was based on a total of 29,211 observations taken at the Airport for the period 1965 to 1974.

- Mean Maximum Daily Temperature of the Hottest Month. 75.6°F (July). This is the airport reference temperature that will be shown on the Airport Layout Plan and used for runway length analyses.

- Precipitation. Total precipitation averages 39.3 inches a year. This includes an average annual snowfall of 19 inches which translates into approximately 2 inches of water, thus the annual rainfall can be estimated at approximately 37 inches. December and January are the wettest months accounting for 13.8 inches of precipitation. Rain occurs on average 205 days a year. Precipitation is important in airport design since it affects aircraft braking performance and is also considered in runway length requirements.

- Ceiling/visibility. Additional ceiling/visibility categories commonly tabulated by NCDC, along with the frequency of their occurrence at Sea-Tac, are as follows:

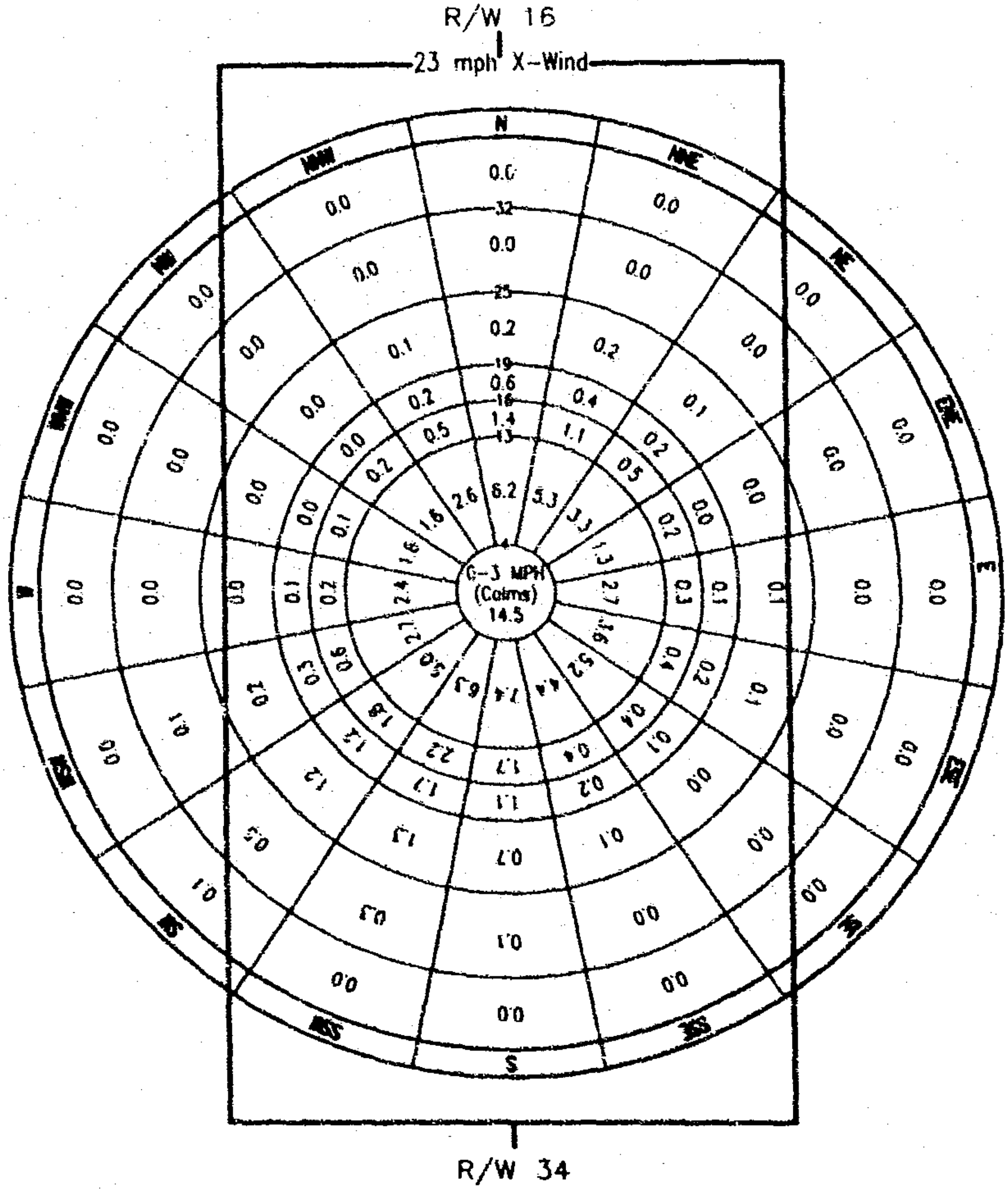
Ceiling Less Than and/or Visibility Less Than	Percent Occurrence
1,500 feet/3 miles	14.9
1,000 feet/3 miles	9.4
400 feet/1 mile	3.5
200 feet/1/2 mile	1.5
100 feet/1/4 mile	0.8

- Visual flight rules (VFR) conditions are defined in the Federal Aviation Regulations (FAR) as weather conditions when the ceiling is 1,000 feet or more and visibility is 3 miles. Instrument flight rules (IFR) conditions are defined as conditions when ceiling is less than 1,000 feet and/or visibility less than 3 miles. It is seen from the above, that basic VFR minimums prevail 90.6 percent of the time.

  While basic VFR weather conditions occur 90.6 percent of the time, from an operational standpoint the Airport is restricted to a single arrival stream during certain VFR conditions, i.e., when ceilings are between 2,500 and 4,999 feet and visibility is greater than 3 miles (VFR 2). This is because aircraft conducting simultaneous arrivals may not be able to maintain the required visual separation under VFR2 conditions.

- Wind Rose. Figure 2-3 presents an All-weather wind rose based on 90,550 observations for the period 1948-1978. It is recommended that this data be used for wind coverage as represented on the Airport Layout Plan. This indicates prevailing winds from the southwest.

FIGURE 2-3
ALL WEATHER WIND ROSE



SOURCE: BASED ON 90,550 OBSERVATIONS TAKEN AT SEATTLE-TACOMA INTERNATIONAL AIRPORT FOR THE YEARS 1948-1978. NATIONAL CLIMATIC DATA CENTER.

Section 3
EXISTING AIRSPACE SYSTEM

SECTION 3
EXISTING AIRSPACE SYSTEM

Section 3 of this report presents a discussion of the Seattle area airspace system. P&D originally inventoried the Sea-Tac airspace environment as part of an airspace study conducted in 1988. The discussion presented herein represents an updated version of the original text (*Comprehensive Planning Review and Airspace Update Study, Working Paper 1. P&D Technologies, March 1988*). This discussion provides the background information required to proceed with the subsequent detailed modeling of airfield capacity. The section includes an explanation of the existing airspace configuration, airspace usage, visual and instrument flight rule (VFR and IFR) operations, flow control procedures, and existing interactions under north and south flow conditions.

Interactions between Boeing Field and Seattle-Tacoma International Airport (Sea-Tac) occur primarily during south flow conditions with cloud ceilings less than 2,500 feet, and during all IFR weather conditions. Although statistics indicate these weather conditions occur approximately 15 percent of the time, air traffic control (ATC) procedures have been developed to minimize the loss of airfield capacity due to the interactions. The next phase of the airspace study will further analyze the quantitative effects of these interactions on capacity.

AIRSPACE CONFIGURATION

The Seattle-Tacoma Terminal area airspace is shown in Figure 3-1. This airspace has been delegated to the Sea-Tac Terminal Radar Approach Control (TRACON) facility by the Seattle Air Route Traffic Control Center (ARTCC or Center). The Center provides Air Traffic Control (ATC) services to aircraft between terminal areas. The Seattle TRACON provides approach/departure control services within its delegated airspace. Eight of the busiest airports within the Seattle TRACON's airspace have Air Traffic Control Towers (ATCT) or "towers". These towers provide control within their respective airport traffic areas (ATA). The airports within the TRACON's airspace that have control towers are listed below:

- Boeing Field/King County International
- Gray Army Air Field
- McChord Air Force Base
- Olympia Airport
- Renton Municipal
- Seattle-Tacoma International
- Tacoma Narrows
- Paine Field

The Center and TRACON provide control primarily to aircraft operating under instrument flight rules (IFR). In addition, TRACON provides control or service to aircraft operating under visual flight rules (VFR) within the Seattle Class B Airspace, (formerly TCA). An ATC clearance and control is mandatory for VFR aircraft operating within Class B airspace. The Seattle Class B Airspace Area is depicted on Figure 3-1.

Published instrument approach procedures exist for nine airports within the Seattle TRACON airspace as listed in Table 3-1.

Table 3-1 differentiates between precision and nonprecision approaches. A precision approach, by definition, provides electronic vertical guidance to the pilot as well as horizontal (azimuth) guidance. A nonprecision approach provides horizontal guidance only. Generally the azimuth guidance for a precision approach is

FIGURE 3-1
AIRSPACE AREA BOUNDARIES SEATTLE TRACON

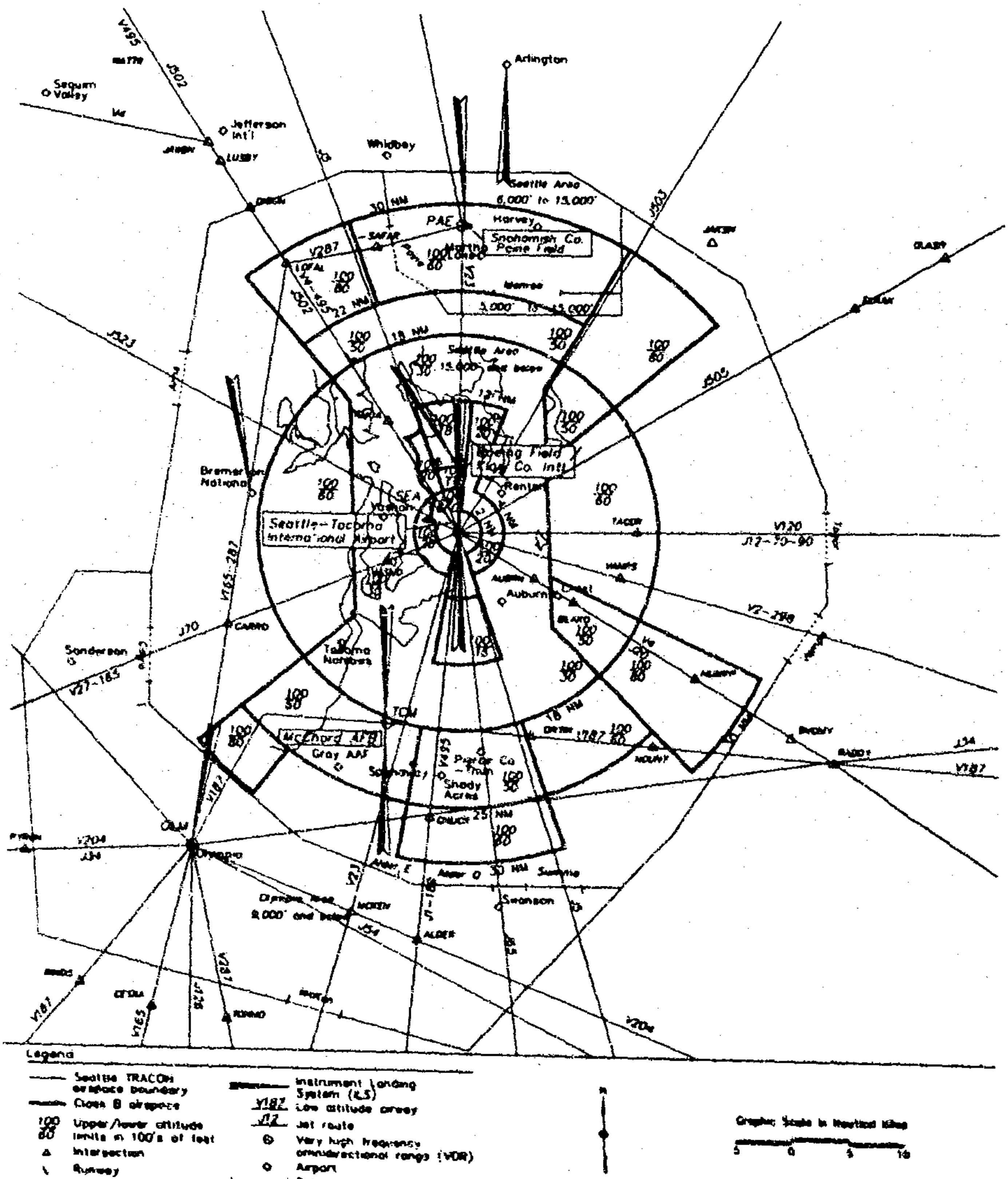


TABLE 3-1
PUBLISHED IFR APPROACH PROCEDURES [a]

Airport Name	Runway	Procedures [b]
1. Boeing Field/King County International	13R 31L	ILS (CAT I) LOC BC
2. Bremerton National	1 19	NDB ILS (CAT I)
3. Gray Army Air Field	15 33	ILS, NDB VOR, NDB
4. McChord Air Force Base	34 16	ILS, HI-TACAN ILS, TACAN
5. Olympia	17 35 to airport	ILS (CAT I) VOR/DME VOR-A
6. Renton Municipal	15	NDB
7. Seattle-Tacoma International	16R 34L 34R 16L/R 34L/R	ILS (CAT III B), NDB ILS (CAT I) ILS (CAT I), NDB VOR VOR
8. Shelton/Sanderson Field	to airport	NDB-A
9. Tacoma Narrows	17 35	ILS (CAT I) NDB

[a] Source: United States Government Flight Information Publication, "U.S. Terminal Procedures" Northwest (NW) Volume 1.

[b] Abbreviations:

DME = distance measuring equipment
ILS = instrument landing system
LOC BC = localizer back course
NDB = nondirectional (radio) beacon
TACAN = tactical air navigation
VOR = very high frequency omnidirectional range

more precise. For an Instrument Landing System (ILS) approach procedure, a localizer transmitter provides the azimuth guidance and a glide slope transmitter provides the vertical guidance.

AIRSPACE USAGE

All aircraft flights are governed by either visual flight rules (VFR) or instrument flight rules (IFR). Definitions are contained in FAR Part 91. The basic difference between VFR and IFR is that the pilot maintains spatial orientation of an aircraft by reference to the earth's surface for VFR and by reference to aircraft instruments for IFR. Under IFR rules, the pilot can operate in poor visibility conditions and must have an ATC clearance when operating in controlled airspace. Flight under VFR rules requires good visibility and maintenance of specified distances from clouds.

- VFR. When weather conditions are good (when the cloud ceiling is 1,000 feet or more above the surface and the visibility is 3 miles or more), flight may be conducted in accordance with VFR. Outside controlled airspace the weather requirements are less stringent.

- IFR. When weather conditions are poor (when the cloud ceiling is less than 1,000 feet or the visibility is less than 3 miles), aircraft are required to fly according to IFR in controlled airspace. Outside controlled airspace the weather requirements are less stringent.

Although IFR weather conditions in the Seattle region occur only about 15% of the time, air carrier aircraft and many military and high-performance general aviation aircraft operate according to IFR regardless of the weather conditions.

The Seattle terminal airspace area includes nine IFR airports and approximately thirty VFR airports. Two of the IFR airports are military, McChord AFB and Gray AAF and ten of the VFR airports are private or restricted and generally not available to the public.

IFR Operations

Air carrier and many turbojet general aviation and military aircraft operating to or from the Airport under IFR, are assigned coded flight routes and procedures referred to as Standard Instrument Departures (SIDs) and Standard Arrival Routes (STARs). These SID and STAR routes are depicted on Figure 3-2 for north flow and on Figure 3-3 for south flow. These figures also depict arrival and departure gates. Navigation of IFR aircraft within the Seattle TRACON airspace is generally provided by radar vectors to achieve efficient sequencing, spacing, and separation between aircraft. Therefore, actual aircraft flight tracks, particularly closer in to the Airport, will not conform exactly with the gates, SIDS, and STARS depicted.

In general, however, IFR arrival aircraft are cleared to the Airport by the Seattle Center via these STARs, while descending from enroute altitudes. These aircraft arrivals are "handed off" via radar from the Seattle Center to the Seattle TRACON at various entry points referred to as "gates".

In April, 1990 the Federal Aviation Administration standardized the air traffic patterns for jet aircraft flying in and out of Sea-Tac. The new air traffic plan referred to as the "4-Post Plan", changed the arrival and departure procedures used by the traffic controllers to transfer the aircraft from the enroute to the terminal environment. The FAA determined that safety and efficiency could be improved if the procedures used to route air traffic to the

FIGURE 3-2
STANDARD INSTRUMENT DEPARTURE AND ARRIVAL ROUTES NORTH FLOW

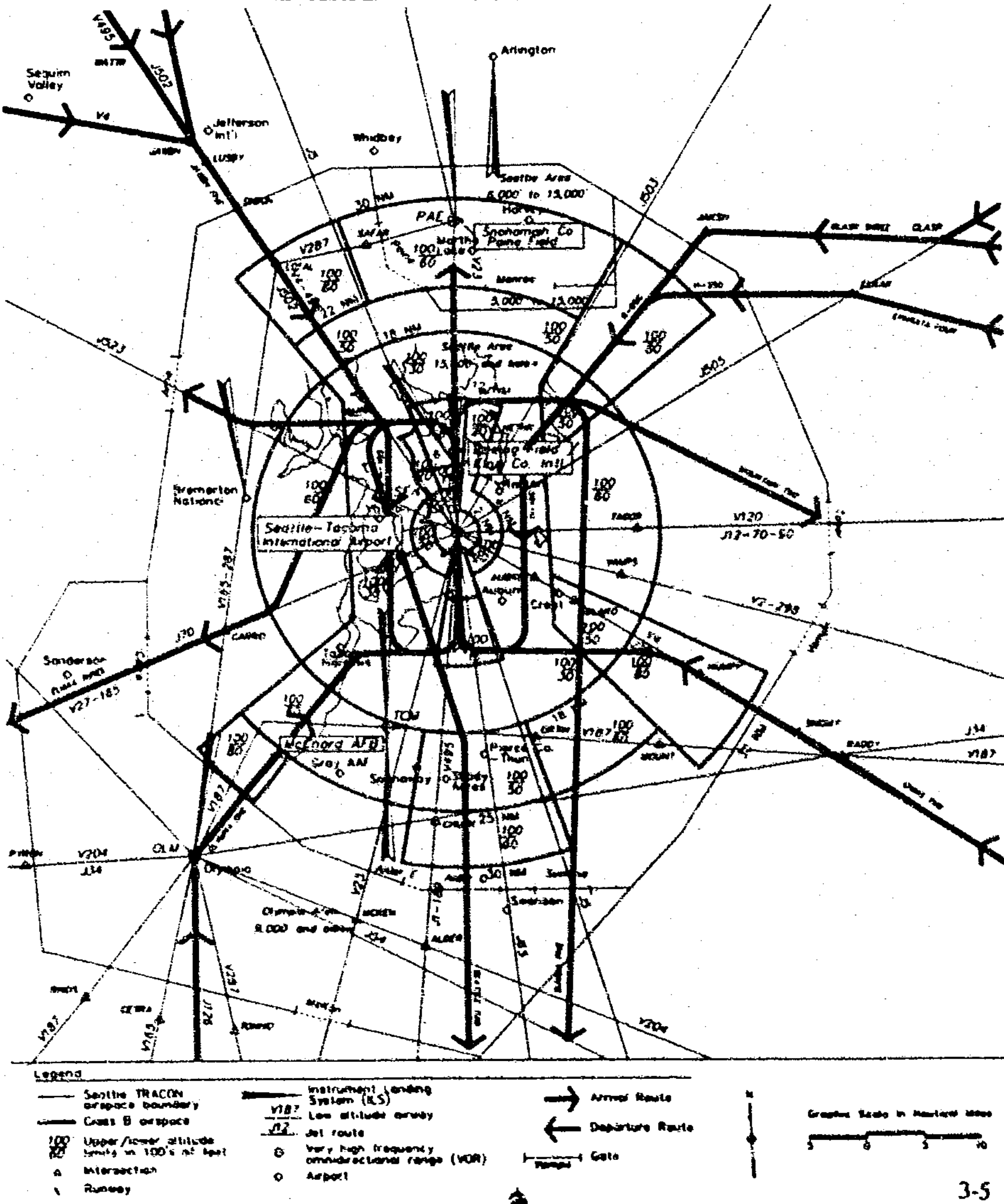
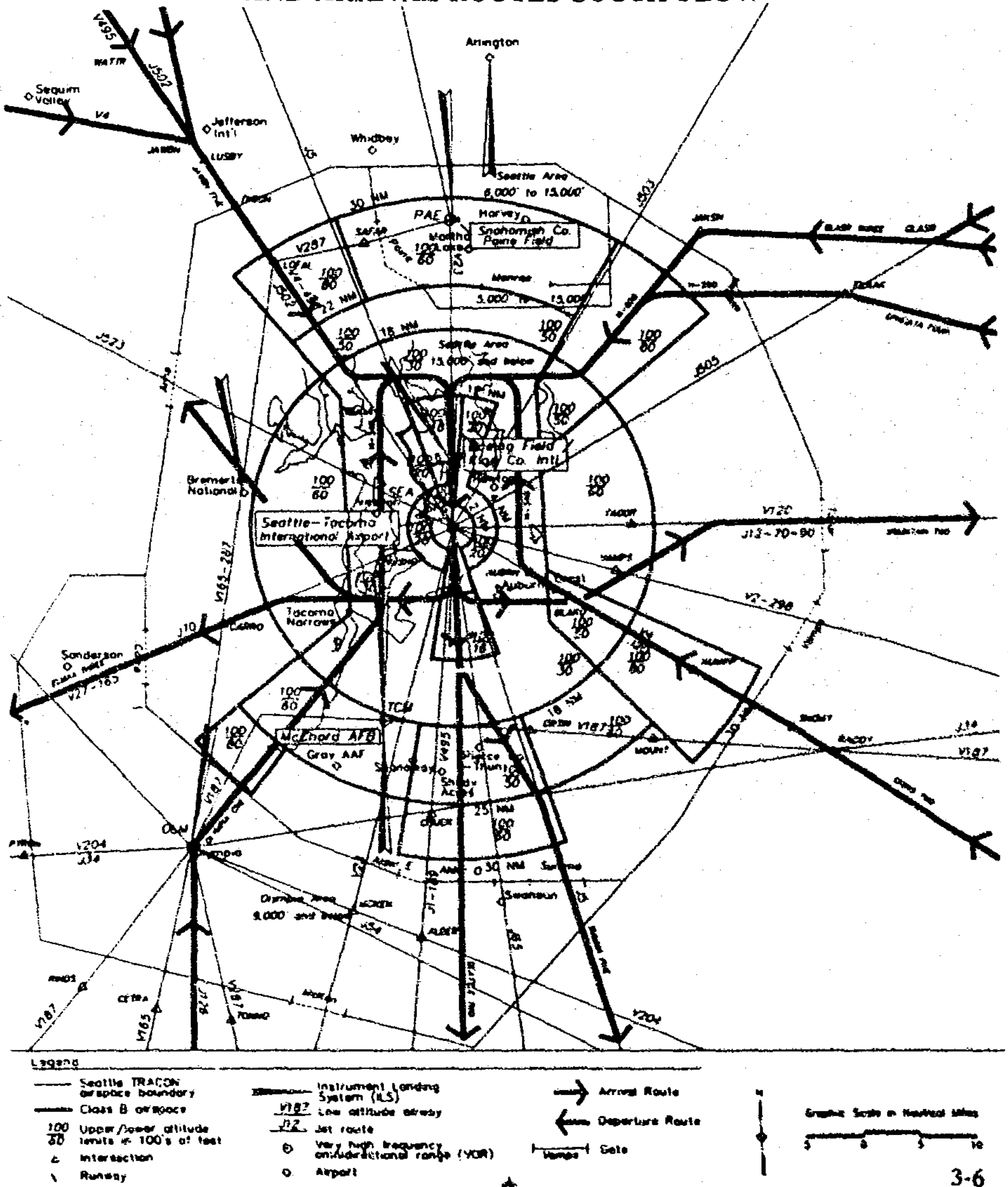


FIGURE 3-3
STANDARD INSTRUMENT DEPARTURE AND ARRIVAL ROUTES SOUTH FLOW



terminal airspace area were designed to be the same regardless of the direction of traffic flow. Depending on the city of origin, aircraft enter the terminal airspace from one of the four "posts", or corners of the terminal airspace area. These procedures helped to alleviate difficulties associated with having two different sets of patterns that were wind dependent.

The TRACON assumes responsibility for guiding the arrival aircraft to the final approach course at the destination airport and separating it from other aircraft. Lower performance aircraft, and some commuter/air taxi aircraft, operate at lower altitudes below or clear of the jet aircraft routes. The lower performance aircraft are "laced" into the arrival routes closer in to the Airport to minimize the effects of the speed differentials.

When arrival aircraft are in the vicinity of their destination airport they are given descent instructions by TRACON until they are approximately 1,500 feet above the airport and approximately 5 nautical miles from the runway threshold on the final approach. At approximately 5-10 nautical miles from the airport, TRACON clears them for the approach and instructs the pilot to contact the destination airports tower.

Similarly, departing IFR aircraft are guided by the Seattle TRACON through its delegated airspace and separated from other aircraft. Shortly after departure aircraft are airborne, the tower clears the aircraft to contact the TRACON for departure control. The TRACON then directs departing aircraft toward the departure gates. Similar to arrivals, departing low performance aircraft are turned immediately after take off to separate them from the jet departure stream and are kept at lower altitudes. As soon as departing aircraft either pass the departure gate or climb out of the TRACON airspace, they are transferred to ARTCC for enroute control.

Unless visual separation is applied, TRACON provides all IFR aircraft with a radar separation of at least 3 nautical miles longitudinally or 1,000 feet of vertical separation throughout their terminal airspace. Additional longitudinal separation to avoid wake turbulence is provided for various combinations of aircraft sizes. The minimum longitudinal separation in terminal airspace is listed below:

Aircraft Longitudinal Separations [1]

Lead Aircraft Classification	Aircraft Classification	Separation (Nautical Miles)
Heavy	Heavy	4
Heavy	Large	5
Large	Small	4
Heavy	Small	6

[1] Source: FAA Handbook 7110.65L, "Air Traffic Control" with changes.

For the purposes of wake turbulence separation minims, FAA classifies aircraft as Heavy, Large and Small as follows:

- Heavy. Aircraft capable of takeoff weights of 300,000 pounds or more whether or not they are operating at this weight during a particular phase of flight.
- Large. Aircraft of more than 12,500 pounds, maximum certified takeoff weight, up to 300,000 pounds.
- Small. Aircraft of 12,500 pounds or less maximum certified takeoff weight.

Within the Seattle Class B airspace, the Seattle TRACON provides all VFR aircraft a radar separation of 1/2 nautical mile longitudinally or 500 feet of vertical separation from all IFR and

VFR aircraft.

VFR Operations

Flights conducted under VFR, unlike IFR flights, are not always under ATC jurisdiction. Under VFR, pilots may normally operate without an ATC clearance except when operating within Class B Airspace. When operating in visual meteorological conditions, all pilots, regardless of type of airspace flight plan or ATC clearance, are ultimately responsible to see and avoid other aircraft.

The lower altitudes of airspace to the east and west of the Seattle area are restricted by the Cascade and Olympic Mountains. These mountains and the Class B Airspace tend to channel north/south VFR traffic. One north/south channel or VFR flyway exists at approximately 5 to 6 miles east of the Sea-Tac Airport and below 4,000 or 5,000 feet above mean sea level (MSL). The other north/ south VFR flyway is somewhat wider, extending over the Puget Sound west to the Olympic Mountains. Those transiting under Class B Airspace in the vicinity of Sea-Tac and over the Puget Sound are below 3,000 feet. Some VFR aircraft fly over the tops of the Class B Airspace. The top of the Class B Airspace is at 10,000 feet above MSL.

FLOW CONTROL

During peak air traffic periods of the day, especially during bad weather, arrival aircraft traffic demand exceeds the arrival capacity of Sea-Tac Airport. In the past, when this occurred, TRACON would advise ARTCC to place arrivals in holding patterns at the edge of TRACON airspace. Because it is more efficient for delays to be absorbed enroute, a procedure called Flow Control has been developed. In extreme conditions, aircraft destined for Sea-Tac may be held on the ground at the departure airport prior to takeoff.

In general, Flow Control refers to a procedure allowing TRACON to determine the maximum hourly rate of arrivals to Sea-Tac. The TRACON advises Seattle Center so that adjustments can be made to the rate of entries into TRACON airspace. This hourly rate of arrivals is known as the Airport Acceptance Rate (AAR). The AARs for Sea-Tac are shown in Table 3-2 as provided by the TRACON. The AAR varies according to several conditions including number of runways available for landings, weather conditions, direction of traffic flow, types of approach in use, and runway operational conditions. Because Sea-Tac is located in the northwestern part of the contiguous continental U.S., most air traffic is to or from the south and east. The portion of traffic related to the north and to the Pacific region however has been growing in recent years.

EXISTING INTERACTIONS

The term interaction as use in this report refers to a situation requiring special controller and/or pilot attention to ensure adequate separation or sequencing is accomplished. Although this broad definition could include random occurrences that do not affect capacity, there are two interactions which affect Sea-Tac capacity that occur regularly during IFR weather conditions and one that occurs regularly when visual approaches are in progress.

These three interactions occur during: (1) IFR south flow conditions; (2) IFR north flow conditions; and (3) visual approaches in south flow conditions.

IFR Weather Conditions-South Flow

During IFR weather conditions when Sea-Tac and Boeing Field are operating with south

TABLE 3-2
SEA-TAC AIRPORT ACCEPTANCE RATES (AAR's) [a]

1. Runways - Weather - Flow - Conditions - AAR -	Both available for arrivals. Visual approach conditions or above (VFR). North and south. Visual approaches in use and aircraft see each other and pilots provide visual separation. **60**
2. Runways - Weather - Flow - Conditions - AAR -	Both available for arrivals. Visual approach conditions or above and pilots do <u>not</u> provide visual separation and do not see each other (IFR1). [b] North and south. Visual approaches in use. **48**
3. Runways - Weather - Flow - Conditions - AAR -	Both available for arrivals. Basic VFR to visual approach conditions for visual approaches (IFR1). [c] North and south. Jets making ILS/straight in approaches. **36/8 [d]**
4. Runways - Weather - Flow - Conditions - AAR -	Single available for arrivals. Basic VFR to visual approach conditions for visual approaches (IFR1). [c] North and south. Departures can use other runway. **36**
5. Runways - Weather - Flow - Conditions - AAR -	Single available for arrivals. IFR - ILS approaches (no visual approaches) (IFR1). North and south. Departures can use other runway. **36**
6. Runways - Weather - Flow - Conditions - AAR -	Single available for all operations. Basic VFR and above (IFR2). North and South Departures use arrival runway. 24 - 50/50 rate [e]
7. Runways - Weather - Conditions - AAR -	Single available for all operations. IFR - ILS approaches (no visual approaches) (IFR2 and 3). Maintenance closure (runway) Runway 16R = 24 - 50/50 rate [e] Runway 34R = 16 - 50/50 rate [e]

[a] AAR figures, not airport conditions, are given to ARTCC. AAR figures do not include provision for 8-12 internal arrivals in VFR conditions.
[b] Visual approaches can normally be conducted when cloud ceiling is at least 5,000 feet and pilots have visual contact with the preceding aircraft.
[c] Basic VFR = Cloud ceiling at least 1,000 feet and visibility at least 3 statute miles.
[d] The slant, "/8", rate indicates arrival rate for additional piston driven and certain turboprop aircraft entering the airport traffic pattern and executing a visual approach.
[e] 50/50 rate = 50% arrivals/50% departures (i.e. 24 arrivals/24 departures).

flows, interactions exist between the arrivals to the two airports. Although a minimum of 1,000 feet of altitude separation exists between the published Instrument Landing System (ILS) approaches, a need exists to protect a Boeing Field missed approach possibility. In weather conditions which allow Boeing Tower controllers to see the Sea-Tac arriving aircraft, visual separation is provided by the controllers and no loss in capacity is experienced. This operating arrangement is known as Plan Alpha. Cloud ceilings at Boeing must be at least 2,500 feet for Boeing Tower personnel to see Sea-Tac arrivals. The yearly frequency of occurrence of south flow conditions, with ceilings below 2,500 (no Plan Alpha) feet is approximately 17 percent. Based on observations, this is estimated to drop to about 16 percent during the busiest part of the day, 7:00 a.m. to 9:00 p.m. Additionally, weather conditions below minimums (closed conditions) at Sea-Tac would reduce the occurrence of the interaction by another 1 or 2 percent.

Weather statistics indicate this interaction should occur approximately 15 percent of the time. However, the actual time of this impact on capacity is less because of special ATC procedures. Under these procedures, during certain weather conditions and with pilots familiar with Boeing Field, the Sea-Tac approaching aircraft will be advised to maintain 3,000 feet MSL until Boeing Tower advises TRACON that the landing of the other aircraft at Boeing Field is assured. At this point the Sea-Tac approaching aircraft pilot is given his final approach clearance and authorization to land. If the Boeing Field approaching pilot executes a missed approach, TRACON will vector the Sea-Tac approach back into the arrival stream and one arrival interval or slot is lost in arrival capacity at Sea-Tac. However, this situation occurs very rarely.

If the pilot familiarity with Boeing Field is unknown, the TRACON will leave an interval or empty slot in the Sea-Tac arrival stream in order to provide for a potential missed approach at Boeing Field. This situation results in the loss of one or two arrival intervals in the arrival capacity at Sea-Tac. The frequency of this occurrence is dependent on arrival demand at the two airports and the percentage of low-familiarity pilots in the arrival stream to Boeing Field.

IFR Weather Conditions - North Flow

During north flow IFR conditions, interactions exist between the arrivals to Boeing Field and departures from Sea-Tac. Sea-Tac departures are held on the ground from the time a Boeing arrival nears the final approach fix located just east of Sea-Tac until Boeing Tower reports the landing is assured or until visual separation can be provided. This situation can result in the loss of more than one interval in the Sea-Tac departure capacity. If a Sea-Tac arrival is within 2 nautical miles of the Runway 34R threshold, a departure from Sea-Tac in certain IFR conditions cannot be released. As a result one to three intervals could be lost.

Visual Approaches - South Flow

Visual approaches can normally be conducted to Sea-Tac Airport when the cloud ceiling is at least 5,000 feet over the Puget Sound and pilots have visual contact with the preceding aircraft or airport.

When visual approaches are being conducted, the TRACON will radar vector aircraft on three arrival routes and sequence them into a common arrival stream over Elliott Bay. This activity takes place over the top of straight-in arrivals to Boeing Field.

During peak periods, both Runways 16L and 16R at Sea-Tac Airport are used if visual approach conditions exist. Two common arrival streams are formed over Elliott Bay. This situation requires special attention on the part of both controllers and pilots. When pilots are making the turns into Elliott Bay from the north and south, visibility from the cockpit is reduced. If two aircraft are about to make the turn at about the same time onto different arrival streams, one pilot often tends to reduce speed and fall back in order to keep the other aircraft in sight. This will increase the longitudinal spacing in the arrival stream and reduce the arrival rate.

Section 4
LANDSIDE FACILITIES

SECTION 4
LANDSIDE FACILITIES

INTRODUCTION

At Sea-Tac the landside facilities include aircraft parking aprons, passenger terminal, cargo facilities, airline maintenance hangars, airport maintenance facilities, fire station, flight kitchens, and fuel facilities. The landside facilities at the Airport are generally located on the east side of the airport along Runway 16L-34R except for the Weyerhaueser Corporate Hangar located on the westside of the airfield. Ground access, also a landside element, is treated as a separate component since it deals with facilities for ground transportation as opposed to facilities for aircraft operation.

Land use in the terminal area is very intensive. The passenger terminal is situated south of the midpoint of the runway system. Air cargo facilities primarily are situated north of the passenger terminal, and most airline maintenance hangars are generally located south of the passenger terminal. Expansion capabilities of the various components are limited toward the airside (to the west) and the airport access roads and SR-99 constrict the development of the terminal area to the east.

PASSENGER TERMINAL BUILDING

The Port of Seattle undertook a Terminal Development Program (TDP) planning effort in 1991 to define a plan for expansion of the terminal building to effectively handle future passenger demands. This section of the terminal area building inventory is largely based upon report material from the TDP. The information on existing building facilities has been updated to reflect present conditions.

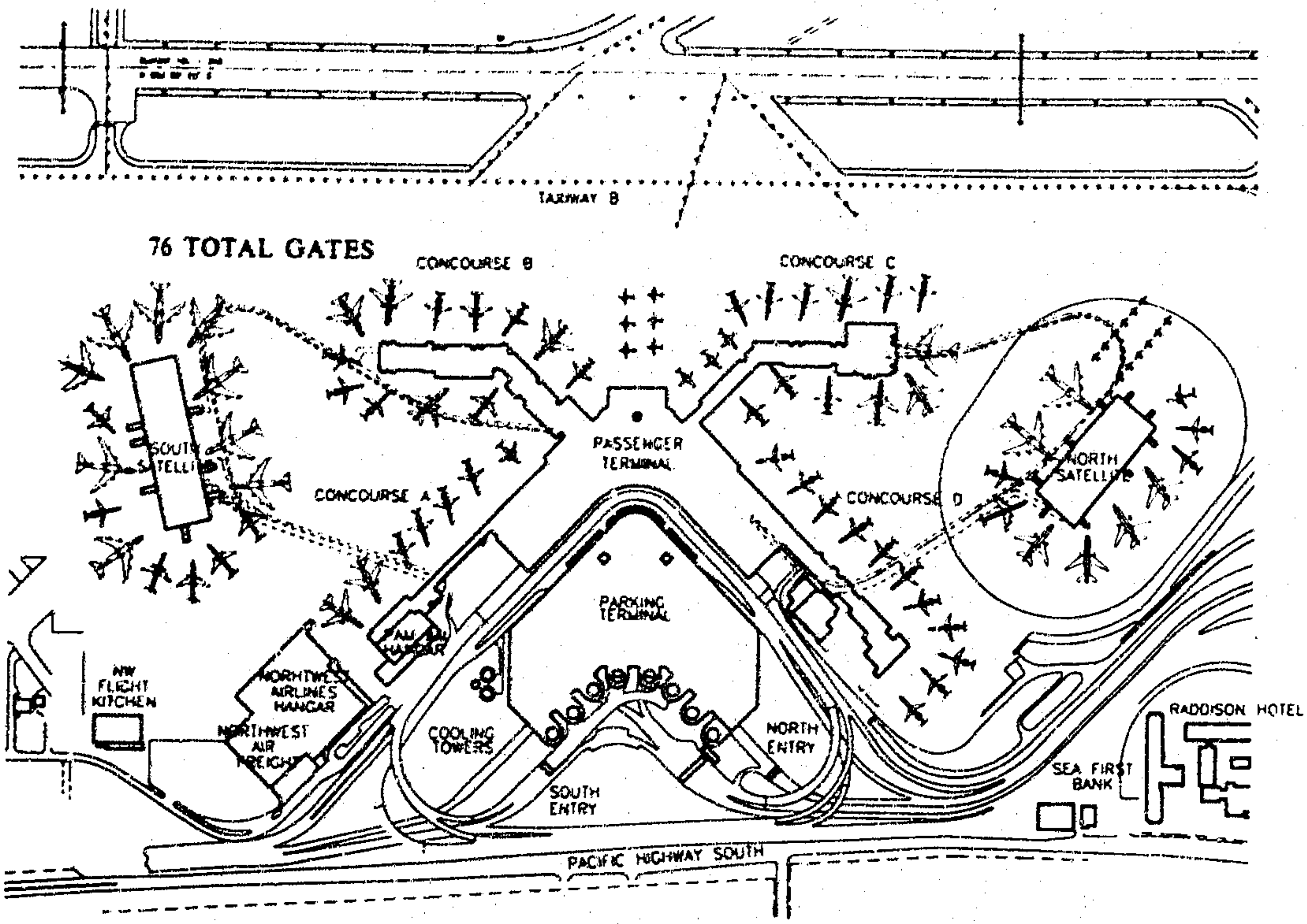
The origin of the present terminal at Sea-Tac extends back to 1949 when two airlines, Northwest and United, served the airport. The original terminal facilities, including support systems and landside/airside interfaces, have been modified many times over the ensuing years. Terminal modification projects of various types were undertaken in 1959, 1961, 1964, 1965, 1966, 1967 and 1970. A major renovation and expansion project, completed in 1973, gave the terminal its present size and form, including its subsurface transit system and satellites. In 1983 an expansion of the international facilities and in 1986 an expansion of the main terminal building were accomplished. In 1992 a expansion and refurbishment of Concourses B, C and D was completed. These have serviced the airport well as the number of airlines and traffic levels since 1973 have increased more than three-fold. Primarily as a result of airline deregulations, the demand for space in the terminal has exceeded availability. The plan of the current terminal is depicted in Figure 4-1. This plan reflects the one bay expansion to the north end of the main terminal, the Concourse D addition, and the expansion of the parking structure completed in 1992.

The passenger terminal complex is comprised of the components described in following subsections.

Main Passenger Terminal

The main passenger terminal at Sea-Tac is the primary focus of the terminal complex. This facility includes four concourses connected directly to the main terminal and two satellites which are linked by a subsurface people mover transit system (STS). Within the main terminal are passenger and baggage processing functions, administrative and security facilities,

FIGURE 4-1
EXISTING TERMINAL PLAN



concessions, and an FAA control tower. The main body of the terminal is arranged on 8 levels, with the FAA control tower comprising Levels 9 through 13. The satellite transit system is at the basement level. All areas of the main terminal are generally well maintained and in good condition. It should be noted that the overall condition of this facility is used as a standard from which to draw comparisons on the condition of other terminal facilities.

Concourses

Concourse A. Concourse A is a single loaded concourse (aircraft parked on one side only) providing a total of seven boarding gates for America West, Mark Air, TWA, and USAir. It is a two level concourse with a ramp level and a concourse level. The concourse is approximately 35 feet wide at the narrowest portion on the concourse level and 900 feet long. The existing condition of the public areas of Concourse A is fair as compared to the main terminal. There is a general need to upgrade the finishes in the public areas to provide consistency with the condition and quality found in the main terminal building.

Concourse B. Concourse B is a double loaded concourse (having aircraft parked on both sides) providing a total of 13 boarding gates for Delta, Air BC, Continental, Harbor, and Reno Air. It is a two level concourse consisting of a ramp level and concourse level with a transit station below ramp level. The concourse is approximately 56 feet wide at the narrowest portion on the concourse level and is about 930 feet long. The concourse has recently undergone an expansion and refurbishment program completed in 1992. Additional holdrooms and concessions areas have been provided. The overall condition of Concourse B is equal to the quality of the main terminal with the exception of the terrazzo floor.

Concourse C. Concourse C is a double loaded concourse providing a total of fifteen boarding gates for Alaska, American, Canadian Regional and Horizon. It is a three level concourse consisting of a ramp level, concourse level, and partial mezzanine level, with a transit station below the ramp level. The concourse is approximately 56 feet wide at the narrowest portion on the concourse level and is about 930 feet long. The concourse has recently undergone an expansion and refurbishment program completed in 1992. Additional holdroom and concession areas are located on the concourse level. American Airlines Club rooms and office space are located on the mezzanine level. The overall condition of Concourse C is equal to the quality of the main terminal with the exception of the terrazzo floor.

Concourse D. Concourse D is a single loaded concourse providing a total of eleven boarding gates for Alaska. It is a two level concourse with a ramp level and a concourse level. The concourse is approximately 70 feet wide at the narrowest portion on the concourse level and is about 1,020 feet long. The concourse has recently undergone a six gate expansion and refurbishment program completed in 1992. Additional holdrooms and concession areas have been provided in the existing portion of the concourse. The overall condition of Concourse D is equal to the quality of the main terminal with the exception of the terrazzo floor.

Satellites

North Satellite. The North Satellite is a three level building with a transit level, ramp level and concourse level. The satellite provides a total of 16 boarding gates for United and United Express. North Satellite is approximately 478 feet long and 190 feet wide on the concourse level. This satellite provides a public space with the quality of the main terminal.

South Satellite. The South Satellite is a six level building with a basement level, transit level, mezzanine level, ramp level, international corridor level and a concourse level. The South Satellite houses a consolidated Federal Inspection Services (FIS) facility for arriving international passengers. Although all international arriving passengers must be processed through the South Satellite, international departures may occur at any domestic gate in the terminal which can accommodate the type of aircraft required. The South Satellite provides a total of fifteen boarding gates for British, China Eastern, Hawaiian, Southwest, EVA, Aeroflot, Martinair, Northwest KLM, and SAS. This satellite provides a public space equal to the quality of the main terminal.

Baggage Conveyor Systems

There are currently several baggage conveyor systems and facilities within the terminal complex. All of the baggage processing systems at Sea-Tac are owned and maintained by the Port of Seattle. This policy was established during the terminal expansion of the early 1970s. The domestic and international baggage systems may be categorized as outbound baggage, inbound baggage, and interline baggage.

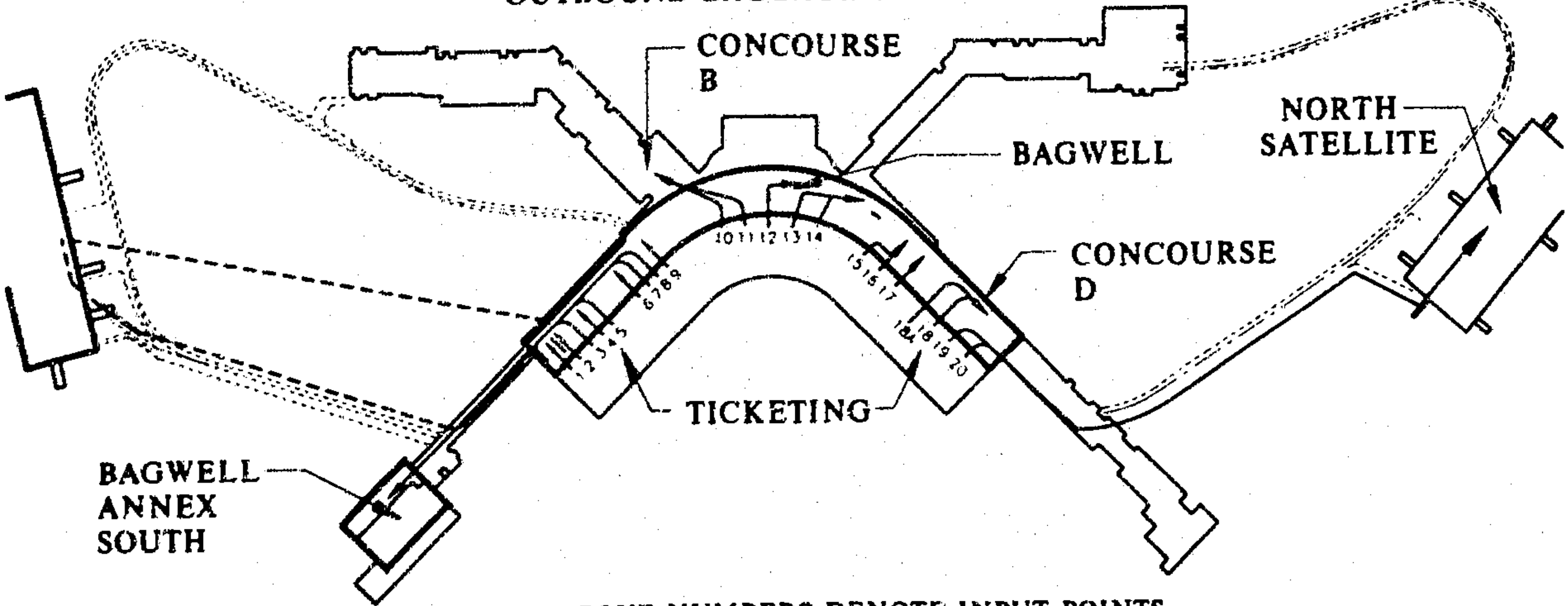
Outbound Baggage Systems. Twelve years ago the entire outbound baggage system was located in the bagwell of the main terminal building, with the exception of Delta's outbound baggage system located on the apron level in the throat of Concourse B. To expand the capacity of the outbound baggage system other facilities were added. These include: 1) The Bagwell Annex-South, located in the expanded Pan Am Hangar at the end of Concourse A. This location currently has one large racetrack sorting device used by Northwest and a smaller racetrack sorting device shared by TWA and Southwest; 2) The apron level of Concourse D contains a new automated pier sort system used by Alaska; 3) The apron level of the North Satellite contains a laser/bar code sorting system used by United. The remainder of the airlines serving Sea-Tac continue to use the Bagwell for their outbound baggage systems. The systems found in the Bagwell range from simple indexing belts of varying lengths to various types of racetrack sorting systems. All outbound baggage systems originate on the ticketing level and move into the bagwell through floor openings. There are currently two curbside conveyors, one each for Alaska and United Airlines. Six more curbside conveyors have been planned.

The outbound baggage system is considered to be in good operational condition. A conceptual diagram of the outbound baggage system is shown in Figure 4-2.

Inbound Baggage System. With the exception of the FIS baggage claim, all of the baggage claim facilities are located on the lower level of the main terminal. Several types of claim devices are used including oval and circular carousals which are remotely fed from above or below the unit, and flat crescent plate recirculating devices which are fed directly from the inbound baggage drop points behind the wall. In theory, all claim devices are shared by more than one carrier, although individual carriers do tend to use the same units and locations on a regular daily basis.

The inbound baggage conveyors and baggage claim devices are in good condition. Claim devices 5 and 6 are scheduled to be replaced with a single larger claim device, as are claim devices 10 and 11. A conceptual diagram of the inbound baggage system is shown in Figure 4-3.

FIGURE 4-2
OUTBOUND BAGGAGE SYSTEM



NOTE: ABOVE NUMBERS DENOTE INPUT POINTS

MAIN TERMINAL BAGWELL

1	USAIR	· RACETRACK
2	CHINA EASTERN, SAS	· INDEX BELT
4	BRITISH AIR	· INDEX BELT
6	AMERICA WEST	· INDEX BELT
9	CONTINENTAL, AIR BC	· RECIRCULATING DEVICE
12	EVA	· INDEX BELT
13	MARTIN AIR	· RACETRACK
14	AMERICAN, CANADIAN REGIONAL	· RACETRACK
16	CHARTERS	· RACETRACK
17	RENO AIR, HARBOR	· RACETRACK

BAGWELL ANNEX · SOUTH

3,5	TWA, SOUTHWEST	· RACETRACK
7,8	NORTHWEST, HAWAIIAN AEROFLOT	· RACETRACK

CONCOURSE B

10,11	DELTA	· RACETRACK

CONCOURSE D

18,18A	ALASKA	· LASER SORT SPUR

NORTH SATELLITE

19,20	UNITED, UNITED EXPRESS	· LASER SORT SPUR

Interline Baggage. When passengers are connecting from one flight to another their baggage is referred to as interline baggage. There have been several ways that Sea-Tac airport has attempted to process interline baggage. In the present system the airlines bring transfer baggage to one of three transfer zones in the terminal bagwell. These bags are placed on racks designated for the proper airlines. The contract company now only has to transfer baggage within the bagwell to the airline outbound system.

The most complex system was a tracked vehicle system of small baggage carts referred to as the GTX automated interline system. This system provided for the delivery of interline baggage within the terminal bagwell and interline and terminating baggage from the South Satellite. With new and future inbound and outbound systems being provided in areas remote from the bagwell, the GTX system was considered to be too costly to expand. This system was decommissioned about six years ago.

The GTX system was replaced by a manual system which provided for baggage transfer points on the ramp level at several locations near the terminal, concourse and satellite complex. The airlines would drop off the interline bags at one of these transfer points and a contract company would cart the bags from the transfer points to the airline make-up areas. However, this system did not provide the transfer times required (a minimum of 70 minutes during peak periods) and it has been refined to what is now the present interline baggage system. A conceptual diagram of the interline baggage system is shown in Figure 4-4.

Federal Inspection Services (FIS) Systems. Baggage processing systems at the FIS facility in the South Satellite consist of four oval baggage claim units which are fed by conveyor, and interline recheck and reclaim facilities. The four large baggage claim units are located in a common area just prior to customs processing. After claim and customs processing, all baggage must be rechecked for intra/interline transfer or for baggage reclaim in the main terminal claim area. Baggage other than hand luggage is not permitted on the transit system. As a part of the inbound baggage system a baggage belt runs from the baggage re-check area to claim device #1 in the main terminal baggage claim. A baggage belt transfers interline baggage from the South Satellite to a carrousel in the bagwell.

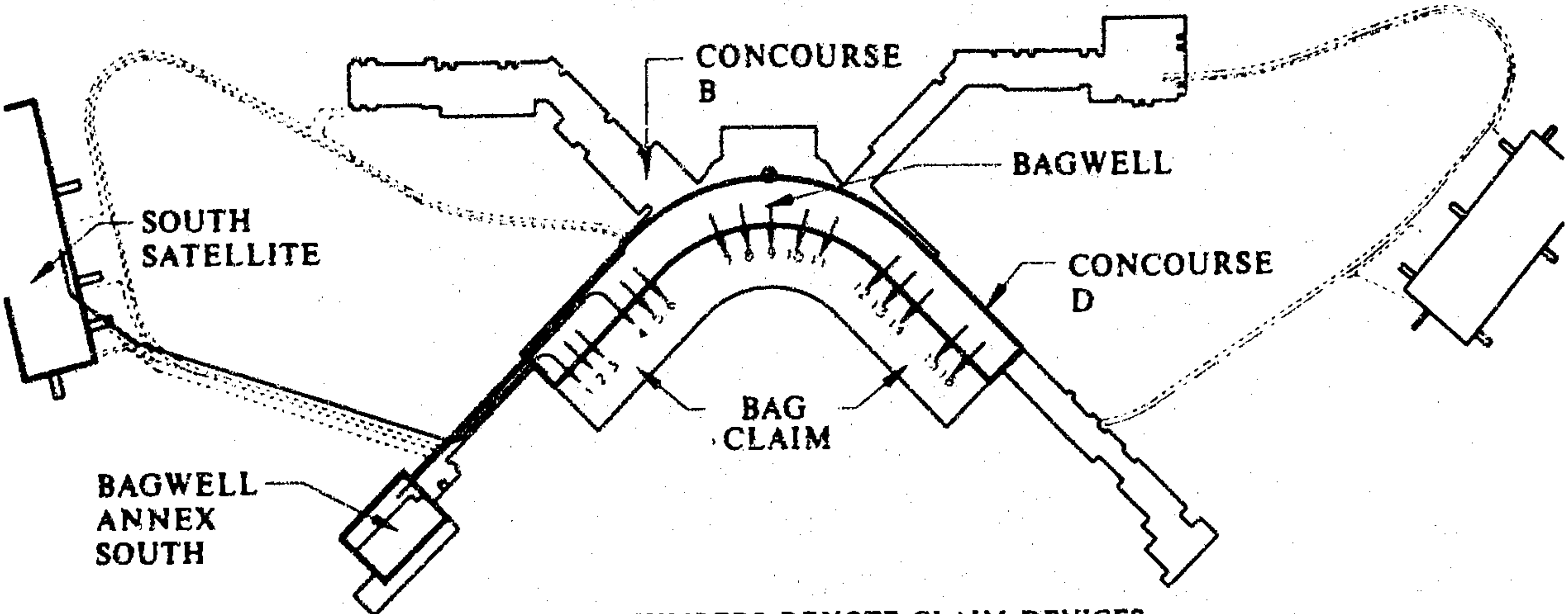
Satellite Transit System (STS)

The transit system consists of two car trains operating on a north loop and a south loop and a single car operating as a liner shuttle to connect the two loops. In addition, there are system maintenance facilities located below grade. The train operation is completely automatic. The north loop operates from the North Terminal (adjacent to Concourse D) to the North Satellite, to Concourse C and back to the North Terminal. Each complete 4,092 foot trip is accomplished in four minutes 14 seconds, for an average speed of 11.07 miles per hour.

The south loop operates from the South Terminal (adjacent to Concourse A) to the South Satellite, to Concourse B and back to the South Terminal. Each complete 3,720 foot trip is accomplished in four minutes nine seconds, for an average speed of 10.19 miles per hour.

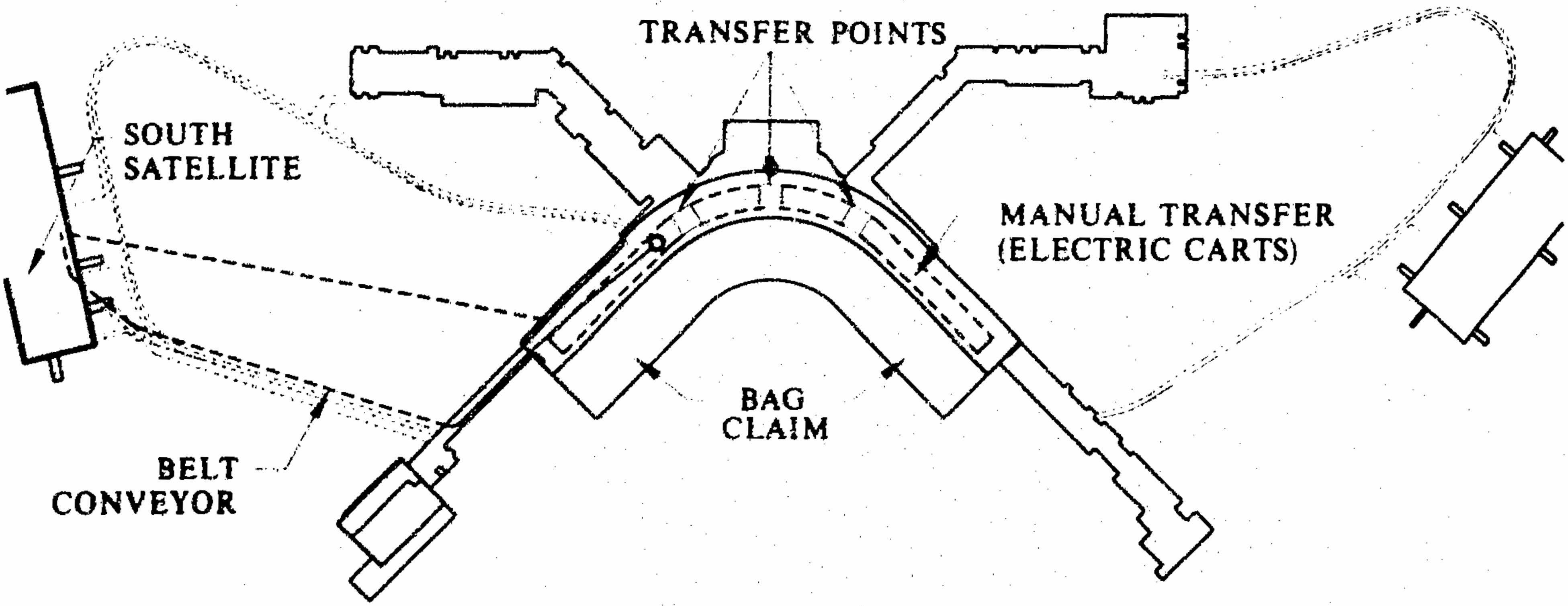
The shuttle operates between North and South Terminals. This 1,960 foot round trip takes three minutes 20 seconds, for an average speed of 6.7 miles per hour. The trip times noted above include intermediate station stop times, but not origin and destination terminal times. Except for the very early hours of the morning, two trains operate on each loop at a two minute head spacing. During peak travel periods of the year, three two-car trains are operated on each

FIGURE 4-3
INBOUND BAGGAGE SYSTEM



NOTE: NUMBERS DENOTE CLAIM DEVICES

CLAIM	1	INTERNATIONAL RE-CLAIM
	2	USAIR,TWA
	3	AMERICA WEST,TWA,USAIR
	4	NORTHWEST
	5	NORTHWEST,AMERICAN
	6	AMERICAN
	7	DELTA
	8	DELTA,CANADIAN,HAWAIIAN
CLAIM	9	CONTINENTAL
	10	AIR CANADA
	11	HORIZON
	12	ALASKA,HORIZON
	13	ALASKA
	14	ALASKA
	15	UNITED
	16	UNITED



INTERLINE SYSTEM

1) AIRLINES DELIVER INTERLINE BAGGAGE TO ONE OF THREE TRANSFER ZONES.

2) DYNEAIR PICKS UP INTERLINE BAGGAGE AT THE TRANSFER ZONES AND DELIVERS THEM TO THE PROPER OUTBOUND DEVICE FOR THE DEPARTING AIRLINE.

3) INTERLINE BAGGAGE AT THE SOUTH SATELLITE IS TRANSFERED BY INTERLINE BELT TO THE BAGWELL AND DELEVERED TO THE PROPER OUTBOUND DEVICE BY DYNEAIR.

FIGURE 4-4
INTERLINE BAGGAGE SYSTEM

loop.

The system has a practical capacity (based on 80 passengers per car) which is summarized as follows:

Loop	Present
North	Two 2-Car Trains 4,130 Pass./Hr.
South	Two 2-Car Trains 4,200 Pass./Hr.
Shuttle	One Single Car 1,800 Pass./Hr.
	Present Maximum
North	Three 2-Car Trains 6,190 Pass./Hr.
South	Three 2-Car Trains 6,300 Pass./Hr.
Shuttle	One Single Car 1,800 Pass./Hr.
	Future Maximum
North	Three 3-Car Trains 9,290 Pass./Hr.
South	Three 3-Car Trains 9,450 Pass./Hr.
Shuttle	One Single Car 1,800 Pass./Hr.

The future maximum capacity indicated will require expansion of STS lobbies, vehicle electronic changes, computer modifications and changes to wayside door controls, antennae and operating electronics. The transit system is well maintained and since 1979, it has had an availability factor of 99.8 percent.

Passenger Terminal Apron

The passenger terminal complex includes approximately 165 acres of concrete apron which is bounded by hangars of Alaska, Delta and Northwest Airlines on the south side, the Airport Rescue and Fire Fighting (ARFF) station on the north side, by the aircraft operating area (AOA) on the west and by the terminal and concourses on the east. The immediate terminal facilities are bounded by airline leaseholds and Port-controlled areas which are shown in Figure 4-5. In addition to aircraft parking positions at the terminal, there are several remote aircraft parking positions but these are generally not used for passenger operations. Most aircraft parked at the main terminal are serviced by loading bridges, except for commuter aircraft which are ground level loaded. Ramp facilities and systems such as pre-conditioned air, 400 Hz ground power, potable water, etc, vary depending upon the needs of the airline.

An evaluation of portions of the terminal apron was conducted in 1992 (*Taxiway/Apron Area Pavement Evaluation Study Seattle-Tacoma International Airport, Final Report, Pavement Consultants Inc. March 1992*). The evaluation recommended removal of existing sections of terminal apron and replacement with portland concrete cement. Figure 4-6 depicts the terminal apron area included in the evaluation. A ten-year apron replacement program was started in May, 1994.

AIR CARGO FACILITIES

Air cargo was the focus of a recent study at Sea-Tac. (*Seattle-Tacoma International Airport Air Cargo Study, Technical Report, Howard Needles Tammen & Bergendoff, June 1993*).

FIGURE 4-5
EXISTING APRON LEASEHOLDS

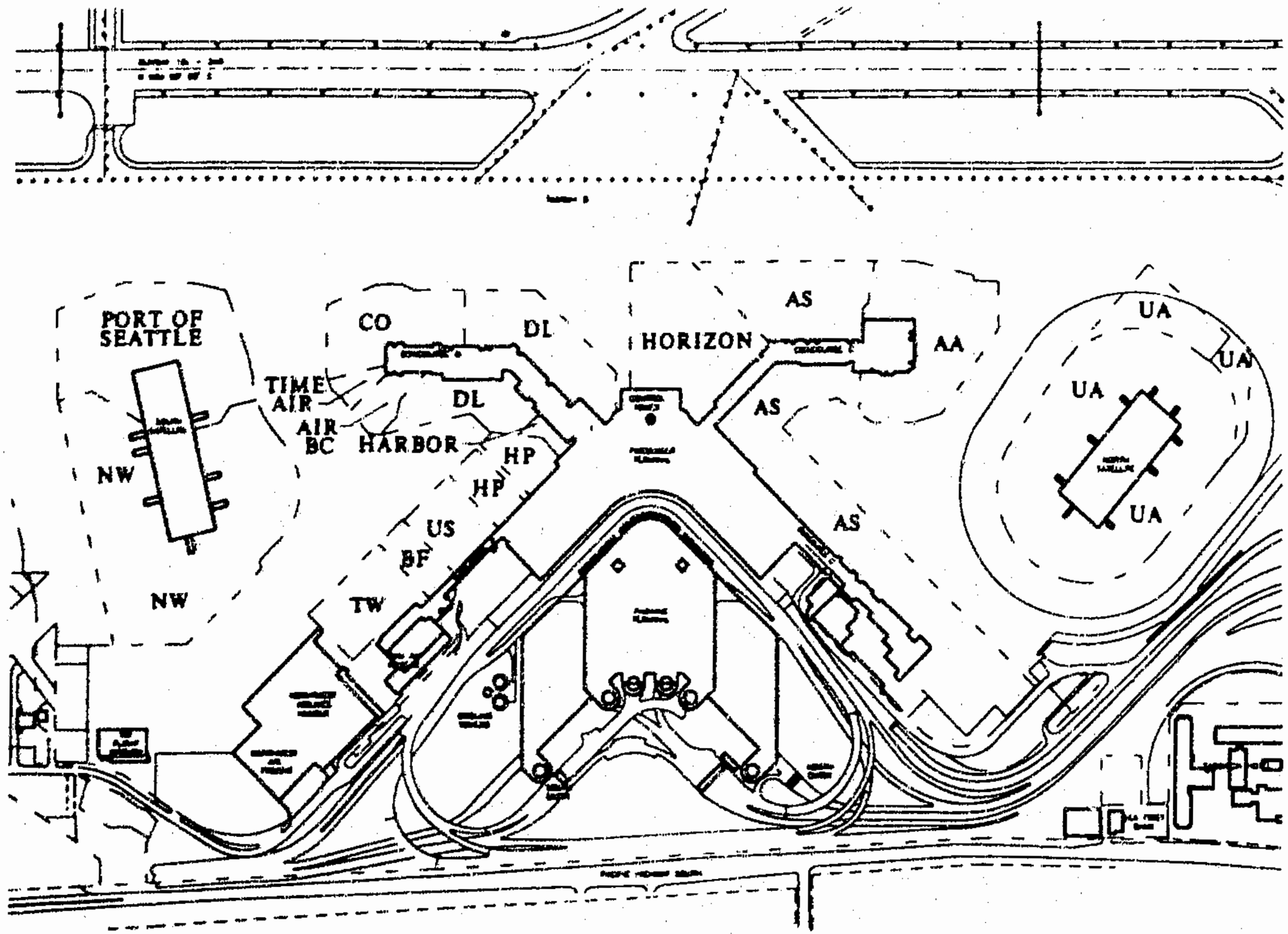
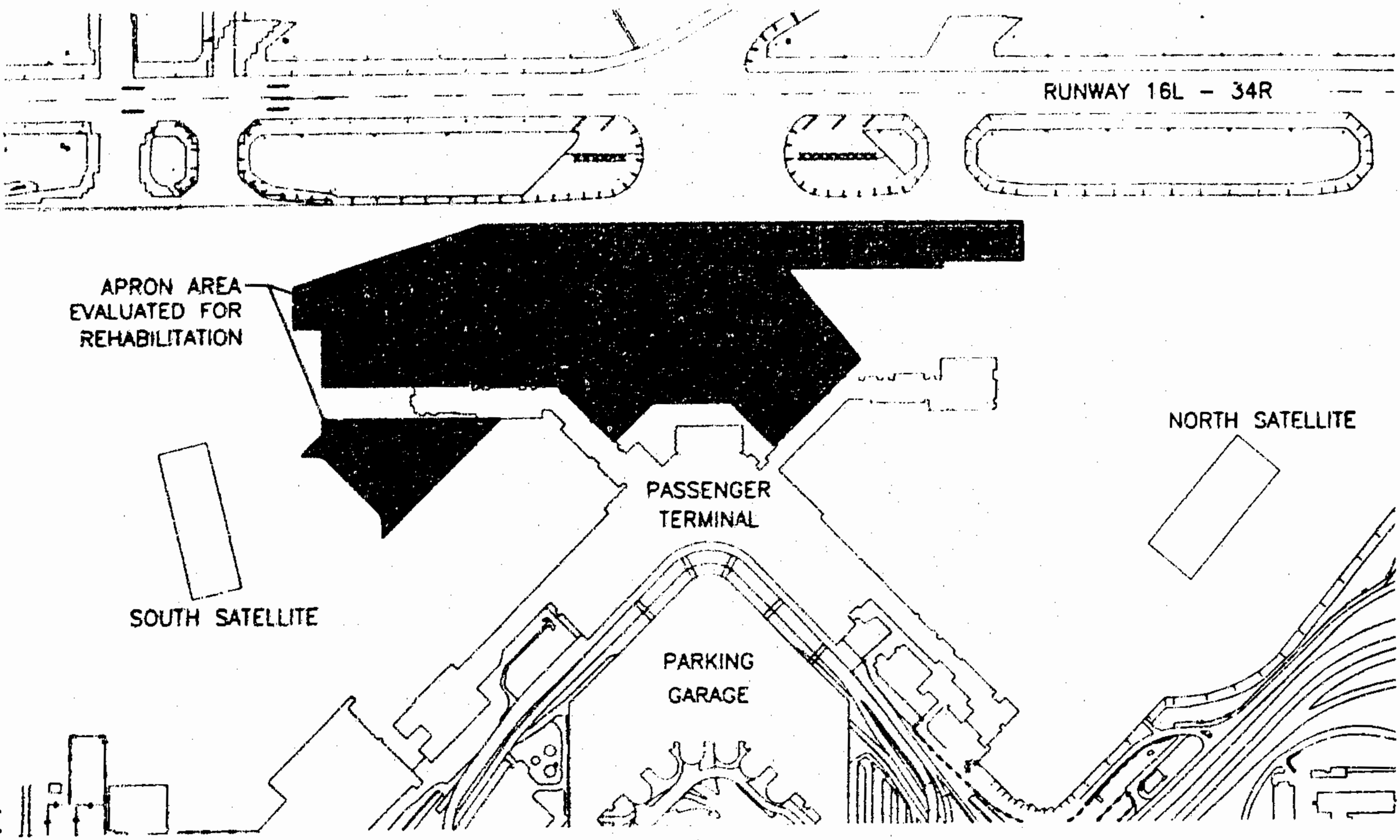


FIGURE 4-6
AREA OF TERMINAL APRON REHABILITATION



The inventory of existing cargo facilities uses this recently published report. Subsequent analysis in this master plan will assess the recommendations of the Air Cargo Study.
Most cargo facilities at Sea-Tac are located in the Northeast Cargo Area north of the passenger terminal and bounded on the west by the airfield and on the east by Air Cargo Road and the entry drives connecting State Highway 518 and the terminal. Approximately 81 acres of land is dedicated for cargo use of which 21 acres are undeveloped.

The Northwest Airlines cargo building is the only building located outside the Northeast Cargo Area, and is located south of the passenger terminal. Northwest air cargo operations are collocated with airline maintenance in the Northwest hangar complex. The cargo operations occupy the south part of the building.

Air Cargo Buildings

The air cargo building area on-airport currently totals 626,366 square feet. This does not include the air mail facility operated by the U.S. Postal Service. A listing of air cargo facilities at the Airport is presented in Table 4-1. These facilities are graphically shown in Figure 4-7.

Air Cargo Aircraft Apron

A total of 121,836 square yards of aircraft parking apron for all-cargo aircraft exists on the airport in nine different areas. Depending on the mix of aircraft using the apron, parking is available to accommodate up to 18 DC-10s or 24 B727s. One hardstand is also available at the United cargo facility for general use when it is not being occupied by a United aircraft. Table 4-2 summarizes the existing cargo aircraft apron areas.

Air Mail

In addition to the aforementioned air cargo facilities, the U.S. Postal Service (USPS) operates a 182,500 square feet air mail facility which is also located in the Northeast Cargo Area. The USPS operation entails the following facilities:

- Leasehold - 9.7 acres
- Leasehold - 9.7 acres
- Warehouse - 149,444 square feet
- Office - 33,056 square feet
- Truck Docks - 20
- Auto Parking - 239 spaces

AIRLINE MAINTENANCE

Airline aircraft maintenance on the airport is primarily housed in three major hangar facilities. These are Northwest, Delta and Alaska Airlines. The building area of these facilities totals approximately 340,000 square feet. A summary of each facility follows. These are depicted in Figure 4-8.

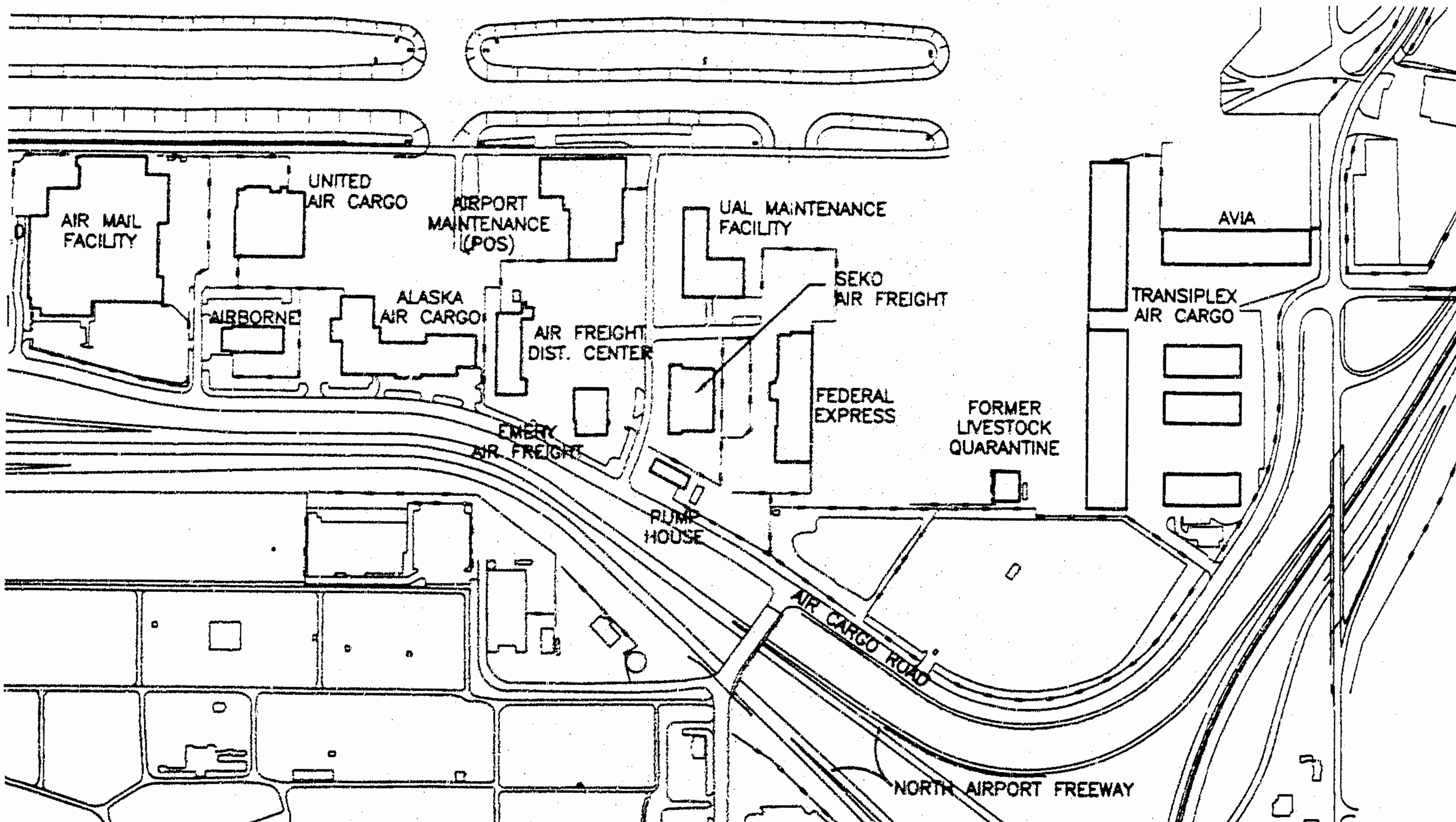
- Northwest Airlines. This 172,000 square feet hangar is immediately south of Concourse A of the passenger terminal. The original part of the hangar was constructed in the 1940s for DC-3s. The hangar was expanded in 1970 to accommodate aircraft as large as the B747. The Northwest cargo operation occupies 58,000 square feet of the facility in the older portion. The area dedicated to aircraft maintenance therefore totals 114,000 square feet. The hangar can house a B747 or 2 DC-10s. The facility is used to perform overnight maintenance service checks. Aircraft cannot park on the apron due to the conflict created with aircraft taxiing around the South Satellite. However, Northwest Airlines cargo aircraft park at the south corner of the building.

- Delta Airlines. The Delta hangar (formerly owned by Western Airlines) is approximately

TABLE 4-1
EXISTING AIR CARGO FACILITIES

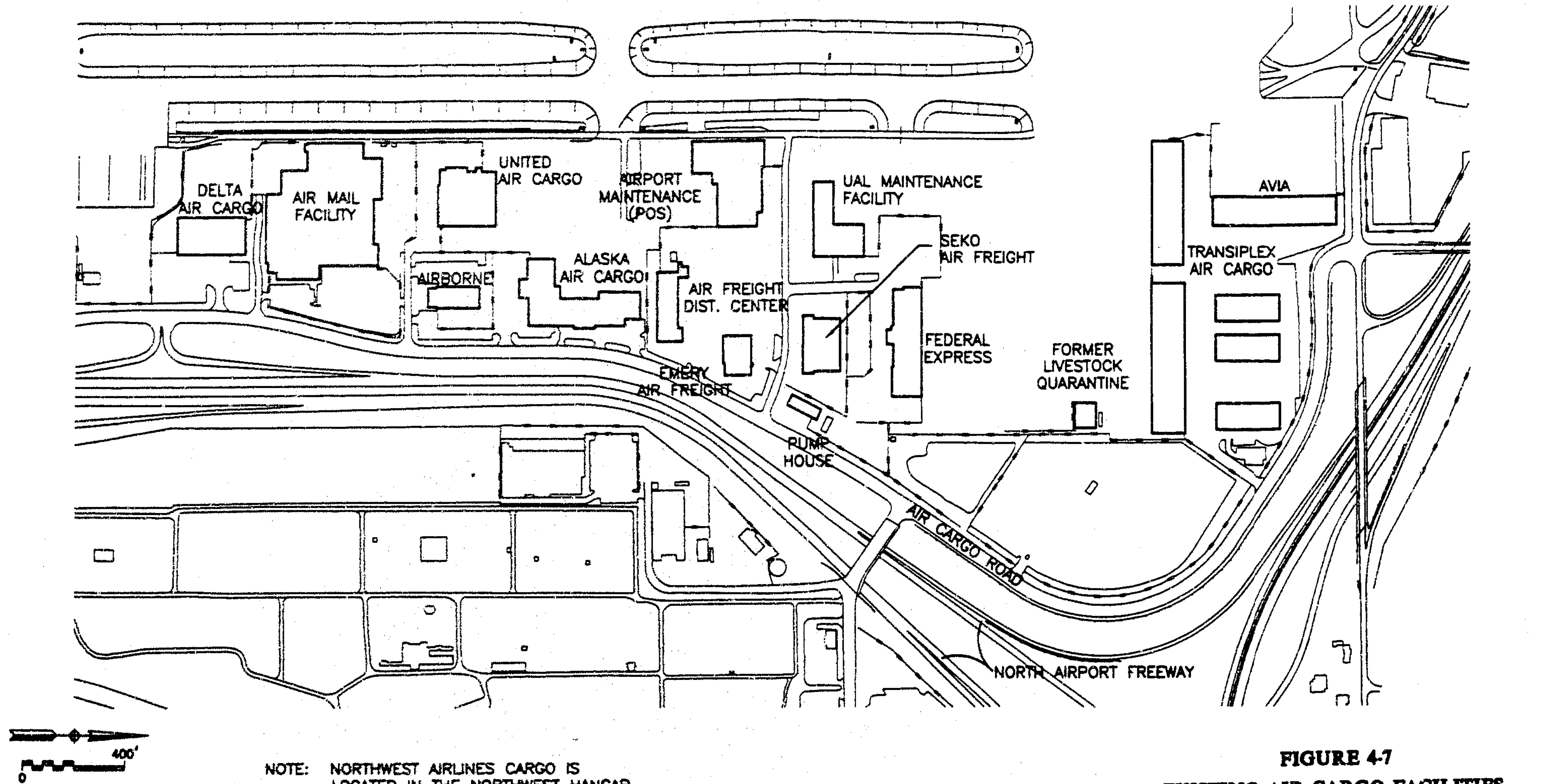
Building	Leasehold (acres)	Warehouse (SF)	Office (SF)	Total Area (SF)	Truck Docks	Auto Parking
Northwest Airlines	1.6	48,000	10,000	58,000	16	350
Delta Airlines	5.0	29,046	2,514	31,560	16	53
Airborne Express	2.3	17,500	5,000	22,500	8	48
United Airlines	5.9	41,004	20,000	61,004	12	78
Alaska Airlines	4.7	63,734	5,000	68,734	16	67
Airfreight Dist. Center	2.1	15,190	10,512	25,702	9	38
Emery Worldwide	3.8	9,799	5,159	14,958	12	44
SEKO Air Freight	2.1	25,350	9,750	35,100	14	49
Federal Express	10.1	45,000	3,000	48,000	28	108
Transiplex Building A	12.8	61,500	22,515	84,015	30	51
Transiplex Building E		22,000	3,000	25,000	14	40
Transiplex Building F		22,000	3,000	25,000	14	40
Transiplex Building G		19,500	5,500	25,000	12	65
AVIA Air Cargo No. 1	11.1	42,151	8,442	50,593	28	63
AVIA Air Cargo No. 2		43,075	8,125	51,200	30	79
Total Air Cargo Buildings		**504,849**	**121,517**	**626,366**	**259**	**1,173**

Source: Seattle-Tacoma International Airport Air Cargo Study, June 1993.



NOTE: NORTHWEST AIRLINES CARGO IS LOCATED IN THE NORTHWEST HANGAR, SOUTH OF THE PASSENGER TERMINAL.

FIGURE 4-7
EXISTING AIR CARGO FACILITIES



NOTE: NORTHWEST AIRLINES CARGO IS LOCATED IN THE NORTHWEST HANGAR, SOUTH OF THE PASSENGER TERMINAL.

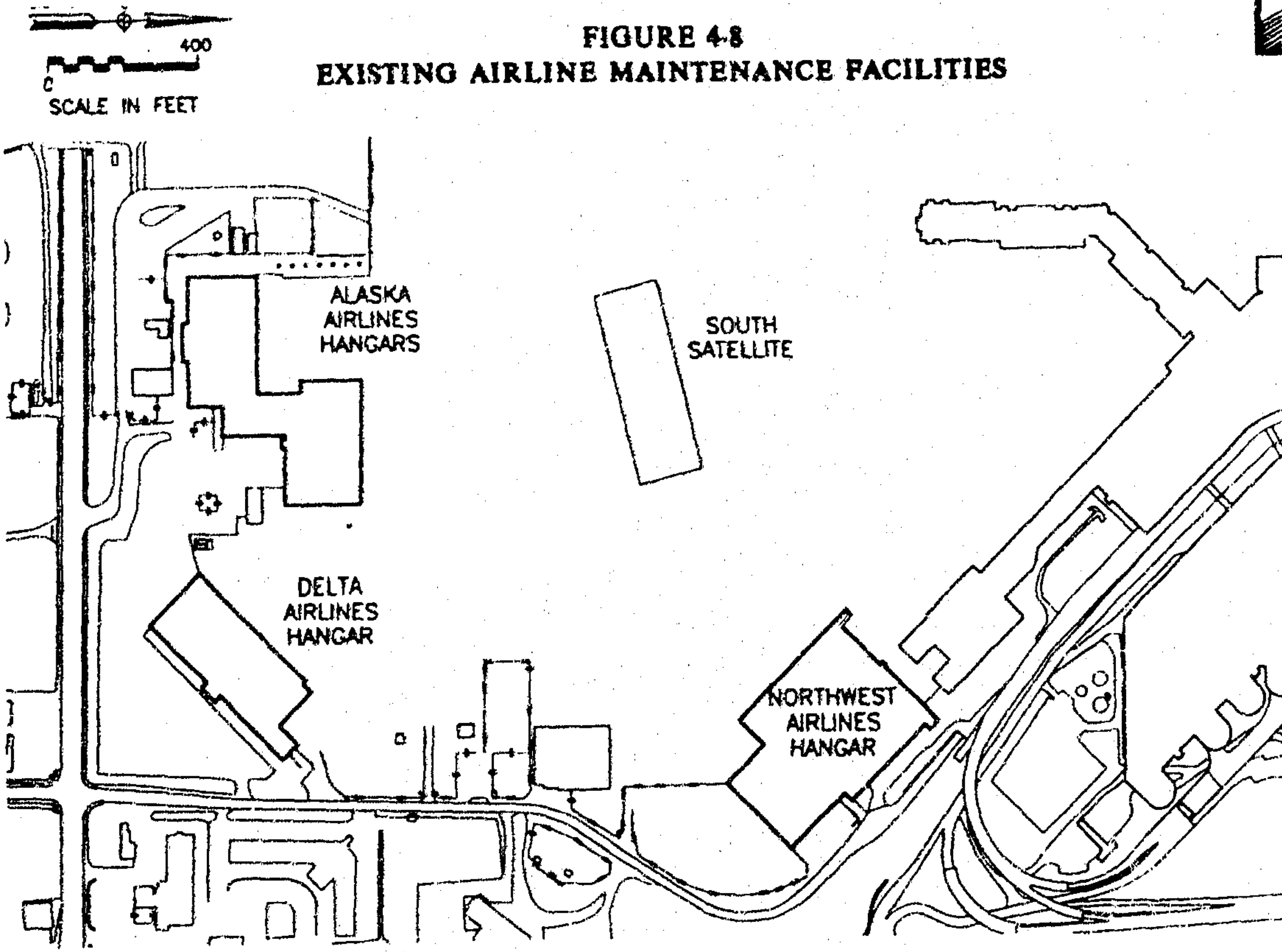
FIGURE 4-7
EXISTING AIR CARGO FACILITIES

TABLE 4-2
EXISTING CARGO AIRCRAFT APRON

Location	DC-10 Parking Positions	B727 Parking Positions	Area (Square Yards)
AVIA 2	3	4	22,222
AVIA 1	3	4	19,683
Transiplex	1	1	2,756
Federal Express	3	4	22,800
POS Cargo 3	2	3	22,800
POS Cargo 4	2	3	10,500
Alaska Air Cargo	1	1	5,100
South Hardstand	2	3	8,944
Northwest Hangar	1	1	7,031
Total	**18**	**24**	**121,836**

Source: Seattle-Tacoma International Airport Air Cargo Study. June 1993.

FIGURE 4-8
EXISTING AIRLINE MAINTENANCE FACILITIES



82,000 square feet and is located along South 188th Street. The building is estimated to be 30 to 35 years old. It can accommodate two B757/B767s. The adjacent apron is used for aircraft parking and can accommodate four B757/B767s. The facility is also used for regularly scheduled overnight maintenance service checks.

- Alaska Airlines. Alaska occupies two hangars west of the Delta hangar along South 188th Street. The larger, newer hangar (approximately 64,400 square feet) can house three B737/MD80 size aircraft and the smaller, older building (approximately 60,000 square feet) can accommodate two. Approximately 20,000 square feet of shop area connects the two hangars. The adjacent apron can serve seven similar size aircraft. The maintenance facility is used for heavy maintenance checks (C checks) with the new hangar used for base maintenance and the older hangar for line maintenance. An aircraft can be hangared for maintenance for periods ranging from two weeks to two months.

- United Airlines. United occupies a building in the North Cargo area which is primarily used for automotive and building maintenance and storage. Some space is available for engine work and tire repair; however, the building cannot house an aircraft. An aircraft parking apron is adjacent to the facility and will be used for minor scheduled maintenance checks if aircraft are parked there overnight. These same checks will also be performed on aircraft parked at the North Satellite gates.

IN-FLIGHT CATERING

Flight kitchens are required for catering airline flights. There are four flight kitchens on the airport. These total 170,100 square feet as follows: Caterair - 36,000 square feet; Caterair - 35,100 square feet; Northwest - 34,000 square feet; and, Dobbs - 65,000 square feet. One other flight kitchen is nearby, but is not on airport property.

AIRPORT RESCUE AND FIRE FIGHTING STATION

The Airport Rescue and Fire Fighting (ARFF) building is centrally located with respect to runway ends and airport structure, and is the first building to the north of the North Satellite. The ARFF building totals 28,000 square feet. ARFF facilities need to be provided at an airport in accordance with FAR Part 139. The FAR specifies an airport index system for determining the level of protection for fire fighting and rescue services, with the index based on the length of aircraft (expressed in aircraft groups) and the number of average daily departures of the aircraft groups. Sea-Tac is categorized as an Index E airport which is the highest index. Table 4-3 summarizes the ARFF vehicles housed in the fire station.

Far Part 139.319 states the response time requirements for an emergency. Within 3 minutes at least one required ARFF vehicle must reach the midpoint of the farthest runway and begin application of required extinguishing agents. Within 4 minutes of the alarm, all other required vehicles must reach this point. The Airport complies with these requirements. A practice burn pit is located on the southwest side of the Airport.

Airport fire personnel indicate that there is a shortage of space in the existing building, particularly with regard to storage, office and living quarters for firemen on duty. A second building has been considered for the west side of the Airport. While the existing building is centrally located, future extension of the North Satellite as well as construction of any new

TABLE 4-3
AIRPORT RESCUE AND FIRE FIGHTING VEHICLES

Vehicle No.	Vehicle Type	Manufacturer	Year	Agent	Water (gal.)	Foam (con.)	AFFF (gal.)	Dry Chem (lbs.)	Response Time (min:sec)
CM-700	Command Vehicle	Ford (350 Van)	1986	A B	None	None	None	None	*
E-711	Pumper	Darley	1987	A B	500 2,000	3%	36	35	*
E-712	Triple Comb. Pumper	American LaFrance	1969	A B	270 1,500	3%	10	1,000 10	*
S-776	Crash Truck	Oshkosh	1986	A B	1,500	3%	300 400		*
T-762	Crash Truck	Oshkosh	1992	A B	3,000 1,800	3%	410	500 12	*
T-763	Crash Truck	Oshkosh	1982	A B	3,000 1,800	3%	400	35	*
T-764	Crash Truck	Oshkosh	1986	A B	3,000 1,800	3%	400	35	*
T-765	Crash Truck	Oshkosh	1988	A B	3,000 1,800	3%	400	35	*
A-732	Aid Vehicle	Ford	1982	None	None	None	None	None	Not required
A-731	Aid Vehicle	Ford	1990	None	None	None	None	None	Not required
S-777	Haz-Mat Response Unit	Ford	1989	None	None	None	None	None	Not required
S-778	Disaster Medical Supplies	International Tractor	1978	A B	None	None	None	None	Not required

TABLE 4-3
AIRPORT RESCUE AND FIRE FIGHTING VEHICLES

Key:
A = Quantity of Extinguishing Agent
B = Discharge rate in gallons per minute, or pounds per second
AFFF = Aqueous film forming foam extinguishing agent
** = Meets FAR Part 139 requirements*

Note: While the crash trucks are technically not classified as Rapid Intervention Vehicles, they do meet RIV performance specifications.

Source: Port of Seattle Fire Department runways could hinder response time.

There is presently a task force comprised of local fire departments and airports that are considering developing a regional practice area. Development of such a facility would eliminate live fires at the on-airport practice burn pit.

GENERAL AVIATION

General aviation activity at the airport is minimal, accounting for less than three percent of aircraft operations in 1993. The Weyerhaueser Company's flight operations are based at the airport in a 26,900 square feet hangar/office on the west side of the airfield. The facility houses a Gulfstream II, two Cessna Citation IIIs, a Beechcraft King Air 200, and Bell Jet Ranger. The facility includes underground fuel tanks. The property is leased through a 40 year lease which has approximately 30 years remaining in the term.

Because of minimal general aviation activity there is only one fixed base operator (FBO). Fuel service to general aviation aircraft is provided by Signature. A small general aviation apron, approximately 67,400 square feet, is located west of the Alaska Airline maintenance hangars.

AIRPORT MAINTENANCE

The main airport maintenance and equipment yard is in a building in the north cargo area (Air Cargo No. 4). Other airport maintenance facilities are located at other areas, usually close to a specific facility to be maintained such as the satellite transit system, HVAC, etc. Maintenance areas are also located in the main passenger terminal, parking garage and service tunnel, terminal satellites, and industrial waste treatment plant. A main drawback of the existing facilities is the number of locations.

FUELING SYSTEMS

The main fuel storage is located in a tank farm which provides a total storage capacity of 24,109,000 gallons. The main tank farm is fed by an Olympic pipeline. These tanks feed three hydrant systems owned by Delta, Northwest and United Airlines, with each of these hydrant systems also having an intermediate underground storage system. Two other hydrant systems (Continental and Pan Am) are no longer operating and the intermediate underground tanks for these have been removed. The main tank farm also feeds the fuel truck fill stand on the south end of the Airport. Presently about 60 percent of the aircraft gates are served by hydrant fueling. The three fuel hydrant systems still in operation are aging and the remaining life is questionable as the operators are considering fueling trucks in the short term. The feasibility of a comprehensive hydrant system serving all airline gates should be explored in later phases of the master plan. Weyerhaueser also has underground fuel tanks in support of their business aviation activities.

Section 5
GROUND ACCESS

SECTION 5
GROUND ACCESS

INTRODUCTION

This section deals with the description and condition of the ground access facilities that link the Airport to the regional highway system as well as auto parking facilities and public transportation services available for passengers and employees. While technically included under the heading of landside facilities, this separate section has been devoted to ground access due to the breadth of travel modes and facilities available for ground transportation. The section addresses landside passenger travel patterns first, the regional access system second, existing public and commercial transit systems third, and finally describes the on-site airport roadway and parking systems.

LANDSIDE PASSENGER TRAVEL PATTERNS

Origin/Destination Patterns

In 1984, a report was prepared documenting airport origin/destinations Departing Passenger Survey and Terminal Observations, (Hall and Associates). This study showed that airport users (one-third local residents/two-thirds visitors) originated from or were destined to several defined areas, as follows:

Seattle Central Business District (CBD)	27%
Immediate Airport area	23%
Eastern King County	11%
Southern King County	9%
Pierce County	9%
Northern King County	8%
Snohomish County	4%
Kitsap County	4%
Other	5%
Total	100%

In 1991, another Origin/Destination study by the Port of Seattle (Evans/McDounagh Associates) showed similar results, i.e. that Sea-Tac users originated from the following counties: King County 69%; Pierce County 8%; Snohomish County 8%; Kitsap County 3%; Thurston County 3%; and, other points in the region 9%

Mode Choice

In 1988, the Sea-Tac South Access Study indicated that passengers used several modes of ground transportation for travel to and from the Airport. Private autos were used by 67% of all passengers; 20% used transit; and, 13% used other modes (car rental, etc.), with slight differences between arriving and departing passengers. A summary of passenger mode of access from several recent surveys is shown in Table 5-1.

In 1987, another survey stated that 46% of departing passengers and 37% of arriving passengers used modes other than private autos to access the airport. This observation was repeated again in 1988, in another study of over 41,000 passengers (40% business travelers/60% recreation travelers). Results of this study are shown in Table 5-2. As shown, the majority of data from 1984-88 shows consistency in mode share between private autos and other travel modes.

TABLE 5-1
SUMMARY OF SEA-TAC TERMINAL MODE CHOICE SURVEYS
PERSON TRIPS

Mode of Arrival	1994 Air Survey	Landside Access Plan 1988 ([a]	Hall Survey 1984 [b]	Visitors [c]	Employees [c]
Private Auto -Curbside Only	34%	NA	NA	25%	NA
Private Auto: On-Site Parking-Metered Lots	36%	67%	70%	65%	9%
Private Auto: On-Site Long-Term Lots	NA	NA	NA	10%	90%
Private Auto: Off-Site Lots	NA	NA	NA	0	0
Rental Car: On-site	NA	10%	10%	0	0
Rental Car: Off-Site	NA	3%	2%	0	1%
Transit: Public Bus	3%	NA	2%	0	0
Transit: For-Hire Shuttles	23%	7%	6%	0	0
Transit: Courtesy Vans	NA	9%	5%	0	0
Taxi	4%	4%	5%	0	0

Source: Port of Seattle, Unpublished records, 1994.

[a] CH2M Hill, Landside Access Plan, 1988.

[b] Hall and Associates, Departing Passenger Survey, 1984.

[c] Unpublished Port Records, 1993.

TABLE 5-2
SEA-TAC PASSENGER ARRIVAL MODE
CHOICE PATTERNS - VEHICLE TYPE [a]

Mode	Percent
Auto - On-Site Parking	38.5%
Auto - Off-Site Parking	28.2%
Auto - Drop-off No Parking	12.1%
Auto Share of Access (Subtotal)	78.8%
Subscription Bus/Airporter	6.6%
Auto Rental: On-site	5.2%
Hotel Courtesy Van	3.7%
Taxi	2.6%
Other Shuttle Vans	1.7%
Public Transit	1.4%
Total	100%

[a] Source: CH2M Hill, Landside Access Plan, 1988.

This same study showed that surveyed business and recreation travelers used different transportation means. Two-thirds to 80 percent of all auto rental, shuttle van, taxi, and hotel users were business travelers, while 100% of public transit users were recreational travelers, as were, 80% of for-hire bus services. In 1994, a Port of Seattle passenger survey, regardless of trip purpose showed the following travel patterns: Curbside only - 34%; Short-term parking 36%; Transit bus - 3%; For-hire and courtesy vans - 23%; and, Taxi - 4%. This study shows a shift in travel behavior from earlier studies but was done of an stratified sample in a survey of a limited number of passengers.

Peak Period Activity

About 30% of all Sea-Tac passengers are connecting between flights according to airline records for Sea-Tac terminal. Connecting passengers impact on-site terminal facilities and activities, but have no off-site or ground access impact. Table 5-3 shows the relationship of average daily passenger activity compared to Average Day Peak Month (ADPM) activity, excluding transfer passengers, giving an accurate picture of passenger ground travel at the terminal.

On a typical day in 1993, based on daily airline records at Sea-Tac, between 11:00 a.m. and 1:00 p.m. over 2,500 passengers enter or leave the terminal building each hour, with a peak of nearly 3,000 passengers between 12:00 p.m. and 1:00 p.m. In the August peak period, this surge factor grows to over 3,500 passengers in each of those hours and over 4,100 passengers in the 12:00 p.m. to 1:00 p.m. peak. These totals exclude employees, visitors, and other persons meeting or greeting air travelers.

REGIONAL ACCESS

The regional access system which serves the airport is described in the following subsections. Included are descriptions of the existing highway network, discussion of existing public and commercial transit services, and planned improvements.

Existing Highway Network

Figure 5-1 illustrates the existing regional highway network within the vicinity of the Airport. Figure 5-2 illustrates existing Average Daily Traffic (ADT) for each of the roadways discussed. General descriptions of the existing roadways are provided in the following paragraphs.

Interstate 5 (I-5) is an 8-lane freeway which runs north-south and is located approximately one mile east of the Airport. This facility provides a critical link between the Seattle Central Business District (CBD), Tacoma and the Airport. Interchange connections to routes servicing the Airport include SR 518, South 188th Street and South 200th Street. Existing I-5 traffic ranges between 195,000 ADT north of SR 518 to 182,000 ADT south of South 200th Street.

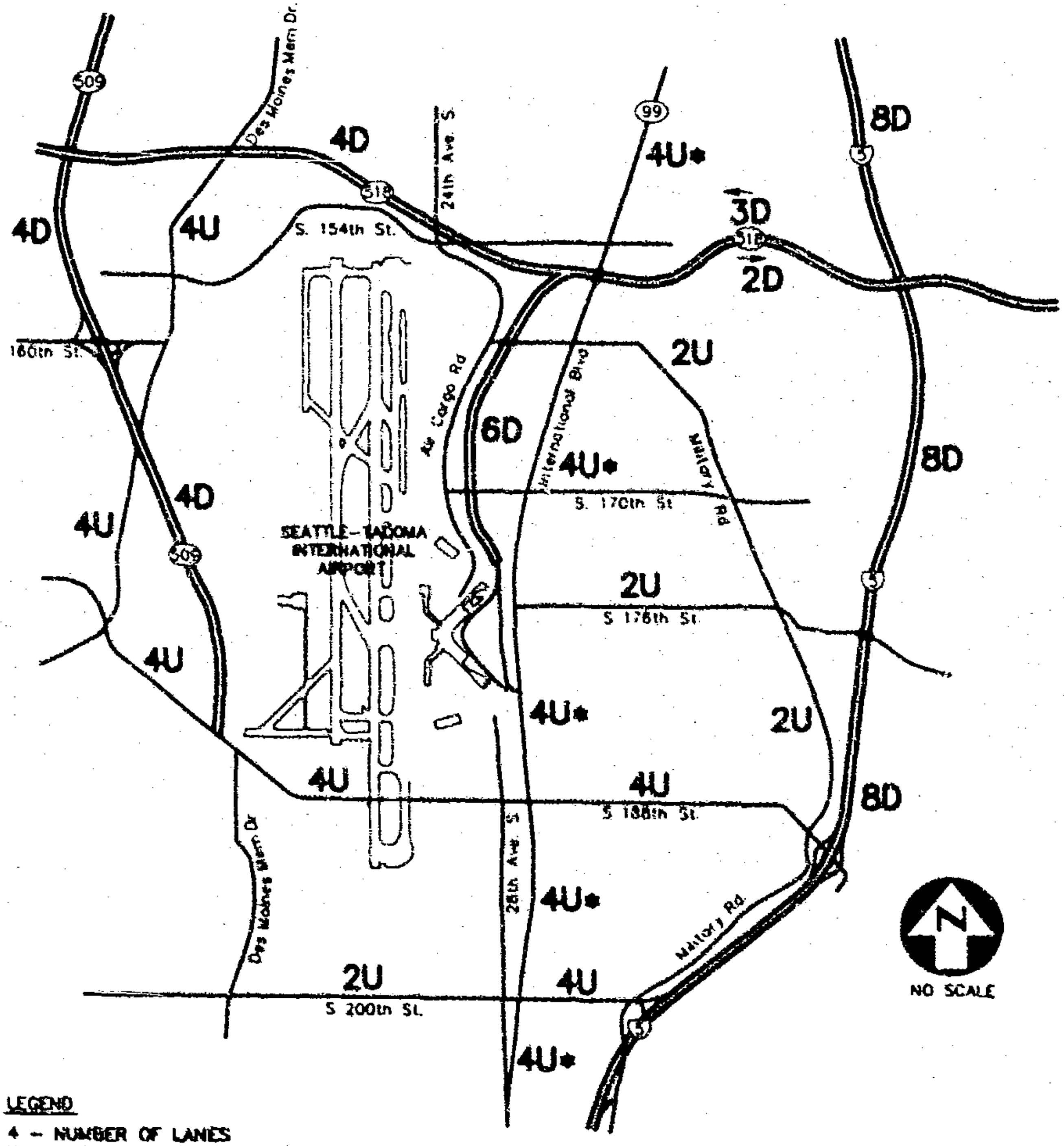
State Route 509 (SR 509) is a 4 lane freeway which runs north-south and generally parallels the western border of the City of SeaTac. The freeway originates in Seattle and terminates at South 188th Street in the City of Seatac. Interchange locations which provide access to the Airport include State Route 518, South 160th Street and South 188th Street. Existing traffic ranges between 50,000 ADT north of SR 518 to 31,000 ADT near the freeway's terminus at South 188th Street.

TABLE 5-3
COMPARISON OF AVERAGE AND PEAK DAILY PASSENGER ACTIVITY IMPACTING GROUND ACCESS

Hour	Passenger Activity Excluding Connecting Passengers [a] [b]			
	Average Month [c] Daily Passenger Activity		Peak Month Daily Passenger Activity	
	Enplaned	Deplaned	Enplaned	Deplaned
2400	134	462	189	651
100	104	0	147	0
200	0	0	0	0
300	0	50	0	70
400	0	0	0	0
500	0	293	0	413
600	969	368	1365	518
700	1610	631	2268	889
800	1784	735	2527	1050
900	890	631	1253	889
1000	870	1436	1225	2023
1100	1069	1695	1505	2387
1200	1397	1153	1967	1624
1300	2018	939	2842	1323
1400	790	706	1113	994
1500	999	910	1407	1281
1600	671	557	945	784
1700	691	1163	973	1638
1800	1123	1078	1582	1519
1900	984	1123	1386	1582
2000	512	1749	721	2464
2100	452	1431	637	2016
2200	542	567	763	798
2300	517	457	728	644
Total	18100	18100	25550	25550

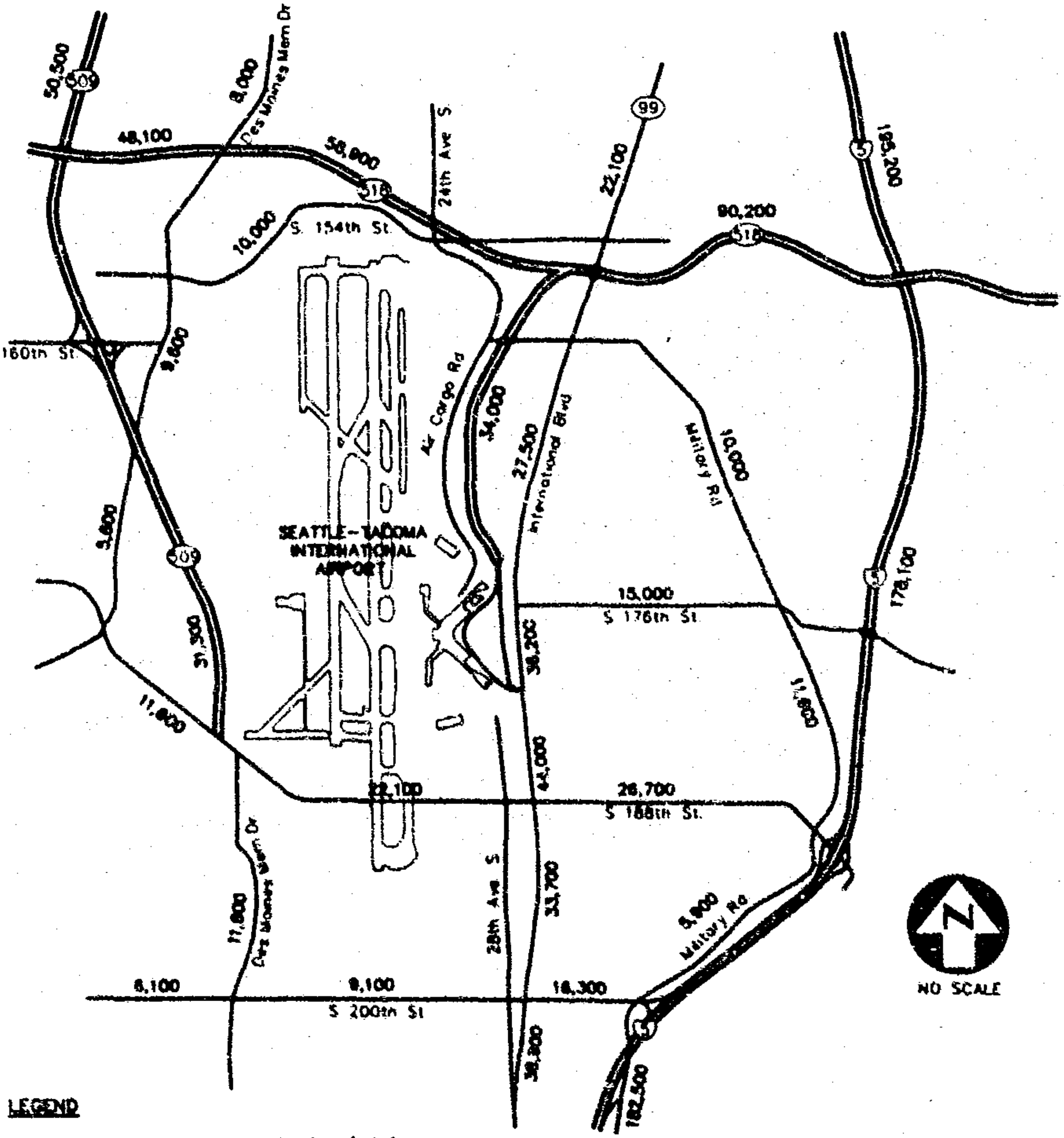
[a] Technical Report No.5 Passenger Forecasts March 1994.
[b] Connecting passengers are 30% of all passengers.
[c] Average month activity is about 70% of peak month activity (August).

FIGURE 5-1
EXISTING HIGHWAY SYSTEM



LEGEND
4 – NUMBER OF LANES
U – UNDIVIDED
D – DIVIDED
* – SEPARATE TURNING LANE

FIGURE 5-2
EXISTING TRAFFIC VOLUMES



LEGEND

10,000 – AVERAGE DAILY TRAFFIC (ADT)

SOURCES: 1. CITY OF SEATAC COMPREHENSIVE TRANSPORTATION PLAN, THE TRANSPO GROUP, 1991
2. WASHINGTON STATE DOT, JULY 1992 LIMITED COUNTS.

State Route 518 (SR 518) is a 6-lane freeway which provides an east-west regional connection between I-5 and SR 509. This facility provides a direct link to the North Access Freeway which serves the majority of airport traffic from the north. Additional interchanges which provide access to the Airport are located at Des Moines Way South and Pacific Highway (US 99). Existing traffic ranges from 48,000 ADT near the SR 509 interchange to 90,000 ADT near the I-5 interchange.

The Sea-Tac North Access Freeway is a high speed limited access roadway which provides a direct connection between the passenger terminal at the Airport to the regional highway system by way of an interchange with SR 518. This facility generally provides six travel lanes and existing traffic is approximately 34,000 ADT.

Arterial Facilities

The local arterial streets which provide access to the freeway facilities, the airport terminal and employment areas near the airport are described in the following paragraphs.

Des Moines Memorial Drive runs north-south along the west side of the airport. It is a 4-lane undivided facility which provides a connection between South 176th Street on the south side of the airport to South 156th Street on the north side of the airport. Existing traffic on this facility is approximately 12,000 ADT.

International Boulevard (Pacific Highway) (US 99) runs north-south along the Airport's eastern border. It is a 4-lane facility with a two-way center turn lane. The posted speed limit is 45 mph. At present, this facility provides the only access to the passenger terminal from the south via a signalized intersection at the Sea-Tac South Entry/Exit Drive. Existing traffic on this facility is approximately 25,000 ADT north of the Airport and 40,000 ADT south of the Airport.

Military Road runs north-south near and parallel to I-5. It is a 2-lane road with varying speed limits between 35 and 40 mph. Existing traffic is approximately 11,000 ADT north of South 188th Street and 6,000 ADT south of South 188th Street.

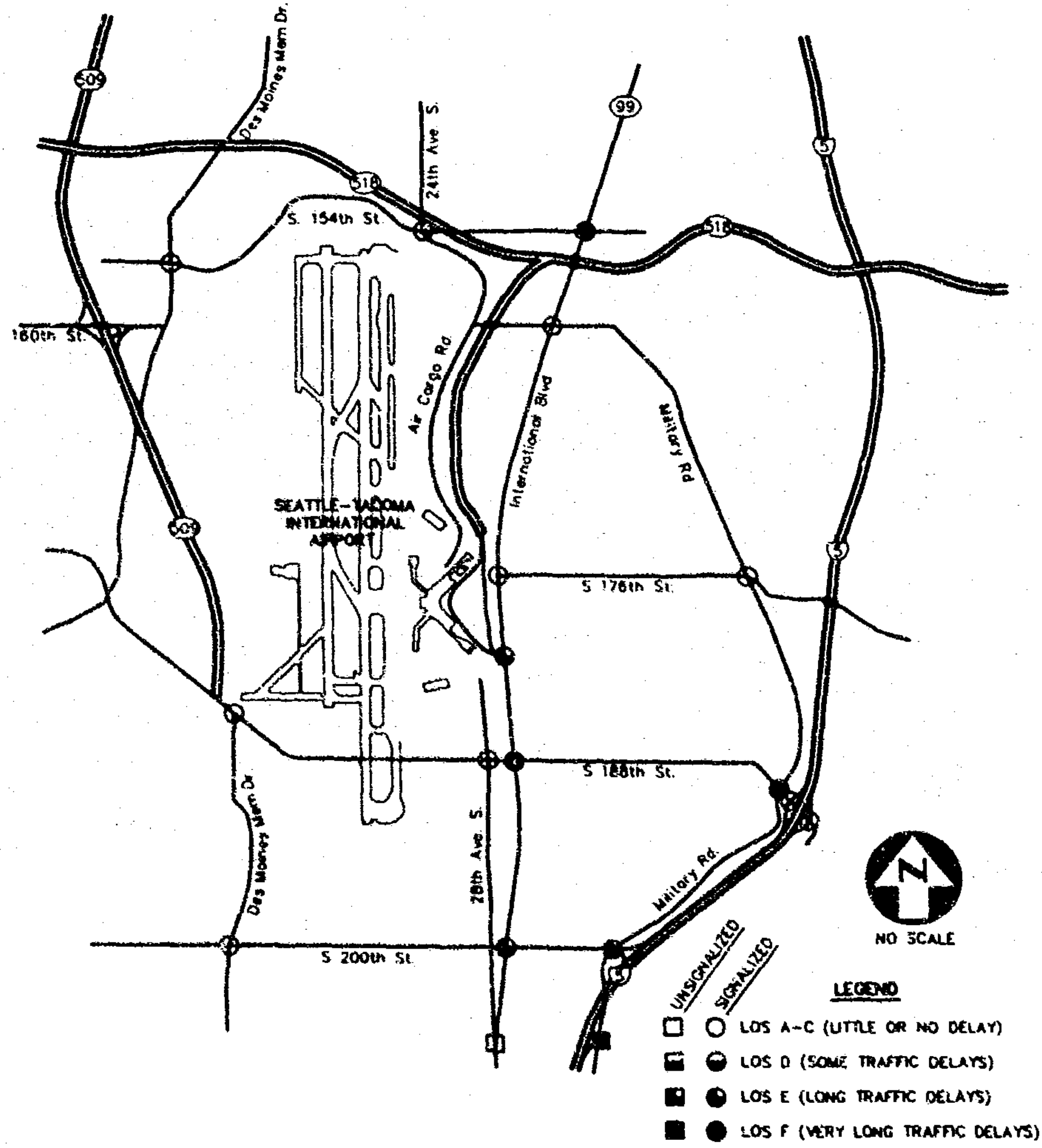
South 188th Street runs east-west along the southern portion of the airport, tunneling under the runways. It is a 4-lane facility with a center turning lane in sections near SR 99. The posted speed limit ranges from 35 to 40 mph. Existing traffic ranges from approximately 22,000 ADT near the SR 509 interchange to approximately 27,000 ADT near I-5.

South 200th Street is located south of South 188th Street and runs east-west between Des Moines Memorial Drive and the I-5 on-ramp. It is a 2-lane undivided minor arterial with a posted speed limit of 25 mph, west of SR 99 but in 4 lanes between SR 99 and I-5. Existing traffic is approximately 9,700 ADT west of International Boulevard and 16,000 ADT east of International Boulevard.

Key Intersections

P&D has identified the key intersections for inclusion in the analysis of projected airport traffic demand. These intersections, along with respective 1993 PM peak hour Level of Service (LOS), are noted in Figure 5-3.

FIGURE 5-3
KEY INTERSECTION LEVEL OF SERVICE



SOURCE: CITY OF SEATAC COMPREHENSIVE TRANSPORTATION PLAN, THE TRANSPO GROUP, 1991

Accidents

Figure 5-4 illustrates the average accident history at study area arterial intersections for the period 1988-1990. The highest accident rates occur along International Boulevard (SR99) between South 154th and south 200th Streets. This section of the highway experiences the highest traffic volumes and congestion levels. The intersection with the highest number of reported accidents is at South 188th Street and SR 99, with most accidents due to left-turn and rear-end collisions. The City of SeaTac Comprehensive Transportation Plan (1991) indicates that the actual accident rate, based on vehicle traffic for the area, is not excessively high according to typical safety standards.

PUBLIC AND COMMERCIAL TRANSIT

Existing Public Transit Services

The King County Department of Metropolitan Service (Metro) currently operates four transit routes that serve the Airport. Three of the four routes are destined for the Seattle CBD, while the last route connects with the Bellevue CBD and then terminates at the Aurora Village Mall. Routes 174, 184 and 194 serve the I-5 and US 99 corridor between Federal Way and the Seattle CBD. All three routes offer direct service to the Airport, while Route 194 offers express service to the downtown Bus Tunnel. The four routes typically provide 25- to 30-minute headways. Only one, route 184 offers late night service. Another route, 191, runs along SR99 with stops near the airport entrance.

Route 340 links the Shoreline Park-and-Ride lot and ends at the Burien Transit Center, running along the east side of Lake Washington. Stops are made at the Aurora Village Transit Center, Lake Forest Park, Kenmore, Bothell, Kirkland, the Bellevue Transit Center, Renton, Southcenter Shopping Mall, and the Airport. This transit route operates at 10- to 60-minute headways.

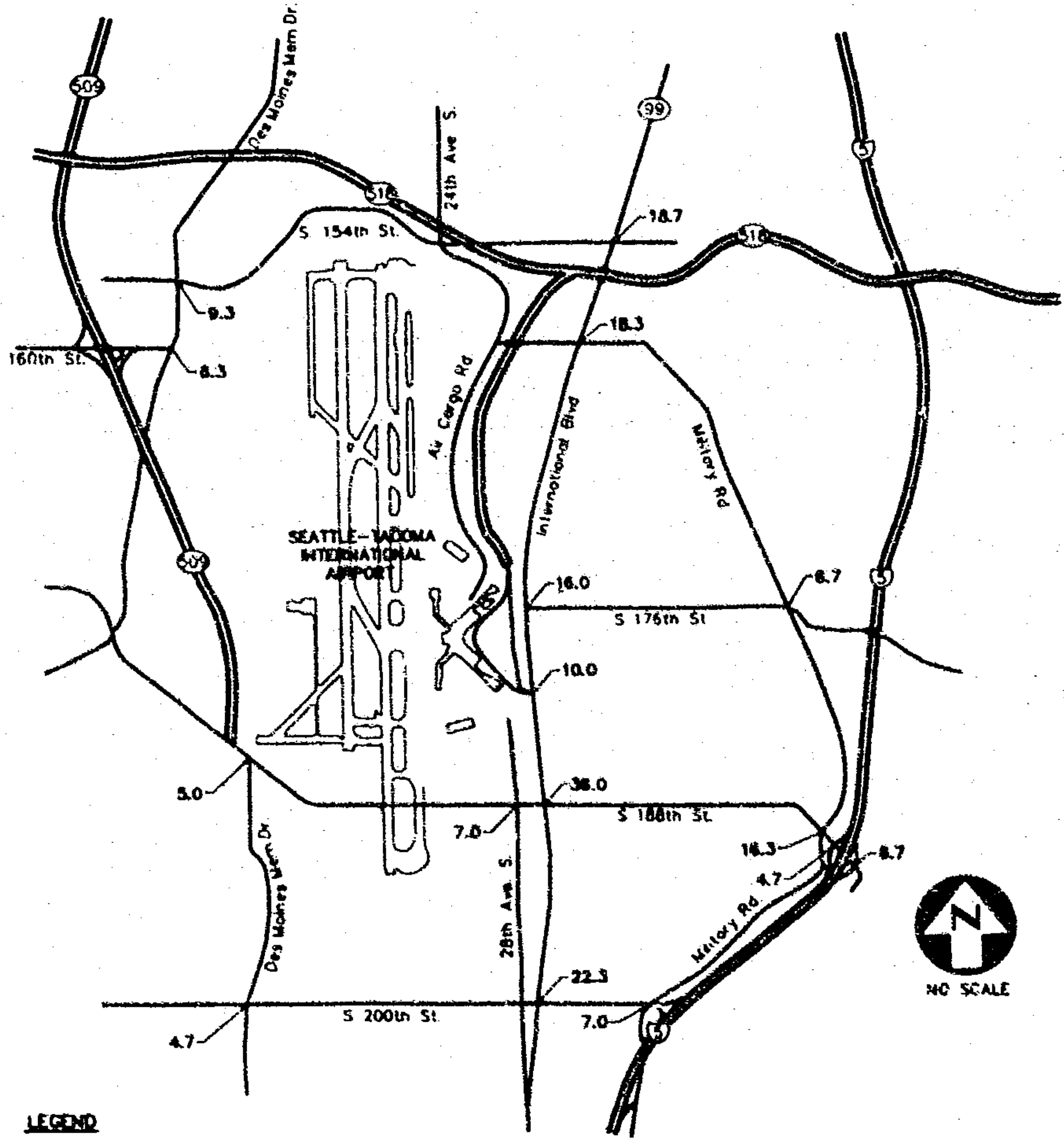
Existing Commercial Transit Services

About 20-25% of vehicles on terminal drives are transit vehicles and taxis based on a 1993 Port congestion survey. Very few are Metro buses. The vast majority are operated by private for-hire operations (taxis, limousines, airporters, charter coaches), or are courtesy vans operated by nearby hotels, off-site parking facilities, or off-site car rental firms. A small number of daily vehicles also connect the terminal with remote employee parking lots. In a 1990 terminal survey, over 550 transit vehicles per hour (all types) were counted on the upper and lower roadways.

In 1984 the Port of Seattle organized a ground transportation system for commercial operators. In December 1992 a Ground Transportation Plaza was opened on the third level of the main terminal parking structure for use by commercial vans in order to provide additional curb space for other vehicles and reduce congestion along the existing terminal curbside.

Fee Structure. The Port of Seattle collects revenue from commercial vehicles in three ways: 1 - Permits; 2 - Percent of gross outbound fares; and, 3 - Fees per trip. All commercial vehicles, except those operated on an exclusive basis, i.e. Grey Line Airport Express, pay a user fee to help off-set the Port's capital, operating, and overhead costs based on assigning the total cost of these services by the number of trips each commercial vehicle makes. An automatic vehicle identification system was

FIGURE 5-4
HISTORICAL INTERSECTION ACCIDENT RATES



LEGEND

10.0 – AVERAGE ANNUAL ACCIDENTS (1988–1990)

SOURCE: CITY OF SEATAC COMPREHENSIVE TRANSPORTATION PLAN, THE TRANSPO GROUP, 1991 installed and vehicles were tagged by July 1992. Off-site rental car operations have an access privilege agreement, obtained in September 1991.

Scheduled Airporter Bus Service. Under state license the Airporter Bus Service operates shuttle service from the Airport to specific points on fixed routes. They have an airport concession agreement as well as a separate layover areas just north and south of the terminal on the lower drive, with an additional upper roadway drop-off area and two lower roadway pick-up areas. There are seven private operators.

Scheduled Carriers. There are four scheduled carriers with airport concession agreements. Grey Line operates exclusive service to downtown Seattle. American Greyhound stops at the terminal as part of its regular Bellingham-Portland intercity service. Canadian Greyhound makes four daily stops, and Quick Shuttle makes six daily trips. All of these operators use the lower southern transit terminal.

Charter Operators. Approximately 80-100 charter buses access the Airport daily in the May-September period at pre-arranged boarding areas. These operators service cruise ship operators in the region. Eighteen operators can access the terminal.

Door-Door For-Hire Van Service. Shuttle Express serves a large part of the greater Seattle area through group loaded transit trips to the Airport. They can drop passengers anywhere on the upper roadway and have three pick-up sites on the lower roadway. In 1993, they made about 275 trips daily to the Airport. In August, 1993 travel volume increased to over 300 daily trips.

Courtesy Vans. The largest number of daily operations comes from courtesy vans, which pay the Port nine cents per outbound trip. Operations are restricted to the third floor transit center. Over 140 vans operated by 68 companies circulate at the terminal (50 hotel/motel, six off-site parking facilities, 10 off-site car rental agencies, and two miscellaneous services). In 1988, the CH2M Hill study indicated a maximum of 150 vehicles per hour on either the upper or lower drive. However, recent automated counts show that over 5,000 vans daily serve the Airport. Concentrations could reach 500 in a peak hour based on this travel demand. Since 1992 these vehicles have been assigned to the transit center lanes on the third floor of the parking garage.

Port records for 1993 show that off-site auto rentals and remote parking lots generate a disproportionate share of courtesy van activity. Auto rental companies, i.e., Advantage, Alamo, Budget, Dollar-Rent-A-Car, Payless, Thrifty Car Rental, etc. are responsible for 30-35% of all courtesy vehicle movement. Off-site parking operations, i.e., Ajax Park and Fly, Dollar Park-and-Shuttle, Doug Fox Parking, Master Park, the Red Lion hotel, etc. generate about 30% of all courtesy vehicle activity.

Taxicabs. All cabs must be licensed to operate in King County. There are two types of cab operations. Full licensed cabs belong to STITA (Sea-Tac International Taxicab Association) and are made up of independent operators who can wait for riders at the terminal and are dispatched by Port staff. However, any cab can drop-off passengers at the terminal, but only licensed or "belled" cabs can pick-up at the terminal. "Belled" taxis operate on the upper roadway for pre-scheduled travel. There are about 550 taxi dispatches daily for both long and short distance fares. Currently 166 fully licensed cabs exist. Operators pay a $2.00 fee to Sea-Tac, of which $1.00 can be passed on to the rider.

Parcel carriers. There are over 250 licensed parcel carriers with Sea-Tac permits.

Limousine Service. Like taxis, there are two types of limousines: Pre-arranged and stand/hail. There are seven stand/hail companies with twelve permits. There are permits for 182 pre-arranged limousines. In addition, a third class of limousines operates vans. Known as contracted carriers, these operators pre-arrange client travel. There are twenty contract operators.

PLANNED IMPROVEMENTS

This section describes improvements proposed for the circulation system within the vicinity of the airport. The section discusses proposed highway improvements first, followed by discussion of proposed transit improvements.

Proposed Highway Improvements

The City of SeaTac Comprehensive Transportation Plan indicates the following improvements to the highway network in the vicinity of the Airport.

Sea-Tac South Access Freeway. The South Access Freeway would be similar to the existing limited access, divided highway serving the Airport from SR 518 to the north, except that it would proceed south from the terminal vehicular drives to tie into an extended SR 509 or the regional highway system. As currently envisioned, the South Access Freeway would be grade separated at South 188th Street and South 200th Street. The proposal is jointly sponsored by the Washington DOT, the Port of Seattle, King County, Metro, the City of Seatac and the City of Des Moines.

State Route 509 Extension. The SR 509 extension is a proposal to connect the SR 509 freeway from its current terminus at South 188th Street through the City of SeaTac. It could possibly extend farther south through Des Moines to I-5. As the alignment passes through the City of SeaTac, it would most likely use the existing right-of-way owned by the Washington DOT and also may use property south of South 200th Street owned by the Port of Seattle. The SR 509 extension would be a limited access, divided highway of the same character as the existing SR 509.

28th/24th Avenue South Arterial. A consortium consisting of the cities of SeaTac and Des Moines, the Port of Seattle, Metro/King County, and local property owners is studying alternative boulevard alignments for a 5-lane arterial to serve existing and expected local access traffic generated by anticipated development in the cities of SeaTac and Des Moines. The alternative designs must anticipate the potential development of the Aviation Business Center in the City of SeaTac north of South 212th Street, and the potential business park development by the City of Des Moines west of 24th Avenue South, adjacent to South 216th Street. A Final EIS on the project was completed in 1993, and subject to funding availability, construction is anticipated in two-three years.

International Boulevard Enhancements. The City of SeaTac is in the process of designing improvements to International Boulevard (Pacific Highway) between South

170th Street and South 188th Street. The preliminary preferred alternative involves expansion from 5 to 6 lanes (2 general purpose lanes northbound, 2 general purpose lanes southbound, 1 continuous HOV lane southbound, and at least 1 left-turn lane at intersections). Plan review is anticipated this spring with construction to be finished toward the end of 1995.

Proposed Transit Improvements

Regional Transit Project. The goal of the PSRC Regional Transit Project (RTP) is to reduce dependence on private vehicles, improve air quality, limit urban sprawl, reduce energy consumption, and protect and enhance the regions communities and neighborhoods. Although still in the planning stages, the RTP would likely have a grade-separated light rail line or exclusive busway connecting the airport vicinity to downtown Seattle and other parts of the region. Metro has indicated potential station locations adjacent to the air passenger terminal and near South 156 and South 200th Streets. All together the RTP includes a comprehensive package of transit improvements including: Expanded and improved bus services; expanded priority facilities for busses and carpools (HOV lanes); and construction of a regional High Capacity Transit System using separate right-of-way, either in the form of a transitway for busses or a rail system. Washington DOT is committed to completion of the HOV lanes in the I-5 corridor near the airfield. Funding for other plan elements, especially rail elements, is uncertain at this time. Regional voters will vote on this plan in 1995. Figure 5-5 depicts the RTA's rail plan at this time.

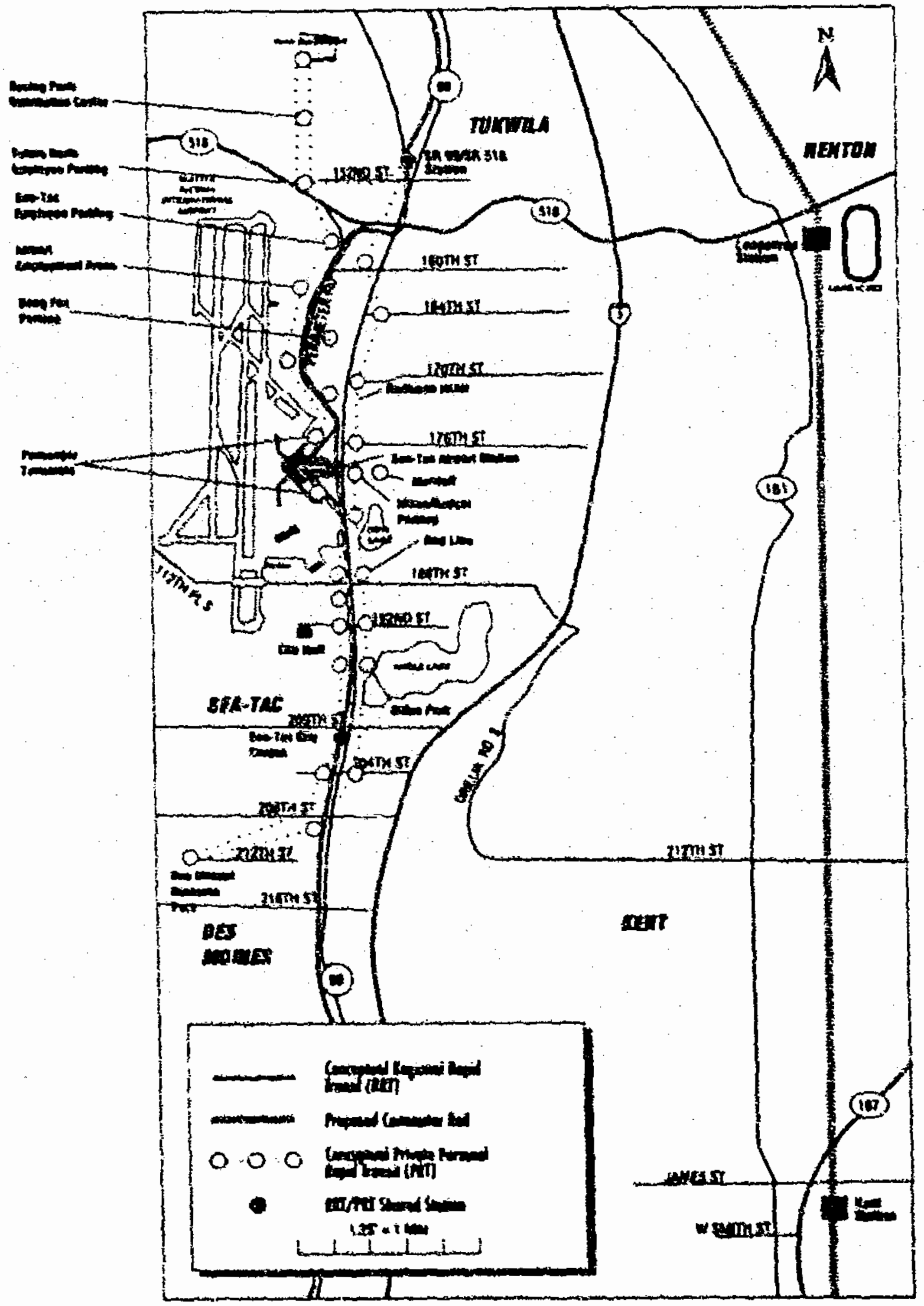
Commuter Rail. As shown in Figure 5-5, the proposed commuter rail element of the regional transportation plan does not directly serve the Sea-Tac International Airport area. The reason for this is that it has been proposed that the commuter rail line use one of two existing track systems. One system belongs to the Burlington Northern Rail Road (BNRR) and the other the Union Pacific Rail Road (UPRR). (The alignment which would provide the closest station capable of serving the airport would be located near Longacres Racetrack.) The proposed Kent Station, shown in Figure 5-5, could also be used to serve the Airport. This station is located in downtown Kent.

The proposed Longacres Station could be located west of the site of the former Longacres Racetrack.

Proposed initial commuter rail service would likely focus on the morning and afternoon peak periods only. Seven peak period runs and one late-arrival run could be provided on 30 minute headways. Service could be increased to 15 minute headways along with increases in mid-day and weekend service, if warranted by demand.

Privatized Personal Rapid Transit (PRT) Development. The City of SeaTac is considering the use of a Personal Rapid Transit (PRT) system to transport people within the Sea-Tac Airport area, to be developed by private parties without public funds. This is a conceptual plan with details to be worked out with private investors who intend to build and operate the system for profit. A conceptual alignment of the system with possible station locations has been developed and is shown in Figure 5-5. The City of SeaTac was recently awarded approximately $600,000 from the Federal government to develop detailed preliminary schematics of the system. The

FIGURE 5-5
PROPOSED RAIL SYSTEMS IN THE SEATTLE - TACOMA AREA



request for proposals for this study has not been issued at this time. The developers have requested that Washington DOT recognize their private initiative.

The City of SeaTac and private developers are considering the Taxi 2000 PRT system, developed by Raytheon Corporation. This is the same system that the Chicago area's METRA is considering for a PRT system, with a pilot project proposed for a suburban community northwest of O'Hare Airport. The Taxi 2000 system is purported to cost approximately $10 million per mile.

The City of SeaTac proposes to have a system in the 3 to 5 miles long when completed. The number of stations, phasing and their locations are conceptual since the project is still in the preliminary planning stage. It is likely that the PRT system would connect in some way to the Regional Rapid Transit system which would serve the City of SeaTac core area. A direct connection between the PRT system and the proposed commuter rail system is not planned at this time, although Washington DOT has requested this concept be examined according to potential developers.

High-Speed Ground Transportation Commission. The commission studied two corridors, one between Vancouver, B.C. and Portland, and the other from Seattle to Spokane by way of Moses Lake. This study was completed in 1992. A review of the ridership projections and feasibility of developing either line is currently underway and will be completed in late 1994.

A study was developed entitled "High Speed Ground Transportation Study - Final Report; October 15, 1992," for the state's High Speed Ground Transportation Steering Committee. Extensive surveys and studies were undertaken in this effort. Business and non-business travel for both highway and Sea-Tac airport users were studied with concentrated effort placed on trips between the Portland - Seattle - Vancouver corridor (North/South) and the Seattle - Moses Lake - Spokane corridor (East-West). The north-south market was much stronger than the east-west market.

In 1992 an estimated 59 million trips are made in these two corridors, but only about 1.5% are by air (728,500 annual trips). There are about 110 flights daily between Sea-Tac and Portland, Bellingham, Spokane and Vancouver combined, or about 10% of daily commercial movements at Sea-Tac. By 2020 the report estimated that all travel would grow about 100% between corridor cities in proportion to current auto/air mode shares. The report showed that north-south or east-west corridor movements were in aggregate about the same, but the north-south corridor had a greater likelihood of greater rail travel than the east-west corridor. In all cases, a station at Sea-Tac terminal would be the greatest destination on any alignment. The study also showed that a Bellevue high speed rail station would increase ridership compared to a downtown Seattle station due to the ability to maintain higher speeds to the Bellevue station regardless of other influences.

Without high speed rail, air travel in the Portland-Seattle-Bellingham-Vancouvercorridor is projected to grow to about 1.5 million annual trips, while all travel will grow to 104 million annual trips in the study.

Several different rail options were examined with train speeds ranging from 185 miles per hour (mph) to 300 mph. Train service would reduce air travel from Sea-Tac airport by about 10% under the most favorable rail scenario to about 1.4 million annual air trips, but this is still about 100% over existing travel levels among the city pairs studied. Rail travel could reach from 2.7 million to nearly 6.2 million annual trips depending on the corridor, technology and assumptions used.

Vision 2020. In September, 1990, Puget Sound Regional Council (PRSC - formerly PSCOG) integrated the Regional Transportation Plan (adopted 1982) and the Regional Development Plan (adopted 1979) into one plan entitled Vision 2020. Vision 2020 effectively replaces all existing regional transportation and development plans and policies and serves to guide transportation and related land use decisions for the 1990-2020 period.

In general, planned improvements are contained within existing plans and VISION 2020 includes freeway and arterial widening or additions, new arterial, and regional transit and ferry improvements, and transportation demand strategies.

ON-SITE AIRPORT ROAD SYSTEM

Sea-Tac terminal is connected to the regional highway system by roads from the north and south. The six-lane north freeway carries most of the traffic to the site, while the two-lane south access road connects to the Sea-Tac entrance at SR 99 at about South 180 Street. Both roads connect to the terminal's on-site parking structure, freight delivery tunnel, parking garage exit, and curbside drop-off/pick-up areas on separate roadways for each function. Single lane ramps from the access road connect to both the upper road which services the ticketing concourse and the lower road which services the baggage claim. The upper roadway is four lanes wide and the lower is five lanes. On the upper roadway the two curbside lanes are dedicated to pick-up/drop-off activity, and the other lanes are for through traffic. On the lower roadway, the two curbside lanes are used for pick-up activities and the remainder for through traffic.

The upper roadway, servicing the ticketing concourse of the terminal, has 1,673 feet of curb, with four traffic lanes and a 14 feet-4 inches wide sidewalk. The curb lane is 11 feet wide, lanes two and three are 9 feet wide, and lane four is 8 feet-10 inches wide. The lower roadway has 1,668 feet of curb space with five traffic lanes and a 21 foot wide sidewalk to serve the baggage claim area. The lower roadway curb lane is 10 feet-8 inches wide, lane two is 9 feet-11 inches, lane three is 10 feet-5 inches, lane four is 12 feet-6 inches, and lane five is 12 feet-3 inches wide. Pick-ups and drop-offs are allowed in the lanes next to the curb, vehicles leave the upper roadway via two through lanes and the lower roadway via three through lanes. Both roadways have 20 mph speed limits.

In the 1987 Landside Access Program (CH2M Hill), the capacity of the ramps to the upper and lower terminal roadways was estimated at 1,500 and 1,700 vehicles per hour (vph), respectively. The curb lanes were estimated at 800 vph. Recent Federal Aviation Administration (FAA) standards estimate that each added lane next to the curb lane handles only 60% of initial lane capacity, a third lane handles 60% of the second lane, etc. Thus, the 1987 study may be overestimating the capacity of the curbside roadway.

A summary of curb space allocation is shown in Table 5-4.

In a five minute period, the upper roadway level (ticketing concourse) can handle approximately 125-150 private passenger vehicles based on FAA standards, including average dwell times, or a maximum of 1,500 vph in the two lanes under optimal conditions. The lower roadway level (baggage claim) can handle 80-100 private passenger vehicles since dwell times are normally longer for baggage claim. The lower roadway can handle approximately 1,000 private vehicles per hour with the current configuration.

The 1987 landside access report noted that ramp traffic backups were due to delays at curbside during peak periods. At that time, curb space was considered to be over utilized by about 25% during peak periods.

Recently, the third level of the parking garage was converted to an express parking area and transit center for small private transit vehicles (non-diesel powered) The two additional lanes were added for passenger pick-up or drop-off at six stops near pedestrian bridges to the terminals. This transit center added 750 feet of mixed-use curb space. These transit vehicles are no longer permitted to use the main roadway system adjacent to the terminal. The Port estimates the two-lane transit roadway can handle another 100 private transit vehicles for departing passengers, or half that number of arrival pick-ups in a five minute period. Existing pedestrian overpasses eliminate all conflicts with vehicles between the parking garage and the passenger terminal.

Studies have shown that about 60% of traffic approaching the terminal is from the northern access road and 40% from the southern access road. However, 70% of traffic exits via the northern road and the remainder via the southerly access road. This difference accounts for part of the on-site recirculation problem. The northern roadway is bi-directional with six lanes and a median. The southern access road is two-way, divided, with five lanes. While the volumes may have changed in recent years, the overall distribution pattern closely parallels data for airport access obtained from other sources.

Traffic volumes on the roadways vary, however volumes peak during mid-day passenger activity periods in August. In 1992, the Port conducted a congestion study during the August peak period with the results shown in Table 5-5. According to airline records and Port estimates, daily boardings at Sea-Tac during this period ranged from 7,996 to 8,859 passengers, the average being 8,428. P&D estimates that in August approximately 1.5 vehicle trips per boarding passenger are on the terminal roadway, reflecting local traffic recirculation from curbside to parking garage as well as courtesy bus activity.

The 1992 Port Drive Congestion Study noted two congestion spots on the upper roadway impacting 75% of all vehicles. These spots are: 1) The Delta, American, and Northwest check-in area, and, 2) The Alaska/United check-in areas. The volume of passengers served by these carriers, plus the competitive flight scheduling, result in heavy traffic at these adjacent ticketing areas. The report noted that the upper roadway should be able to accommodate 50-80 vehicles at any given time, but sharp rises during peak periods result in extensive congestion. Typically during the August peak, at any 4-5 minute period, the actual number of vehicles was only 55-70, with

TABLE 5-4
EXISTING SEA-TAC TERMINAL CURB LANE SPACE ALLOCATION

	Upper Roadway	Lower Roadway
Port Bus Zone	162 ft.	
Commercial Bus Zones	130 ft.	251 ft.
Parcel Zone	121 ft.	
Taxi Zones	184 ft.	219 ft.
Limousine and Van Zones	50 ft.	123 ft.
Police Zone	47 ft.	
General Traffic Zones	975 ft.	511 ft.
TOTAL	1,673 ft.	1,668 ft.

Source: Port of Seattle (undated) GAA/3013P

TABLE 5-5
SEA-TAC TERMINAL PEAK PERIOD TRAFFIC VOLUMES
UPPER AND LOWER ROADWAY TRAFFIC VOLUME

August 1992 Upper Drive Traffic Volume			
Survey Week	**High Volume**	**Low Volume**	**Average**
Week 8/3	12,708	10,901	11,790
Week 8/10	14,583	10,112	12,168
Week 8/17	12,616	10,922	12,078
Week 8/24	12,409	10,471	11,681
Peak Period Flow (1100-1300 hrs)	1,796	1,420	1,608

August 1992 Lower Drive Traffic Volume			
Survey Week	**High Volume**	**Low Volume**	**Average**
Week 8/3	15,448	13,198	14,138
Week 8/10	15,155	14,115	15,005
Week 8/1.	15,866	13,710	14,622
Week 8/24	15,680	12,629	14,560
Peak Period Flow (1100-1300 Hrs)	2,262	1,633	1,948

Source: Port of Seattle - Drive Congestion Study, October, 1992.

the majority of the vehicles at the loading areas of the five major carriers.

ON-SITE TRAFFIC PATTERNS

Vehicle Classification, Occupancy, and Travel Pattern Studies

In the Port of Seattle Drive Congestion Study completed in 1992, 23% of all vehicles on the Upper Drive were courtesy bus, vans, or multiple occupant vehicles; on the lower drive the figure was 21%. This observation lead to development of the additional curb space inside the parking garage on the third level, with special bus/van loading areas, and indicates that the balance of vehicles are private autos and taxis.

Results from a 1994 Port of Seattle Sea-Tac passenger survey showed average vehicle occupancy was 2.3 persons per parked private auto. In May 1990, for-hire shuttle vans were surveyed by the Port and had 2.04 passengers per vehicle, with nearly 25% of all vehicles empty when surveyed. Data from a Port of Seattle survey completed in July, 1990 estimated the following occupancy rates for courtesy type vehicle trips: 1) Off-Site Car Rentals - 1.75; 2) Off-Site Parking Lots - 1.8; 3) Misc. Courtesy vehicles - .65; and, 4) Hotel Courtesy vehicles - 1.25.

The Port has conducted previous studies with somewhat similar results, although P&D notes that the classifications and methods used in these surveys were somewhat different and a precise direct comparison among these surveys Port studies is difficult due to methodology and terminology used in different studies.

Autos arriving at Sea-Tac also varied in their on-airport travel patterns. First, of all travelers arriving by private car, 39% are dropped at the curb, 31% parked on-site, 17% parked off-site, and about 9% of autos dropped passengers off at curbside and then parked on-site. Thus, only about 40% of autos arriving at Sea-Tac actually park on-site, with 17-19% parking off-site. The vast majority of autos park less than 24 hours, although about 25% of all passengers do arrive or depart from a car parked in the garage. In 1993, Sea-Tac records show that 53% of all autos used the short-term parking area, with about 14,300 cars using the garage's 8,000 public spaces daily in August the peak travel month. Short-term parking spaces have a fairly high turn-over rate, while the long-term on-site parkers are rare. Port records show that the median length of stay for all cars is 45-60 minutes, reflected by the fact that 53% of garage users use short-term parking. Only 10% of autos stayed over 4 hours with 70% of those staying over 24 hours. Thus, very few long-term parkers use the on-site garage or stay over four hours.

In 1984, a survey by the Hall Associates showed that the lower roadway averaged: 68% private cars; 11% courtesy vans; 14% auto rentals; 5% taxis; 3% buses; and, 2% other vehicles. On the upper roadway curb (ticketing) the vehicle distribution was as follows: 59%; courtesy vans 13%; rental vehicles 16%; taxis 6%; buses 5% and other vehicles 3%. The lower roadway handled about 20% more vehicles than the upper roadway.

In August 1992 a transit vehicle classification study was undertaken by the Port of Seattle, with the following results: 91% courtesy vans; 8% for-hire shuttles; and 1% port buses and vehicles. Port vehicles were primarily evident in the normal morning and afternoon peak periods. There were a fairly constant 130-150 courtesy vans every hour between 6 a.m. and midnight. There were 10-17 for-hire shuttles every hour from 10:00 a.m. to midnight. (18)

On-Site Vehicle Traffic

Table 5-5 previously showed actual vehicle counts taken in 1984. Table 5-6 shows projected changes from 1984 to 1993. Significantly, while daily passenger activity (to the Sea-Tac complex) has increased by 40%, (based on P&D's analysis of available data) traffic volumes grew by no more than 12%. Projections made for 1993 in another study for the Port, projected a continuation of this trend, particularly for arriving and departing passengers who increasingly appear to be using shuttles, courtesy vehicles, and group drop-offs as their preferred mode of arrival.

PARKING SYSTEMS AND PEDESTRIAN ACCESS

Figure 5-6 shows the location and number of both on and off-site parking spaces for the public and Sea-Tac employees.

On-Site Terminal Parking

Pedestrian overpasses, which pass over the roadway system, connect the terminal directly with the parking garage, which holds approximately 9,400 public spaces for all parking. The garage was expanded to its present size in 1992. The structure contains approximately 1,000 spaces designated for rental cars, approximately 400 spaces for employee parking, 1,000 short-term "express" spaces and 7,000 general spaces for a total of 9,400 spaces in the structure. In 1993, the third floor of the structure was assigned to short-term "express" parking for approximately 1,000 spaces, as well as transit pick-ups and drop-offs for vans, courtesy buses, and off-site parking garages. This new "express" parking area has its own entry area with a "pay-on-foot" cash system. There are two entrances to the main part of the garage, convenient for north or south approaches. One eight booth cashier exit area serves the main garage.

Parking rates vary by length of stay. The Express parking area is $1 for up to two-hours and an additional $1 for a third hour. The general terminal rate is $2 for the first 30 minutes; $3 for the first hour; $4 for 2 hours; $6 for four hours; $8 for 8 hours; and $10 for up to 24 hours. In addition, the City of SeaTac levies a transaction tax (50 cents) for each vehicle in the garage, plus a state 8.2% sales tax.

Based on Sea-Tac records the garage has seen an annual growth of 5% per year in parked vehicles, growing from about 6,890 per average day in 1984 to 10,340 per average day in 1993. During the August peak period, nearly 14,400 vehicles used the garage daily in 1993. This 40% difference between average month and peaks month activity is consistent with terminal passenger activity. The sample in Table 5-7 shows daily activity record for a recent weekday. Nearly 40% of all parking activity is in the 10:00 a.m. to 2:00 p.m. period. Other important, but far smaller activity periods are 5:00-8:00 a.m. and 4:00 - 8:00 p.m.

Off-Site Parking

In recent years, a large number of off-site parking facilities, clustered along State Route 99 (SR99) have opened. These lots have about

TABLE 5-6
SEA-TAC TERMINAL CHANGE IN AVERAGE DAILY VEHICLE TRAFFIC

	1983	1987	1993 (Projections)
Departure	NA	15,000	17,800
Arrival	NA	15,000	17,800
Long-Term Parking (on-site)	NA	14,000	22,700
Car Rental	NA	3,100	3,400
Employees	NA	20,000	28,500
Daily Origin/Destination Passenger Load (1)	19,440	27,700	NA
Total	60,500	67,100	90,200

Source: CH2MHill, Landside Access Plan, 1987-88 Derived from annual passenger activity, less connecting passengers.

FIGURE 5-6
EXISTING PARKING

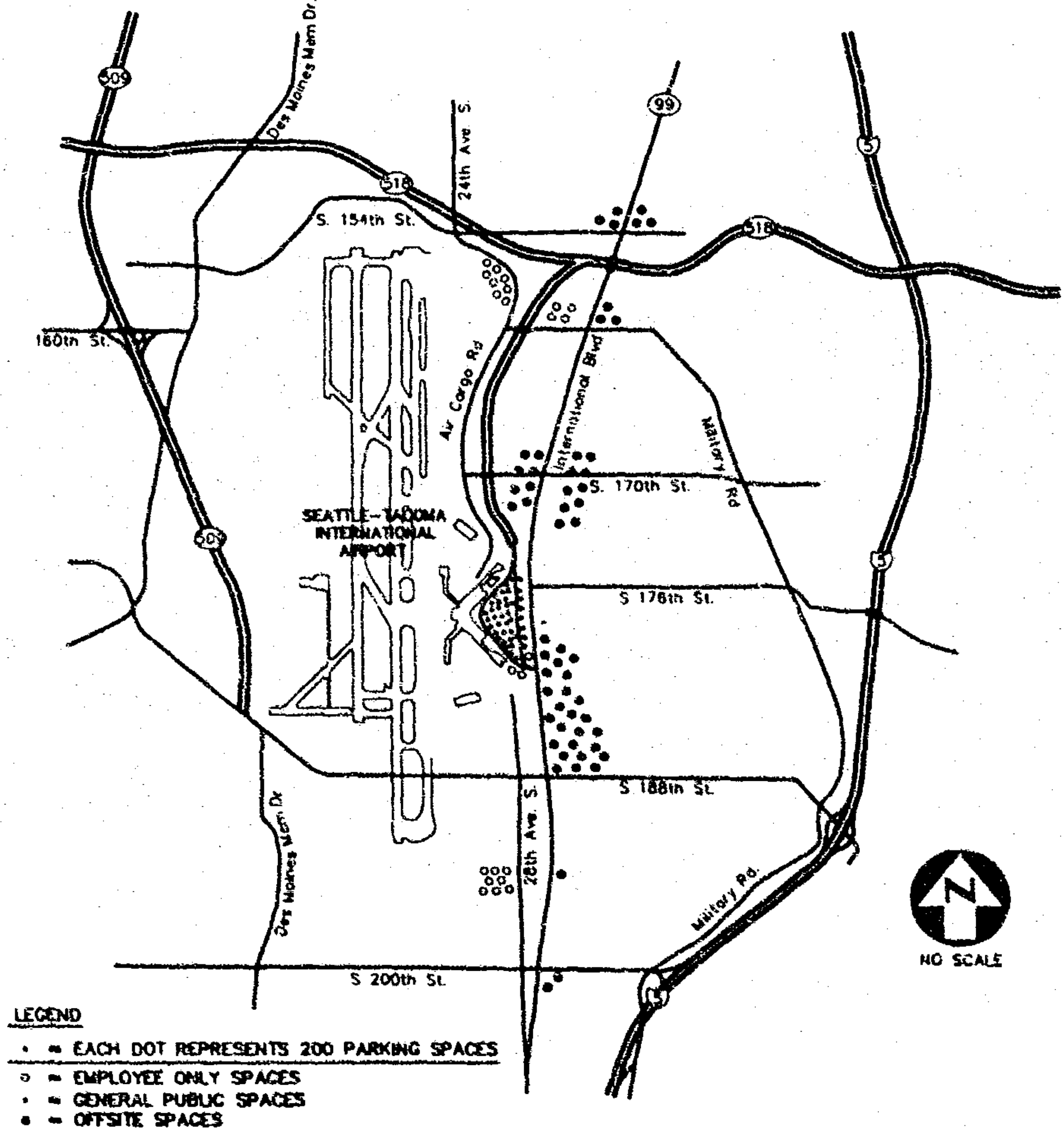


TABLE 5-7
ON-SITE PUBLIC SEA-TAC TERMINAL PARKING ACCUMULATION

Sea-Tac On-Site Parking Hourly Accumulation Sample									
Hour	North Entrance	South Entrance	Meter Total	Total	Hour	North Entrance	South Entrance	Meter Total	Total
0-100	9	11	0	20	12-1300	158	259	235	652
1-200	2	7	0	9	13-1400	166	214	230	610
2-300	6	7	0	13	14-1500	105	157	189	451
3-400	5	15	0	20	15-1600	109	138	165	412
4-500	29	38	0	67	16-1700	124	176	182	482
5-600	192	165	1	358	17-1800	122	222	252	596
6-700	327	253	0	580	18-1900	95	143	207	445
7-800	175	225	1	401	19-2000	94	127	205	426
8-900	133	189	6	328	20-2100	92	144	232	468
9-1000	141	186	41	368	21-2200	68	106	190	364
10-1100	128	215	256	599	22-2300	63	80	121	264
11-1200	191	225	235	651	23-2400	27	52	36	115
Subtotal	1,338	1,536	540	3,414		1,223	1,818	2,244	5,285

Source: Port of Seattle - Parking Records for May 1993.

9-10,000 spaces according to recent studies for both the City of SeaTac and the Port of Seattle, although the number fluctuates based on actual operators and on-site parking practices. A report in 1988 showed about the same number of off-site parking spaces. Table 5-8 shows the location and size of these off-site facilities. Previously cited data show that 17%-19% of Sea-Tac travelers use these off-site lots, which appear to be favored by long term parkers for their reduced long-term rates compared to the on-site terminal. Operators run courtesy shuttles to the Sea-Tac terminal for off-site users and these represent a considerable share of on-site roadway vehicles.

Since an average of 500 cars remain over-night in the on-site garage, they represent an important element of access to the terminal for users. Parking rates vary but typically are $5-$8 daily, plus sales tax and City of SeaTac parking charges. No data exists on actual occupancy rates, but Port staff estimates that off-site parkers remain 3-5 days with a 70% occupancy rate. Figure 5-6 shows the general concentration of area parking.

Employee Parking

The Port also has employee parking scattered around the airfield as shown in Table 5-9 totaling about 4,300 spaces. Due to work shifts about 8,200 employees have parking permits to use these lots (2.5 permits per space maximum). Shuttle buses connect the north and south lots with the main terminal. Lot 5 near the garage has 200 spaces southeast of the garage and another 100 spaces are east of the tunnel access to the terminal but do not require shuttle service and about 300 employees park inside the terminal garage. Port lot users pay $19 monthly for parking permits. There are other employers on the Sea-Tac site which have employee parking adjacent to their hangers and buildings. However, there are no estimates of parking spaces allocated to these users. Figure 5-6 shows the location of area parking lots.

Employee Parking Relocation

There currently are about 1,500 airline/airport employee parking spaces on remote lots in the vicinity of South 192nd Street and 28th Avenue South. Most of these spaces are to be moved to the north end of the airport to a site previously identified and reviewed in the Port of Seattle's Parking and Facilities Expansion Project EIS.

TABLE 5-8
OFF-SITE PARK AND RIDE LOTS

Lot and Name	Location	Parking Spaces
Ajax Lot #1	3211 South 154 Street	600
Ajax Lot #2	15426 35th Avenue South	575
Ajax Lot #3	19031 Pacific Highway, So.	225
Budget Lot #1	17808 Pacific Highway, So.	800
Budget Lot #2	18445 Pacific Highway, So.	1,075
Budget Lot #3	18221 Pacific Highway, So.	325
Doug Fox	South 170 Street	1,650
Dollar	17600 Pacific Highway So.	750
Jet Motel	17300 Pacific Highway So.	300
Master Park	18220 Pacific Highway So.	689
U-Save Park-N-Fly	1629 Pacific Highway So	400+
Shuttle Park	15667 Pacific Highway So.	550
Park-and-Fly/Tac-Sea Motel	17024 Pacific Highway So.	114
Hulings Thrifty Parking	18836 Pacific Highway So.	1,000
VIP Parking	18000 Pacific Highway So.	350
Other Outside Lots		930
Total Spaces		9,983

Sources: Port of Seattle - Park and Shuttle Lots Report, February 24, 1994. BRW, Sea-Tac People Mover Study - Final Report, February, 1992.

TABLE 5-9
SEA-TAC EMPLOYEE PARKING AREAS

Lot Name or Designation	Parking Capacity	Assigned Permits
No. 1 - Main North Employee Lot	1,517	
No. 2 - Secondary North Employee Parking	700	
No. 3 - Employee Close-In Parking (Tunnel area, lot 5, 5th floor of terminal garage)	600	
No. 4 - South Employee Lot	1,500	
Total	4,317	8,206

Source: Port of Seattle Unpublished Records, BRW, Sea-Tac People Mover Study, 1991.

Section 6
EXISTING UTILITIES

SECTION 6
EXISTING UTILITIES

INTRODUCTION

This report section describes the existing utility systems and services at the Airport. The Port of Seattle is authorized to own, operate and maintain public utility systems under the RCW Title 53 (Port Districts). Sea-Tac Airport utilities are the responsibility of the Aviation Division Managing Director.

DOMESTIC WATER SUPPLY

This description of the existing water system is based on information from: Airport Comprehensive Water System Plan, *Horton Dennis & Associates, Inc., August 1991*. The Airport owns and operates the water system as its own purveyor and sells water to its tenants. Day-to-day operation of the Sea-Tac water system is carried out by the Sea-Tac Facilities and Maintenance Department. The POS Fire Department has overall responsibility for fire protection services within the Airport.

Water Service Area

The existing Sea-Tac Airport water system service area is limited to the property owned by the Port which is being used for aviation related operations. Metered connections to the sea-Tac system are currently being increased in number, and presently there are 71-75 connections to 32-35 tenants on the system. This area is generally bounded on the east by State Route 99, on the west by 12th Avenue south, on the north by State Route 518 and on the south by South 188th Street. No residential uses are connected to the Sea-Tac water system. Additional property owned by the Port in the vicinity of the Airport is within the service areas of other purveyors in the area. Future expansion of the service area will be limited to those developments on Port owned property which are proposed for aviation related facilities. Negotiation of a service area agreement with the Highline Water District may be required if the Port is to expand the service area for the area south of the Airport.

Water Demand

The current water demand of the Sea-Tac water system is estimated at approximately 233 million gallons annually or approximately 0.64 million gallons per day.

Water Supply

Under normal operating conditions, the Airport receives its water from the Cedar River Pipeline Number 4, a 60-inch, concrete transmission main. This facility originates at Lake Youngs, which is southeast of the City of Renton and approximately nine miles from the Airport. The Seattle transmission main enters the Airport property from the east along South 160th Street.

The Airport water system is supplied entirely by a direct service connection from the City of Seattle water system. Water is purchased at retail commercial rates through two 24 inch meters located near the northeast corner of the Airport. In addition, a manual intertie with the Highline Water District at the south end of the Airport provides a backup source of supply in the event of interruption in the Seattle supply. This intertie requires manual operation and no intertie agreement exists for this connection.

The existing connections to the Seattle system are somewhat vulnerable because they are located adjacent to each other and therefore both subject to localize system failure. In addition, the existing domestic jockey pump has been found to be inadequately sized to meet existing domestic demand requirements.

Storage

The Port of Seattle maintains up to 300,000 gallons of on-site storage in an elevated reservoir at the northeast corner of the Airport. Additional storage is available in the City of Seattle system and their 20 million gallon Riverton Heights reservoir is located less than one mile north of the Airport.

The combined storage available from the on-site reservoir and the City of Seattle's Riverton Heights reservoir is adequate to meet existing and projected water system storage requirements.

The City of Seattle Riverton Heights Reservoir provides fire reserve storage and a portion of the standby storage requirements, although availability of water from the Riverton Heights facility is subject to limitations by the elevation of the facility in relation to the Sea-Tac system. It has been found that water can not be provided under greater than 50% reservoir drawdown conditions.

Pumping System

The two 24-inch mains that serve the Airport are connected directly to the pump station and serve as suction headers for the pumps. The pump station is located at the northwest corner of the intersection of Air Cargo Road and South 161st Street.

The existing domestic pumping system is insufficient in capacity to meet existing and future water system demands. Also, the existing configuration of pumping to the elevated reservoir for subsequent gravity flow to the distribution system does not provide the pressures desired under normal operating requirements. Presently, when demands exceed the capacity of the domestic system, the fire pumping system is activated to assist and provide the required pressures. High areas of the Airport near the elevated storage tank can not be supplied from the tank and a separate pump is required to serve these facilities.

Based on the analysis of the existing fire pumping system described in the Airport Comprehensive Water System Plan, the system is determined to be adequate for both existing and projected system requirements. However, it is currently activated under relatively small demand conditions. This situation contributes to the potential for water hammer and surge damage to the system and facilities. Revising the domestic pumping system to provide fire flow requirements for all facilities except those requiring high fire flows (such as hangars) would reduce the frequency in which the fire pumping system is activated.

Distribution System

The main portion of the primary distribution loop is composed of 24-inch ductile iron pipe constructed in the early 1970's, and is interspersed with smaller diameter loops and connections around main buildings and facilities. The type and condition of 8,000 linear feet of pipeline east of the terminal is unknown and this line may be part of the Airport's distribution system. If this line is still in service, it is approximately 45 years old, and future problems can be anticipated.

Because of the hydraulic gradient of the Seattle supply, all water consumed by the Sea-Tac system is pumped. Under normal operating conditions the system supplies water to the various Airport facilities by pumping to the on-site elevated storage reservoir and gravity flow from that facility. Under high demand conditions, such as a fire, a bank of eight fire pumps are available to boost the system pressure and provide the high pressures and flows required in such an emergency.

Water Quality

Cross-connection control and emergency spill response programs are critical to the protection of water supply quality. Satisfactory programs addressing these issues are in effect.

The State Department of Health requires monitoring of water quality throughout any public water system. This requirement is in addition to the water quality testing programs carried out by the City of Seattle.

ELECTRIC POWER DISTRIBUTION

The main power system is fed by Puget Sound Power and Light through two substations. The North Substation receives 12.5 kv power from either of two Puget Power substations, Bow Lake and Asbury. The South substation receives 12.5 kv power from either of two Puget Power substations, Manhattan and Sweptwing. Each substation provides six (6) 12.5 kv feeders and has a transformer on the Puget Power side which provides six (6) 4.16 kv feeders, for a total of twelve (12) 12.5 kv feeders and twelve (12) 4.16 kv feeders into the Airport. These 24 feeders are routed to transformers, via cable vaults and utility tunnels, all of whose secondaries are 480 volts. This lower voltage is distributed throughout the facility, and provides all lighting and tenant needs.

In addition to the above main power system, two smaller 12.5 kv subsystems are separately fed by Puget Power. One is limited to the Weyerhauser hanger on the west side of the airfield, and the other serves the inflight kitchen, Port equipment shelter, and the water tower on the east side of the Airport.

The emergency power system is a separate 4.16 kv system served normally through tie-breaker switch 52. This system serves loads through ten (10) emergency transformers in the Passenger Terminal, Parking Terminal, and the North and South Satellites. Its primary function is to provide back-up electrical power to the Field Lighting Vault for all AOA (Air Operation Area) runway and taxiway lighting and critical communication and control systems, as required by the FAA.

Two 600 kw 4.16 kv diesel generators are located in the Main Terminal Switchboard Room. When commercial power loss is sensed, both generators start. The first to come up to voltage picks up the Field Lighting Vault load. The second generator automatically synchronizes with the on-line generator and the above ten transformers are switched to the emergency power thru tie-breaker switch 52. This action is normally completed within 30 seconds. On the average, every fifth light fixture in public areas is connected, and other essential Port functions connected to these ten emergency transformers receive power.

There are additional stand alone emergency generators at the fire station, the maintenance building, and pump house.

The Port does not currently provide a 400 HZ aircraft ground power system. The Port plans to double the capacity of the emergency system since the existing system is fully loaded. The Port is currently preparing a study which describes the existing electric power distribution system, the current electrical demands and future improvements. This study is anticipated to be completed by the end of 1994.

INDUSTRIAL WASTEWATER SYSTEM (IWS)

The industrial wastewater collection system was designed and constructed based on 100-year criteria to service 135 acres of paved area. The system consists of a network of underground trunk sewers and surface gutters designed to collect, treat and dispose of wastewater from areas of aircraft fueling, washing and maintenance, air cargo handling, de-icing and the main parking garage. The system's treatment plant removes solids, fuel, and oil from the wastewater with three lagoons and dissolved-air flotation (DAF) treatment. Plant effluent is then piped to a point downstream from the Des Moines domestic sewage treatment plant, where it joins that plant's effluent and is conveyed to Puget Sound.

Based on the conclusions found in the Task 3 Report-Existing Industrial Wastewater System of the Comprehensive Stormwater and Industrial Wastewater Plan, the IWS is in fairly good condition with no evidence of structural deficiencies. However, storage in addition to that provided by the three lagoons is needed under the present conditions. Modifications to the IWS service area and future airport expansion would also increase the volume of storage needed in the lagoons.

Future expansion of the IWS is currently being addressed through and NPDES permit and an overall planning program.

STORMWATER DRAINAGE SYSTEM (SDS)

The description of the existing stormwater drainage system is based on information obtained from the *Industrial Wastewater System and Stormwater Drainage System Study, Anne Symonds & Associates, Inc., April 1993*. The system at Sea-Tac typically drains areas free of industrial waste such as water runoff from roof tops, runways, taxiways and roadways which are typically free from oil, fuel, and de-icing contaminants.

The SDS has been divided into eight drainage areas as dictated by gravity flow and natural drainage boundaries. The total drainage area is approximately 790 acres, and the conveyance system consists of 1,451 manholes/catch basins and 185,600 linear feet of piping. Pipe sizes range from 4 to 60 inches in diameter. One pump station is also included in the system and is located on the east side of the Airport.

There are eight discharge locations for the storm drainage system. Three discharges are located at the north end of the Airport which drain into Lake Reba and then into Miller Creek. Five discharges are located at the south end and drain into Des Moines Creek.

The stormwater drainage system is in fairly good physical condition. The system however does have hydraulic capacity and surface ponding problems. Part of this can be attributed to the change in system sizing regulations which have occurred through the years. Specific SDS deficiencies, along with a detailed analysis of the system, are identified in the aforementioned 1993 study. There are also certain areas that drain into the SDS which should drain into the IWS. These areas are also identified in the 1993 study.

SANITARY WASTE

Sanitary waste is conveyed to the Midway and Val Vue Sewer Districts for treatment before finally being discharged into Puget Sound. The existing sanitary sewer system consists of gravity type sewer mains, and therefore there are no pumping requirements. The existing system is in good condition and is sized to accept the loads anticipated in the foreseeable future. Possible minor improvements, upsizing of pipes, may be required depending on future development.

There are two aircraft waste disposal points. The disposal point by the North Satellite is owned and operated by United Airlines. The other is used by the remaining airlines, and is coordinated by Northwest Airlines.

NATURAL GAS

There is a six-inch gas line along Pacific Highway South that branches at 188th Street with service west into Des Moines. The Airport is served with branch lines from these mains at seven points with two-inch, four-inch, and six-inch lines. Existing on-airport lines can be extended to accommodate expansion. The demand on the mains is dependent on service to a much larger service area.

TELEPHONE COMMUNICATIONS

There are three telephone systems providing service at the Airport. All public telephone service is provided by U.S. West Communications.

APPENDIX A
GLOSSARY OF TERMS

GLOSSARY OF TERMS

"A"

A-WEIGHTED SOUND LEVEL - The sound pressure level which has been filtered or weighted to approximate the response of human hearing to different frequencies (dBA).

AC - Advisory Circular published by the Federal Aviation Administration.

ADPM - Average Day of the Peak Month

AFB - Air Force Base

AIA - Annual Instrument Approaches

AIR CARRIER AIRCRAFT - Aircraft with more than 60 seats operated by an air carrier airline.

AIR CARRIER AIRLINE - An airline certificated in accordance with FAR Part 121 or 127 to conduct scheduled services on specified routes operating aircraft with more than 60 seats. These air carriers may also provide nonscheduled or charter services as a secondary operation. Four carrier groupings have been designated for statisitical and financial data aggregation and analysis.

1. MAJORS; Air carriers with annual operating revenues greater than $1 billion.

2. NATIONALS: Air Carriers with annual operating revenues between $100 million and $1 billion.

3. LARGE REGIONALS: Air carriers with annual operating revenues between $20 million and $99,999,999.

4. MEDIUM REGIONALS: All carriers with annual operating revenues less than $20 million.

AIRCRAFT MIX - The relative percentage of operations conducted at an airport by each of four classes of aircraft differentiated by gross takeoff weight and number of engines.

AIRCRAFT TYPES - An arbitrary classification system which identifies and groups aircraft having similar operational characteristics for the purpose of computing runway capacity.

AIR NAVIGATIONAL FACILITY (NAVAID) - Any facility used for guiding or controlling flight in the air or during the landing or takeoff of aircraft.

AIR ROUTE SURVEILLANCE RADAR (ARSR) - Long-range radar which increases the capability of air traffic control for handling heavy enroute traffic. An ARSR site is usually located at some distance from the ARTCC it serves. Its range is approximately 200 nautical miles. Also called ATC Center Radar.

AIR TAXI/COMMUTER AIRCRAFT - Aircraft with 60 seats or less operated by a commuter carrier, air taxi operator, or air carrier.

AIR TAXI OPERATOR - An operator certificated in accordance with FAR Part 135 and authorized to provide, on demand, public transportation of persons and property by aircraft. Generally operates small aircraft "for hire" for specific trips.

AIRPORT ENVIRONS - The area surrounding an airport that is affected by airport operations.

AIRPORT LAYOUT PLAN (ALP) - The current and planned airport development portrayal, which may be part of an airport master plan.

AIRPORT MASTER PLAN (AMP) - A long term development plan for an airport, adopted by the airport proprietor.

AIRPORT NOISE COMPATIBILITY PROGRAM - A program developed in accordance with FAR Part 150, including measures proposed or taken by the airport operator to reduce existing incompatible land use and to prevent the introduction of additional incompatible land uses within the area.

AIRPORT SURVEILLANCE RADAR (ASR) - Radar providing position of aircraft by azimuth and range. It is designed for a range of 50 miles. Also called ATC Terminal Radar.

AIR ROUTE TRAFFIC CONTROL CENTER (ARTCC) - A facility established to provide air traffic control service to aircraft operating on an IFR flight plan within controlled airspace and principally during the enroute phase of flight.

AIRSPACE - The space lying above land or water which is necessary to conduct aeronautical operations.

ALERT AREA - Airspace which may contain a high volume of pilot training activities or unusual type of aerial activity.

ALP - Airport Layout Plan

ALSF-1 - Approach Light System with Sequence Flasher Lights.

AGL - Above Ground Level

ALS - Approach Light System

AMBIENT SOUND LEVELS - Ambient noise is the total noise associated with a given environment and usually comprises sounds from many different sources both near and far. Ambient noise is often defined in terms of the following statistical indicators:

L10 - the sound pressure level exceeded 10 percent of the time
L50 - the sound pressure level exceeded 50 percent of the time
L90 - the sound pressure level exceeded 90 percent of the time

ANCLUC - Airport Noise and Compatible Land Use Control Plan; an FAA sponsored land use compatibility planning program preceding Part 150 Airport Noise Compatibility Program.

APPROACH CONTROL SERVICE - Air traffic control service provided by a terminal area traffic control facility for arriving and departing IFR aircraft and, on occasion, VFR aircraft.

APPROACH FIX - The point from or over which final approach (IFR) to an airport is executed.

APPROACH LIGHTING SYSTEM - Approach lighting systems (ALS) are configurations of lights positioned symmetrically along the extended runway centerline and extend towards the approach. An ALS augments the electronic navigational aids.

APPROACH SLOPE - Imaginary areas extending out and away from the approach ends of runways which are to be kept clear of obstructions.

APPROACH SURFACE - An element of the airport imaginary surfaces, longitudinally centered on the extended runway centerline, extending upward and outward from the end of the primary surface at a designated slope.

AREA NAVIGATION(RNAV) - A method of navigation that permits aircraft operations on any desired course within the coverage or stationed-reference navigation systems or within the limits of self-contained system capability.

ARFF - Airport Rescue and Fire Fighting.

ARTS-III - Automated Radar Terminal Service - Phase III. A terminal facility in the air traffic control system using air ground communications and radar intelligence to detect and display pertinent data such as flight identification, altitude and position of aircraft operating in the terminal area.

ASDE - Airport Surface Detection Equipment

ASV - Annual Service Volume - a reasonable estimate of the airfield's annual capacity.

ATCT - Airport Traffic Control Tower

ATC - Air Traffic Control

ATIS - Automatic Terminal Information Service

AVERAGE DAY PEAK MONTH (ADPM) ACTIVITY - Activity (passengers or aircraft operations) in the average day of the peak month of the activity. Average day activity is obtained by dividing the peak month activity by the number of days in the month. ADPM activity is used for planning airport requirements.

AVIGATION AND HAZARD EASEMENT - An easement which provides right of flight at any altitude above the approach surface, prevents any obstruction above the approach surface, provides a right to cause noise vibrations, prohibits the creation of electrical interferences, and grants right-of-way entry to remove trees or structures above the approach surface.

"B"

BASED AIRCRAFT - An aircraft permanently stationed at the airport, usually by some form of agreement between the aircraft owner and airport management.

BUSINESS JET - Any of a type of turbine powered aircraft carrying six or more passengers and weighing less than approximately 70,000 pounds gross takeoff weight.

"C"

CAT I - Category I Instrument Landing System. (Minimums: decision height of 200 feet; Runway visual range 1,800 feet).

CAT II - Category II Instrument Landing System. (Minimums: decision height of 100 feet; Runway visual range 1,200 feet).

CAT III - Category III Instrument Landing System. (Minimums: no decision height; Runway visual range of from 0 to 700 feet depending on type of CAT III facility).

CALIBRATION - The procedure used to adjust a computer model so that it matches base year of present day conditions.

CAPACITY - The maximum number of vehicles which have a reasonable expectation of passing over a given section of a lane or a roadway during a given period under a specified speed or level of service.

CAPACITY MANUAL - Special Report 209 published by the Highway Research Board (now Transportation Research Board). Current issue is 1985.

CAPACITY RESTRAINT - See Trip Assignment.

CENTER'S AREA - The specified airspace within which an air route traffic control center provides air traffic control and advisory service.

CFR - Crash, Fire and Rescue (now called Airport Rescue and Fire Fighting (ARFF)

CIRCLING APPROACH - A maneuver initiated by the pilot to align the aircraft with a runway for landing when a straight-in instrument approach is not possible. This maneuver requires ATC clearance and that the pilot establish visual reference to the airport.

CL - Centerline

CLEARWAY - A defined rectangular area beyond the end of a runway cleared or suitable for use in lieu of runway to satisfy takeoff distance requirements.

COLLECTOR - A roadway with no control of access providing movement between residential areas and the arterial system.

COMMERCIAL SERVICE AIRPORT - A public airport which received scheduled passenger service and enplanes annually 2,500 or more passengers.

COMMUTER CARRIER - An airline certificated in accordance with FAR Part 135 or 121 that operates aircraft with a maximum of 60 seats, and that provides at least five scheduled round trips per week between two or more points, or that carries mail.

CONICAL SURFACE - An imaginary surface extending upward and outward from the periphery of the horizontal surface at a slope of 20 to 1 for a horizontal distance of 4,000 feet.

CONNECTING PASSENGER - A passenger who boards an aircraft directly after deplaning from another flight. On-line single carrier connections involve flights of the same carrier, while interline or off-line connections involve flights of two different carriers. The term connection can also be applied to freight shipments.

CONTROL AREAS - These consist of the airspace designated as VOR Federal Airways, additional Control Area Extensions but do not include the Continental Control Area.

CONTROLLED AREA - Airspace within which some or all aircraft may be subject to air traffic control.

CONTROL TOWER - A central operations facility in the terminal air traffic control system consisting of a tower cab structure (including an associated IFR room if radar equipped) using air/ground communications and/or radar, visual signaling and other devices to provide safe and expeditious movement of terminal air traffic.

CONTROL ZONES - These are areas of controlled airspace which extend upward from the surface and terminate at the base of the continental control area. Control zones that do not underlie the continental control area have no upper limit. A control zone may include one or more airports and is normally a circular area with a radius of 5 statute miles of any extensions necessary to include instrument departure and arrival paths and are regulatory in nature.

CONTROLLED AIRSPACE - Airspace designated as continental control area, control area, control zone or transition area within which some or all aircraft may be subject to air traffic control.

CRITICAL LANE VOLUME ANALYSIS - A short-cut technique for relating the level of service at intersections to traffic volumes in the "critical lane."

CROSSWIND RUNWAY - A runway aligned at an angle to the prevailing wind which allows use of an airport when crosswind conditions on the primary runway would otherwise restrict use.

CURFEW - A restriction placed upon all or certain classes of aircraft by time of day, for purposes of reducing or controlling airport noise.

CYCLE - The time period required for one complete sequence of vehicle traffic signal indications.

"D"

D - Dual Gear Aircraft

DECISION HEIGHT (DH) - With respect to the operation of aircraft, this means the height at which a decision must be made, using an ILS or PAR instrument approach, to either continue the approach or to execute a missed approach.

DECLARED DISTANCES - The distances the airport owner declares available and suitable for satisfying the airplane's takeoff urn, takeoff distance, accelerate-stop distance, and landing distance requirements. The distances are:

- *Takeoff run available (TORA)* - the runway length declared available and suitable for the ground run of an airplane taking off.
- *Takeoff distance available (TODA)* - the TORA plus the length of any remaining runway and/or clearway beyond the far end of the TORA.
- *Accelerate-stop distance available (ASDA)* - the runway plus stopway length declared available and suitable for the acceleration and deceleration of an airplane aborting a takeoff; and
- *Landing distance available (LDA)* - the runway length declared available and suitable for a landing airplane.

DEMAND - The actual number of persons, aircraft or vehicles currently using a facility if that facility is operating at or below capacity or the number of persons, aircraft or vehicles who want to use the facility when the facility is operating above capacity or that incur delay if capacity is exceeded.

DEPLANEMENT - Any passenger getting off an arriving aircraft at an airport. Can be either a terminating or connecting passenger. Also applies to freight shipments.

DESIGN HOUR VOLUME (DHV) - The number of vehicles expected to use a road section, intersection, etc. in the design hour, which is usually the 30th highest hour of the year for commuter roads, the 150th highest hour for recreational roads, twice the average for shopping center facilities, etc.

DESIGN SPEED - The maximum safe speed for which the various physical features of the roadway were designed.

DISPLACED THRESHOLD - A threshold that is located at a point on the runway other than the designated beginning of the runway.

DISTANCE MEASURING EQUIPMENT (DME) - An electronic installation established with either a VOR or ILS to provide distance information from the facility to pilots by reception of electronic signals. It measures, in nautical miles, the distance of an aircraft from a NAVAID.

DIRECTIONAL SPLIT - The proportional distribution between access and egress flows of traffic into and out of a development or between opposite flows of traffic on two-way streets or highways.

DNL (ldn) - DNL is based upon the Leq with the aircraft operations occurring during the period 10 p.m. to 7 a.m. weighted by a 10 dB penalty.

"E"

EA (Environmental Assessment) - A document prepared under the National Environmental Policy Act of 1969 to determine whether potential impacts appear to be significant. The completion of an EA often precedes the decision to prepare and EIS.

ENPLANEMENT - Any passenger boarding a departing aircraft at an airport. Can be both a local origin and a connecting passenger. Applies also to freight shipments.

ENROUTE - The route of flight from point of departure to point of destination, including intermediate stops (excludes local operations).

ENROUTE AIRSPACE - Controlled airspace above and/or adjacent to terminal airspace.

ENVIRONMENTAL IMPACT STATEMENT (EIS) - A document prepared under the National Environmental Policy Act of 1969 to describe the social, economic, and physical impacts of proposed federal projects or projects requiring federal money or approval.

EQUIVALENT SOUND LEVEL (LEQ) - The steady A-weighted sound level over a specified period that has the same acoustic energy as the fluctuating noise during that period.

ERG - Effective Runway Gradient

EXPRESSWAY - A divided highway for through traffic with full or partial control of access generally using grade separated interchanges and some well spaced at-grade intersections.

"F"

F&E - Facilities and Equipment Programming - FAA

FAR Part 36 - A federal aviation regulation establishing noise certification standards for aircraft.

FAR Part 77 - Establishes standards for determining obstructions in navigable airspace, sets forth requirements for notice of proposed construction or alteration and provides for aeronautical studies of obstructions to air navigation.

FAR Part 150 - The regulation describing the requirements and procedures for conducting a voluntary aircraft noise and land use compatibility study.

FEDERAL AIRWAYS - See Low Altitude Airways.

FEDERAL AVIATION ADMINISTRATION (FAA) - The federal agency charged with regulating air commerce to promote its safety and development, encouraging and developing civil aviation, air traffic control, and air navigation and promoting the development of a national system of airports.

FEDERAL AVIATION REGULATIONS (FAR) - Regulations issued by the FAA to regulate air commerce; issued as separate "Parts," e.g., Part 77.

FINAL APPROACH IFR - The flight path of landing aircraft in the direction of landing along the extended runway centerline from the base leg to the runway.

FIXED BASE OPERATOR (FBO) - An airport service operation, normally consisting of fuel sales, aircraft rentals, charter aircraft sales and maintenance with a fixed base of operation at the airport.

FLEET MIX - The proportion of aircraft types or models expected to operate at an airport.

FLIGHT SERVICE STATION (FSS) - A facility operated by the FAA to provide flight assistance service.

FREEWAY - A divided highway for through traffic with full control of access at grade separated interchanges.

FY - Fiscal Year

"G"

GENERAL AVIATION (GA) - All segments of aviation except air carrier and military. Included are corporate, industrial, agricultural, public and emergency services, business, charter, personal and sport flying.

GENERATION - See trip generation.

GLIDE SLOPE (GS) - The vertical guidance component of an Instrument Landing System (ILS).

GRAVITY MODEL - Newton's Law of Gravitation used to simulate traffic movements by distributing trips among zonal pairs in direct proportion to the number of trips originating in those zones and in inverse proportion to a measure of the spatial separation between the zones, such as travel time.

"H"

HIGH ALTITUDE AIRWAYS - See Jet Routes.

HIRL - High Intensity Runway Edge Lighting.

HOLDING PROCEDURE - A predetermined maneuver which keeps an aircraft within a specified airspace while awaiting further clearance from air traffic control.

HORIZONTAL SURFACE - An imaginary surface constituting a horizontal plane 150 feet above the airport elevation.

"I"

IMAGINARY SURFACE - An area established in relation to the airport and to each runway consistent with FAR Part 77 in which any object extending above these imaginary surfaces is, by definition, an obstruction.

INDUCED TRIPS - See Trip.

INSTRUMENT APPROACH - A series of predetermined maneuvers for the orderly transfer of an aircraft under instrument flight conditions from the beginning of the initial approach to a landing or to a point from which a landing may be made visually.

INSTRUMENT FLIGHT RULES (IFR) - FAR rules that govern the procedures for conducting instrument flight (FAR Part 91).

INSTRUMENT LANDING SYSTEM (ILS) - A precision landing aid consisting of localizer (azimuth guidance), glide slope (vertical guidance), outer marker (final approach fix) and approach light system.

INSTRUMENT OPERATION - A landing or takeoff conducted while operating on an instrument flight plan.

INSTRUMENT RUNWAY - A runway equipped with electronic and visual navigation aids for which a precision or non-precision approach procedure having straight-in landing minimums has been established.

INTEGRATED NOISE MODEL (INM) - A computer-based airport noise exposure modelling program developed for the FAA.

ISOPLETH - A line on a map connecting points at which a given variable (ground travel time) has a specified constant value.

ITINERANT OPERATIONS - All aircraft arrivals and departures other than local operations.

INTERNATIONAL OPERATIONS - Aircraft operations performed by air carriers engaged in scheduled international service.

"J"

JET ROUTES - A route designed to serve aircraft operating from 18,000 feet MSL up to and including flight level 450.

"L"

LAT - Latitude

LDA - Localizer Type Directional Aid

LDN - Day-Night Average Sound Level. The 24-hour average sound level, in decibels, from midnight to midnight, obtained after the addition of ten decibels to sound levels for periods between 10 p.m. and 7 a.m.

LENGTH OF HAUL - The non-stop airline route distance from a particular airport.

LEQ - Leq is the equivalent continuous sound level defined as the steady state sound pressure level dB(A) which, over a given period of time, has the same total energy as the actual fluctuating noise.

LEVEL OF SERVICE (LOS) - A standardized index of the relative service provided by street or intersection, ranging from A (extremely favorable) to E (oversaturation).

LIRL - Low Intensity Runway Edge Lighting

LOAD FACTOR - Ratio of the number of passenger miles to the available seat miles flown by an airline representing the proportion of aircraft seating capacity that is actually sold and utilized. Load factors are also referred to in air cargo and can be determined by weight or volume.

LOC - Localizer (part of a ILS)

LOCAL OPERATION - Operations performed by aircraft which: (a) operate in the local traffic pattern or within the sight of the tower; (b) are known to be departing for, or arriving from, flight in local practice areas located within a 20-mile radius of the control tower, or (c) execute simulated instrument approaches or low passes at the airport.

LOM - Compass locator at an outer marker (part of an ILS). Also called COMLO.

LONG - Longitude

LOW ALTITUDE AIRWAYS - Air routes below 18,000 feet MSL. They are referred to as Federal Airways.

LRR - Long-Range Radar

"M"

MALS - Medium Intensity Approach Light System

MALSF - Medium Intensity Approach Light System with sequenced flashing lights.

MALSR - MALS with Runway Alignment Indicator Lights (RAIL)

MARKER BEACON - An electronic navigation facility which transmits a fan shaped signal pattern. When received by compatible airborne equipment they indicate to the pilot that he is passing over the facility. Beacons are used to advise pilots of their position during an ILS approach. Marker beacons are of three types: Outer Marker, Middle Marker, and Inner Marker.

MASTER PLAN - Long-range plan of airport development requirements.

MEAN MAX - Normal maximum temperature of hottest month.

MGW - Maximum Gross Weight

MILITARY OPERATION - An operation by military aircraft.

MINIMUM DESCENT ALTITUDE (MDA) - The lowest altitude, expressed in feet above mean sea level, to which descent is authorized on final approach or during circling-to-land maneuvering in execution of a standard instrument approach procedure where no electronic glide slope is provided.

MIRL - Medium Intensity Runway Edge Lighting

MISSED APPROACH - A prescribed procedure to be followed by aircraft that cannot complete an attempted landing at an airport.

MITL - Medium Intensity Taxiway Edge Lighting

MLS - Microwave Landing System

MM - Middle Marker (part of an ILS)

MOA - Military Operations Area

MODAL SPLIT - The distribution of trips among competing travel modes, such as walk, auto, bus, etc.

MODE - A particular form or method of travel such as walk, auto, carpool, bus, rapid transit, etc.

MOVEMENT - Synonymous with the term operation, i.e., a takeoff or a landing.

MSL - Mean Sea Level

"N"

NA - Not applicable

NARROWBODY AIRCRAFT - A commercial passenger jet having a single aisle and a maximum of three seats on each side of the aisle. Narrowbody aircraft include the B727, B737, B757, DC9, MD80, MD90 and A320.

NAS - NATIONAL AIRSPACE SYSTEM - The common system or air navigation and air traffic encompassing communications facilities, air navigation facilities, airways, controlled airspace, special use airspace and flight procedures authorized by Federal Aviation Regulations for domestic and international aviation.

NAVAID - Any facility used for guiding or controlling flight in the air or during the landing or takeoff of aircraft.

NDB - NON-DIRECTIONAL BEACON - An electronic ground station transmitting in all directions in the L/MF frequency spectrum; provides azimuth guidance to aircraft equipped with direction finder receivers. These facilities are often established with ILS outer markers to provide transition guidance to the ILS system.

NEPA - National Environmental Policy Act

NM - Nautical Mile

NOISE ABATEMENT - A procedure for the operation of aircraft at an airport which minimizes the impact of noise on the environs of the airport.

NOISE CONTOUR - A noise impact boundary line connecting points on a map where the level of sound is the same.

NOISE EXPOSURE MAP (NEM) - A scaled, geographic depiction of an airport, its noise contours and surrounding area, as described in FAR Part 150.

NOISE LEVEL REDUCTION (NLR) - The amount of noise level reduction achieved through incorporation of noise attenuation (between outdoor and indoor levels) in the design and construction of a structure.

NON-PRECISION APPROACH - A standard instrument approach procedure in which no electronic glide slope is provided.

NPI - Non-Precision Instrument Runway

"O"

OAG - Official Airline Guide

OBSTRUCTION - Any structure, growth, or other object, including a mobile object, that exceeds a limiting height established by federal regulations or by a hazard zoning regulation.

OM - Outer Marker (part of an ILS)

OPERATING SPEED - The maximum average speed for a given set of roadway and traffic conditions.

OPERATION - An aircraft arrival at or departure from an airport.

ORIGIN AND DESTINATION PASSENGERS (O&D) - Those passengers- whether visitors or residents-- whose trips begin or end in the region.

OUTER FIX - A point in the destination terminal area from which aircraft are cleared to the approach fix or final approach course.

"P"

PAPI - Precision Approach Path Indicator

PAR - Precision Approach Radar

PAX - Passengers

PEAK HOUR FACTOR - The ratio of the average flow rate during the peak hour to the highest short-term (say 15 minutes) rate within the peak hour.

PEAK HOUR ACTIVITY - Activity (passengers or aircraft operations) in the busiest hour of the average day peak month (ADPM).

PEAK HOUR PERCENTAGE - The percentage of total daily trips or traffic occurring in the highest or "peak" hour. Frequently confused with Peak Hour Factor.

PERSON TRIP - A trip made by a person by any travel mode or combination of travel modes. A carpool of four persons entails one vehicle trip and four person trips.

PI - Precision Instrument Runway marking.

POSITIVE CONTROL AREA - Airspace wherein aircraft are required to be operated under Instrument Flight Rules.

PRECISION APPROACH - A standard instrument approach procedure in which an electronic glideslope/glidepath is provided; eg., ILS/MLS and PAR.

PRIMARY COMMERCIAL SERVICE AIRPORT - A commercial service airport which enplanes 10,000 or more annual enplanements.

PRIMARY RUNWAY - The runway on which the majority of operations take place. On large, busy airports, there may be two or more primary runways.

PRIMARY SURFACE - An area longitudinally centered on a runway with a width ranging from 250 to 1,000 feet and extending 200 feet beyond the end of a paved runway.

PROHIBITED AREA - Airspace of defined dimensions identified by an area on the surface of the earth within flight is prohibited.

"Q"

QUEUE - A line of pedestrians or vehicles or aircraft waiting to be served.

"R"

RADAR SEPARATION - Radar spacing of aircraft in accordance with established minima.

RAIL - Runway Alignment Indicator Lights

RCAG - Remote Center Air/Ground Communications

REIL - Runway End Identification Lights

RELIEVER AIRPORT - An airport in a metropolitan area which is intended to relieve congestion at a high density air carrier airport by providing alternative landing areas to general aviation pilots.

RESTRICTED AREAS - Airspace of defined dimensions identified by an area on the surface of the earth within which the flight of aircraft, while not wholly prohibited, is subject to restrictions.

RNAV - See Area Navigation.

ROTATING BEACON - A visual aid displaying flashes of white and/or colored light used to indicate the location of an airport.

RPZ - Runway Protection Zone (inner portion of runway approach zone; formerly called Clear Zone)

RUNWAY SAFETY AREA - An area symmetrical about the runway centerline and extending beyond the ends of the runway which shall be free of obstacles as specified.

RVR - Runway Visual Range

RVV - Runway Visibility Value

R/W - Runway

"S"

SALS - Short Approach Light System

SCREEN LINE - A line dividing a study area into two parts and used for a detailed comparison of measured and simulated traffic or travel during a model calibration process.

SDF - Simplified Directional Facility landing aid providing final approach course.

SEGMENTED CIRCLE - An airport aid identifying the traffic pattern direction.

SEPARATION MINIMA - The minimum longitudinal, lateral, or vertical distances by which aircraft are spaced through the application of air traffic control procedures.

SMSA - Standard Metropolitan Statistical Area.

SOCIOECONOMIC - Data pertaining to the population and economic characteristics of a region.

SOUND EXPOSURE LEVEL - That constant sound level which in one second has the same amount of energy as the original noise event had in its entire duration.

SSALF - Simplified Short Approach Light System with Sequence Flashing lights.

SSALS - Simplified Short Approach Light System.

SSALR - Simplified Short Approach Light System with Runway Alignment Indicator Lights (RAIL)

STANDARD LAND USE CODING MANUAL (SLUCM) - A standard system for identifying and coding land use activities published by the U.S. Department of Housing and Urban Development and the Federal Highway Administration.

STOPWAY - A defined rectangular surface beyond the end of a runway prepared or suitable for use in lieu of runway to support an airplane, without causing structural damage to the airplane, during an aborted takeoff.

STRAIGHT-IN APPROACH - A descent in an approved procedure in which the final approach course alignment and descent gradient permits authorization of straight-in landing minimums.

STOL - Short Takeoff and Landing

STOVL - Short Takeoff Vertical Landing

SWL - Single Gear Aircraft

SYSTEM PLAN - A representative of the aviation facilities required to meet the immediate and future air transportation needs and to achieve the overall goals.

"T"

TACAN - Tactical Air Navigation

TDZ - Touchdown Zone

TERMINAL AIRSPACE - The controlled airspace normally associated with aircraft departure and arrival patterns to/from airports within a terminal system and between adjacent terminal systems in which tower enroute air traffic control service is provided.

TERMINAL CONTROL AREA (TCA) - This consists of controlled airspace extending upward from the surface or higher to specified altitudes within which all aircraft are subject to positive air traffic control procedures.

TERPS - Terminal Instrument Procedures

T-HANGAR - A T-shaped aircraft hangar which provides shelter for a single airplane.

THRESHOLD - The beginning of that portion of the runway usable for landing.

TIME ABOVE - Time above indicates the time in minutes that a given dB(A) levels is exceeded during a 24-hour period.

TOUCH-AND-GO OPERATION - An operation in which the aircraft lands and begins takeoff roll without stopping.

TRAFFIC CONTROL DEVICE - Any sign, signal, marking or device placed or erected for the purpose of regulating, wording or guiding vehicular traffic and/or pedestrians.

TRAFFIC PATTERN - The traffic flow that is prescribed for aircraft landing at, taxiing on, and taking off from an airport. The usual components of a traffic pattern are upwind leg, crosswind leg, downwind leg and final approach.

TRANSIENT OPERATIONS - See Itinerant Operations.

TRANSITIONAL SURFACE - An element of the imaginary surfaces extending outward at right angles to the runway centerline and from the sides of the primary and approach surfaces to where they intersect the horizontal and conical surfaces.

TRANSITIONAL AIRSPACE (TRANSITION AREA) - Areas designated to contain IFR operations in controlled airspace during portions of the terminal operations and while transitioning between the terminal and enroute environment.

TRIP - The one-way unit of travel between an origin and a destination.

TRIP ASSIGNMENT - That portion of the transportation planning process where distributed trips are allocated among the actual routes they can be expected to use.

TRIP DISTRIBUTION - That portion of the transportation planning process that estimates the spatial distribution of trips estimated during the trip generation phase.

TRIP END - The beginning or end of a trip.

TRIP GENERATION - That portion of the transportation planning process concerned with developing an estimate of the total number of trips attracted or produced by each traffic analysis zone in a study area.

TRIP PURPOSE - The primary reason for making a trip, i.e., work, shop.

TW & T/W - Taxiway

TWR - Control Tower

TVOR - Terminal Very High Frequency Omnirange Station

"U"

UHF - Ultra High Frequency

UNCONTROLLED AIRSPACE - That portion of the airspace that has not been designated as continental control area, control area, control zone, terminal control area or transition area and within which ATC has neither the authority nor the responsibility for exercising control over air traffic.

UNICOM - Radio communications station which provides pilots with pertinent airport information (winds, weather, etc.) at specific airports.

UTILITY RUNWAY - A runway intended to be used by propeller driven aircraft of 12,500 pounds maximum gross weight or less.

"V"

VASI - Visual Approach Slope Indicator providing visual glide path guidance.

VASI-2 - Two Box Visual Approach Slope Indicator

VASI-4 - Four Box Visual Approach Slope Indicator

VECTOR - A heading issued to an aircraft to provide navigational guidance by radar.

VEHICLE MILES OF TRAVEL (VMT) - A measure of total travel within a study area, usually estimated as the total number of trips multiplied by the average length of a typical trip.

VFR - Visual Flight Rules that govern flight procedures in good weather.

VFR AIRCRAFT - An aircraft conducting flight in accordance with Visual Flight Rules.

VHF - Very High Frequency

VISUAL APPROACH RUNWAY - A runway intended for visual approaches only.

VOR - Very High Frequency Omnirange Station. A ground-based radio (electronic) navigation aid transmitting radials in all directions in the VHF frequency spectrum; provides azimuth guidance to pilots by reception of electronic signals.

VORTAC - Co-located VOR and TACAN.

V/STOL - Vertical/Short Takeoff and Landing

VTOL - Vertical Takeoff and Landing (includes, but is not limited to, helicopters).

"W"

WARNING AREA - Airspace which may contain hazards to non-participating aircraft in international airspace.

WIND CONE (WIND SOCK) - Conical wind directional indicator.

WIND TEE - A visual device used to advise pilots about wind direction at an airport.

Attachment B
to Port Resolution 3245

TECHNICAL REPORT NO. 5
FINAL FORECAST REPORT

AIRPORT MASTER PLAN UPDATE

F O R

SEATTLE-TACOMA
INTERNATIONAL AIRPORT

P&D Aviation

TECHNICAL REPORT NO. 5
FINAL FORECAST REPORT

AIRPORT MASTER PLAN UPDATE
FOR
SEATTLE - TACOMA INTERNATIONAL AIRPORT

Prepared by:

P&D AVIATION

Prepared for:

The Port of Seattle
SEATTLE - TACOMA INTERNATIONAL AIRPORT

APRIL 12, 1994
REVISED JUNE 27, 1994
REVISED AUGUST 30, 1994

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TECHNICAL REPORT NO. 5
PRELIMINARY FORECAST REPORT

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Section 1
INTRODUCTION

SECTION 1
INTRODUCTION

BACKGROUND

The genesis of the Seattle-Tacoma International Airport (Sea-Tac) Master Plan Update was the "Comprehensive Planning Review" conducted in 1988. This ten month program evaluated the 1985 Airport Master Plan as well as several other related planning studies. The conclusions of this analysis, as well as the results of the Puget Sound Regional Council's 1988 Regional Airport System Plan, led the Port of Seattle Commissioners to formally acknowledge that Sea-Tac would reach runway saturation near the turn of the century. In response to this challenge, the Commissioners, and the Puget Sound Council of Governments (now Puget Sound Regional Council), entered into a three-year planning effort known as the "Flight Plan" project.

The purpose of Flight Plan was to develop a regional airport system, that would meet the aeronautical needs of the region to the year 2020 and beyond. In the third phase of Flight Plan, alternative airport systems were evaluated. In the end, the 39-member Puget Sound Regional Air Transportation Committee (PSATC) chose as its preferred alternative the construction of a new runway at Sea-Tac and development of two reliever satellite airports. This ultimately led to the adoption by the Port of Resolution No. 3125, which directed that a new runway for Sea-Tac be examined in detail. Subsequently, a planning team led by P&D Aviation was selected for an Airport Master Plan Update and began work on December 3, 1993.

PROJECT OBJECTIVES

The overall objective of this project is to "prepare a comprehensive Airport Master Plan [Update] for the airside, terminal, and landside facilities needed at Sea-Tac to meet air travel demand to the year 2020 and beyond." Specifically, the master plan update study must fulfill each of the relevant objectives stated in Port Resolution 3125. These are as follows:

- Design a mechanism and process to promote [land use and community] compatibility through improved coordination, communication and involvement.
- In addition to the third runway studies, include a reconsideration of a fast rail system together with diversion of all cargo carriers.
- Fully explore the impacts of peak period pricing and other demand management techniques.
- Explore land acquisition and redevelopment to compatible uses.
- Attenuate airport noise through the use of berms and barriers.
- Promote aggressive on-airport emission reductions.
- Promote regional transit and reduction in use of automobiles.
- Improve the aesthetic appearance of the airport boundary.
- Develop a comprehensive stormwater management plan.

SCOPE OF STUDY

The first assignment of the Airport Master Plan Update study was the development of a detailed scope of work designed to fulfill the project objectives. The final scope of work, prepared on December 2, 1993, contains forty-five work tasks (Table 1-1). The detailed scope of work is contained in Technical Report No. 1, Scope of Work.

The primary issues addressed in the scope of work include:

- ***Forecasts.*** The master plan update and related Environmental Impact Statement and FAA Part 150 Study must be based on a reliable and generally accepted set of forecasts.

- ***Airside Evaluations.*** An important component of the study is the analysis of a new dependent parallel (minimum runway separation of 2,500 feet) runway. The Airspace Update Study and the FAA Airport Capacity Enhancement Task Force both determined that a substantial capacity improvement can be achieved by constructing a new parallel dependent runway.

- ***Terminal Evaluations.*** A key issue in the terminal development is to achieve a balance between added terminal capacity and additions to airside and landside capacity. Curb frontage, roadway and automobile parking are critical components.

- ***Multi-Modal Evaluations.*** There is considerable interest at the Federal, State and local levels of government to development inter-modal transportation systems that are economically efficient and improve air quality and reduce airport congestion.

- ***Financial Planning.*** A comprehensive financial plan and implementation strategy must be developed to maximize the Port's ability to fund needed capital improvement projects.

- ***Part 150 Issues.*** The Noise Mediation Agreement resulted in substantial noise reduction programs, now being implemented. This agreement plays a vital role in existing and future planning efforts at the airport and has been incorporated into the recently completed FAR Part 150 Study 1993 Amendments. However, those amendments did not consider the implementation of a third runway, and thus the Noise Exposure Maps that were generated in the study will require updating to consider the third runway option.

- ***Process.*** Public involvement in the planning process is an important element of the Airport Master Plan Update. The public involvement program developed for the study will allow for better understanding of the sentiments in the surrounding communities and constructively involve the public in focused workshops for the project. Elements of the public involvement program include workshops, public opinion surveys, and dissemination of project information through newsletters and technical reports prepared during the study.

STUDY SCHEDULE AND DOCUMENTATION

The Airport Master Plan Update is scheduled to be completed in December 1995. During 1994, forecasts will be prepared, facility requirements will be developed and individual options for accommodating projected needs will be evaluated. In 1995, option "packages" will be developed and evaluated and concurrently an Environmental Impact Statement will be prepared.

TABLE 1-1
LIST OF TASKS FOR AIRPORT MASTER PLAN UPDATE,
SEATTLE-TACOMA INTERNATIONAL AIRPORT

Task	Title
TASK 1	**PROJECT MANAGEMENT/COORDINATION**
1.1	Develop Detailed Work Program
1.2	Monthly Progress Reports
1.3	Subconsultant Management
1.4	Program Coordination
1.5	Other Presentations and Meetings
1.6	FAR Part 150 Coordination
TASK 2	**PUBLIC INVOLVEMENT PROGRAM**
2.1	Market Research
2.2	Public Involvement Program Development
2.3	Public Involvement Program Implementation
2.4	EIS Scoping Meetings
2.5	Project Brochure
TASK 3	**INVENTORY**
3.1	Review Planning History
3.2	Study Relationships
3.3	Review Sea-Tac Ground Access Plans and Studies
3.4	Inventory Facilities
3.5	Inventory Existing Ground Access Facilities
TASK 4	**ACTIVITY FORECASTS**
4.1	Evaluate and Refine Forecasts
4.2	Ground Access Forecasts
TASK 5	**FACILITY ANALYSIS**
5.1	Airside Facility Analysis
5.2	Ground Access Facility Analysis
5.3	Terminal Data Collection
5.4	Terminal Programming
5.5	Cargo Facility Analysis
5.6	Other Airport Elements

TABLE 1-1
LIST OF TASKS FOR AIRPORT MASTER PLAN UPDATE, SEATTLE-TACOMA INTERNATIONAL AIRPORT

Task	Title
TASK 6	**CONCEPT ANALYSIS**
6.1	Develop Criteria
6.2	Airside Options Analysis
6.3	Multi-Modal Airport Landside Options Analysis and Evaluation
6.4	Development of Terminal Options
6.5	Evaluation of Terminal Options
6.6	Refinement of Terminal Options
6.7	Terminal Documentation
6.8	Site Beautification Options
6.9	Cargo Options
6.10	Other Airport Element Options
6.11	Evaluate "Packages"
6.12	Preferred Package
TASK 7	**FINANCIAL PLAN**
7.1	Cost Estimates
7.2	Phasing Plan
7.3	Operating and Maintenance (O&M) Forecasts
TASK 8	**PSRC IMPLEMENTATION STUDIES**
8.1	PSRC Demand Management/System Management Analysis
8.2	Diversion to Ground Mode
8.3	PSRC Noise Performance Analysis
TASK 9	**DOCUMENTATION**
9.1	Update ALP
9.2	Draft Final Report
9.3	Final Report

The following documents are scheduled to be delivered to the Port during the course of the project:

- Technical Report No. 1, Final Work Scope
- Technical Report No. 2A, Market Research Results
- Project Brochure
- Technical Report No. 2B, Program Development Report
- Technical Report No. 3, Planning History and Study Relationships
- Technical Report No. 4, Facilities Inventory
- Technical Report No. 5A, Preliminary Forecast Report
- Technical Report No. 5B, Final Forecast Report
- Technical Report No. 6A, Preliminary Airside Report
- Technical Report No. 6B, Demand, Capacity Requirements
- Technical Report No. 7, Options Evaluation Report
- Demand Management Report
- Technical Report No. 8, "Package" Evaluations Report
- Technical Report No. 9, Draft of Master Plan Update Final Report
- Airport Layout Plan Set
- Final Report

PLANNING TEAM COMPOSITION

The Master Planning Team led by P&D Aviation consists of eight firms which are listed below with their key responsibilities:

- ***P&D Aviation*** - Project Management, Forecasts and Facility Requirements, Airside Planning, Ground Access Planning, Overall Airport Master Planning and Coordination
- ***O'Neill & Company*** - Public Involvement
- ***Parsons Brinckerhoff*** - Multi-Modal Evaluations
- ***Thompson Consultants International*** - Terminal Planning
- ***Barnard Dunkelberg & Company*** - Part 150 Integration
- ***Berk & Associates*** - Financial Planning
- ***Murase Associates*** - Airport Beautification, Landscape Architecture
- ***Mestre Greve Associates*** - Aircraft Noise Impacts

CONTENTS OF THIS REPORT

The remainder of this report is organized in the following sections:

- Section 2 Executive Summary
- Section 3 Historic Aviation Activity
- Section 4 Air Service Market
- Section 5 Aviation Demand Forecasts

The final forecast report will contain another section describing the airport ground access projections.

The forecasts contained in this document are unconstrained forecasts, prepared on the basis that Sea-Tac will be able to accommodate all future aviation demand to the year 2020 without allocation of a portion of the demand to one or more satellite airports. Future documentation prepared during the Master Plan Update Study will discuss the affects of Sea-Tac Airport capacity constraints, allocation of demand to one or more satellite airports, the potential diversion of demand to future high speed rail transportation, and a variety of potential demand management techniques.

Section 2
EXECUTIVE SUMMARY

SECTION 2
EXECUTIVE SUMMARY

The aviation forecasts for Seattle-Tacoma International Airport (Sea-Tac) for the period from 1993 to 2020 are summarized in Table 2-1. The forecasts of total passengers and aircraft operations are shown graphically in Figure 2-1.

PASSENGER FORECAST

Total annual passengers at Sea-Tac are projected to grow from 18.8 million in 1993 to 23.8 million in 2000, 30.6 million in 2010 and 38.2 million in 2020. This Airport Master Plan Update projection is lower than the Flight Plan Phase I forecast (45 million passengers in 2020) and the FAA Hub forecast (36.6 million passengers in 2010), but is very close to the 1993 FAA terminal area forecast (27.8 million passengers in 2005). The total passenger forecast developed for the Airport Master Plan Update is a composite of forecasts prepared for domestic passengers and international passengers, using econometric models derived through statistical techniques such as multiple regression analysis.

In 2020, the passenger mix is anticipated to be 85 percent domestic air carrier, 5 percent domestic air taxi/commuter and 10 percent international compared with a 1993 mix of 87 percent domestic air carrier, 6 percent domestic air taxi/commuter and 7 percent international. Total passengers in the peak hour of the average day peak month are projected to grow from 5,950 in 1993 to 12,100 in 2020.

AIRCRAFT OPERATIONS

Total aircraft operations are projected to increase from 339,500 in 1993 to 379,200 in 2000, 405,800 in 2010 and 441,600 in 2020. Aircraft operations are expected to grow at a slower rate than total passengers because of increased use of larger air carrier and commuter aircraft at Sea-Tac and rising load factors. For example, the average number of domestic air carrier enplanements per departure is projected to increase from 87.5 in 1993 to 123 in 2020.

Operations in the peak hour of the average day peak month are projected to increase from 76 in 1993 to 85 in 2000, 91 in 2010 and 101 in 2020.

AIR CARGO

An air cargo forecast was developed using a regression equation model. Air cargo shipments are projected to increase from 381,500 metric tons in 1993 to 880,000 metric tons in 2020. International freight is anticipated to grow at the greatest rate, increasing from 15 percent of air cargo in 1993 to 21 percent in 2020.

FORECAST SENSITIVITY

The forecasts presented herein are planning level estimates for evaluating and guiding future airport improvements. Planning levels will be used throughout the master plan to identify trigger points for facility improvements. Since many factors can influence exactly when these trigger points are reached, planning levels rather than specific dates will generally be used to describe the point at which facility improvements are required.

Many factors can influence the growth of aeronautical demand at Sea-Tac. The demand forecasts developed for this Master Plan Update are based on several of key factors (i.e., population, income, and average air fares).

TABLE 2-1
SUMMARY OF AVIATION FORECASTS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

Forecast Element	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
Annual Passengers (Millions) and Annual Growth Rate				
Annual Enplaned Passengers	9.4	11.9	15.3	19.1
Annual Total Passengers	18.8	23.8	30.6	38.2
(Average Annual Growth Rate)		(3.4%)	(2.5%)	(2.2%)
Annual Origin-Destination and Connecting Passengers				
Origin-Destination	13.2	16.4	21.2	26.4
Connecting	5.6	7.4	9.4	11.8
Total	18.8	23.8	30.6	38.2
Annual Domestic and International Passengers				
Domestic Air Carrier	16.2	20.2	26.0	32.6
(Average Annual Growth Rate)		(3.2%)	(2.6%)	(2.3%)
Domestic Air Taxi/Commuter	1.2	1.4	1.6	1.8
(Average Annual Growth Rate)		(2.2%)	(1.3%)	(1.2%)
International to Canada	0.8	1.2	1.8	2.2
(Average Annual Growth Rate)		(6.0%)	(4.1%)	(2.0%)
Other International	0.6	1.0	1.2	1.6
(Average Annual Growth Rate)		(7.6%)	(2.7%)	(2.1%)
Total	18.8	23.8	30.6	38.2
Annual Air Carrier and Commuter Passengers				
Air Carrier	17.2	21.8	28.5	36.0
Air Taxi/Commuter	1.6	2.0	2.1	2.2
Total	18.8	23.8	30.6	38.2
Passengers in Peak Hour of Average Day Peak Month				
Enplanements in Enplanement Peak	4,060	5,100	6,300	7,500
Deplanements in Deplanement Peak	3,520	4,500	5,500	6,700
Total in Total Passenger Peak	5,950	7,700	9,800	12,100

TABLE 2-1
SUMMARY OF AVIATION FORECASTS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 (a)

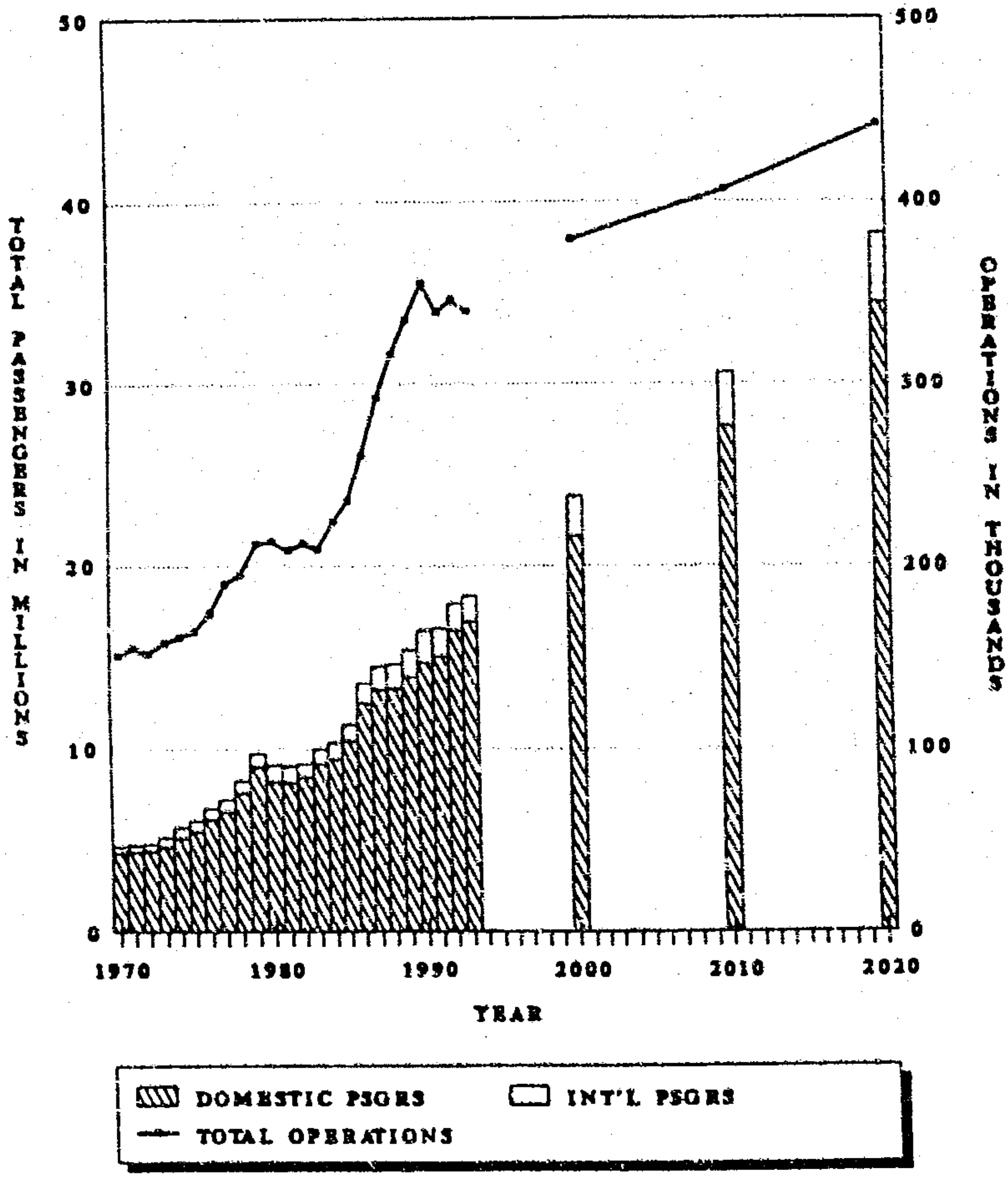
Forecast Element	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
Annual Aircraft Operations (Thousands) and Annual Growth Rates				
Total Annual Operations	339.5	379.2	405.8	441.6
(Average Annual Growth Rate)		(1.6%)	(0.7%)	(0.8%)
Annual Operations by Type Aircraft				
Air Carrier	200.0	237.0	272.0	309.0
(Average Annual Growth Rate)		(2.5%)	(1.4%)	(1.3%)
Air Taxi/Commuter	131.0	133.0	124.0	122.0
(Average Annual Growth Rate)		(0.2%)	(-0.7%)	(-0.2%)
General Aviation	8.1	8.9	9.5	10.3
(Average Annual Growth Rate)		(1.4%)	(0.7%)	(0.8%)
Military	0.3	0.3	0.3	0.3
(Average Annual Growth Rate)		(0%)	(0%)	(0%)
Total	339.5	379.2	405.8	441.6
Annual Airline Operations by Type Service				
Passenger Service				
Domestic Air Carrier	180	210	238	266
Domestic Air Taxi/Commuter	106	100	88	86
International to Canada	26	34	40	44
Other International	3	6	7	8
Subtotal Passenger	315	350	373	404
All-Cargo Service	16	20	23	27
Total Airline	331	370	396	431
Peak Hour and Daily Aircraft Operations				
Operations in Peak Hour of Average Day				
Peak Month				
Air Carrier	48	57	65	74
Air Taxi/Commuter	26	26	24	24
General Aviation	2	2	2	3
Military	0	0	0	0
Total	76	85	91	101

TABLE 2-1
SUMMARY OF AVIATION FORECASTS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

Forecast Element	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
Average Daily Operations				
Passenger				
Air Carrier	515.1	611.0	698.6	786.3
Air Taxi/Commuter	347.9	347.9	323.3	320.5
All-Cargo	43.8	54.8	63.0	74.0
General Aviation	22.2	24.4	26.0	28.2
Military	0.8	0.8	0.8	0.8
Total	930.0	1038.9	1111.7	1209.8
Air Cargo (Thousand Metric Tons) and Annual Growth Rates				
Air Cargo (Inbound and Outbound)				
Domestic Freight	246.3	310	420	550
(Average Annual Growth Rate)		(3.3%)	(3.1%)	(2.7%)
International Freight	51.0	100	140	190
(Average Annual Growth Rate)		(10.1%)	(3.4%)	(3.1%)
Air Mail	84.2	100	120	140
(Average Annual Growth Rate)		(2.5%)	(1.8%)	(1.6%)
Total	381.5	510	680	880
(Average Annual Growth Rate)		(4.2%)	(2.9%)	(2.6%)

[a] Source: P&D Aviation.

FIGURE 2-1
TOTAL PASSENGER AND OPERATIONS FORECASTS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT



Others which are more difficult to predict include changes in air carriers (such as the entry of a low-cost carrier), technological advances in telecommunications, and international bilateral agreements. Some of these factors are outside the control of the Port while others can be influenced by Port programs and policies. Additional discussion of influencing factors is provided on pages 5-2 through 5-4.

Section 3
HISTORIC AVIATION ACTIVITY

SECTION 3
HISTORIC AVIATION ACTIVITY

This section describes past trends in activity at Seattle-Tacoma International Airport (Sea-Tac). Data on air passengers, air cargo and aircraft operations (takeoffs and landings) from 1970 to the present are discussed.

AIR PASSENGERS

Total Passengers

Total passengers have grown from 4.7 million in 1970 to approximately 18.8 million in 1993 (Table 3-1). Passenger growth over the last 10 years has averaged 6.4 percent per year. Recently, the passenger growth rate has slowed, averaging 5.3 percent per year over the past five years. In contrast, total U.S. passenger growth has averaged 1.7 percent a year over the last five years (Figure 3-1).

The rate of passenger growth at Sea-Tac has outpaced the national rate over the last two decades. In 1970, Sea-Tac enplaned 1.4 percent of U.S. passengers, whereas in 1993, Sea-Tac enplaned 1.8 percent. The slowing of national passenger growth that has occurred since 1987 has not been experienced at Sea-Tac.

Domestic and International Passengers

Domestic enplanements have consistently accounted for approximately 90 to 92 percent of total enplanements (Table 3-2). Most domestic enplanements are carried on air carrier aircraft (aircraft of 60 seats or more). In 1993, commuter aircraft enplaned approximately 590,000 passengers, or 6.8 percent of domestic enplanements (Table 3-3). From 1985 to 1992, the column headed Enplanements on Air Carrier Aircraft in Table 3-3 includes some passengers on commuter aircraft. All data for Horizon Airlines from 1985 to 1992 are included under Air Carrier, including passengers flying on aircraft with less than 60 seats, because the airline operates aircraft larger than 60 seats and, therefore is classified as an air carrier airline. The 1993 data have been adjusted to account for Horizon passengers by type of aircraft.

Data are available on the number of domestic air carrier origination and destination passengers from a 10 percent sample survey of airline tickets conducted by the U.S. Department of Transportation. This data indicate that domestic air carrier originations have been 69 to 74 percent of domestic air carrier enplanements at the airport since 1976 (Table 3-4), averaging 72.5 percent.

Although international passengers at Sea-Tac have declined over the last three years they represent an important segment of passenger traffic at the airport (Table 3-5). Recent declines in international passengers have been particularly felt in the Asian markets (Figure 3-2). The reasons for the decline in Asian service from Sea-Tac, according to the airlines serving Asian markets, are a general decline in demand from the Seattle area to Asian markets and the transfer of flights formerly served through Sea-Tac to Los Angeles, San Francisco and Vancouver, British Columbia.

The only sector that has experienced an increase in international passengers from 1985 is service to Canada, which has seen passengers increase 2.7 times from 1985 to 1993. One possible explanation for this growth in traffic is the relatively lower fares for air travel through Sea-Tac on U.S. carriers compared with corresponding travel through Canadian cities on Canadian

TABLE 3-1
ENPLANED AND DEPLANED PASSENGERS AT
SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1970 TO 1993 [a]

Year	Enplaned Passengers	Deplaned Passengers	Total Passengers	Percent Change in Total Passengers	
				Annual	10-year Average
1970	2,351,812	2,301,631	4,653,443	-3.2	[b]
1971	2,370,360	2,327,245	4,697,605	0.9	[b]
1972	2,395,241	2,393,721	4,788,962	1.9	9.1
1973	2,588,959	2,616,134	5,205,093	8.7	11.3
1974	2,862,890	2,909,326	5,772,216	10.9	11.2
1975	3,038,999	3,073,424	6,112,423	5.9	10.1
1976	3,381,864	3,424,884	5,806,748	11.4	9.2
1977	3,625,965	3,706,478	7,332,443	7.7	6.6
1978	4,150,438	4,217,539	8,367,977	14.1	6.6
1979	4,879,285	4,941,134	9,820,419	17.4	7.4
1980	4,578,447	4,616,203	9,194,650	-6.4	7.0
1981	4,536,472	4,581,158	9,117,630	-0.8	6.9
1982	4,608,633	4,670,104	9,278,737	1.8	6.8
1983	5,008,874	5,132,863	10,141,737	9.3	6.9
1984	5,167,185	5,309,445	10,476,630	3.3	6.1
1985	5,683,437	5,783,318	11,466,755	9.5	6.5
1986	6,810,585	6,832,081	13,642,666	19.0	7.2
1987	7,248,535	7,196,947	14,445,482	5.9	7.0
1988	7,313,886	7,181,633	14,495,519	0.3	5.6
1989	7,509,012	7,732,246	15,241,258	5.1	4.5
1990	8,225,920	8,014,389	16,240,309	6.6	5.9
1991	8,294,093	8,019,196	16,313,289	0.4	6.0
1992	8,978,740	8,983,477	17,962,217	10.1	6.8
1993	9,384,565	9,415,959	18,800,524	5.3	6.4

[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report."
[b] Data not available.

FIGURE 3-1
U.S. AND SEATTLE-TACOMA INTERNATIONAL AIRPORT ENPLANEMENTS, 1970 TO 1993

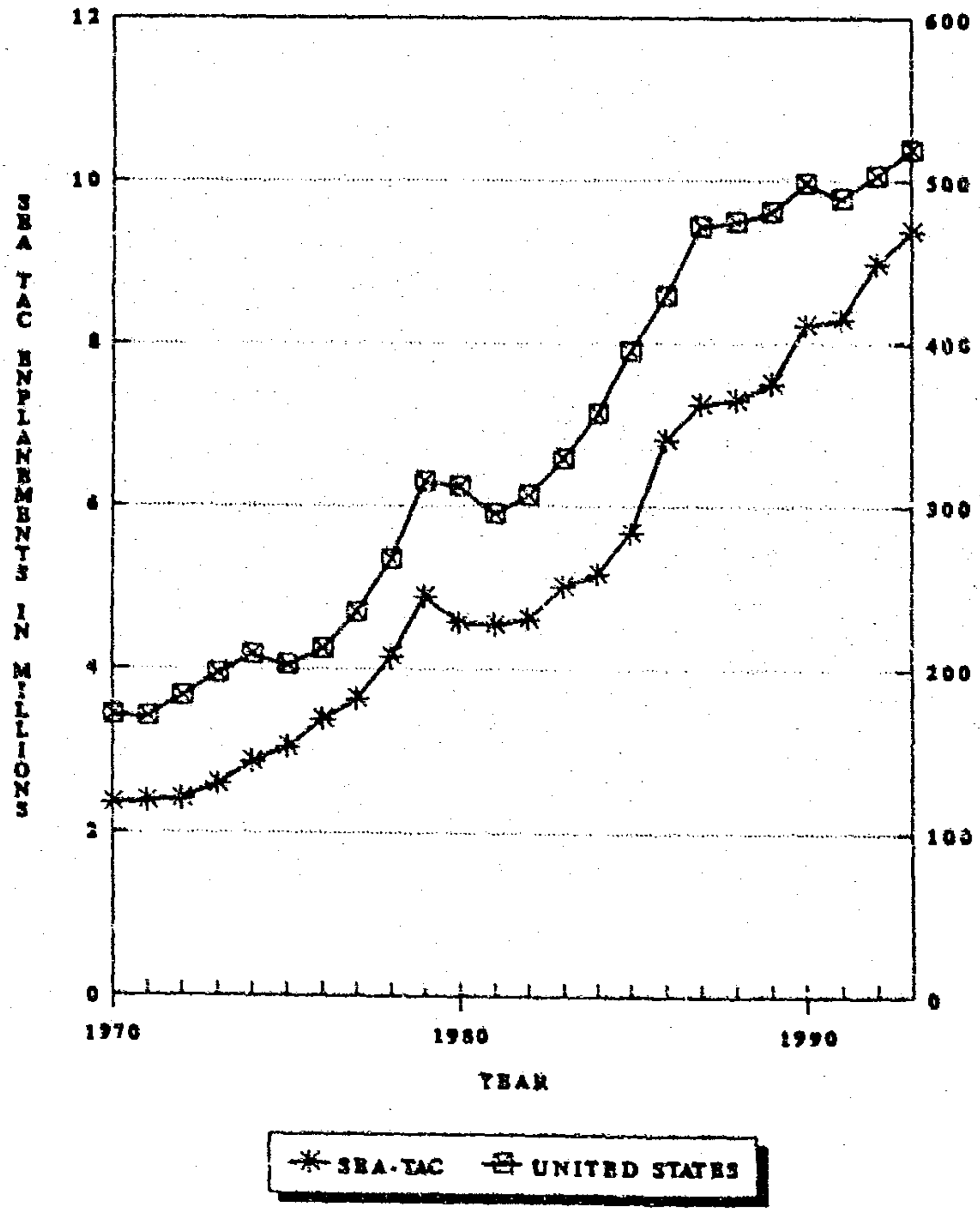


TABLE 3-2
DOMESTIC AND INTERNATIONAL ENPLANEMENTS
AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1970 to 1993 [a]

Year	Total Enplanements (Thousands)	Domestic Enplanements (Thousands)	International Enplanements (Thousands)	Percent International
1970	2,352	2,162	190	8.1
1971	2,370	2,196	175	7.4
1972	2,395	2,208	187	7.8
1973	2,589	2,319	270	10.4
1974	2,863	2,547	316	11.0
1975	3,039	2,733	306	10.1
1976	3,382	3,065	317	9.4
1977	3,626	3,296	330	9.1
1978	4,150	3,815	336	8.1
1979	4,879	4,497	383	7.8
1980	4,578	4,118	461	10.1
1981	4,536	4,070	466	10.3
1982	4,609	4,243	365	7.9
1983	5,009	4,593	416	8.3
1984	5,167	4,709	458	8.9
1985	5,683	5,204	479	8.4
1986	6,811	6,243	568	8.3
1987	7,249	6,629	620	8.6
1988	7,314	6,640	674	9.2
1989	7,732	6,971	761	9.8
1990	8,226	7,341	885 [b]	10.8
1991	8,294	7,526	768	9.3
1992	8,979	8,254	725	8.1
1993	9,385	8,700	685	7.3

[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report."

[b] International traffic increase was probably due largely to the Goodwill Games.

TABLE 3-3
DOMESTIC AIR CARRIER AND COMMUTER CARRIER ENPLANEMENTS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1970 TO 1993

Year	Total Domestic and International Enplanements (Thousands)	Domestic Enplanements (Thousands)			
		Total [a]	Enplanements on Air Carrier Aircraft (Over 60 Seats)	Enplanements on Commuter Aircraft (60 Seats or Less) [b]	
				Number	Percent
1970	2,352	2,162	[c]	[c]	[c]
1971	2,370	2,196	[c]	[c]	[c]
1972	2,395	2,208	[c]	[c]	[c]
1973	2,589	2,319	[c]	[c]	[c]
1974	2,863	2,547	[c]	[c]	[c]
1975	3,039	2,733	[c]	[c]	[c]
1976	3,382	3,065	2,993	72	2.6
1977	3,626	3,296	3,208	88	2.7
1978	4,150	3,815	3,703	112	3.0
1979	4,879	4,497	4,365	132	3.0
1980	4,578	4,118	4,050	68	1.7
1981	4,536	4,070	3,998	72	1.8
1982	4,609	4,243	4,049	194	4.8
1983	5,009	4,593	4,368	225	5.2
1984	5,167	4,709	4,448	261	5.9
1985	5,683	5,204	5,076 [d]	128 [d]	2.5 [d]
1986	6,811	6,243	6,155 [d]	88 [d]	1.4 [d]
1987	7,249	6,629	6,566 [d]	63 [d]	1.0 [d]
1988	7,314	6,640	6,442 [d]	198 [d]	3.1 [d]
1989	7,732	6,971	6,681 [d]	290 [d]	4.3 [d]
1990	8,226	7,341	7,073 [d]	268 [d]	3.8 [d]
1991	8,294	7,526	7,316 [d]	210 [d]	2.9 [d]
1992	8,979	8,254	8,064 [d]	190 [d]	2.4 [d]
1993	9,385	8,700	8,110	590	6.8

[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report."

[b] Sources: Federal Aviation Administration, Terminal Area Forecasts (data from 1976-1990); Seattle-Tacoma International Airport data (1991-1993).

[c] Data not available.

[d] From 1985 to 1992, air carrier data include Horizon Airlines passengers on aircraft with 60 seats or less. Therefore, the commuter percentage for those years was actually greater than indicated in this table. In 1993 Horizon Airlines enplaned approximately 410,000 domestic passengers on aircraft with 60 seats or less.

TABLE 3-4
SCHEDULED DOMESTIC AIR CARRIER ORIGINATING PASSENGERS
AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1976 TO 1992

Year	Total Enplanements [a] (Thousands)	Domestic Air Carrier Enplanements [a] (Thousands)	Domestic Air Carrier Originations [b] (Thousands)	Domestic Air Carrier Originations - Percent of Domestic Enplanements
1976	3,382	2,993	2,155	72.0
1977	3,626	3,208	2,332	72.7
1978	4,150	3,703	2,750	74.3
1979	4,879	4,365	3,163	72.5
1980	4,578	4,050	2,892	71.4
1981	4,536	3,998	2,763	69.1
1982	4,609	4,049	3,083	76.1
1983	5,009	4,368	3,340	76.5
1984	5,167	4,448	3,248	73.0
1985	5,683	5,076	3,582	70.6
1986	6,811	6,155	5,504 [c]	[c]
1987	7,249	6,566	4,548	69.3
1988	7,314	6,442	4,670	72.5
1989	7,732	6,681	4,757	71.2
1990	8,226	7,073	5,236	74.0
1991	8,294	7,315	5,330	72.9
1992	8,979	8,064	5,767	71.5
Average	-	-	-	72.5

[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report."

[b] Source: U.S. Department of Transportation, <u>Origin-Destination Survey of Airline Passenger Traffic,</u> Table 1, 1975-1992.

[c] Originations data for 1986 appears to be in error and was therefore not used in the analysis.

TABLE 3-5
INTERNATIONAL ENPLANEMENTS AT
SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1970 to 1993

Year	Total Enplanements (Thousands) [a]	International Enplanements (Thousands)			
		Total [a]	Canada [b]	Asia [b]	Europe and Other [b]
1970	2,352	190	[c]	[c]	[c]
1971	2,370	175	[c]	[c]	[c]
1972	2,395	187	[c]	[c]	[c]
1973	2,589	270	[c]	[c]	[c]
1974	2,863	316	[c]	[c]	[c]
1975	3,039	306	[c]	[c]	[c]
1976	3,382	317	[c]	[c]	[c]
1977	3,626	330	[c]	[c]	[c]
1978	4,150	336	[c]	[c]	[c]
1979	4,879	383	[c]	[c]	[c]
1980	4,578	461	[c]	[c]	[c]
1981	4,536	466	[c]	[c]	[c]
1982	4,609	365	[c]	[c]	[c]
1983	5,009	416	[c]	[c]	[c]
1984	5,167	458	[c]	[c]	[c]
1985	5,683	479	131	183	165
1986	6,811	568	166	244	158
1987	7,249	620	176	256	188
1988	7,314	674	217	254	203
1989	7,732	761	308	281	172
1990	8,226	842 [d]	347	317	178
1991	8,294	768	357	286	125
1992	8,979	725	371	216	138
1993	9,385	685	356	171	158

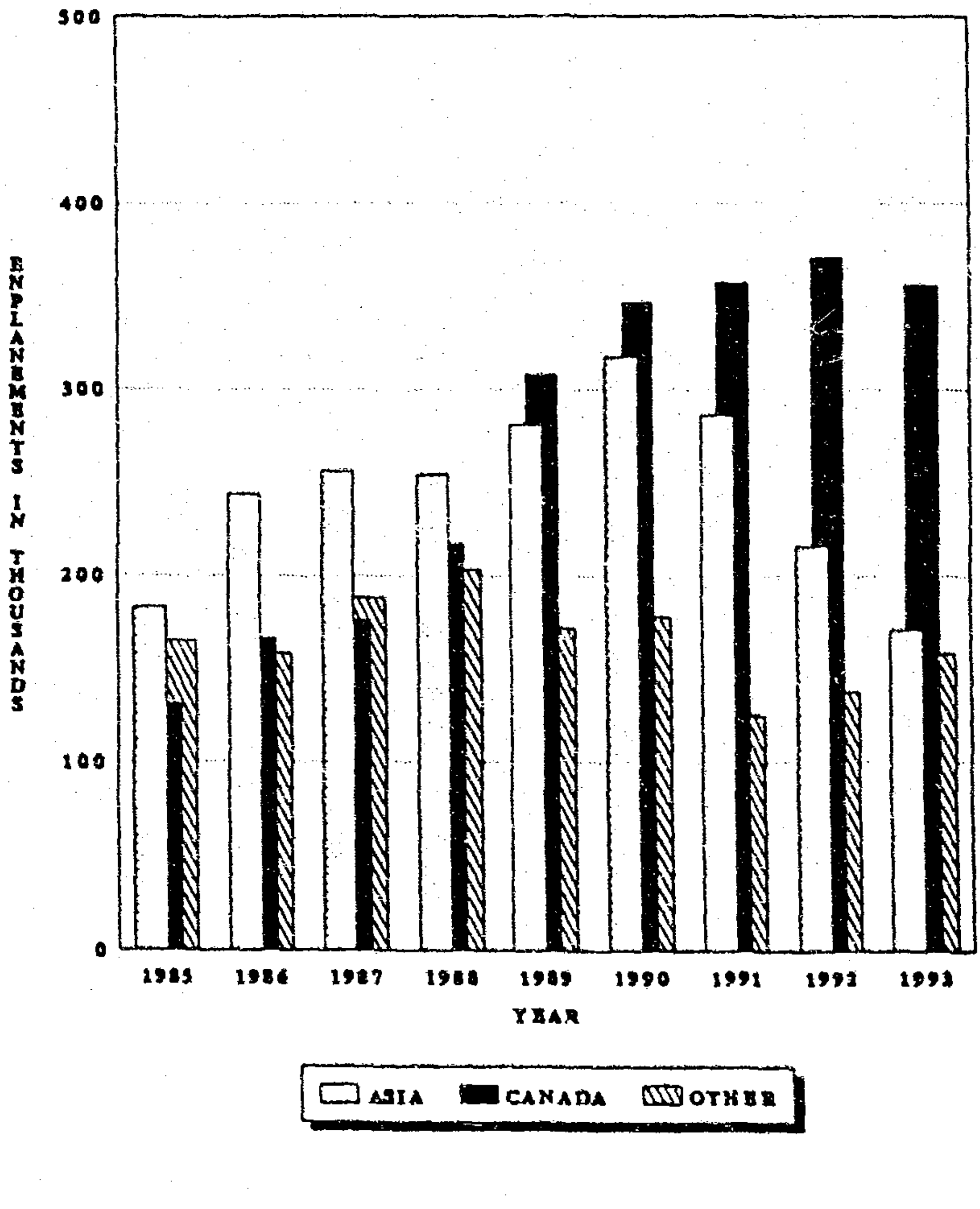
[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report."

[b] Source: Developed by P&D Aviation from data supplied by Seattle-Tacoma International Airport, contained in "International Passenger/Freight Comparison Report."

[c] Data not available.

[d] International traffic increase was probably due largely to the Goodwill Games.

FIGURE 3-2
INTERNATIONAL ENPLANEMENT DESTINATIONS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT



carriers.

Monthly Passenger Distribution

Passenger enplanements typically peak in the month of August (Tables 3-6 and 3-7). From 1989 to 1992, an average of 12.2 percent of total passengers were enplaned in the peak month. The months of January through April typically have the fewest number of enplanements (Figure 3-3).

Hourly Passenger Distribution

For terminal and ground access planning, it is necessary to consider the number of passengers enplaning and deplaning during peak periods of the day. Peak hour passengers are typically estimated for the average day of the peak month (August at Sea-Tac). The average day peak month (ADPM) passengers and operations for August 1993 were derived by dividing the August total by 31. The hourly distributions of passengers and operations were derived from airline flight schedules and estimates relating to aircraft load factors.

Total passengers at Sea-Tac generally have three peaks during the day: 7:00 a.m. to 9:00 a.m., 11:00 a.m. to 2:00 p.m. and 4:00 p.m. to 7:00 p.m. (Table 3-8 and Figure 3-4). Enplanements peak from 7:00 a.m. to 9:00 a.m. and again from 12:00 p.m. to 2:00 p.m. Deplanements peak from 10:00 a.m. to 12:00 p.m. and from 8:00 p.m. to 10:00 p.m. In the peak hour of the average day of August (peak month) 1993 (from 1:00 p.m. to 2:00 p.m.), 5,950 passengers were enplaned and deplaned.

AIR CARGO TONS

In 1993, 382,000 tons of air cargo (freight and mail) were handled at Sea-Tac by a wide range of carriers: major U.S. combination carriers, integrated express services, dedicated cargo airlines, overseas passenger airlines, local, regional and charter services. Major air cargo carriers at Sea-Tac and their percentages of cargo carried are Federal Express (23%), United (15%), Alaska (14%), and Northwest (11%). Air cargo aircraft range from small turboprop aircraft to Boeing B747 aircraft. There were approximately 16,000 all-cargo operations in 1993. Cargo operations are discussed further in Section 5.

From 1970 to 1993 total air cargo shipped in and out of Sea-Tac has increased at an annual compounded rate of 4.8 percent. In 1993, 64 percent of cargo was domestic air freight, 13 percent international air freight and 22 percent air mail (Table 3-9). The greatest gains in recent years have been in domestic air freight.

The Seattle-Tacoma International Airport Air Cargo Study, Technical Report was published by the Port of Seattle in June 1993. This report updated the air cargo master plan for the development of all-cargo facilities at the airport.

AIRCRAFT OPERATIONS

Total Operations

In 1993 there were approximately 340,000 aircraft operations (takeoffs and landings) at the airport (Table 3-10). The total number of operations has been relatively stable over the last three years. In 1993, certificated air carrier aircraft accounted for approximately 59 percent of the airport's total operations (Table 3-11) and 60 percent of airline operations. The number of air taxi/commuter operations increased rapidly in the late 1980s, significantly increasing the percentage of smaller aircraft operating at the airport. Commuter operations peaked in 1990 and have declined slightly since then.

**TABLE 3-6
MONTHLY DISTRIBUTION OF PASSENGER ENPLANEMENTS
AT SEATTLE-TACOMA INTERNATIONAL AIRPORT,
1990 TO 1993 [a]**

	Enplaned Passengers (Thousands)				
Month	**1989**	**1990**	**1991**	**1992**	**1993**
January	504	560	540	558	581
February	437	493	479	526	524
March	550	620	579	646	651
April	566	570	603	607	695
May	606	643	672	685	729
June	773	811	806	934	911
July	828	888	903	1,037	998
August [b]	925	996	995	1,152	1,131
September	700	751	759	842	867
October	622	640	673	663	773
November	590	593	589	621	740
December	631	661	696	708	784
Total	**7,732**	**8,226**	**8,294**	**8,979**	**9,385**

[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report."

[b] Note that passenger enplanements typically peak in August. From 1989 to 1992, the average percent of passengers in the peak month to total annual passengers was:

Domestic	12.2%
International	12.5%
Total	12.2%

TABLE 3-7
MONTHLY DISTRIBUTION OF DOMESTIC AND INTERNATIONAL ENPLANEMENTS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 [a]

	Total Enplanements		Domestic Enplanements		International Enplanements	
Month	Number (Thousands)	Percent	Number (Thousands)	Percent	Number (Thousands)	Percent
January	581.4	6.2	537.3	6.2	44.1	6.4
February	523.9	5.6	483.1	5.6	40.8	6.0
March	651.2	6.9	600.3	6.9	50.9	7.4
April	694.6	7.4	643.5	7.4	51.1	7.5
May	729.5	7.8	670.1	7.7	59.3	8.7
June	911.3	9.7	843.0	9.7	68.3	10.0
July	998.2	10.6	924.0	10.6	74.2	10.8
August [b]	1131.1	12.1	1050.5	12.1	80.5	11.8
September	867.3	9.2	798.6	9.2	68.8	10.1
October	772.6	8.2	717.1	8.2	55.5	8.1
November	739.7	7.9	698.7	8.0	41.0	6.0
December	784.1	8.4	734.0	8.4	50.1	7.3
Total	**9384.6**	**100.0**	**8700.1**	**100.0**	**684.5**	**100.0**

[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report."

[b] Note that the domestic and international enplanements peaked in August.

FIGURE 3-3
MONTHLY DISTRIBUTION OF ENPLANED PASSENGERS, 1993

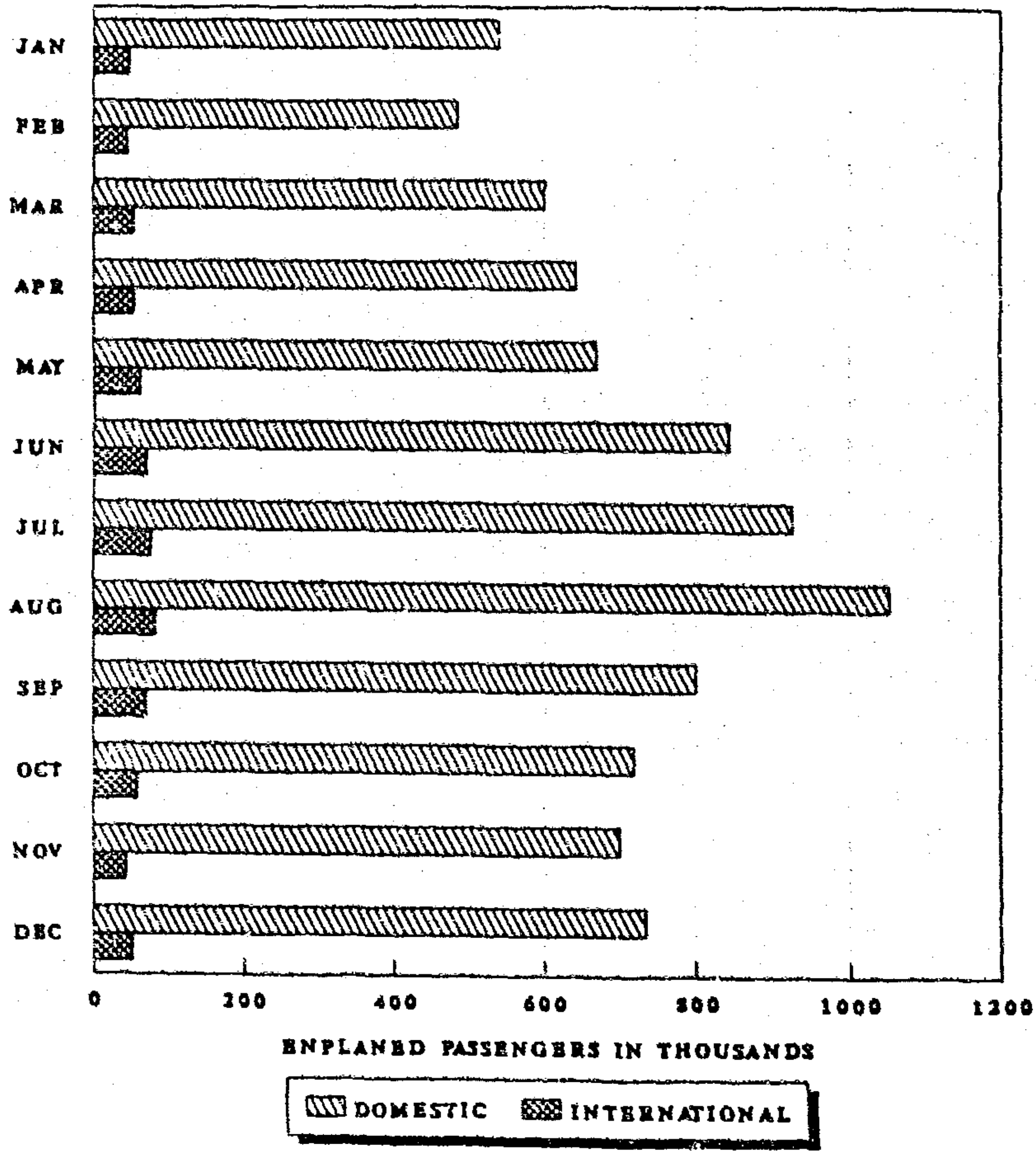


TABLE 3-8
HOURLY PASSENGERS IN THE AVERAGE DAY OF THE PEAK MONTH, SEATTLE-TACOMA INTERNATIONAL AIRPORT
AUGUST 1993

Hour [b]	Passengers [a]		
	Total Passengers	Enplaned Passengers	Deplaned Passengers
2400	1,200	270	930
0100	210	210	0
0200	0	0	0
0300	100	0	100
0400	0	0	0
0500	590	0	590
0600	2,690	1,950	740
0700	4,510	3,240	1,270
0800	5,110	3,610	1,500
0900	3,060	1,790	1,270
1000	4,640	1,750	2,890
1100	5,560	2,150	3,410
1200	5,130	2,810	2,320
1300	5,950	4,060	1,890
1400	3,010	1,590	1,420
1500	3,840	2,010	1,830
1600	2,470	1,350	1,120
1700	3,730	1,390	2,340
1800	4,430	2,260	2,170
1900	4,240	1,980	2,260
2000	4,550	1,030	3,520
2100	3,790	910	2,880
2200	2,230	1,090	1,140
2300	1,960	1,040	920
Total	**73,000**	**36,500 [c]**	**36,500 [c]**

[a] Source: Developed by P&D Aviation from data from Official Airline Guide, August 15, 1993 and Seattle-Tacoma International Airport.

[b] Hourly intervals are for hours beginning at the time listed (i.e., the 0900 interval is from 9:00 a.m. to 9:59 a.m.).

[c] Individual numbers do not sum to total due to independent rounding.

FIGURE 3-4
HOURLY PASSENGER DISTRIBUTION FOR AVERAGE DAY OF PEAK MONTH (AUGUST) 1993

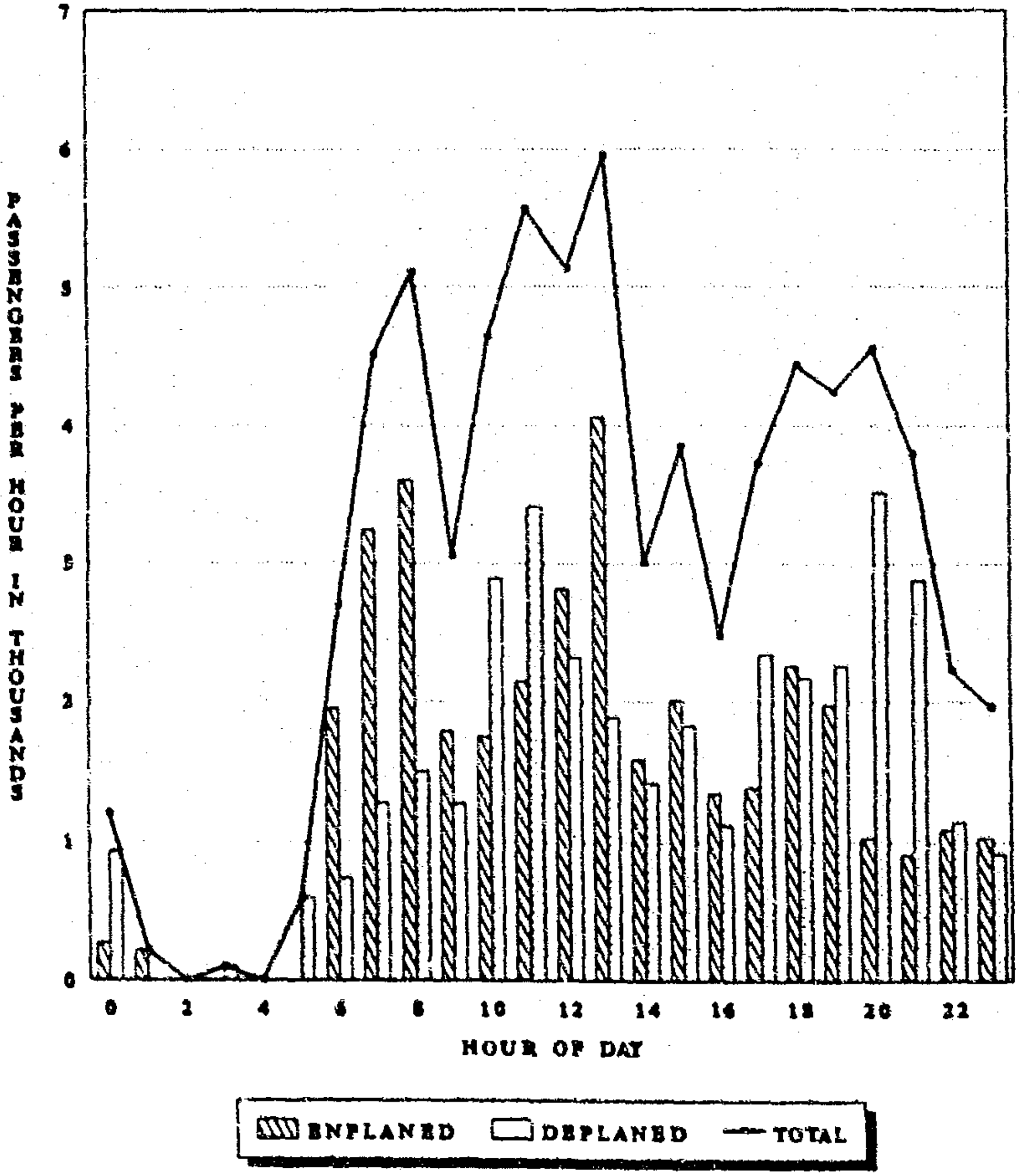


TABLE 3-9
AIR CARGO AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1970 to 1993 [a]

Year	Total Cargo (Thousand Metric Tons)			Air Freight (Thousand Metric Tons)				Air Mail (Thousand Metric Tons)	
				Domestic		International			
	Total	In	Out	In	Out	In	Out	In	Out
1970	130	67	63	39	35	[b]	1	27	28
1971	133	65	68	40	43	1	1	24	24
1972	137	70	67	47	46	1	1	22	20
1973	151	80	71	59	50	1	3	21	18
1974	168	84	84	64	63	1	3	19	18
1975	190	89	101	64	78	6	6	20	18
1976	200	95	106	68	80	6	8	21	17
1977	215	103	113	75	87	5	8	23	19
1978	213	105	108	76	78	6	9	24	20
1979	214	102	112	71	79	8	13	23	19
1980	211	98	113	64	78	8	12	26	23
1981	211	96	114	64	79	7	12	26	24
1982	199	91	108	55	74	8	10	27	24
1983	214	102	111	60	77	12	10	30	25
1984	228	110	118	62	77	15	13	32	28
1985	210	102	108	54	65	14	13	34	30
1986	223	105	118	55	66	15	20	35	31
1987	259	118	141	66	81	18	29	34	31
1988	277	122	155	71	90	17	33	34	32
1989	291	128	163	75	99	18	34	35	30
1990	313	139	174	82	104	20	39	37	31
1991	348	160	188	98	111	20	40	42	37
1992	362	170	192	107	119	21	37	42	36
1993	382	182	200	119	127	18	33	44	40

[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report." One metric ton equals 2,205 pounds.

[b] Less than 0.5.

TABLE 3-10
AIRCRAFT OPERATIONS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1970 TO 1993 [a]

Year	Air Carrier Aircraft [b]	Air Taxi (Commuter) Aircraft [b]	General Aviation Aircraft [c]	Military Aircraft	Total	Annual Percent Change in Total Operations
1970	104,414	6,202	38,893	1,167	150,676	-9.1
1971	114,372	5,215	33,874	1,683	155,144	3.0
1972	109,278	4,353	36,335	2,378	152,344	-1.8
1973	115,445	17,866	22,878	1,942	158,289	3.9
1974	106,466	31,654	21,492	1,304	161,077	1.8
1975	109,962	30,896	21,888	1,013	163,923	1.8
1976	114,998	31,818	25,865	844	173,699	6.0
1977	119,166	39,143	30,835	882	190,216	9.5
1978	119,850	41,747	32,787	607	195,186	2.6
1979	131,647	45,739	33,988	568	211,942	8.6
1980	143,646	40,681	27,876	541	212,744	0.4
1981	141,015	39,400	27,053	477	208,153	-2.2
1982	138,415	49,040	23,583	356	211,605	1.7
1983	137,920	48,757	22,247	329	209,462	-1.0
1984	142,717	59,824	20,878	409	224,052	7.0
1985	158,904	56,954	18,537	327	234,957	4.9
1986	187,870	54,977	16,606	286	260,199	10.7
1987	178,682	95,337	17,671	355	292,337	12.4
1988	176,732	124,245	14,520	447	316,260	8.2
1989	182,460	139,215	12,865	384	335,259	6.0
1990	193,482	150,376	10,844	305	355,007	5.9
1991	186,717	142,828	8,773	289	338,607	-4.6
1992	196,141	140,744	8,800	310	345,995	2.2
1993	200,040	131,046	8,097	276	339,459	-1.9

[a] Source: Seattle-Tacoma International Airport, Traffic and Operations Report.*

[b] Horizon Airlines has flown both air carrier and air taxi/commuter aircraft from 1985 to 1993. Operations by each aircraft type are included in the appropriate column.

[c] Includes training flights.

TABLE 3-11
AIR CARRIER AND AIR TAXI OPERATIONS
AT SEATTLE-TACOMA INTERNATIONAL AIRPORT,
1970 TO 1993 [a]

Year	Total Airport Operations	Air Carrier Aircraft Operations	Air Taxi (Commuter) Aircraft Operations	Percent Airlines (Air Carrier and Air Taxi)	Percent Air Carrier
1970	150,676	104,414	6,202	74	67
1971	155,144	114,372	5,215	77	74
1972	152,344	109,278	4,353	75	72
1973	158,289	115,445	17,866	84	73
1974	161,077	106,466	31,654	86	66
1975	163,923	109,962	30,896	86	67
1976	173,639	114,998	31,818	84	66
1977	190,216	119,166	39,143	83	63
1978	195,186	119,850	41,747	83	62
1979	211,942	131,647	45,739	83	62
1980	212,744	143,646	40,681	86	67
1981	208,153	141,015	39,400	87	68
1982	211,605	138,415	49,040	88	65
1983	209,462	137,920	48,757	89	66
1984	224,052	142,717	59,824	91	63
1985	234,957	158,904	56,954	92	68
1986	260,199	187,870	54,977	93	72
1987	292,337	178,682	95,337	94	61
1988	316,260	176,732	124,245	95	56
1989	335,259	182,460	139,215	96	54
1990	355,007	193,482	150,376	97	54
1991	338,607	186,717	142,828	97	55
1992	345,995	196,141	140,744	97	57
1993	339,459	200,040	131,046	97	59

[a] Source: Seattle-Tacoma International Airport, Traffic and Operations Report."

TABLE 3-12
MONTHLY DISTRIBUTION OF TOTAL OPERATIONS
AT SEATTLE-TACOMA INTERNATIONAL AIRFORT,
1989 TO 1993 [a]

Month	Total Aircraft Operations				
	1989	1990	1991	1992	1993
January	25,192	28,073	26,982	27,671	26,851
February	22,191	24,768	23,724	25,405	24,099
March	25,081	28,746	27,181	27,133	27,159
April	25,483	27,827	26,780	27,362	26,635
May	28,033	30,675	28,437	28,908	28,014
June	30,102	32,228	29,666	31,048	30,462
July [b]	32,219	33,753	31,593	33,064	32,337
August [b]	32,549	34,046	32,061	32,922	32,232
September	29,556	29,796	28,892	29,376	29,071
October	29,212	30,497	28,901	28,148	27,973
November	27,609	27,277	26,384	26,785	26,757
December	27,697	27,321	28,006	28,173	27,869
Total	**334,924**	**355,007**	**338,607**	**345,995**	**339,459**

[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report."

[b] Note that operations typically peak in July or August. From 1989 to 1993, the average percent of peak month operations to annual operations was:

Air Carrier	9.7%
Air Taxi (Commuter)	9.4%
General Aviation	11.2%
Military	8.8%
Total	9.6%

Monthly Distribution of Operations

Total operations at the airport typically peak in July or August (Table 3-12). From 1989 to 1992, 9.6 percent of the airport's operations occurred in the peak month. In 1993, total operations and air carrier operations both peaked in July (Table 3-13). During that year, the distribution of air taxi/commuter operations was relatively flat. Over the past five years, the total numbers of operations in July and August of each year have been very similar and no particular anomaly is thought to be responsible for 1993 operations peaking in July.

Hourly Distribution of Operations

Total airport operations have three peaks during the day, generally following the pattern of peak passenger times. Peaks in total operations occur from 7:00 a.m. to 9:00 a.m., from 10:00 a.m. to 2:00 p.m. and from 6:00 p.m. to 8:00 p.m. (Table 3-14 and Figure 3-5). There are two primary arrival peaks and two departure peaks, mirroring the hourly distribution of enplanements and deplanements described earlier. In 1993 there were 74 peak hour scheduled operations in the peak hour of the average day peak month (August). The 74 peak hour scheduled operations occurred between 7:00 a.m. and 8:00 a.m. and also between 1:00 p.m. and 2:00 p.m.

In addition to the 74 scheduled operations in the peak hour there were an estimated (from FAA air traffic control tower records) 2 general aviation operations for a total of 76 peak hour operations in 1993 (Table 3-15). The total operations in the peak hour represent approximately 7.2 percent of the operations in the average day of the peak month indicating a relatively flat distribution of operations. This relatively flat distribution is exhibited in Figure 3-5 by the frequency of a occurrences of hourly scheduled operations in the 60 to 75 per hour range, which occurs during 10 hours of the day. The relative flatness of this distribution suggests that the percentage of peak operations to average day operations may not decrease substantially in the future, regardless of the growth in total operations.

Enplanements Per Departure

The number of enplaned passengers per passenger departure has increased from 45.2 in 1970 to 60.0 in 1993 (Table 3-16). The growth in enplanements per departure has been tempered since the late 1980s due to the increased percentage of air taxi/commuter operations. In 1986 when enplanements per departure averaged 60.4, air taxi/commuter operations were only 23 percent of total passenger operations. In 1993 air taxi/commuter operations were 40 percent of passenger operations. Nevertheless, from 1986 to 1993 the number of passengers per departure declined by less than one percent.

Aircraft Fleet Mix

The airport is served by a variety of aircraft types (Table 3-17). In 1993 most air carrier passenger aircraft departures were by the Boeing B737 (29.4 percent), McDonnell-Douglas MD80 (23.7 percent) and Boeing B757-200 (12.6 percent).

The 39 to 45 seat DeHavilland DHC-8 (Dash-8) accounted for 46.8 percent of air taxi/commuter passenger departures in 1993. Other common air taxi/ commuter aircraft are the British Aerospace J31 (24.2 percent) and the Fairchild Metro (18.8 percent).

Sixty-four percent of the all-cargo aircraft departures in 1993 were by aircraft over 60,000 pounds gross weight, such as the Boeing B737, Boeing B727, McDonnell-Douglas DC9, McDonnell-Douglas DC8, McDonnell-Douglas DC10, B747-200F and B747-400F.

TABLE 3-13
MONTHLY DISTRIBUTION OF OPERATIONS BY TYPE AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 [a]

Month	Total	Air Carrier	Air Taxi (Commuter)	General Aviation	Military	Training Flights
January	26,851	15,630	10,759	426	22	14
February	24,099	13,456	10,185	440	16	2
March	27,159	15,133	11,349	636	31	10
April	26,635	14,920	11,122	540	30	23
May	28,014	15,986	11,289	686	26	27
June	30,462	17,992	11,537	914	15	4
July [b]	32,337	19,877	11,502	917	31	10
August	32,232	19,714	11,552	907	37	22
September	29,071	17,349	10,842	839	23	18
October	27,973	16,933	10,391	626	17	6
November	26,757	16,072	10,129	544	10	2
December	27,869	16,978	10,389	454	18	30
Total	**339,459**	**200,040**	**131,046**	**7,929**	**276**	**168**

[a] Source: Seattle-Tacoma City International Airport, "Traffic and Operations."

[b] In 1993, total and air carrier operations peaked in July although both have often peaked in August.

TABLE 3-14
HOURLY SCHEDULED OPERATIONS IN THE AVERAGE DAY OF THE PEAK MONTH, SEATTLE-TACOMA INTERNATIONAL AIRPORT
AUGUST 1993

	Scheduled Airline Operations [a]								
	Total			Air Carrier Aircraft (Over 60 Seats)			Air Taxi/Commuter Aircraft (60 Seats or Less)		
Hour	Tot.	Arr.	Dep.	Tot.	Arr.	Dep.	Tot.	Arr.	Dep.
2400	14	11	3	13	10	3	1	1	0
0100	2	0	2	2	0	2	0	0	0
0200	1	1	0	1	1	0	0	0	0
0300	2	1	1	2	1	1	0	0	0
0400	1	1	0	1	1	0	0	0	0
0500	10	9	1	9	8	1	1	1	0
0600	48	22	26	29	11	18	19	11	8
0700	74	25	49	43	11	32	31	14	17
0800	62	23	39	41	12	29	21	11	10
0900	47	22	25	26	12	14	21	10	11
1000	71	40	31	42	25	17	29	15	14
1100	73	44	29	46	29	17	27	15	12
1200	67	29	38	45	20	25	22	9	13
1300	74	27	47	48	15	33	26	12	14
1400	47	24	23	27	14	13	20	10	10
1500	61	30	31	33	16	17	28	14	14
1600	45	22	23	24	11	13	21	11	10
1700	57	32	25	33	20	13	24	12	12
1800	71	38	33	46	23	23	25	15	10
1900	67	36	31	44	21	23	23	15	8
2000	60	37	23	41	30	11	19	7	12
2100	44	29	15	31	22	9	13	7	6
2200	30	15	15	19	10	9	11	5	6
2300	28	10	18	20	10	10	8	0	8
Total	1,056	528	528	666	333	333	390	195	195

[a] Source: Official Airline Guide, August 15, 1993. Includes scheduled passenger and all-cargo flights. Excludes unscheduled (charter or air taxi) operations, general aviation, and military operations.

Tot. = Total
Arr. = Arrivals
Dep. = Departures

[b] Hourly intervals are for hours beginning at the time listed (i.e., the 0900 interval is from 9:00 a.m. to 9:59 a.m.).

FIGURE 3-5
HOURLY SCHEDULED OPERATIONS DISTRIBUTION
AVERAGE DAY OF PEAK MONTH (AUGUST) 1993

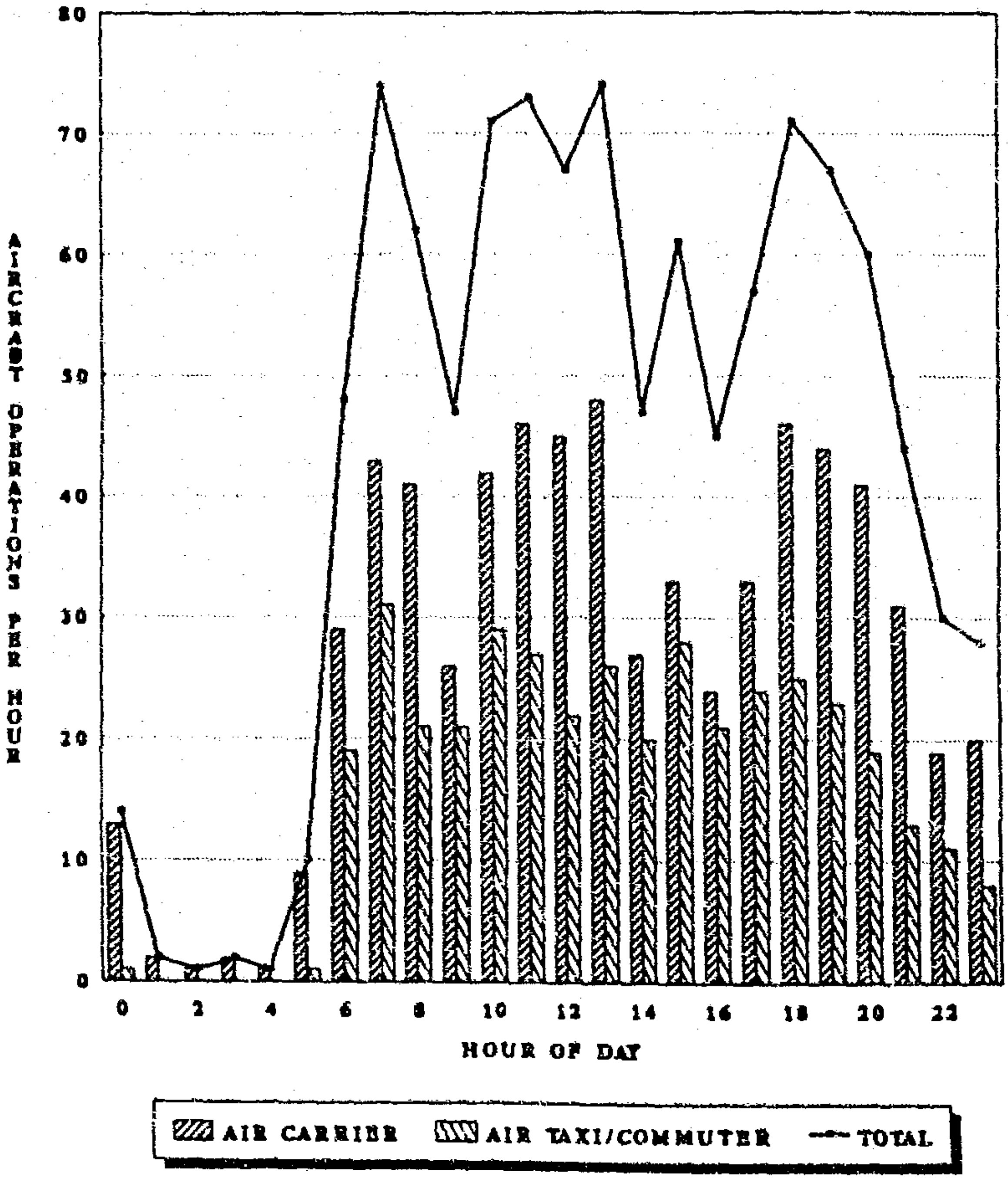


TABLE 3-15
PEAK HOUR OPERATIONS IN THE AVERAGE DAY OF THE PEAK MONTH
AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993

Item	Total Operations	Air Carrier Operations	Air Taxi (Commuter) Operations	General Aviation Operations	Military Operations
Annual Operations [a]					
Number (Thousands)	339.5	200.0	131.0	8.1	0.3
Percent of Total	100.0	58.9	38.6	2.4	0.1
Peak Month (August) Operations [a]					
Number (Thousands)	32.2	19.7	11.6	0.9	[b]
Percent of Total	100.0	61.2	36.0	2.8	[b]
Percentage of Peak Month Operations to Annual	9.5	9.9	8.9	11.1	[c]
Operations on Average Day of Peak Month (ADPM) [d]	1,056	666	390	29	1
Operations in Peak Hour of ADPM [e]					
Number	76	48	26	2	0
Percent of Total	100.0	63.2	34.2	2.6	0
Percentage of Peak Hour to ADPM Operations	7.2	7.2	6.7	6.9	[c]

[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report." Although there were approximately 100 more operations in July than August of 1993, August is used as the peak month for the development of forecasts because August was the peak passenger month. The difference of 100 monthly operations represents less than one peak hour flight and is therefore insignificant for purposes of this analysis.

[b] Value is rounded to zero.

[c] Not applicable.

[d] Sources: Table 3-14 (for airline operations) and August values divided by 31 (for general aviation and military).

[e] Sources: Official Airline Guide data for August 1993 (air carrier and commuter) and FAA Air Traffic Control Tower data (general aviation and military).

TABLE 3-16
ENPLANED PASSENGERS PER PASSENGER DEPARTURE AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1970 TO 1993

Year	Enplaned Passengers [a] (Thousands)	Revenue Passenger Departures (Thousands) [a]	Enplaned Passengers per Revenue Passenger Departure
1970	2,352	52 [b]	45.2
1971	2,370	56 [b]	42.3
1972	2,395	53 [b]	45.2
1973	2,589	62 [b]	41.8
1974	2,863	65 [b]	44.0
1975	3,039	66 [b]	46.0
1976	3,382	69 [b]	49.0
1977	3,626	74 [b]	49.0
1978	4,150	76 [b]	54.6
1979	4,879	83 [b]	58.8
1980	4,578	86 [b]	53.2
1981	4,536	84 [b]	54.0
1982	4,609	77.9	59.2
1983	5,009	87.6	57.2
1984	5,167	92.9	55.6
1985	5,683	98.6	57.6
1986	6,811	112.8	60.4
1987	7,249	127.2	57.0
1988	7,314	136.6	53.5
1989	7,732	149.1	51.9
1990	8,226	159.6	51.5
1991	8,294	154.2	53.8
1992	8,979	158.8	56.5
1993	9,385	156.4	60.0

[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report" and "Aircraft Landings Summary."

[b] Source: Estimated by P&D Aviation from total airline departures.

TABLE 3-17
AIRCRAFT FLEET MIX SERVING SEATTLE-TACOMA INTERNATIONAL AIRPORT, AVERAGE DAY OF AUGUST 1993 [a]

Seat Capacity and Aircraft Type (Typical Seats at Sea-Tac) [b]	Departures in the Average Day of August, 1993	
	Number	Percent
Air Taxi/Commuter Passenger Aircraft (60 Seats or Less)		
Under 10 Seats		
All Types (8)	16	8.6
11 to 20 Seats		
British Aerospace J31 (19)	45	24.2
Fairchild (Swearingen) Metro (19)	35	18.8
21 to 60 Seats		
Boeing Canada DHC-8 (39-45)	87	46.8
Shorts 360 (36)	3	1.6
Total Air Taxi/Commuter	186	100.0
Air Carrier Passenger Aircraft (Over 60 Seats)		
61 to 90 Seats		
Fokker F28 (65)	19	6.0
Subtotal	19	6.0
91 to 120 Seats		
Boeing B737-200 (109)	6	1.9
Boeing B737-500 (108)	9	2.8
Subtotal	15	4.7
121 to 170 Seats		
Airbus A320 (148-150)	8	2.5
Boeing B727-200 (147-163)	39	12.3
Boeing B737-300 (128)	55	17.4
Boeing B737-400 (136)	23	7.3
McDonnell-Douglas MD-80 (132-144)	75	23.7
Subtotal	200	63.1
171 to 240 Seats		
Boeing B757-200 (182-190)	40	12.6
Boeing B767-200 (197-204)	4	1.3
Subtotal	44	13.9

TABLE 3-17
AIRCRAFT FLEET MIX SERVING SEATTLE-TACOMA INTERNATIONAL AIRPORT, AVERAGE DAY OF AUGUST 1993 [a]

Seat Capacity and Aircraft Type (Typical Seats at Sea-Tac) [b]	Departures in the Average Day of August, 1993	
	Number	Percent
Air Carrier Passenger Aircraft (Over 60 Seats) (Continued)		
<u>241 to 350 Seats</u>		
Airbus A300 (257)	5	1.6
Boeing B767-300 (206-254)	5	1.6
Lockheed L1011 (302)	7	2.2
McDonnell-Douglas DC10 (271-296)	18	5.7
Subtotal	35	11.0
<u>Over 350 Seats</u>		
Boeing B747 (404)	2	0.6
McDonnell-Douglas MD-11 (245)	2	0.6
Subtotal	4	1.3
Total Air Carrier	317	100.0
Total Air Carrier and Air Taxi/Commuter	503	-
All-Cargo Aircraft		
Small All-Cargo Aircraft (Under 60,000 lbs. gross weight) Cessna, Piper, Metro, DC-3, Convair	9	36.0
Medium All-Cargo Aircraft (60,000 to 250,000 lbs. gross weight) Electra, B737F, B727F, DC-9F	10	40.0
Large All-Cargo Aircraft (Over 250,000 lbs. gross weight) DC8F, DC10F, B747-200F, B747-400F	6	24.0
Total All-Cargo	25	100.0

[a] Source: Developed by P&D Aviation from data from <u>Official Airline Guide</u>, August 15, 1993.

[b] Some aircraft, especially aircraft operated in international service, may be configured with significantly fewer seats than the maximum capacity.

Section 4
AIR SERVICE MARKET

SECTION 4
AIR SERVICE MARKET

In this section, the demographic and economic characteristics of the local air service area are described. The top city markets served by the airport are identified, and airlines with the greatest market share at the airport are discussed.

AIR SERVICE AREA

Identification of Primary Air Service Area

The primary local area which the airport serves is generally considered to be the four-county central Puget Sound region. This local air service area consists of King, Kitsap, Pierce and Snohomish Counties. In 1993, the region had a population of 2.95 million and employed 1.58 million persons.

Economic Base of the Region (1)

The demand for air service in a region is directly tied to the region's economy. The discussion which follows describes the current economic base of the central Puget Sound region and its prospects for growth.

The Economic Base. Two categories of industries make up a region's economy: the "basic" sector, which exports goods and services outside the immediate regional area, and the "non-basic" sector, which produces goods and services which are consumed within the local economy. Growth of basic sector industries is crucial for generating new employment, income, and sales by injecting new funds into the local economy, and through multiplier effects (supplemental income and employment generated). By definition, basic industries are driven by forces outside the region, usually beyond the control of local government or firms.

While the region has a rich fabric of ties to distant markets, many of its basic industries continue to function as suppliers of goods and services to communities in the Pacific Northwest. Exports of consumer and business services, and of goods sold through wholesalers located within the region, are traded to outside communities through distribution channels in the central Puget Sound region.

Forest products, pulp, paper, aircraft, ships, and seafood products are recognized as the traditional components of the region's "economic base" (Table 4-1). Several services, such as transportation, engineering, and finance, are also exported and thus considered base industries. Finally, an increasing share of software and durable goods is exported, making these industries significant contributors to the economic base.

Three Fortune 500 manufacturing companies are headquartered in the region: Boeing, PACCAR, and Weyerhaeuser. The economy's strong service base is reflected in the number of Fortune 500 service companies headquartered in the region, including Safeco Financial, Washington Mutual Savings & Loan Association, Microsoft, Nordstrom, Costco Wholesale, Alaska Air Group, Airborne Freight, and Univar.

Although the region's economic base is strong, it is highly concentrated in the aerospace industry.

Aerospace Industry. Aerospace is the largest

TABLE 4-1
BASIC SECTOR EMPLOYMENT OF THE CENTRAL PUGET SOUND REGION, 1970-1990 [a]

Industry	1970		1980		1990	
	Employment [b] (Thousands)	Percent of Basic	Employment [b] (Thousands)	Percent of Basic	Employment [b] (Thousands)	Percent of Basic
Resources	3.8	1.0	4.2	1.0	3.2	0.6
Construction	5.2	1.4	7.5	1.8	11.4	2.1
Manufacturing	179.9	48.3	197.4	47.7	239.3	43.6
Transportation, Commun/Utilities	18.8	6.5	31.2	7.5	40.1	7.3
Retail and Wholesale Trade	32.0	11.8	65.2	15.7	90.6	16.5
Finance, Insurance, Real Estate	8.5	3.6	21.4	5.2	28.1	5.1
Producer Services	5.8	2.7	24.0	5.8	50.2	9.1
Personnel Services	3.7	1.5	8.1	2.0	12.4	2.3
Federal-Military	51.0	20.5	42.0	10.1	57.2	10.4
State/Local	5.6	2.7	13.0	3.1	16.6	3.0
Total	263.8	100.0	413.9	100.0	549.1	100.0

[a] Source: Puget Sound Regional Council, Foundations for the Future, An Economic Strategy for the Central Puget Sound Region, Volume One, An Economic Profile: Our Jobs, People and Resources, October 1993.

[b] Employment shown in this table includes only "basic sector employment." Basic employment is that portion of an industry's employment which corresponds to its output sold outside the region. Total employment for the Central Puget Sound Region in 1990 was 1,546,000 of which 549,100 was basic sector employment.

private manufacturing industry in the central Puget Sound region, leading the region and nation in dollar value of exports. In 1990, the industry employed 115,300 employees locally, accounting for 44.7 percent of the area's total manufacturing jobs and 8.4 percent of total employment. For the central Puget Sound region, the industry's 1990 job level was its highest in 30 years. Every aerospace job directly and indirectly supports about 3.14 jobs regionwide. This job multiplier is the highest of any of the region's industries, and represents 363,000 direct and indirect jobs. Overall, more than one in five jobs in the region can be attributed to the aerospace industry.

The Boeing Company is the dominant employer with a work force comprising about 90 percent of all aerospace workers in this region. Boeing leads the world's aerospace industry with a market share of 61 percent. Based on an export-sales ratio of 46.3 percent, Boeing is also the nation's most export-intensive company.

The Boeing Company holds a unique position nationally and even internationally for its dominance of a major metropolitan labor market. The auto industry has a very large presence in Detroit and Cleveland; however, none of the individual auto makers has a concentrated share of the local labor market that is close to Boeing's share of the central Puget Sound region's employment base.

Periodically, this industry goes through serious cyclical downturns. From 1968 to 1971, Boeing's employment declined almost 60 percent, from 104,200 to 42,500 jobs. The cuts in production in 1975-76, and in the early 1980s also resulted in a substantial drop in employment during those same time periods. The fourth cycle is occurring now. At the beginning of 1993, the Boeing Company employed 132,700 company-wide and 98,600 in the Puget Sound region. In February 1993, the company announced that 23,000 jobs would be cut over the next 18 months (including 19,000 in the central Puget Sound region). At the end of 1993, Boeing employed 116,200, with 87,200 in the Puget Sound region. Boeing currently expects company-wide job losses in 1994 to total 7,000, all of which are expected in the Puget Sound region, which is consistent with Boeing projections made in February 1993.

Industry Trends. Long term aerospace employment in the central Puget Sound region will be affected by several factors. They include the possibility that future aircraft models may be assembled elsewhere, and the likelihood that they will require less labor per unit produced due to cost reduction and quality control initiatives at Boeing. New production partnerships could emerge from research and development efforts currently underway, with the effect of reducing the local labor content of future Boeing aircraft. (Boeing may contract for super-jumbo aircraft with Airbus, the European consortium, and Japanese firms, and for a supersonic passenger aircraft with McDonnell-Douglas.) Imports of aircraft components have been increasing gradually. This reflects the industry's changing production process, which involves more collaboration with foreign manufacturers in order to share the high cost and risk of developing new airplanes and to gain access to foreign markets. Japanese manufacturers will supply an estimated 20 percent of the Boeing 777's components, constraining future employment growth in the aerospace industry in this region. The lessening of worldwide tension will further contribute to a continued decline in the purchase of defense-related aerospace products.

Although aerospace is the largest private manufacturing industry in the region and the largest exporter by dollar value in both the region and the nation, drops in aerospace employment are not necessarily followed by a decline in other sectors. In fact, the impact of aerospace layoffs may be buffered somewhat by a surge in high technology startups.

The strong, long-established sectors of the economy are enhanced by a number of emerging enterprises, including environmental industries, and advanced technologies such as computer and software, microelectronics, communications, biotechnology, medical technology, and new materials. These growing sectors have a substantial and increasing importance in trade and provide benefits in increased productivity, technology development, and high-wage job creation. Microsoft, which is headquartered in the Seattle area, is one example of an advanced technology firm in the computer industry.

Regional Population and Employment Growth. Population growth (See Puget Sound Regional Council 1991 Projections in Table 4-2) is expected to be slower between 1990 and 2010 (32 percent) than in the past two decades (42 percent). In 1991 the Puget Sound Regional Council forecasted that growth in the region's population will approach 900,000 from 1990 to 2010, with over 60 percent of this growth occurring by the year 2000. Employment growth is also projected to be slower between 1990 and 2010 (38 percent) than in the past two decades (89 percent), but slightly greater than the population growth forecast for the same period. The region is expected to gain 550,000 jobs from 1990 to 2010, with nearly 57 percent of this growth occurring by the year 2000.

These forecasts are based on the assumption of a Boeing employment level of 100,000 in the Puget Sound region. However, Boeing's Puget Sound employment, which was 98,600 at the beginning of 1993, is projected to fall to about 80,000 by the end of 1994. To account for the employment reductions by Boeing and other economic conditions, alternate projections of population, employment and personal income were developed by P&D Aviation from recent projections supplied by Dick Conway Associates (see Alternate Projections in Table 4-2). These alternate projections are based on the current aerospace downturn having long-term impacts on the economic base of the region.

MARKETS SERVED

Cities with Scheduled Non-stop Service

In August 1993, 59 cities had scheduled non-stop passenger service with at least four flights per week from Seattle-Tacoma International Airport (Table 4-3). Principal international markets served are Copenhagen, London, Tokyo, Vancouver and Victoria. The greatest non-stop distance flown is to Copenhagen, 4,868 miles.

Domestic cities having the greatest airline competition for service from Seattle are Portland (9 carriers), Anchorage (7 carriers) and Los Angeles (6 carriers). Most of the Horizon Airlines flights are code-shared by both Alaska Airlines and Northwest Airlines.

Top Origination and Destination Cities.

The top 30 domestic origin and destination markets for Sea-Tac are listed in Table 4-4. These 30 markets represent about 72 percent of total domestic origination and destination passengers at the airport and 48 percent of total airport passengers. Origin and destination passengers are passengers whose origin or destination airport is Sea-Tac, and do not include connecting passengers. The top 10 origin and destination markets account for approximately 45 percent of Sea-Tac origin and destination traffic. The top origin and destination market is Los Angeles, with over 10 percent of the Sea-Tac market share.

TABLE 4-2
POPULATION, INCOME AND EMPLOYMENT IN THE PUGET SOUND REGION, 1970 TO 2020

Year	July 1 Population (Thousands)	Personal Income (Millions of 1982 Dollars)	Per Capita Personal Income (1982 Dollars)	Total Employment (Thousands)	Unemployment Rate
Actual [a]					
1970	1,937	20,261	10,354	803	9.4
1971	1,937	19,811	10,106	759	11.9
1972	1,908	20,207	10,480	755	10.5
1973	1,913	21,291	11,063	797	7.8
1974	1,946	21,737	11,146	831	6.6
1975	1,985	22,661	11,373	848	9.5
1976	2,007	24,020	11,897	873	8.9
1977	2,043	25,290	12,269	924	8.5
1978	2,104	27,768	13,082	1,007	6.2
1979	2,173	29,629	13,559	1,085	5.7
1980	2,255	30,414	13,450	1,111	6.6
1981	2,306	30,987	13,443	1,121	8.1
1982	2,331	30,929	13,269	1,107	10.6
1983	2,348	31,212	13,206	1,121	10.0
1984	2,376	32,438	13,539	1,173	8.1
1985	2,418	33,770	13,813	1,221	6.8
1986	2,465	35,377	14,101	1,266	6.8
1987	2,526	36,547	14,196	1,333	6.4
1988	2,602	38,327	14,465	1,405	5.1
1989	2,686	40,677	14,883	1,483	4.9
1990	2,770	42,013	14,917	1,546	4.3
1991	2,844 [b]	42,866 [c]	15,072 [c]	1,554 [c]	5.1 [b]
1992	2,900 [b]	44,255 [c]	15,260 [c]	1,573 [c]	6.5 [b]
1993	2,952 [b]	44,338 [c]	15,020 [c]	1,580 [c]	7.0 [b]
PSRC 1991 Projections [d]					
2000	3,277	53,950	16,406	1,876	6.2
2010	3,616	66,804	18,440	2,127	6.0
2020	3,963	80,863	20,364	2,326	5.7
Alternate Projections [e]					
2000	3,167	51,000	16,100	1,799	6.5
2010	3,495	63,200	18,100	2,040	6.0
2020	3,830	76,400	19,900	2,231	5.7

[a] Source: Puget Sound Regional Council, from U.S. Bureau of Economic Analysis data.
[b] Source: Dick Conway and Associates.
[c] Estimated from data furnished by Dick Conway and Associates.
[d] Source: Puget Sound Regional Council, "PSCOG 1991 Regional Forecasts," July 1991. Forecasts are "STEP 91" baseline projections.
[e] Revised by P&D Aviation based on data furnished by Dick Conway and Associates to account for the recent downward trend in employment in the Puget Sound Region, especially in the aircraft manufacturing industry.

TABLE 4-3
CITIES WITH SCHEDULED NON-STOP PASSENGER SERVICE
FROM SEATTLE-TACOMA INTERNATIONAL AIRPORT,
AUGUST 1993 [a]

City Code	City	Distance	Airline Code [b]	Aircraft Type
ANC	Anchorage, AK	1,448	AS BF CO DL KN NW UA	B737, B727, MD80 B737 MD80 B757 B737 B757 B737
ATL	Atlanta, GA	2,181	DL	B757
BLI	Bellingham, WA	94	HZ UA	DHC-8 J31
BOI	Boise, ID	399	HZ KN	F28 B737
BOS	Boston, MA	2,495	KL NW	B757 B757
BUR	Burbank, CA	937	AS	MD80
CLT	Charlotte, NC	2,279	US	B737
ORD	Chicago (O'Hare), IL	1,736	AA UA	B757, B727, DC10, MD80 B737, B757, B727, DC10
CVG	Cincinnati, OH	1,971	DL	B757
CLE	Cleveland, OH	2,020	CO	B737
CPH	Copenhagen, Denmark	4,868	SK	B767
DFW	Dallas-Ft. Worth, TX	1,676	AA DL	B757, B727, DC10, MD80 B757, B767, B727
DEN	Denver, CO	1,019	BF CO UA	B737 A300, MD80 B737, B757, B727, DC10
DTW	Detroit, MI	1,937	KL NW	B757 B757, B727, DC10
EUG	Eugene, OR	234	HZ UA	DHC-8, SWM J31
FAI	Fairbanks, AK	1,533	AS	B727
FRD	Friday Harbor, WA	82	HG	Piper

TABLE 4-3
CITIES WITH SCHEDULED NON-STOP PASSENGER SERVICE FROM SEATTLE-TACOMA INTERNATIONAL AIRPORT, AUGUST 1993 [a]

City Code	City	Distance	Airline Code [b]	Aircraft Type
HNL	Honolulu, HI	2,677	HA NW UA	L1011 DC10 DC10
HQM	Hoquiam, WA	84	EM	SWM
IAH	Houston (Intercontinental), TX	1,892	CO	A300, MD80
JNU	Juneau, AK	909	AS DL	B737, B727, MD80 B727
MCI	Kansas City, MO	1,501	US	B737
KTN	Ketchikan, AK	677	AS	B737
LAS	Las Vegas, NV	866	AS BF HP	B727 B737 A320, B737
LWS	Lewistown, ID	260	HZ	DHC-8, SWM
LHR	London (Heathrow), England	4,806	BA UA	B767 B767
LAX	Los Angeles, CA	955	AS BF DL KN NW UA	B737, MD80 B737 B757, B727 B737 A320 B737, B727
MEM	Memphis, TN	1,870	NW	A320, B737
MIA	Miami, FL	2,724	AA	B767
MSP	Minneapolis-St. Paul, MN	1,398	KL NW	DC10 B747, B757, B727, DC10
MWH	Moses Lake, WA	145	HZ	SWM
JFK	New York (J.F. Kennedy), NY	2,408	AA TW UA	B767 L1011 B757
EWR	Newark, NJ	2,408	CO	A300
ODW	Oak Harbor, WA	59	HG	Piper

TABLE 4-3
CITIES WITH SCHEDULED NON-STOP PASSENGER SERVICE FROM SEATTLE-TACOMA INTERNATIONAL AIRPORT, AUGUST 1993 [a]

City Code	City	Distance	Airline Code [b]	Aircraft Type
OAK	Oakland, CA	672	AS KN UA	MD80 B737 B737
ONT	Ontario, CA	956	AS	MD80
SNA	Orange County, CA	979	AA AS	MD80 B737, MD80
PSC	Pasco, WA	172	HZ UA	DHC-8, SWM J31
PHL	Philadelphia, PA	2,378	US	B757
PHX	Phoenix, AZ	1,106	HZ HP	MD80 A320
PIT	Pittsburgh, PA	2,138	US	B737, B757
CLM	Port Angeles, WA	73	HZ	DHC-8, SWM
PDX	Portland, OR	130	AS HZ BF CO DL KN NW TW UA	B737, MD80 DHC-8, F28 B737 MD80 B757, B767 B737 B757 L1011 J31
PUW	Pullman, WA	249	HZ	DHC-8
RNO	Reno, NV	563	AS HP QQ	B727 A320, B737 MD80
SMF	Sacramento, CA	605	AS UA	MD80 B737, B727
SLC	Salt Lake City, UT	689	DL KN	B767, B727, L1011 B737
SAN	San Diego, CA	1,050	AS UA	B737, MD80 B737
SJC	San Jose, CA	697	AS KN QQ	B727, MD80 B737 MD80

TABLE 4-3
CITIES WITH SCHEDULED NON-STOP PASSENGER SERVICE FROM SEATTLE-TACOMA INTERNATIONAL AIRPORT, AUGUST 1993 [a]

City Code	City	Distance	Airline Code [b]	Aircraft Type
SFO	San Francisco, CA	679	AS BF QQ UA	MD80, B737, B727 B737 MD80 B737, B757, B727, DC10
GEG	Spokane, WA	223	HZ KN UA	DHC-8, F28 B737 J31
STL	St. Louis, MO	1,722	TW	MD80
NRT	Tokyo (Narita), Japan	4,797	AA NW	MD11 B747
YVR	Vancouver, BC	126	AC HZ CP UA	DHC-8 DHC-8 SH360 B737, B757, B727, DC10
YYJ	Victoria, BC	98	HZ	DHC-8, SWM
ALW	Walla Walla, WA	211	HZ	SWM
IAD	Washington (Dulles), D.C.	2,327	UA	B757, DC10
EAT	Wenatchee, WA	99	HZ	DHC-8, SWM
YKM	Yakima, WA	103	HZ UA	DHC-8, SWM J31

[a] Source: Official Airline Guide, August 15, 1993. Includes only service with at least four flights per week.

[b] Airline codes are:

AA	American Airlines	HP	America West Airlines
AC	Air Canada	HZ	Horizon Airlines
AS	Alaska Airlines	KL	KLM-Royal Dutch Airlines
BA	British Airways	KN	Morris Air
BF	Mark Air	NW	Northwest Airlines
CO	Continental Airlines	QQ	Reno Air
CP	Canadian Airlines	SK	Scandanavian Airlines System (SAS)
DL	Delta Airlines	TW	TransWorld Airlines
HA	Hawaiian Airlines	UA	United Airlines
HG	Harbor Airlines	US	US Air

Most flights by Horizon Airlines are code-shared by Alaska Airlines and Northwest Airlines.

TABLE 4-4
TOP THIRTY DOMESTIC ORIGIN AND DESTINATION MARKETS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1992 [a]

1992 Rank	City/Metropolitan Area	Origin and Destination Passengers	Market Share
1	Los Angeles (Burbank, LAX, Long Beach, Ontario)	1,162,820	10.1%
2	Bay Area (San Francisco, Oakland, San Jose)	998,950	8.7%
3	Hawaiian Islands	515,310	4.5%
4	New York/Newark	467,650	4.1%
5	Anchorage	454,180	4.0%
6	Chicago	391,030	3.4%
7	Portland	318,550	2.8%
8	Denver	295,790	2.6%
9	Phoenix	291,150	2.5%
10	Washington, D.C.	289,400	2.5%
11	San Diego	287,750	2.5%
12	Orange County, CA	246,960	2.1%
13	Dallas/Fort Worth	235,680	2.0%
14	Minneapolis/St. Paul	228,010	2.0%
15	Spokane	225,060	1.9%
16	Las Vegas	210,780	1.8%
17	Boston	206,940	1.8%
18	Reno	206,000	1.8%
19	Oakland	193,150	1.7%
20	Atlanta	173,400	1.5%
21	Detroit	165,650	1.4%
22	Orlando	153,290	1.3%
23	Houston	135,370	1.2%
24	Sacramento	121,220	1.1%
25	Miami	121,200	1.1%
26	Philadelphia	114,850	1.0%
27	Burbank	106,080	0.9%
28	St. Louis	103,930	0.9%
29	Juneau	98,950	0.9%
30	Kansas City	86,380	0.8%

[a] Source: Seattle-Tacoma International Airport, Airport Activity Report, 1992 (developed from data from Back Information Services). The top 30 domestic origin and destination (O&D) markets represent about 72 percent of total domestic O&D passengers at Sea-Tac. O&D data does not include connecting passengers.

AIRLINE MARKET SHARE

In 1992, 29 scheduled and 12 charter airlines provided passenger service at the airport. Three airlines (United, Alaska and Northwest) carried over half of the passengers in 1992 (Table 4-5). The airport is not dominated by any single airline and is not used by any airline as a central hub in a hub-and-spoke system. However, Alaska Airlines is headquartered in Seattle and relies on Horizon Airlines for feeder service from many smaller surrounding cities.

FOOTNOTES

[1] This section has been taken from a report titled, Foundations for the Future, an Economic Strategy for the Central Puget Sound Region, Volume I, an Economic Profile: Our Jobs, People and Resources, prepared by the Puget Sound Regional Council in October 1993.

TABLE 4-5
AIRLINES RANKED BY PASSENGER TRAFFIC
SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1992 [a]

1992	Airline	1991 Rank	Enplaned and Deplaned Passengers	Percent of Total
	Domestic Passengers			
1	United	(1)	3,520,202	21.4%
2	Alaska	(2)	3,279,822	19.9%
3	Northwest	(3)	1,829,722	11.1%
4	Delta	(4)	1,487,870	9.0%
5	American	(5)	1,364,186	8.3%
6	Horizon	(6)	1,229,950	7.5%
7	Continental	(7)	740,885	4.5%
8	US Air	(8)	548,606	3.3%
9	America West	(9)	531,050	3.2%
10	TWA	(10)	447,793	2.7%
11	United Express	(11)	316,383	1.9%
12	Markair	N/A	260,960	1.6%
13	Hawaiian	(12)	198,341	1.2%
14	Sierra Pacific	(13)	157,280	1.0%
15	Reno Air	N/A	132,581	0.8%
	Other		426,884	2.6%
	TOTAL DOMESTIC		16,462,515	100.0%
	INTERNATIONAL PASSENGERS			
1	United	(1)	302,521	20.8%
2	Northwest	(2)	261,385	17.4%
3	Horizon	(3)	235,788	15.7%
4	Air BC	(4)	129,559	8.6%
5	American	(12)	123,452	8.2%
6	Scandinavian	(5)	102,248	6.8%
7	British Airways	(9)	82,834	5.5%
8	Alaska	(10)	75,283	5.0%
9	Time Air	(7)	[illegible],919	4.1%
10	Thai	(6)	[illegible]5,390	3.7%
11	Japan Air	(11)	22,974	1.5%
12	Charters (Misc.)	N/A	17,422	1.2%
13	Martinir Holland	(13)	16,947	1.1%
14	Aeromexico	N/A	5,364	0.5%
15	Aerocancun	(14)	4,108	N/A
	Other		2,508	N/A
	TOTAL INTERNATIONAL		1,449,702	100.0%
TOTAL DOMESTIC AND INTERNATIONAL			17,962,217	

[a] Source: Seattle-Tacoma International Airport, Airport Activity Report, 1992.

Section 5
AVIATION DEMAND FORECASTS

SECTION 5
AVIATION DEMAND FORECASTS

INTRODUCTION

This section describes the methodology and results of the development of aviation forecasts for Seattle-Tacoma International Airport. Activity at the airport was projected for the years 2000, 2010 and 2020. Forecasts were prepared for three elements of airport activity: air passengers, air cargo, and aircraft operations (takeoffs and landings).

Purpose

These forecasts have been prepared as an element of the Airport Master Plan Update to be used to develop airport facility requirements and to estimate the timeframes when future improvements are needed. These forecasts will also be considered in estimating aircraft noise impacts and other impacts related to airport activity.

The objective of the forecast task is to develop updated master plan forecasts which can account for a range of potential future airport scenarios and provide a sound basis for guiding the development of future facility improvements at the airport. Accordingly, the forecasts presented here are planning-level estimates and are not intended to be exact predictions. It is anticipated that these forecasts will be updated in several years in response to changing conditions, such as the national or local economy or the aviation industry.

Forecast Approach

Based on past experience in the development of forecasts for Sea-Tac Airport, as well as other large commercial airports, the approach to preparing updated forecasts included the following strategies:

- A multiple regression analysis forecast model similar to the one used for Flight Plan Phase I was used to prepare new forecasts. Updated data was used, including estimated data for 1993. In addition to using proven causal factors in the model (such as population, personal income and average air fares), other potentially relevant factors which are believed to influence aviation demand were examined.

- The forecast approaches were based on data from 1970 to 1993 (more than twenty years of historical data) to account for long term cycles in the airline industry and the economy.

- Alternative forecast approaches were developed as a check against the primary forecast methodology. Alternative approaches were generally based on aggregate, or top down, methods such as historical trend extrapolations and share of the market.

- Upper, lower and mid-range forecasts were prepared to bracket the possible range of future activity at the airport.

- In this preliminary report these forecasts represent unconstrained demand. No Sea-Tac demand is allocated to supplemental airports. In future documentation for the Airport Master Plan Update, the following scenarios will be considered, and the affect of each on the airport forecasts will be determined:

  - Allocation of some air passenger demand to one or more supplemental airports. Allocation of passengers to supplemental airports will be done in coordination with the Puget Sound Regional Council's (PSRC) Major Supplemental Airport Feasibility Study.

- Demand management techniques.
- Potential diversion of air passengers to high speed rail transportation.

■ The forecasts consider the effects of emerging trends such as the airport share of the Pacific Rim market, new technologies, potential diversion of all-cargo flights, changing governmental policies, and other factors raised during the Port-sponsored Business Planning Meetings conducted in October 1993.

INFLUENCES ON AIRPORT DEMAND

Many factors influence the demand for aviation traffic (passengers and aircraft operations) at an airport. Some of these factors are global in nature, some related to the national economy, and some locally-related. The following discussion addresses the primary factors which are likely to affect aviation demand at Sea-Tac.

Obviously the forecast methodology can not directly account for all of these factors. Instead, the forecast techniques used here apply the factors which have been found to have the most direct influence on airport demand and are quantifiable. These factors tend to have a proven historical relationship with aviation demand.

Local Factors

Local factors affecting aviation demand at Sea-Tac include:

■ The economy of the airport's service area. Such factors as population, employment, income, and gross regional or state product are gross measures which are directly related to the amount of business and personal flying. These factors are quantifiable and were examined and tested in the development of forecast models.

■ Changes in carrier service. The addition or withdrawal of carrier service can have a significant influence on the airport's demand. For example, the new service by Southwest Airlines is expected to provide a stimulus to overall passenger demand because of the low fare structure of Southwest. It is difficult to predict whether the entry of Southwest at Sea-Tac will have a long term effect on passenger demand. It is assumed that the prediction model used to forecast passenger demand accounts for long-term effects of competitive pricing by airlines because the model considers trends in passenger demand and airline fares from 1970 through 1993. This model also considered projected air fares to the year 2020.

It appears that the entry of Morris Air, a low-fare subsidiary of Southwest Airlines, was at least partially responsible for the increased growth in passengers during the last half of 1993. The forecast model for projecting domestic enplanements, described later in this section, was used to project 1993 domestic enplanements. The model produced a projection of 8.5 million domestic enplanements, compared with an actual of 8.7 million. Some of the 200,000 enplanement difference might be explained by the entry of Morris Air in 1993. Morris Air's total 1993 enplanements were 456,000.

■ Competing Airports. Sea-Tac competes with other airports within some segments of aviation demand, particularly for international flights. Vancouver, British Columbia and San Francisco have international service which competes with Sea-Tac. Recently United Airlines has elected to concentrate its international flights on the west coast at Los Angeles International and San Francisco International Airports. If new large aircraft (seating 600 to 800 passengers) became significantly more economic for airlines than existing widebodies on international flights, a tendency for further concentration could result.

Also more nonstop international flights are now made from non-seaboard airports such as Dallas-Fort Worth, Denver and Chicago. The competitive position of Sea-Tac depends to some degree on the availability of facilities at Sea-Tac compared to competing airports.

National Factors

Nation-wide factors affecting air transportation demand include:

- National Economy. The overall condition of the national economy, as measured by such factors as gross national product and the rate of unemployment, affect air transportation demand throughout the country.

- Domestic Air Fares. Air fares in real dollars (adjusted for inflation) have decreased from 1970 to 1992. The FAA projects that U.S. air fares will begin to increase in real dollars in 1992. The passenger forecast models account for average U.S. air fares but do not account for local fare variances which may occur on a short-term basis.

- Technological Advances in Communications. New technologies in the telecommunication industry which could affect demand for transportation services generally, and aviation specifically, are as follows:

  - Video Conferencing,
  - Telecommuting,
  - Groupware,
  - Cordless/Cellular Telephony,
  - Wireless Networks and
  - Electronic Data Interchange.

  A study by Apogee Research described in Assessing the Impact of Telecommunications on Business and Pleasure Travel, January 7, 1994, had the following conclusions:

  > "Emerging technologies are expected to have an impact on business travel (but not on pleasure travel). However, this study concludes that while some degree of substitution for air travel is possible (up to 11 percent of all business travel, or some 4.2 percent of total travel), research to date has not documented the counteracting trend associated with use of new technologies -- increased productivity -- and the implications of that change for *additional* travel demand. In short, while a high degree of uncertainty exists, travel stimulated by productivity gains could be significant enough to offset some (if not most) of the air travel demand lost to substitution."

International Factors

Global factors affecting air travel at Sea-Tac include:

- International Economic Growth. The economic growth of regions with air travel from Sea-Tac will strongly influence future international travel. These regions and their share of the Sea-Tac international passenger market are: Canada (52%), Asia (25%), and Europe and Central and South America (23%). The Asian economy is projected to grow rapidly over the next 20 years. Trans-Pacific air travel is projected by Boeing (Current Market Outlook, World Demand and Airplane Supply Requirements, 1993) to increase at an annual rate of 8.2 percent between 1992 and 2000 compared with 4.8 percent for U.S. domestic air travel. In spite of the robust Asian air travel market, travel to Asia from Sea-Tac has declined over the past three years due, in part, to the consolidation of international flights at other cities.

- Bilateral Agreements. International airlines generally conduct operations within the framework of international bilateral agreements that control market entry, capacity, and pricing. In the United States, the State Department, with the assistance of the Department of Transportation (DOT), negotiates bilateral agreements with representatives of other countries. These agreements may specify the U.S. gateway for the airline service which such agreements contemplate. In awarding authority for new service in limited entry markets, the DOT seeks to promote a competitive environment.

  Although there is no longer an operating agreement for Hong Kong service, new airports such as Japan's new gateway, Kansai International Airport provide opportunities for new service. The North American Free Trade Agreement (NAFTA) is expected to result in fewer restrictions in air travel between the U.S. and Canada.

- International Air Fares. International air travel demand is sensitive to changes in international air fares as is domestic travel. The FAA forecasts that international air fares, in real dollars, will continue to decline to 2020.

Although some of the above factors are external, the Port is capable of influencing some of the conditions that affect demand, including the availability of needed airport facilities (such as runway length, runway capacity, terminal capacity).

EXPERT PANEL FINDINGS

In October 1993, the Port of Seattle held two business planning meetings in which expert panels were assembled to discuss the future of the air travel industry and implications for long term growth in activity at Sea-Tac. Members of the expert panels included airline industry representatives, economists, and airline industry analysts.

The following opinions were expressed by individual panel members relating to the growth of aviation activity at Sea-Tac:

- Air transportation is a maturing industry in the United States. Therefore future growth will be at a slower rate. We have not seen the end of technological improvements in communications such as teleconferencing. However, shifts in technology may or may not impact air traffic.

- Slower growth is expected in the 1990s than the 1980s. The greatest growth is expected to be in the leisure travel market. The leisure share of the market has grown from 45 percent in the mid-1980's to 63 percent today.

- Both business and leisure air travelers have become very sensitive to air travel costs, although leisure travelers are more price-conscious.

- Although big growth may not occur in the international market, continued growth is expected. Of the international markets, Asian markets are the most robust, especially China.

- Air travel will grow no faster than the general economy. The 1990s will be a time of greater price growth than volume growth for the airlines. The industry has excess system-wide capacity now. One airline reported that it will be cutting system-wide capacity by 4 percent. Airlines will put aircraft in service at locations that give them the best return.

- High labor costs and (to a lesser degree) airport costs are important factors affecting airline performance. For established airlines, labor is 35 percent of the costs. While airport-related costs are about 7 to 7.5 percent of airline costs now, they are increasing the fastest. One airline reported that, over the last 6 years, its landing fees have increased an average of 7.4 percent a year and its terminal rentals have grown at 11.5 percent a year.

- High speed rail service cannot be competitive with air travel, unless it is subsidized. A major benefit of high speed rail is its convenience, and high speed rail will not work in a suburban market.

- Airlines at Sea-Tac experience delays at peak times now. A third runway would provide additional capacity and, while costs are a concern, is generally viewed favorably by the airlines.

DOMESTIC ENPLANEMENT FORECAST

The Flight Plan Phase I forecast was prepared by developing projections of originating passengers, then estimating the number of connecting passengers to arrive at total enplanements. While this approach is logical and technically sound, it has two disadvantages.

First, hard data on originating passengers are incomplete. A 10 percent sample survey conducted by the U.S. Department of Transportation measures scheduled air carrier originations, but the data base also includes commuter carrier passengers if they travel one segment of their flight itinerary in commuter service and another segment in air carrier service. Furthermore, no reliable data are available on originating and connecting passengers for domestic commuter service and international service.

Second, under this procedure, only a portion of the passenger base is projected (i.e., originating passengers) by a statistical procedure. A significant portion of total enplaned passengers, under this procedure, must be estimated by a percentage factor.

The approach taken for this Airport Master Plan Update was to forecast enplaned passengers then disaggregate the forecasts into originating and connecting passengers. This approach resulted in measures of statistical significance which are extremely good in terms of the degree of variation in past numbers of passengers which is explained by the model.

Primary Forecast Approach

The primary forecast approach was developed using multiple regression analysis in which mathematical relationships were developed between the number of historic domestic enplaned passengers and various parameters known to influence air passenger travel. A number of such relationships were examined, based on parameters such as population, employment, and personal income in the Puget Sound region; average nationwide domestic airfares; per capita income and unemployment rate in the Puget Sound region; and gross state product for Washington. Both linear and logarithmic relationships were tested.

After analyzing dozens of potential equations, the following model was selected for the primary approach to forecasting domestic enplanements at Sea-Tac because it provides an excellent statistical relationship and is based on parameters which are known to affect air travel demand.

Ln of domestic enplaned passengers =

- 3.242
+ 1.307 x Ln of personal income in Puget Sound region (in millions 1982 dollars)
- 0.656 x Ln of domestic airfare (in 1992 cents per passenger mile)

(where Ln equals natural logarithm)

The model performed extremely well in all statistical measures and provided reasonable results when tested for the sensitivity to changes in the inputs. The coefficient of correlation (R^2) of this regression equation is 0.996, which means that 99.6 percent of the variation in enplaned domestic passengers from 1970 to 1993 can be explained with this equation.

Historic data for various parameters tested are shown in Tables 4-2 and 5-1. Projections of domestic enplanements were developed (see Table 5-2) using the income projection developed by the PSRC in 1991 and the revised income projection based on projections by Dick Conway and Associates, shown in Table 4-2.

The form of the equation used for the primary forecast approach differs somewhat from the equation used for the Flight Plan Phase I forecast. The flight plan forecast used separate parameters for population and per capita income. The primary forecast approach uses a single parameter, personal income, which is the product of population and per capita income.

Under this forecast approach, domestic enplanements would increase from 8.5 million in 1993 to 17.2 million in 2020 using the PSRC projection of income and 16.0 million in 2020 using the alternate income projection.

Alternative Approaches

Forecasts of domestic enplanements were prepared under four alternative approaches to test the reasonableness of the primary forecast approach and to provide upper and lower ranges of future domestic enplanements (Table 5-2).

Regression Analysis Using Flight Plan Parameters. Under this approach, a new regression analysis equation was developed using the socioeconomic parameters of the Flight Plan Phase I model. However this alternative approach was used to forecast enplanements, rather than originations as in the Flight Plan Phase I study. Furthermore, this alternative forecast was based on historical data from 1970 to 1993 and updated forecasts of population, per capita income and domestic airfares. The resulting equation is:

Ln of domestic enplanements passengers =

- 11.100
+ 1.805 x Ln of population of Puget Sound region (in thousands)
+ 1.650 x Ln of per capita income of Puget Sound region (in millions of 1982 dollars)
- 0.840 x Ln of domestic airfare (in 1992 cents per passenger mile)

(where Ln equals natural logarithm)

The statistical measures indicating the reliability of this equation are similar to the measures for the primary forecast approach model. This

TABLE 5-1
AVERAGE AIR FARES FOR SELECTED U.S. MARKET SEGMENTS, 1970 TO 2004 [a]

Year	Average Air Fare (1992 Cents Per Passenger - Mile)			
	Total U.S. Domestic and International	U.S. Domestic	U.S. International	U.S. to Pacific Rim
Actual				
1970	20.39	20.84	18.69	20.74
1971	20.25	20.95	17.64	17.74
1972	19.84	20.74	16.69	16.29
1973	19.54	20.34	16.75	16.94
1974	19.95	20.56	17.60	16.96
1975	19.47	19.65	18.73	17.44
1976	18.76	19.02	17.65	16.33
1977	18.83	19.10	17.66	16.91
1978	17.73	18.06	16.34	16.53
1979	16.60	17.03	14.58	14.82
1980	18.05	18.84	15.09	13.65
1981	19.23	20.26	15.16	14.26
1982	17.45	18.19	14.30	13.16
1983	16.26	16.78	14.06	13.15
1984	16.64	17.60	12.84	12.61
1985	15.37	16.14	12.19	11.68
1986	14.05	14.44	12.25	12.35
1987	13.53	13.87	12.10	12.68
1988	14.06	14.55	12.31	13.64
1989	14.11	14.84	11.76	13.33
1990	13.65	14.35	11.56	12.50
1991	13.25	13.74	11.78	12.87
1992 [b]	12.60	12.94	11.70	12.77
1993 [b]	12.79	13.25	11.62	12.69
Projected				
1995	12.74	13.25	11.50	12.54
2000	12.84	13.58	11.22	12.17
2004	12.90	13.86	11.00	11.88
2010 [c]	12.99	14.28	10.67	11.45
2020 [c]	13.14	14.98	10.12	10.72

[a] Source: Federal Aviation Administration, Forecast and Statics Branch, Office of Aviation Policy and Plans, October 1993, except as noted.
[b] Estimated.
[c] Source: P&D Aviation estimates based on a continuation of the trend projected by the FAA from 2000 to 2004.

TABLE 5-2
ALTERNATE PROJECTIONS OF DOMESTIC ENPLANEMENTS
AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020

Method	Domestic Enplanements (Millions)			
	Actual 1993 [a]	Forecast [b] 2000	2010	2020
Primary Forecast Approach				
Ln (Domestic Enplanements) vs. Ln (Income) - Ln (Domestic Airfare)				
PSRC Projected Values	8.7	10.8	13.8	17.2
Alternate Values	8.7	10.8	12.9	16.0
Alternative Forecast Approaches				
Ln (Domestic Enplanements) vs. Ln (Population) + Ln (Per Capita Income) - Ln (Domestic Airfare)				
PSRC Projected Values	8.7	10.3	12.9	15.8
Alternate Values	8.7	9.7	12.2	14.8
Updated Flight Plan Originations Model				
PSRC Projected Values	8.7	10.0	12.2	14.5
Alternate Values	8.7	9.5	11.6	13.7
Percent of U.S. Domestic	8.7	12.2	17.1	22.8
Trend of Past Sea-Tac Domestic Enplanements				
20 Year Trend	8.7	10.4	13.5	16.6
10 Year Trend	8.7	11.4	15.5	19.4

[a] Source: Port of Seattle, "Traffic and Operations Report."

[b] Source: P&D Aviation analysis.

equation was not chosen as the primary forecast approach because the addition of the third independent variable did not significantly improve the statistical reliability of the equation.

Under this alternative approach, the number of domestic enplanements projected for the year 2020 ranges from 14.8 to 15.8 million, somewhat lower than projected under the primary forecast approach.

Updated Flight Plan Originations Model. In this approach an update of the Flight Plan Phase I model was developed maintaining the original model structure but using input data from 1970 through 1993. The updated model is:

Ln of domestic air carrier originations =

- 9.019
+ 0.930 x Ln of population of Puget Sound region (in thousands)
- 1.296 x Ln of per capita income of Puget Sound region (in millions of 1982 dollars)
- 0.854 x Ln of air fare (in 1992 cents per passenger mile)

(where Ln equals natural logarithm)

Domestic air carrier originations were estimated to continue to be 72.5 percent of domestic air carrier enplanements. The results of this alternative approach are shown in Table 5-2. Under this approach, domestic enplanement projections for 2020 range from 13.7 to 14.5 million. Lower passenger projections throughout the forecast period than the projections developed in the Flight Plan Phase I study reflect the slower growth in passengers that has occurred since 1988, compared with earlier years, as well as some reduction in projected population and an increase in projected air fares.

National Market Share. In this approach, the number of Sea-Tac domestic enplanements were projected as a percentage share of U.S. domestic enplanements (Table 5-3). Domestic enplanements at Sea-Tac have increased from 1.38 percent of the U.S. in 1970 to 1.84 percent in 1993. The Sea-Tac share of the national market is projected to continue this increasing trend and grow to 1.95 percent in 2010 and 2.00 percent in 2020. When this projected market share was applied to the FAA forecast for the nation, a projection of 22.8 million domestic enplanements for Sea-Tac in the year 2020 resulted (Table 5-2). The relatively high projection under this forecast approach reflects the aggressive nationwide growth projection by the FAA in spite of relatively flat performance over the past seven years, as well as the estimated continuation in the upward trend of the Sea-Tac market share.

Sea-Tac Domestic Enplanement Trends. Under this approach, past trends of domestic passenger enplanements were projected on a straight-line basis to the year 2020. Two trend projections were made: one based on domestic enplanements for the past twenty years and another based on domestic enplanements over the past ten years. The result of this approach is a range of domestic enplanements in the year 2020 from 16.6 million to 19.4 million (Table 5-2).

Forecast Results

The primary forecast approach based on the PSRC projected values was chosen as the mid-range forecast for the Airport Master Plan Update. This approach is based upon population and economic factors forecasted by the Puget Sound Regional Council in 1991 and assumes a slightly greater rate of growth for the Puget Sound population and income than projected using data from Dick Conway and Associates, which considers the current cutbacks

TABLE 5-3
DOMESTIC AND INTERNATIONAL ENPLANEMENTS, PERCENT SHARE OF UNITED STATES
1970 to 1993

Year	Domestic Enplanements			International Enplanements		
	U.S. [a] (Millions)	Sea-Tac [b] (Thousands)	Sea-Tac % of U.S. [c]	U.S. [a] (Millions)	Sea-Tac [b] (Thousands)	Sea-Tac % of U.S. [d]
Actual						
1970	156.9	2,162	1.38	14.5	190	1.31
1971	153.0	2,196	1.44	17.0	175	1.03
1972	164.5	2,208	1.34	18.4	187	1.02
1973	178.4	2,319	1.30	19.0	270	1.42
1974	189.5	2,547	1.34	18.6	316	1.70
1975	184.9	2,733	1.48	17.0	306	1.80
1976	195.1	3,065	1.57	16.7	317	1.90
1977	216.6	3,296	1.52	17.6	330	1.89
1978	246.7	3,815	1.55	20.0	336	1.68
1979	291.7	4,497	1.54	23.6	383	1.62
1980	287.9	4,118	1.43	24.1	461	1.91
1981	274.7	4,070	1.48	21.2	466	2.20
1982	286.1	4,243	1.48	19.7	365	1.85
1983	308.2	4,593	1.49	21.1	416	1.97
1984	334.0	4,709	1.41	23.3	458	1.97
1985	370.1	5,204	1.41	24.6	479	1.95
1986	404.7	6,243	1.54	24.6	568	2.31
1987	441.2	6,629	1.50	29.4	620	2.11
1988	441.2	6,640	1.50	34.3	674	1.97
1989	443.6	6,971	1.57	36.8	761	2.07
1990	456.6	7,341	1.61	41.3	885 [e]	2.14 [e]
1991	447.3	7,326	1.68	39.7	768	1.93
1992	461.0	8,234	1.79	42.6	725	1.70
1993	472.0 [f]	8,700	1.84	46.5 [f]	685	1.47
Projected						
2000	644.5	12,200	1.90	73.6	1,470	2.0
2010	876.9	17,100	1.95	117.9	2,360	2.0
2020	1,141.3	22,800	2.00	162.1	3,240	2.0

[a] Sources: Federal Aviation Administration, FAA Aviation Forecasts, February 1993 and earlier editions (actual data); Federal Aviation Administration, FAA Long Range Aviation Forecasts, September 1993 (projected domestic data); Federal Aviation Administration, FAA Aviation Forecasts, February 1993 (projected international data to 2004). Projected international U.S. enplanements were extrapolated from 2004 to 2020 by P&D Aviation on a straight-line basis.

[b] Source: Seattle-Tacoma International Airport.
[c] Source: Projected percentage based on a straight-line increase from 1993.
[d] Source: Projected percentage based on the approximate average Sea-Tac percent over the past 10 years, 2.0 percent.
[e] International traffic increase was probably due largely to the Goodwill Games.
[f] Estimated.

by the Boeing Company to have long term effects. The upper and lower range of possible future domestic enplanements results from the upper and lower values of the alternative forecast approaches (Figure 5-1).

INTERNATIONAL ENPLANEMENT FORECAST

The international enplanement forecast was developed similarly to the domestic enplanement forecast. A primary forecast approach was used to derive a mid-range forecast for the Airport Master Plan Update and alternative forecast approaches were prepared to provide a range of possible outcomes.

Primary Approach

Regression analysis was used to develop a model to forecast international enplanements. After analyzing a number of potential equations, the following formula was selected because it had the best statistical measures of reliability and represents a logical relationship between international enplanements and a primary measure of economic activity in the international passenger service market:

Ln of international enplaned passengers =

- 16.968
+ 1.994 x Ln of gross state product of three-state area (in 1982) dollars

(where Ln equals natural logarithm)

This equation produced statistical measures which indicate that the equation is reliable in explaining past variations in international enplanements. The coefficient of correlation (R^2) is 0.94, which means that ninety-four percent of the variation in international enplanements from 1970 to 1993 can be explained by this equation.

The gross state product (Table 5-4) measures the value of goods and services produced in the state. The three-state area of Washington, Oregon and Idaho was selected because it is considered to be the area from which most international passengers using Sea-Tac are drawn. Under the primary forecast approach the number of international enplanements are projected to increase from 0.7 million in 1993 to 1.9 million in 2020 (Table 5-5).

The fact that the coefficient of correlation is lower for this model than the domestic passenger model implies that other factors are influencing international demand which are not being captured by the equation. Such factors could be international air fares and exchange rates, bilateral agreements, airline policies regarding concentration of international routes, and significant passengers from outside the three-state service area identified here.

Alternative Approaches

Four alternate approaches were used to test the reasonableness of the primary forecast approach and to bracket the number of potential international enplanements.

Alternate Regression Analysis Model. The following alternative equation was developed using multiple regression analysis:

Ln of international enplaned passengers =

- 15.129
+ 1.874 x Ln of gross state product of three-state area (in 1982) dollars
- 0.169 x Ln of international air fare (in 1992 cents per passenger mile)
(where Ln equals natural logarithm)

This approach produced statistical measures equal to those under the primary forecast approach and the addition of the second

FIGURE 5-1
DOMESTIC ENPLANEMENT FORECAST FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT

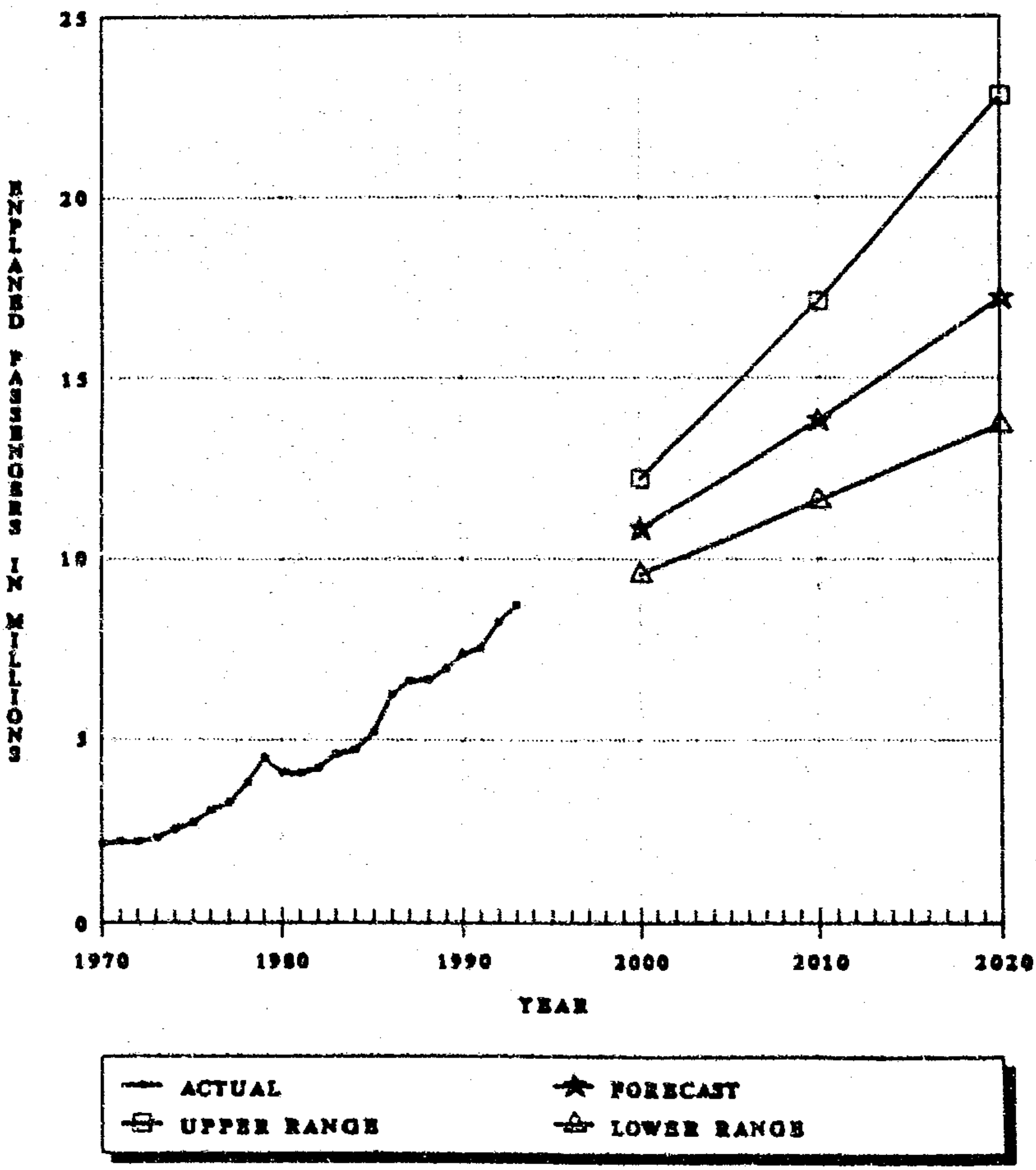


TABLE 5-4
GROSS STATE PRODUCT FOR WASHINGTON, OREGON AND IDAHO, 1970 TO 2020

Year	Gross State Products (Millions of 1982 Dollars)			
	Total	Washington	Oregon	Idaho
Actual [a]				
1970	68,749	39,224	22,350	7,175
1971	69,501	38,966	23,280	7,255
1972	73,789	40,535	25,356	7,898
1973	78,798	43,470	26,976	8,352
1974	82,099	45,385	27,744	8,970
1975	82,940	46,367	27,474	9,099
1976	87,965	48,697	29,559	9,709
1977	92,875	51,511	31,397	9,967
1978	101,496	56,875	33,793	10,828
1979	106,395	60,175	35,296	10,924
1980	105,560	59,796	34,762	11,002
1981	103,550	58,977	33,614	10,959
1982	98,325	56,745	31,148	10,432
1983	101,606	58,828	31,899	10,879
1984	106,516	61,507	33,747	11,262
1985	110,248	63,664	34,769	11,815
1986	114,764	67,158	35,934	11,672
1987	119,207	69,589	37,487	12,131
1988	125,160	72,545	39,870	12,745
1989	131,969	76,628	41,730	13,611
1990	136,490	79,859	42,821	13,810
1991	138,011	81,415	42,591	14,005
1992	142,739	85,123	43,416	14,200
1993	144,403	85,838	44,165	14,400
Projected [b]				
2000	167,400	99,500	51,000	16,900
2010	194,300	116,100	58,700	19,500
2020	216,900	129,800	65,300	21,800

[a] Source: U.S. Department of Commerce, Bureau of Economic Analysis.

[b] Source: Developed by P&D Aviation from projections by states of personal income and related economic factors.

TABLE 5-5
ALTERNATE PROJECTIONS OF INTERNATIONAL ENPLANEMENTS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020

	International Enplanements (Millions)			
		Forecast [b]		
Method	Estimated 1993 [a]	2000	2010	2020
Primary Forecast Approach				
Ln (International Enplanements) vs. Ln (Gross State Product)	0.7	1.1	1.5	1.9
Alternative Forecast Approaches				
Ln (International Enplanements) vs. Ln (Gross State Product) - Ln (International Airfare)	0.7	1.1	1.5	1.8
Percent of U.S. International	0.7	1.5	2.4	3.2
Projected Growth Rates of U.S. International Passengers	0.7	1.0	1.7	2.5
Trend of Past Sea-Tac International Enplanements				
20 Year Trend	0.7	0.9	1.2	1.4
10 Year Trend	0.7	1.0	1.3	1.6

[a] Source: Estimated by P&D Aviation from data through October 1993.

[b] Source: P&D Aviation.

independent variable was not statistically significant. The results of this approach were nearly the same as under the primary forecast approach (Table 5-5).

National Market Share. This approach was similar to the market share approach used for the domestic enplanement forecast. The Sea-Tac share of the U.S. international market has varied between 1.02 percent and 2.31 percent from 1970 through 1993 (Table 5-3). Since 1980, Sea-Tac has averaged 2 percent of U.S. international enplanements and this percentage is expected to remain to the year 2020. Under this approach the international enplanement forecast for 2020 would reach 3.2 million (Table 5-5). The higher forecast under this alternative approach reflects the relatively aggressive projection by the FAA of nationwide international enplanements (Table 5-3).

Projected Growth Rates. This alternative approach is based on international passenger growth rates for the United States developed by the Boeing Company (The Boeing Company, Commercial Airplane Group, Current Market Outlook, World Market Demand and Airplane Supply Requirements, March, 1993). Boeing estimates that the average annual growth rate for U.S. international passengers will be 6.3 percent from 1993 to 2000 and 5.2 percent from 2000 to 2010. From 2010 to 2020 a rate of 4.2 percent was used for this forecast approach. Under this approach, the number of international enplanements at Sea-Tac would reach 2.5 million in 2020 (Table 5-5).

International Enplanement Trends. International enplanement trends at Sea-Tac for the past ten years and twenty years were projected to 2020 on a straight line basis. Under this approach, the number of international enplanements would be 1.4 to 1.6 million in 2020 (Table 5-5).

Forecast Results

Under the primary forecast approach, international enplanements are projected to increase from 0.7 million in 1993 to 1.1 million in 2000, 1.5 million in 2010 and 1.9 million in 2020 (mid-range value). The potential range of enplaned international passengers in the year 2020 is from 1.4 million to 3.2 million, under the alternative forecast approaches (Figure 5-2).

TOTAL ENPLANED PASSENGER FORECAST

Total domestic and international enplanements, under the mid-range forecast, are projected to increase from 9.4 million in 1993 to 11.9 million in 2000, 15.3 million in 2010 and 19.1 million in 2020 (Table 5-6). In 1993, the number of enplaned passengers at Sea-Tac was similar to enplanements at Houston (Intercontinental Airport) and Charlotte, NC. In 2020 Sea-Tac will have approximately 3 million more enplanements than San Francisco International had in 1993 and 2 million fewer enplanements than Atlanta had in 1993 (Table 5-7). In 2010, Sea-Tac is expected to enplane the same number of passengers as Denver had in 1993.

In 1993 approximately 93 percent of domestic passengers were carried by air carrier aircraft (over 60 seats). By 2020, it is expected that 95 percent of domestic enplanements at the airport will be handled by air carrier aircraft (Table 5-6), due to commuter airlines operating greater percentages of air carrier aircraft (60 seats or more).

The international passenger forecast was allocated between passengers to Canada and passengers to other destinations (Table 5-6). This allocation was made on the basis of the existing trends. It is anticipated that the tendency for the percentage of Canadian

FIGURE 5-2
INTERNATIONAL ENPLANEMENT FORECAST FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT

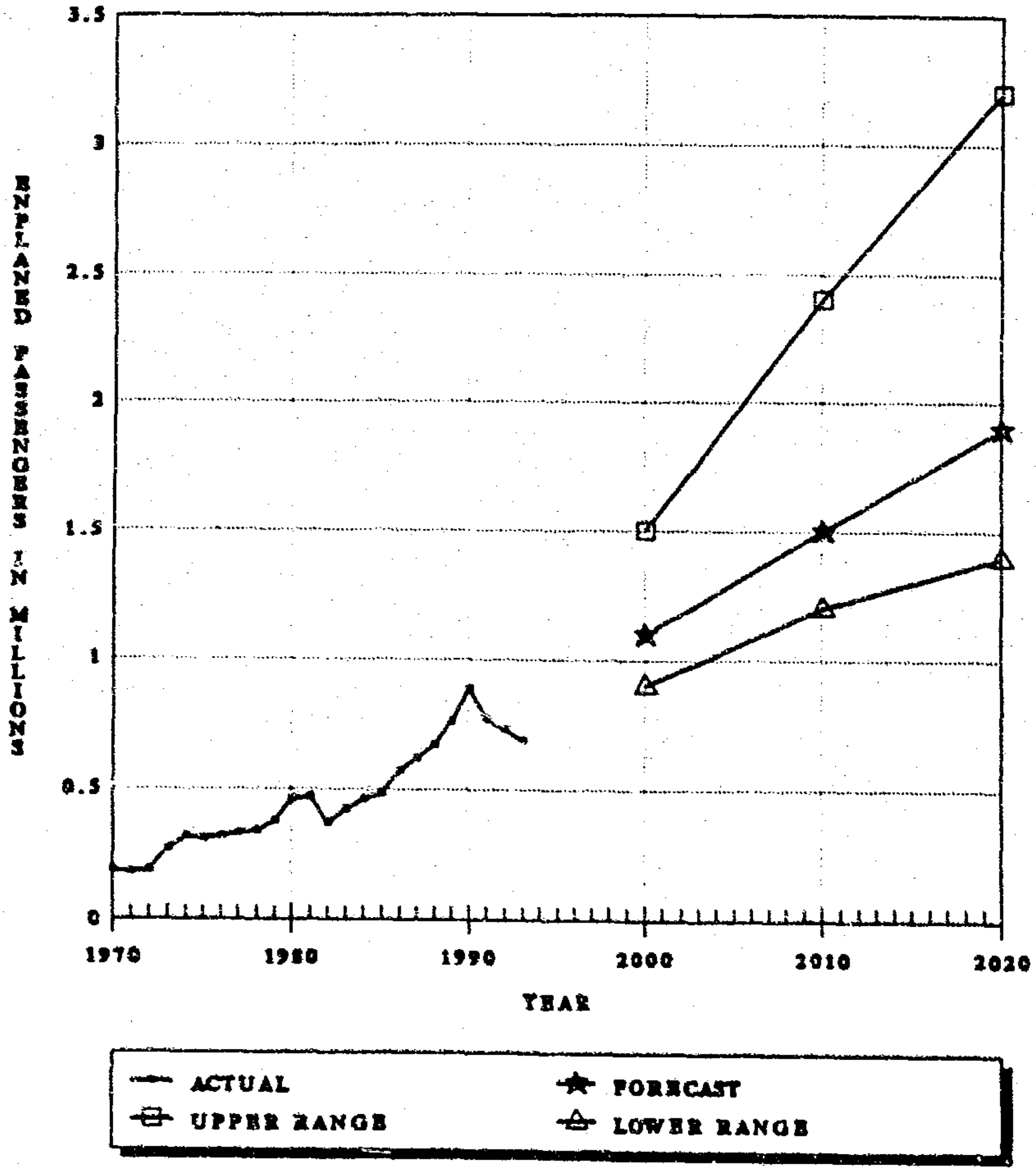


TABLE 5-6
FORECAST OF ENPLANED PASSENGERS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

Description	Actual 1993	Forecast (Mid-Range) 2000	2010	2020
Domestic Air Carrier Service (over 60 seats)				
Domestic Enplaned Passengers (Thousands)	8.7	10.8	13.8	17.2
Domestic Passengers Percent on Air Carrier Aircraft	93.2 [b]	93.5	94.0	95.0
Domestic Air Carrier Enplanements (Thousands)	8.1	10.1	13.0	16.3
(Average Annual Growth Rate)		(3.2)	(2.6)	(2.3)
Domestic Air Taxi/Commuter Service (60 seats or less)				
Domestic Passengers Percent on Air Taxi/Commuter Aircraft	6.8 [b]	6.5	6.0	5.0
Domestic Air Taxi/Commuter Enplanements (Thousands)	0.6	0.7	0.8	0.9
(Average Annual Growth Rate)		(2.2)	(1.3)	(1.2)
International Service to Canada				
International Enplaned Passengers (Thousands)	0.7	1.1	1.5	1.9
International Passengers Percent to Canada	52.0 [c]	55.0	60.0	60.0
International Enplanements to Canada (Thousands)	0.4	0.6	0.9	1.1
(Average Annual Growth Rate)		(6.0)	(4.1)	(2.0)
International Service to Other Destinations				
International Passenger Percent to Other Destinations	48.0 [c]	45.0	40.0	40.0
International Enplanements to Other Destinations (Thousands)	0.3	0.5	0.6	0.8
(Average Annual Growth Rate)		(7.6)	(2.7)	(2.1)
Total Passenger Service				
Total Enplaned Passengers	9.4	11.9	15.3	19.1
(Average Annual Growth Rate)		(3.4)	(2.5)	(2.2)

[a] Source: P&D Aviation, based on mid-range passenger forecast.
[b] Source: Table 3-3.
[c] Source: Table 3-5.

TABLE 5-7
STATISTICS FOR AIRPORTS SIMILAR IN ENPLANEMENTS
TO FORECAST FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 [a]

City and State	Enplanements (Millions)		Enplanements Per Departure	
	Total	Percent Air Carrier (Over 60 seats)	Air Carrier	Air Taxi/ Commuter
Airports with Enplanements Similar to Sea-Tac in 1993				
Washington National, DC	7.5	91.8	73	17
Philadelphia, PA	8.2	90.5	70	13
Houston Intercontinental, TX	9.1	96.5	78	11
Seattle-Tacoma, WA	9.4	91.4	88	13
Charlotte, NC	9.6	92.1	65	12
Orlando, FL	10.1	97.1	90	9
Pittsburgh, PA	11.0	93.5	66	12
Airports with Enplanements Similar to Sea-Tac Projected Forecasts for 2010 to 2020				
Miami, FL	12.9	93.2	84	14
J.F. Kennedy, NY	13.1	94.6	116	13
Denver, CO	15.3	94.7	84	11
San Francisco, CA	16.1	99.3	103	2
Atlanta, GA	21.3	95.3	88	13
Los Angeles International, CA	23.2	96.9	104	7

[a] Source: FAA, Terminal Area Forecasts, FY 1993-2005. Values for 1993 are estimated.

passengers to increase will continue to the year 2010. By 2010 Canadian passengers are projected to account for 60 percent of the international total, compared with 52 percent today. In 2020 the 1.9 million international enplanements are projected to consist of 1.1 million to Canada and 0.8 million to other destinations.

The number of passengers in each of the four major categories (domestic air carrier, domestic air taxi/commuter, international to Canada and international to other destinations) were allocated between origin-destination passengers and connecting passengers (Table 5-8). Origin-destination passengers begin or end their air trip at Sea-Tac. Connecting passengers transfer from one flight to another at Sea-Tac. Passengers who remain on the same aircraft at Sea-Tac (a continuation flight) are not counted as Sea-Tac passengers because they do not embark or disembark an aircraft at Sea-Tac.

An estimate of domestic air carrier origin-destination passengers were obtained from the U.S. Department of Transportation 10 percent sample survey (Table 3-4). The origin-destination percent averaged 72.5 from 1976 to 1992 and this percentage is projected to remain to 2020.

For the remaining three categories of passengers, no reliable historical origin-destination data exist. For these passenger categories, the origin-destination percents estimated in the Flight Plan Phase I study were used (Table 5-8). Overall, 70 percent of Sea-Tac passengers are estimated to be origin-destination passengers.

COMPARISON WITH PREVIOUS PASSENGER FORECASTS

Forecasts prepared for the last Master Plan, completed in 1985, were selected as the starting point for this comparison. The forecasts examined in this review consist of projections prepared for the following studies:

- 1985 Master Plan
- Comprehensive Planning Review and Airspace Update Study (1988)
- The Flight Plan Project - Phase I (1990)
- The Flight Plan Project - Phase III (1991)
- FAA Hub Forecast (1992)
- FAA Terminal Area Forecast (1993)

The forecast methodology and results of each are described in the sections that follow. Past forecasts are summarized and compared with actual airport activity in Table 5-9.

1985 Airport Master Plan Forecasts

A master plan update was completed in 1985 as a guide for the long term development of the airport. It identified actions and physical improvements necessary to accommodate the future growth of air traffic and the evolving characteristics of the air transport industry. Planning activity levels considered in the study were short term (five years), medium term (10 years), and long term (20 years). Airport forecasts were developed for each of these periods (1990, 1995 and 2005).

The passenger and operations forecasts for the 1985 Master Plan were developed by reviewing other airport forecasts dating from 1979, developing a trend-line projection, and estimating future activity levels on the basis of these forecasts. With the exception of the trend-line projection, no independent forecast was developed. The estimated future activity levels appear to be approximately an average of the trend-line projection and forecasts prepared for the Port of Seattle by the Puget Sound Regional Council in 1980 (PSRC, Air Carrier Demand Forecasts, Central Puget Sound Region, October 1980). The PSRC passenger forecast was developed from the following

TABLE 5-8
FORECAST OF ORIGIN-DESTINATION AND CONNECTING ENPLANEMENTS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

Description	Actual 1993	Forecast (Mid-Range) 2000	2010	2020
Domestic Air Carrier Passengers				
Enplanements (Thousands)	8,100	10,100	13,000	16,300
Percent Origin-Destination [b]	72.5	72.5	72.5	72.5
Origin-Destination Passengers (Thousands)	5,900	7,300	9,400	11,800
Connecting Passengers (Thousands)	2,200	2,800	3,600	4,500
Domestic Air Taxi/Commuter Passengers				
Enplanements (Thousands)	600	700	800	900
Percent Origin-Destination [c]	56	56	56	56
Origin-Destination Passengers (Thousands)	340	390	450	500
Connecting Passengers (Thousands)	260	310	350	400
International Passengers to Canada				
Enplanements (Thousands)	400	600	900	1,100
Percent Origin-Destination [c]	50	50	50	50
Origin-Destination Passengers (Thousands)	200	300	450	550
Connecting Passengers (Thousands)	200	300	450	550
International Passengers to Other Destinations				
Enplanements (Thousands)	300	500	600	800
Percent Origin-Destination [c]	46	46	46	46
Origin-Destination Passengers (Thousands)	140	230	280	370
Connecting Passengers (Thousands)	160	270	320	430
Total Enplanements				
Origin-Destination Passengers (Thousands)	6,580	8,220	10,580	13,220
Connecting Passengers (Thousands)	2,820	3,680	4,720	5,880
Total Enplaned Passengers (Thousands)	9,400	11,900	15,300	19,100

[a] Source: P&D Aviation, except as noted. Based on mid-range passenger forecast.

[b] Based on historical average from 1976 to 1992.

[c] Source: KPMG Peat Marwick, Final Report, Phase I Forecasts, Flight Plan Study, Puget Sound Region, July 1990.

TABLE 5-9
COMPARISON OF TOTAL PASSENGER FORECASTS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT WITH PREVIOUS FORECASTS

	Enplaned and Deplaned Passengers (Millions)							
Year	Actual Passengers [a]	Master Plan Update [b]	1985 Master Plan [c]	Comprehensive Planning Review (1988) [d]	Flight Plan Phase I (1990) [e]	Flight Plan Phase III (1991) [f]	FAA Hub Forecast (1992) [g]	FAA Terminal Area Forecast (1993) [h]
Actual								
1970	4.65							
1975	6.11							
1980	9.19							
1985	11.46							
1990	16.24		12.5	17.3				
Projected								
1995		-	15.0	21.9	21.0	21.0	18.4	16.8
2000		23.8	-	26.2	25.4	21.6	24.8	22.7
2005		-	21.0	-	-	-	-	27.8
2010		30.6	-	33.0	34.0	29.0	36.6	-
2015		-	-	-	-	-	-	-
2020		38.2	-	37.4	45.0	38.3	-	-

[a] Source: Seattle-Tacoma International Airport.

[b] Based on mid-range forecast.

[c] Source: Peat, Marwick & Co., Master Plan Update for Seattle-Tacoma International Airport, Working Paper Task 7 - Forecast Review and Assessment, July 1984.

[d] Source: P&D Technologies, Comprehensive Planning Review, Working Paper No. 1 - Airspace Study, March 1988.

[e] Source: KPMG Peat Marwick, Phase I Forecasts, Flight Plan Study, Puget Sound Region, July 1990.

[f] Source: P&D Aviation, The Flight Plan Project Phase III, Working Paper No. 5 - Allocation of Passengers and Aircraft Operations, August 1991.

[g] Source: Federal Aviation Administration, FAA Aviation Forecasts, Seattle-Tacoma Hub, October 1992.

[h] Source: Federal Aviation Administration, Terminal Area Forecasts, FY 1993-2005, July 1993.

model, using data from 1954 through 1978:

$$\text{Ln} \frac{\text{ORIG}}{\text{POP}} = 15.9 + 1.49 \text{ Ln} \frac{\text{RPI}}{\text{POP}}$$

$$- 1.106 \text{ Ln AVREV}$$

where:

ORIG = adjusted regional originations
POP = regional population
RPI = regional personal income ($1982)
AVREV = average passenger revenue per revenue passenger mile ($1982)
Ln = natural logarithm

The resulting 1985 Master Plan Forecast is shown in Table 5-9. This forecast was prepared from data through 1984 and reflected a period of time from the late 1970s to the mid-1980s when activity growth at the airport was relatively slow. For example, passenger growth for the five year period ending in 1984 averaged only 1.3 percent a year. Consequently, the 1985 Master Plan Forecast substantially under-estimated future airport activity. The actual passenger growth rate from 1984 through 1992 was 7.0 percent per year compared with a projected annual growth rate of 3.0 percent.

Comprehensive Planning Review (1988) Forecasts

The Comprehensive Planning Review was completed in 1988 (P&D Technologies, Comprehensive Planning Review and Air Space Update Study, October 1988). Because of rapid growth in airport activity, changing airport characteristics, improvements in technology, and the Port's desire to move forward with needed capital improvements, a review and validation of the airport plans was necessary. As a result, the Port decided to conduct a Comprehensive Planning Review to examine all elements of planning at Sea-Tac and to simultaneously update the analyses of the airspace system. In order to effectively integrate and plan for future requirements of the airport, updated forecasts for activities at Sea-Tac were prepared.

Forecasts for the Comprehensive Planning Review were developed on the basis of PSRC 1987 forecasts and the trend in the annual passenger growth rate from 1980 through 1987. The average historic annual passenger growth rate (approximately 7 percent), was used as the starting point for the passenger projections. The growth rate was estimated to decline each year to approximately 1 percent by the year 2020. The resulting forecast (Table 5-9) revised the near-term forecasts to reflect current conditions, while maintaining the long-term projection from the more detailed PSRC forecasts.

The PSRC population forecast (Puget Sound Regional Council, Regional Airport System Plan, Technical Report on the Air Carrier and General Aviation Elements, July 1987) was developed by updating the model used in the 1980 PSRC study to include data from 1958 through 1985. The updated (1987) PSRC passenger forecast model is as follows:

$$\text{Ln} \frac{\text{ORIG}}{\text{POP}} = 13.69 + 1.07 \text{ Ln} \frac{\text{RPI}}{\text{POP}}$$

$$- 1.65 \text{ Ln AVREV}$$

Variables are defined as in the 1980 study.

The Comprehensive Planning Review forecasts for 1990 were slightly above actual airport activity. The actual annual passenger growth rate from 1987 through 1992 was 4.4 percent compared with a projected annual growth of 5.8 percent. During the same period, actual annual operations growth was 3.5 percent compared with a projected annual growth rate of

5.9 percent.

Flight Plan - Phase I (1990) Forecasts

The Flight Plan Project, conducted in three phases, focused on the air transportation needs of the Puget Sound Region to the year 2020 and beyond. A major emphasis in the project was the identification of regional airports which could meet some of the region's air passenger demands as Sea-Tac reaches its capacity. New passenger and operations forecasts were prepared in Phase I for 1995 through 2020.

The following economic variables for the Puget Sound Region from 1970 through 1988 were considered: total population, total jobs and per capita income. In addition, the national average air fare per passenger mile was considered. A multiple regression model was chosen to forecast originating passengers. Several regressions were evaluated and the following model was selected:

Ln of originating passengers =

- 6.232
+ 1.0390 x Ln of population
+ 0.9832 x Ln of per capita income
- 1.2030 x Ln of air fare

(where Ln equals natural logarithm)

The model passed all statistical and logical tests and produced reasonable results when tested for its sensitivity to variations in the inputs. A range of potential passenger demand was developed based on other forecasts such as those prepared by PSRC and aircraft manufacturers.

The resulting Flight Plan - Phase I passenger forecast (Table 5-9) is similar to the Comprehensive Planning Review forecast through 2010 and significantly higher in 2020. From 1989 through 1992, the actual annual passenger growth rate was 5.6 percent compared with a project growth of 5.9 percent.

Flight Plan - Phase III (1991) Forecast

In Phase II of the Flight Plan study, the aircraft operations forecast prepared under Phase I was revised downward for 1995 and the following years based on data from a study of operations in the three largest regional markets served from Sea-Tac (Portland, Spokane, and Vancouver, British Columbia). During the Phase III study, the forecasts developed in Phases I and II were allocated to various combinations of airports in the Puget Sound Region. The airport system recommended in Phase III is a three airport system consisting of Sea-Tac, passenger service at Paine Field, and passenger service at a Central Pierce County site (a new airport or joint use of McChord Air Force Base). Allocations of passengers to each airport were made on the basis of estimated passenger preferences, driving times from points of origin and destination within the region and airport capacities.

The passenger forecast for Sea-Tac prepared in the Flight Plan - Phase III project (Table 5-9) is lower than the Phase I forecast after 1995 because some of the passenger activity, under the Phase III recommendations, would be shifted to other airports in the region. The regional forecast of passengers under Phase III is the same as Phase I (45 million passengers in 2020).

FAA Hub Forecast. FAA Hub forecasts are developed as part of a program conducted by the FAA Statistical and Forecast Branch, Office of Aviation Policy and plans, to meet the budgeting and planning needs of the various offices and services of the FAA. There are currently 27 large hubs, encompassing 42 air carrier airports, in the United States. Large hub airports are defined by the FAA as those airports which in the most recent year boarded one percent or more of the total domestic enplaned revenue passengers. One percent of total U.S. revenue passenger enplanements equalled approximately 4.7 million enplaned passengers in 1993. FAA has developed forecasts for 25 large hub areas including Seattle.

The most recent FAA Hub forecast for Seattle was completed in 1992 and was based on passenger data through 1991. Consequently, the FAA Hub projection, did not allow for the reduction in international passengers at Sea-Tac in 1992 and 1993 or the recent workforce cutbacks at the Boeing Company and related economic conditions.

The 1992 Hub total passenger projection is 24.8 million in 2000 and 36.6 million in 2010. the Hub projection for 2010 consists of 32.0 million domestic and 4.6 million international passengers.

FAA Terminal Area Forecasts (1993)

The Federal Aviation Administration (FAA) develops forecasts annually for over 800 airports for use in the agency's planning and decision making. The FAA uses these forecasts in developing its program plans and in assessing the level of resources needed to meet the anticipated demands for its services. In addition, the FAA forecasts are often a helpful tool for state and local aviation authorities and the aviation industry in planning for future airport development needs. Although FAA passenger forecasts for 2005 are consistent with Flight Plan Projections, the FAA forecast anticipates a decrease in passengers in 1995 (Table 5-9).

Comparison Summary

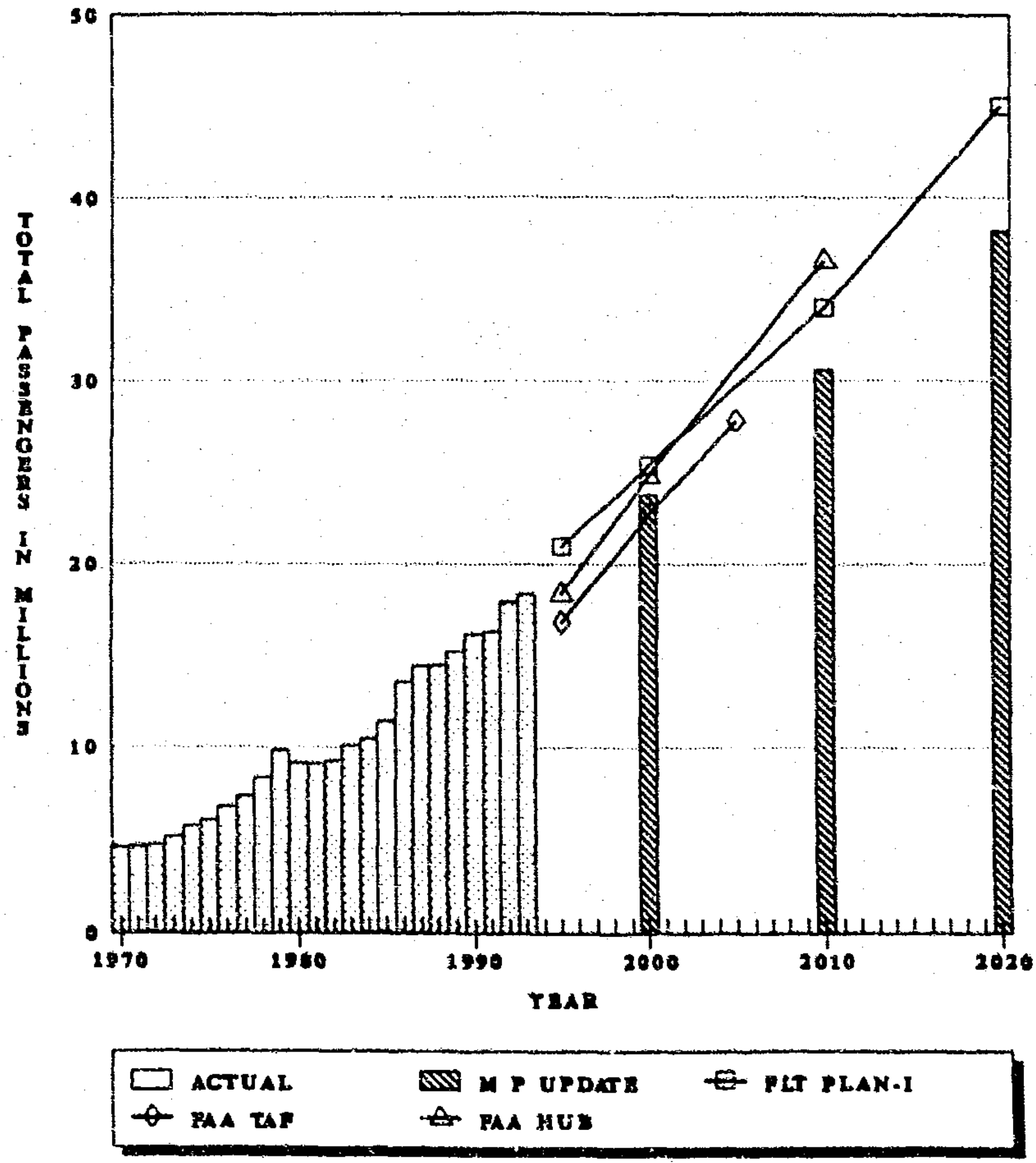
Sea-Tac passenger forecasts prepared since the 1985 Master Plan tend to lie within a relatively narrow range (Figure 5-3) especially considering that some of the projections extend to 2020. This could be partially due to the relatively steady increase in passengers over the past 22 years particularly since 1982. The passenger forecasts for Sea-Tac generally reflect a continuation of this steady growth.

The Airport Master Plan Update forecast is lower than the FAA Hub forecast of 1992 but similar in 2005 to the 1993 FAA Terminal Area Forecast (Table 5-9). In 2005 the Airport Master Plan Update forecast is 2 percent lower than the FAA Terminal Area Forecast. The Airport Master Plan Update forecast is only 4 percent lower than the FAA Hub forecast in 2000 but is 11 percent lower in 2010 and 16 percent lower in 2020.

PEAK HOUR PASSENGER FORECAST

Peak month passenger enplanements are expected to continue at the same percentage of annual passengers experienced over the past five years, 12.2 percent for domestic service and 12.5 percent for international service (Table 3-6). The percentage of average day peak month passengers in the peak hour is projected to decline between 1993 and 2020 as passenger volumes increase, according to established industry relationships between passenger volume and peak hour relationships. The projected peak hour percentages shown in Table 5-10 are based on industry experience and comparisons with airports of the size projected for Sea-Tac between 2000 and 2020. The number of enplanements in the enplanements peak hour is expected to increase from 4,060 in 1993 to 7,500 in 2020. Over the same period, total peak hour passengers are expected to grow from 5,950 to 12,100. The projections of peak hour enplanements, deplanements and total passengers will be used to determine the projected requirements for some of the passenger terminal facilities.

FIGURE 5-3
COMPARISON OF TOTAL PASSENGER FORECASTS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT



AIR CARGO TONNAGE FORECAST

The air cargo forecast was developed using a regression analysis model. Many model forms and variables relating to air cargo tonnage were evaluated. Variables affecting air cargo demand which were examined included the Washington state gross state product, Puget Sound income, Puget Sound employment, Puget Sound population, Puget Sound per capita income and Puget Sound income.

Air Cargo Model and Results

The following equation was chosen, because it had the best overall statistical measures of reliability:

Ln of air cargo (in thousand metric tons) =

- 16.795
+ 2.846 x Ln of Puget Sound population (in thousands)

(where Ln equals natural logarithm)

With this model, 98 percent of the historical variation in air cargo tonnage is explained. Most of the air cargo models analyzed were based on data for the period from 1985 to 1993 (9 years). Air cargo has been very cyclical at Sea-Tac, increasing steadily in the early 1970s, remaining almost constant between the mid-1970s and mid-1980s, and increasing again after 1985 (Table 3-9). From 1985 to 1993 cargo tonnage at Sea-Tac grew at an average annual compounded rate of 7.8 percent. It is felt that the period from 1985 to 1993 is the most representative period for basing future air cargo projections, because it is the most indicative of current air freight trends and is representative of the growth expected in future air cargo volume. For example, Boeing forecasts that air freight growth will average 4.8 percent in the U.S., 6.7 percent world-wide and 7.6 percent between the U.S. and Asia from 1991 to 2005 (Boeing Commercial Airplane Group, <u>1993 Current Market Outlook, World Market Demand and Airplane Supply Requirements</u>, March 1993).

The result of the air cargo model is a projected increase in air cargo from 381,000 metric tons in 1993 to 880,000 metric tons in 2020 (Table 5-11). A range of potential air cargo tonnage was developed by considering several alternative projections, including the extrapolation of past trends and alternative regression analysis approaches. The result is a potential range in air cargo tonnage from 620,000 metric tons to 1,250,000 metric tons in 2020 (Figure 5-4).

The lower range projection was based on a regression model relating the logarithm of cargo tons to the logarithm of personal income in the Puget Sound Region from 1970 to 1993. The lower range projection is also close to the straight line trend of cargo tons from 1970 to 1993. The upper range projection was developed from a logarithmic regression model similar to the lower range model except it considered only the 9-year period from 1985 to 1993.

The total projected air cargo tonnage was allocated among domestic freight, international freight and air mail according to growth trends in the three categories over the past ten years. Although the greatest absolute growth is expected in the domestic freight category, the greatest percentage growth is expected to occur in the international freight category (Table 5-11) because over the last ten years, the international segment has had the greatest percentage growth.

Comparison With Other Cargo Forecasts

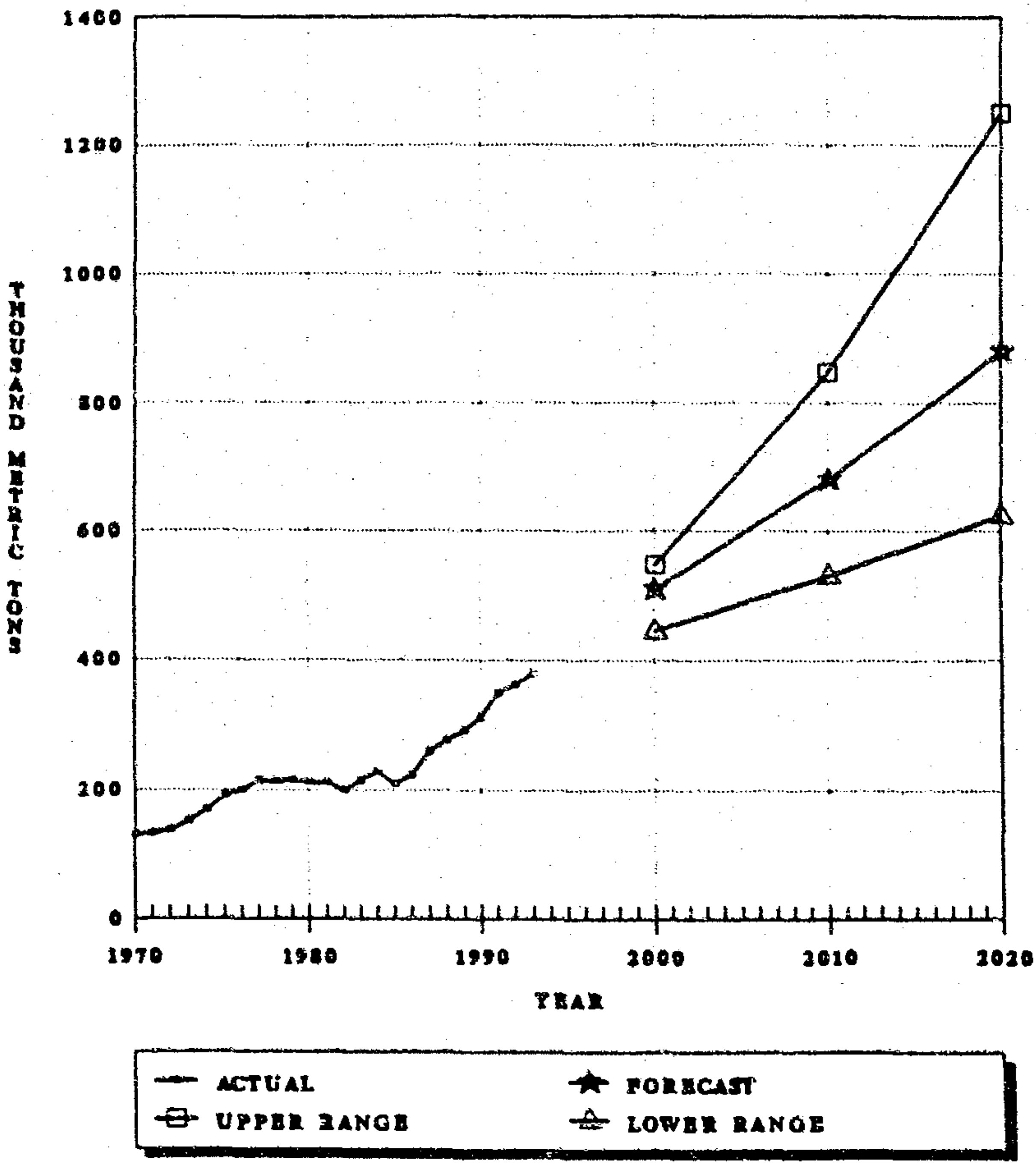
Air cargo forecasts for Sea-Tac were developed in two recent studies, The Sea-Tac Air Cargo Study completed in 1993 and the FAA Seattle

TABLE 5-11
FORECAST OF AIR CARGO TONS AND OPERATIONS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

Description	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
Inbound and Outbound Air Cargo (Thousand Metric Tons)				
Domestic Freight	246	310	420	550
International Freight	51	100	140	190
Air Mail	84	100	120	140
Total	**381**	**510**	**680**	**880**
(Average Annual Growth Rate)		(4.2)	(2.9)	(2.6)
All-Cargo Activity				
Air Freight Carried by All-Cargo Operations (Thousand Metric Tons)	160 [d]	220	300	400
Percent of Air Freight by All-Cargo Operations	54	54	54	54
All-Cargo Operations (Thousands) [b]	16	20	23	27
Air Freight Per Cargo Operation (Metric Tons)	10	11	13	15
Cargo Carried On Passenger Flights				
Air Freight Carried on Passenger Flights (Thousand Metric Tons)	137	190	260	340
Percent of Air Freight Carried on Passenger Flights	46	46	46	46
Air Freight and Mail Carried on Passenger Flights (Thousand Metric Tons) [c]	217 [d]	280	370	470
Passenger Operations (Thousands) [b]	315	350	373	404
Air Freight and Mail Per Passenger Operation (Pounds)	1,500	1,800	2,200	2,600

[a] Source: P&D Aviation. One metric ton equals 2,205 pounds.
[b] Combi (combined passenger and freight in upper deck) flights by Alaska Airlines are included as passenger operations. Passenger operations (315,000) plus all-cargo operations (16,000) equal total airline operations (331,000).
[c] Based on an estimated 95 percent of mail being carried on passenger flights.
[d] Note that mail carried by all-cargo operations (estimated to be 4,000 metric tons in 1993) is not included in these figures.

FIGURE 5-4
AIR CARGO FORECAST
FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT



Tacoma Hub Forecast of October 1992.

Sea-Tac Air Cargo Study. The objectives of the study were:

- To assess the future demand for air cargo of the airport under a variety of scenarios over the next 30 years.
- To assess the facilities needed to accommodate future cargo demand and evaluate alternative cargo facility layouts to meet those needs.

Baseline growth projections from the Sea-Tac Air Cargo are shown in Table 5-12. The Air Cargo Study forecast was developed by projecting total cargo movements by commodity group and assigning percentages of the cargo in each group which would be transported by air. The forecast was prepared on the basis of cargo data for 1991 and preceding years and did not account for the continuation in 1992 and 1993 of the strong growth in air cargo that has occurred since 1985.

FAA Hub Forecasts. These projections (Table 5-12) were developed by the Forecast and Statistics Branch of FAA's Office of Aviation Policy and Plans. In general, these forecasts are developed in accordance with a "top-down" procedure, starting with the development of national level forecasts of aviation activity. The forecasts are then disaggregated into hub forecasts utilizing regional demographic and economic projections.

The Airport Master Pan Update forecasts is within 10 percent of the FAA Hub forecast but is substantially greater than the Sea-Tac Cargo Study forecast. However, note that the Sea-Tac Cargo Study forecast is similar to the lower range forecast shown in Figure 5-4.

PASSENGER AIRCRAFT OPERATIONS FORECAST

The number of aircraft operations in each of the four passenger service categories (domestic air carrier, domestic air taxi/commuter, international to Canada, and international to other destinations) was projected by developing estimates of future aircraft size (average seats per departure) and aircraft boarding load factor (percentage of seats occupied by enplaning passengers). The average number of enplanements per passenger aircraft departure is derived by multiplying the average seats per departure by the boarding load factor. The number of aircraft departures is derived by dividing the number of enplaned passengers by the number of enplanements per departure.

Estimates of the factors described above were prepared for Sea-Tac activity in 1993, the base year for making future projections. The development of these factors is summarized in Table 5-13. Average enplanements per departure in 1993 were 87.5 for domestic air carrier service, 11.3 for domestic air taxi/commuter service, 29.6 for international service to Canada and 172.7 for international service to other destinations. The highest boarding load factor was for international service to other destinations (65.1 percent). Domestic air taxi/commuter service had the lowest average boarding load factor (44.6 percent). Overall in 1993, the airport averaged 104 seats per departing flight and a boarding load factor of 56.5 percent.

The average number of seats per departure was projected on the basis of industry estimates. For domestic air carrier service the seats were forecast to increase at the rate of 2 per year, based on forecasts by the Boeing Company and McDonnell Douglas Corporation (Table 5-14). The average number of seats per departure in the other categories of service is projected to

TABLE 5-12
COMPARISON OF AIR CARGO FORECAST
WITH PREVIOUS PROJECTIONS, 1970 TO 2020

Year	Enplaned and Deplaned Air Freight and Mail (Thousand Metric Tons)			
	Actual [a]	Airport Master Plan Update [b] (1994)	Sea-Tac Air Cargo Study [c] (1993)	FAA Hub Forecast [d] (1992)
Actual				
1970	130	-	-	-
1975	190	-	-	-
1980	211	-	-	-
1985	210	-	-	-
1990	313	-	-	-
Projected				
2000	-	510	427	470
2010	-	680	534	664
2020	-	880	639	-

[a] Source: Seattle-Tacoma International Airport, "Traffic and Operations Report."

[b] Source: P&D Aviation analysis.

[c] Source: Howard Needles, Tammen & Bergendoff, Seattle-Tacoma International Airport, Air Cargo Study, June 1993.

[d] Federal Aviation Administration, FAA Aviation Forecasts, Seattle-Tacoma Hub, October 1992.

TABLE 5-13
ENPLANEMENTS AND DEPARTURES BY TYPE OF SERVICE AND AIRLINE, NOVEMBER 1992 THROUGH OCTOBER 1993 [a]

Airline	Enplaned Passengers (Thousands)	Number of Departures	Average Seats Per Departure	Departing Seats (Thousands)
Domestic Air Carrier Passenger Service (Over 60 Seats)				
American Airlines	625.6	6,825	177	1,208.0
Alaska Airlines	1,631.4	21,057	126	2,653.2
Horizon Air	212.9	5,460	65	354.9
Markair	274.8	3,797	131	497.4
Continental Airlines	343.0	3,513	151	530.5
Delta Airlines	722.5	8,116	199	1,615.1
Hawaiian Airlines	93.0	367	302	110.8
American West Airlines	270.2	2,862	141	403.5
Morris Air Service	420.0	3,961	128	507.0
Northwest Airlines	830.0	7,367	196	1,443.9
Reno Air	218.8	2,377	144	342.3
Trans World Airlines	173.8	2,823	189	533.5
United Airlines	1,765.2	18,210	161	2,931.8
U.S. Air	199.2	2,232	144	321.4
Subtotal	7,780.4	88,967		13,453.3
Summary Statistics				
Average Seats Per Departure		151.2		
Average Boarding Load Factor % (Enplaned Passengers Per Seat)		57.8		
Average Enplanements Per Departure		87.5		
Domestic Air Taxi/Commuter Passenger Service (60 Seats or Less)				
Horizon Air	409.7	29,621	32	947.9
Empire Airlines	3.1	979	19	18.6
Harbor Airlines	20.6	5,763	8	46.1
United Express	145.9	15,019	19	285.4
Subtotal	579.3	51,382		1,298.0
Summary Statistics				
Average Seats Per Departure		25.3		
Average Boarding Load Factor % (Enplaned Passengers Per Seat)		44.6		
Average Enplanements Per Departure		11.3		

TABLE 5-13
ENPLANEMENTS AND DEPARTURES BY TYPE OF SERVICE
AND AIRLINE, NOVEMBER 1992 THROUGH OCTOBER 1993 [a]

Airline	Enplaned Passengers (Thousands)	Number of Departures	Average Seats Per Departure	Departing Seats (Thousands)
International Passenger Service to Canada				
Horizon Air/Alaska Airlines/ Northwest Airlines	132.4	5,252	39	204.8
United Airlines	112.0	1,800	178	320.4
Air Canada/Air BC	56.9	2,897	45	130.4
Canadian Airlines/Canadian Regional	11.9	620	36	22.3
Subtotal	313.2	10,569		677.9
Summary Statistics				
Average Seats Per Departure		64.1		
Average Boarding Load Factor % (Enplaned Passengers Per Seat)		46.2		
Average Enplanements Per Departure		29.6		
International Passenger Service to Other Destinations				
American Airlines	55.6	365	245	89.4
British Airways	50.6	383	197	75.5
EVA	6.7	127	258	32.8
Martinair Holland	8.1	31	390	12.1
Northwest Airlines	108.0	365	400	146.0
Scandinavian Airlines System	54.1	295	220	64.9
United Airlines	32.2	260	244	63.4
Subtotal	315.3	1,826		484.1
Summary Statistics				
Average Seats Per Departure		265.1		
Average Boarding Load Factor % (Enplaned Passengers Per Seat)		65.1		
Average Enplanements Per Departure		172.7		
Total Passenger Service				
All Airlines Surveyed	8,988.2	152,744		15,913.3
Summary Statistics				
Average Seats Per Departure		104.2		
Average Boarding Load Factor % (Enplaned Passengers Per Seat)		56.5		
Average Enplanements Per Departure		58.8		

[a] Source: Developed by P&D Aviation from data furnished by Seattle-Tacoma International Airport. Excludes data for charter airlines and other airlines with low activity levels.

TABLE 5-14
FORECAST OF PASSENGER AIRCRAFT OPERATIONS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

Description	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
Domestic Air Carrier Operations (Over 60 Seats)				
Enplaned Passengers (Millions)	7.9	10.1	13.0	16.3
Average Seats per Departure [b]	151.2	165	185	205
Boarding Load Factor (Percent) [c]	57.8%	58%	59%	60%
Enplanements per Departure	87.5	96	109	123
Departures (Thousands)	90	105	119	133
Operations (Thousands)	180	210	238	266
Domestic Air Taxi/Commuter Operations (60 Seats or Less)				
Enplaned Passengers (Millions)	0.6	0.7	0.8	0.9
Average Seats per Departure [d]	25.3	28	33	38
Boarding Load Factor (Percent) [e]	44.6%	50%	55%	55%
Enplanements per Departure	11.3	14	18	21
Departures (Thousands)	53	50	44	43
Operations (Thousands)	106	100	88	86
International Operations to Canada				
Enplaned Passengers (Millions)	0.4	0.6	0.9	1.1
Average Seats per Departure [f]	64.1	71	81	91
Boarding Load Factor (Percent) [e]	46.2%	50%	55%	55%
Enplanements per Departure	29.6	36	45	50
Departures (Thousands)	13	17	20	22
Operations (Thousands)	26	34	40	44
International Operations to Other Destinations				
Enplaned Passengers (Millions)	0.3	0.5	0.6	0.8
Average Seats per Departure [d]	265.1	270	275	280
Boarding Load Factor (Percent) [g]	65.1%	66%	67%	68%
Enplanements per Departure	172.7	178	184	190
Departures (Thousands)	1.7	3	3.5	4
Operations (Thousands)	3.5	6	7	8
Total Passenger Operations				
Total Passenger Aircraft Operations	315	350	373	404
Domestic	286	310	326	352
International	29	40	47	52
Air Carrier [h]	188	223	255	287
Air Taxi/Commuter	127	127	118	117

TABLE 5-14
FORECAST OF PASSENGER AIRCRAFT OPERATIONS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

[a] Source: P&D Aviation, based on mid-range passenger forecast.

[b] Estimated to increase at the rate of 2 seats per year based on forecasts by The Boeing Company (Current Market Outlook, World Market Demand and Airplane Supply Requirements, 1993, March 1993) and McDonnell-Douglas Corporation (Outlook for Commercial Aircraft, 1992-2011, February, 1993).

[c] Based on projections by McDonnell-Douglas Corporation in Outlook for Commercial Aircraft, 1992-2011, February 1993.

[d] Estimated to increase at the rate of 1/2 seat per year.

[e] Estimated to increase to 55 percent by 2020.

[f] Estimated to increase at the rate of 1 seat per year.

[g] Estimated to increase by 3 percent from 1993 to 2020, similar to the projection for domestic air carrier operations.

[h] Based on the air carrier (over 60 seats) portion of International Service to Canada increasing from 17 percent of operations in 1993 to 20 percent in 2000, 25 percent in 2010 and 30 percent in 2020.

increase from one-half to one seat per year based on industry trends.

The average load factor for domestic air carrier service is projected to increase from 57.8 percent in 1993 to 60 percent in 2020 based on projections by the McDonnell-Douglas Corporation (Table 5-14). The boarding load factor for international operations to other destinations is expected to increase by approximately the same amount, from 65.1 percent in 1993 to 68 percent in 2020. Boarding load factors for domestic air taxi/commuter service and international service to Canada are projected to reach 55 percent by 2020. It is anticipated that load factors will increase due to increasing airline operating costs and increasing competitive pressures.

The resulting number of operations is shown in Table 5-14. Passenger aircraft operations are expected to total 404,000 in 2010. International operations and air carrier operations are both expected to account for greater percentages in the future because these sectors are projected to account for greater percentages of the airport's total passengers in the future. Overall, the average number of enplanements per departure for all sectors of activity at Sea-Tac is projected to increase from 58 in 1993 to 95 in 2020 (Figure 5-5). In the future, the number of domestic air taxi/commuter aircraft operations is projected to decline due to a greater shift towards air carrier service and the use of air carrier aircraft by commuter airlines. A change in the projected value of any of the three factors affecting passenger aircraft operations (number of passengers, average aircraft size, or boarding load factor) would change the projected number of operations. For example if the boarding load factor for all elements of passenger service were to increase to 70 percent in 2020, the total passenger operations forecast for 2020 would decrease from 404,000 to 338,000.

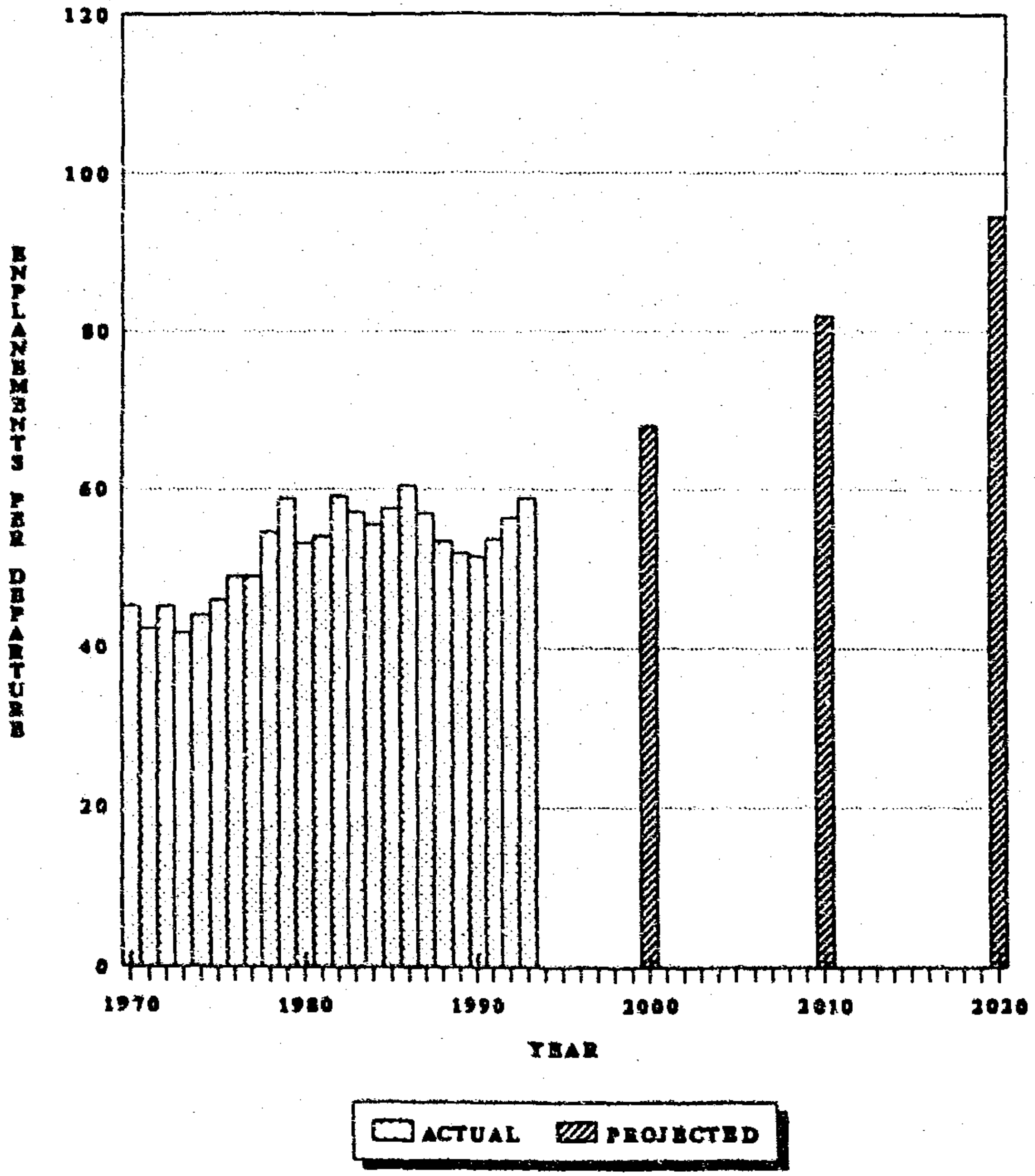
AIR CARGO OPERATIONS FORECAST

The number of all-cargo operations was determined by estimating the amount of freight carried by all-cargo flights and the amount of air freight per all-cargo operation (Table 5-11). Currently 54 percent of air freight is handled on all-cargo flights. The air freight carried per cargo operation averages approximately 10 metric tons. There is no evidence to suggest a relative shifting in air cargo between all-cargo and passenger flights, and therefore it is estimated that the percent of freight carried by all-cargo flights will remain at 54 percent. However, the amount of air freight per flight is projected to increase to 15 metric tons in 2020, due to the use of larger air cargo aircraft. Based on these parameters, the number of all-cargo operations is projected to increase from 16,000 in 1993 to 27,000 in 2020.

In 1993, air cargo operations had some impact on peak hour operations, although most air cargo flights occurred from 6:00 p.m. to 7:00 a.m. Peak hour operations (74 scheduled operations) in 1993 occurred during the 7:00 a.m. and 1:00 p.m. hours (Table 3-14). In the 7:00 a.m. hour, there were two air cargo aircraft arrivals and four departures, approximately eight percent of peak hour operations. There were no scheduled air cargo operations in the 1:00 p.m. hour. There were eight cargo operations (all arrivals) during the 8:00 p.m. hour, which was 11 percent of the total 71 scheduled operations in that hour.

In 1993, passenger aircraft flights carried an average of 1,500 pounds of air freight and mail. This average is expected to increase to 2,600 pounds by 2020 due to the use of larger aircraft in passenger service (Table 5-11).

FIGURE 5-5
ENPLANEMENTS PER PASSENGER DEPARTURE AT SEATTLE-TACOMA INTERNATIONAL AIRPORT



TOTAL AIRCRAFT OPERATIONS FORECAST

General aviation operations at Sea-Tac in 1993 were 2.4 percent of airline operations, and it is projected that this relationship will continue. Accordingly, general aviation operations are projected to increase to 10,300 by the year 2020.

Military operations are projected to remain at about 300 a year.

Total airport operations, including passenger service, all-cargo operations, general aviation and military, are projected to increase from 339,500 in 1993 to 379,200 in 2000, 405,800 in 2010 and 441,600 in 2020 (Table 5-15).

COMPARISON OF TOTAL OPERATIONS FORECASTS

Total aircraft operations at Sea-Tac are compared with forecasts developed in other studies in Table 5-16 and Figure 5-6. The Airport Master Plan Update operations forecast is 10 percent below the 1993 FAA terminal area forecast for 2005 and 9 percent below the 1992 FAA Hub forecast for 2010. Although the other operations forecasts shown in Figure 5-6 are fairly consistent with each other for the period from 2000 to 2010 and are greater than the Master Plan Update forecast, the other projections did not consider the period from 1991 to 1993 in which aircraft operations have dropped by 4.4 percent and the following restructuring of airline operations has occurred:

- A decrease in air taxi/commuter operations from 150,376 in 1990 to 131,046 in 1993.
- An increase in the size of aircraft operated at the airport.

The relatively slower growth rate in aircraft operations under the Airport Master Plan Update forecast reflects a larger increase in aircraft size and/or a greater shift from air taxi/commuter operations to air carrier operations as well as a lower passenger forecast compared with the other projections.

The 1990 Flight Plan Phase II passenger operations forecast was revised in the Terminal Development Program, March 1992, by Thompson Consultants International to account for a greater shift towards larger aircraft, especially for commuter airlines. Total passenger aircraft operations projected in that study were 371,400 in 2000, 407,400 in 2010 and 452,800 in 2020. The number of enplaned passengers per passenger departure estimated in the Terminal Development Study was very close to that projected for the Airport Master Plan Update. Enplanements per departure are projected in the Airport Master Plan Update to grow to 68 in 2000, 82 in 2010 and 95 in 2020 (Figure 5-5). The Terminal Development Study projected the enplanements per departure to increase to 68 in 2000, 83 in 2010 and 99 in 2020.

FLEET MIX FORECAST

A fleet mix forecast was developed by projecting the percentages of aircraft operations by type of aircraft, while maintaining consistency with the average seats per departure projections shown in Table 5-14. As seen in Table 5-17, the mix of aircraft projected to be in service in later years generally contains larger aircraft than in service today. The aircraft models shown in Table 5-17 are representative of types in the forecasted fleet. Some aircraft in later years will be new aircraft but are projected to be of the same size as those shown in the table. Whereas the 121 to 170 seat category is projected to decrease from 63 to 40 percent by the year 2020, the 171 to 240 seat category is projected to increase from 14 to 29 percent by

TABLE 5-15
SUMMARY OF AIRCRAFT OPERATIONS FORECASTS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020

Description	Aircraft Operations (Thousands)			
	Actual 1993 [a]	Forecast [b]		
		2000	2010	2020
Airline Operations				
Passenger Aircraft Operations [c]				
Air Carrier Aircraft Operations	188	223	255	287
Air Taxi/Commuter Aircraft Operations	127.0	127	118	117
Subtotal Passenger Aircraft Operations	315.0	350	373	404
(Average Annual Growth Rate)		(1.5%)	(0.6%)	(0.8%)
All-Cargo Operations	16.0	20	23	27
(Average Annual Growth Rate)		(3.2%)	(1.4%)	(1.6%)
Total Airline Operations	331.0	370	396	431
(Average Annual Growth Rate)		(1.6%)	(0.7%)	(0.9%)
Other Operations%				
General Aviation Operations [d]	8.1	8.9	9.5	10.3
(Average Annual Growth Rate)		(1.4%)	(0.7%)	(0.8%)
Military Operations	0.3	0.3	0.3	0.3
(Average Annual Growth Rate)		(0%)	(0%)	(0%)
Total Airport Operations	339.5	379.2	405.8	441.6
(Average Annual Growth Rate)		(1.6%)	(0.7%)	(0.8%)

[a] Source: Breakdown of airline operations was estimated by P&D Aviation.

[b] Source: P&D Aviation.

[c] Source: Table 5-14.

[d] Projected to remain at 2.4% of airline operations.

TABLE 5-16
COMPARISON OF TOTAL AIRCRAFT OPERATIONS FORECASTS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT WITH PREVIOUS FORECASTS

Year	Aircraft Operations (Thousands)							
	Actual Operations (Thousands) [a]	Master Plan Update - Operations Forecast (1994) (Thousands) [b]	1985 Master Plan [c]	Comprehensive Planning Review (1988) [d]	Flight Plan Phase II (1990) [e]	Flight Plan Phase III (1991) [f]	FAA Hub Forecast (1992) [g]	FAA Terminal Area Forecast (1993) [h]
Actual								
1970	151							
1975	164							
1980	213							
1985	235							
1990	355		232	387				
Projected								
1995		-	250	394	407	390	351	370
2000		379.2		400	410	-	408	417
2005		-	296	-	-	-	-	435
2010		405.8	-	408	450	-	444	-
2015		-	-	-	-	-	-	-
2020		441.6	-	415	526	440	-	-

[a] Source: Seattle-Tacoma International Airport, *"Traffic and Operations Report."*

[b] Based on mid-range forecast.

[c] Source: Peat, Marwick & Co., Master Plan Update for Seattle-Tacoma International Airport, Working Paper Task 7 - Forecast Review and Assessment, July 1984.

[d] Source: P&D Technologies, Comprehensive Planning Review, Working Paper No. 1 - Airspace Study, March 1988.

[e] Apogee Research, Aircraft Operations at Sea-Tac from 1990 to 2020, November 1990.

[f] Source: P&D Aviation, The Flight Plan Project Phase III, Working Paper No. 5 - Allocation of Passengers and Aircraft Operations, August 1991.

[g] Source: Federal Aviation Administration, FAA Aviation Forecasts, Seattle-Tacoma Hub, October 1992. Includes only commercial aircraft operations.

[h] Source: Federal Aviation Administration, Terminal Area Forecasts, FY 1993-2005, July 1993.

FIGURE 5-6
COMPARISON OF OPERATIONS FORECASTS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT

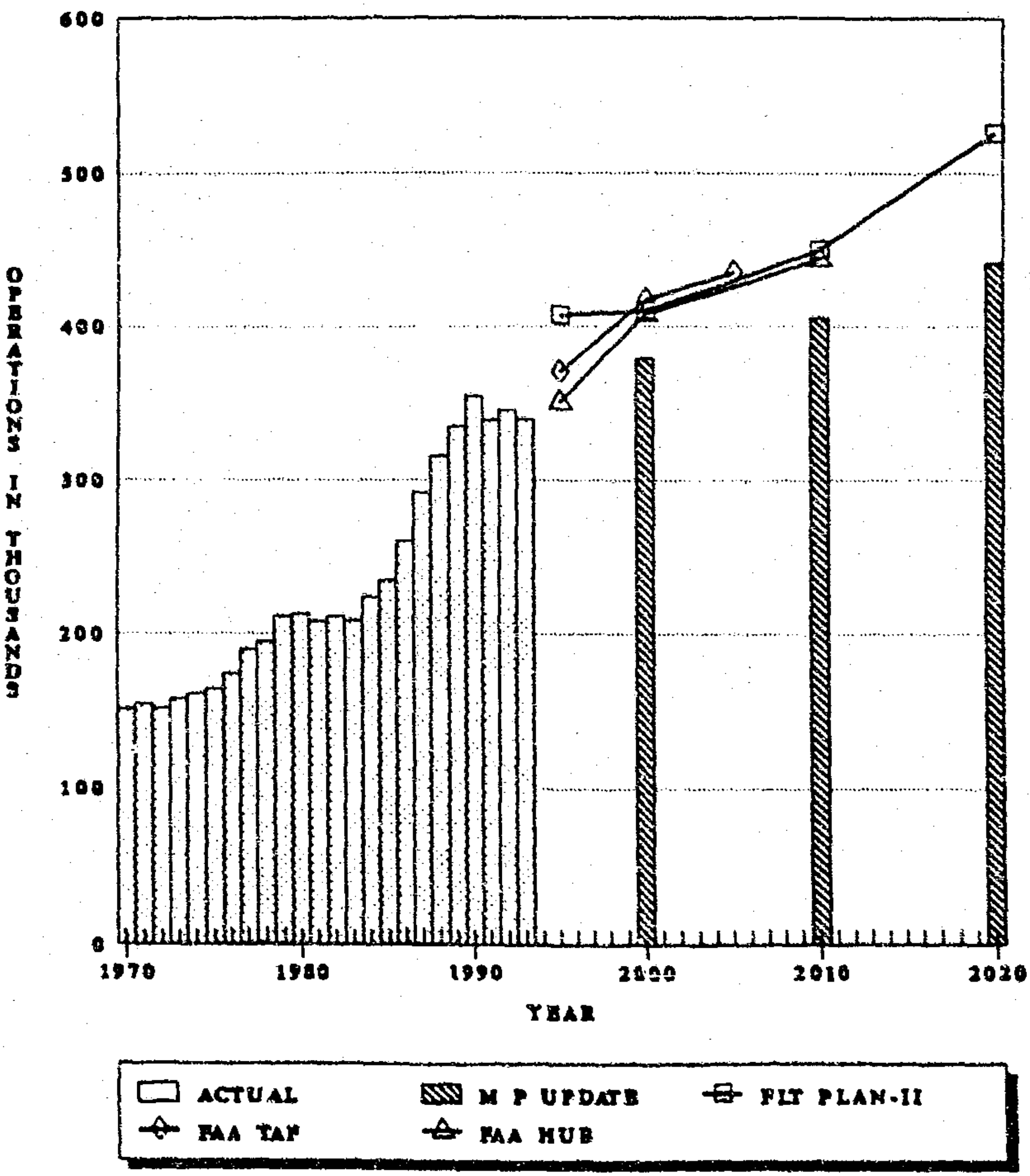


TABLE 5-17
FLEET MIX FORECAST FOR AIRLINE AIRCRAFT OPERATIONS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

Aircraft Category [b]	Actual 1993	Forecast 2000	2010	2020
Air Taxi/Commuter Passenger Aircraft (60 Seats or Less)				
Under 10 Seats				
Average Seats Per Aircraft	8	8	8	8
Percent of Operations	9%	8%	7%	6%
11-20 Seats				
Average Seats Per Aircraft	19	19	19	19
Percent of Operations				
J31, Metro	43%	37%	29%	21%
21-60 Seats				
Average Seats Per Aircraft	40	42	46	50
Percent of Operations				
S360, DHC-8, J41	48%	41%	33%	23%
ATR 42	0%	14%	31%	50%
Subtotal	48%	55%	64%	73%
Total Air Taxi/Commuter Passenger Aircraft				
Average Seats	**28**	**31**	**36**	**41**
Percent of Operations	**100%**	**100%**	**100%**	**100%**
Air Carrier Passenger Aircraft (Over 60 Seats)				
61-90 Seats				
Average Seats Per Aircraft	65	66	68	70
Percent of Operations				
F-28	6.0%	4%	2%	1%
ATR 72, RJ 70/85	0%	1%	2%	2%
Subtotal	6.0%	5%	4%	3%
91-120 Seats				
Average Seats Per Aircraft	109	109	110	110
Percent of Operations				
B737-100/200/500, F100	4.7%	5%	5%	5%
121-170 Seats				
Average Seats Per Aircraft	138	144	152	160
Percent of Operations				
B727	12.3%	5%	0%	0%
B737-300/400	24.7%	25%	24%	20%
MD80, MD90	23.7%	24%	20%	15%
A319, A320	2.5%	3%	4%	5%
Subtotal	63.1%	57%	48%	40%

TABLE 5-17
FLEET MIX FORECAST FOR AIRLINE AIRCRAFT OPERATIONS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

Aircraft Category [b]	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
171-240 Seats				
Average Seats Per Aircraft	190	195	203	210
Percent of Operations				
B757-200	12.6%	13%	14%	15%
B767-200	1.3%	4%	7%	9%
A310, A321	0%	1%	3%	5%
Subtotal	13.9%	18%	24%	29%
241-350 Seats				
Average Seats Per Aircraft	270	280	295	310
Percent of Operations				
A300	1.6%	2%	4%	5%
B767-300	1.6%	6%	10%	12%
L1011, DC10	7.9%	4%	0%	0%
A340-200	0%	1%	2%	2%
Subtotal	11.0%	13%	16%	19%
Over 350 Seats				
Average Seats Per Aircraft	350	370	400	430
Percent of Operations				
B747	0.6%	0.5%	0.8%	1%
MD-11	0.6%	0.5%	0.8%	1%
A340-400, A330	0%	0.5%	0.7%	1%
B777, MD-12	0%	0.5%	0.7%	1%
Subtotal	1.3%	2%	3%	4%
Total Air Carrier Passenger Aircraft				
Average Seats Per Aircraft	155	169	189	209
Percent of Operations	100%	100%	100%	100%
All-Cargo Aircraft [c]				
Under 60,000 Pounds Gross Weight	36.0%	31%	25%	20%
60,000-250,000 Pounds Gross Weight	40.0%	43%	47%	50%
Over 250,000 Pounds Gross Weight	24.0%	26%	28%	30%
Total	100%	100%	100%	100%

[a] Source: P&D Aviation
[b] Aircraft models shown are representative of types in the forecasted fleet. Some aircraft in later years will be new aircraft, but are projected to be of the same size as those listed.
[c] Based on the portion of all-cargo flights by aircraft over 60,000 pounds maximum gross takeoff weight increasing from 64 percent in 1993 to 69 percent in 2000, 75 percent in 2010 and 80 percent in 2020.

TABLE 5-18
FORECAST OF AVERAGE DAILY OPERATIONS BY TYPE OF AIRCRAFT AT
SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

Aircraft Category [b]	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
Average Daily Operations by Air Taxi/ Commuter Passenger Aircraft (60 Seats or Less)				
Under 10 Seats				
All Types	31.3	27.9	22.6	19.2
11-20 Seats				
J31, Metro	149.6	128.7	93.8	67.3
21-60 Seats				
S360, DHC-8, J41	167.0	142.6	106.7	73.7
ATR 42	0	48.7	100.2	160.3
Total Air Taxi/Commuter Passenger Aircraft	347.9	347.9	323.3	320.5
Average Daily Operations by Air Carrier Passenger Aircraft (Over 60 Seats)				
61-90 Seats				
F-28	30.9	9.1	0	0
ATR 72, RJ 70/85	0	21.4	27.9	23.6
91-120 Seats				
B737-100/200/500, F100	24.2	30.6	34.9	39.3
121-170 Seats				
B727	63.3	15.3	0	0
B737-300/400	127.1	159.1	167.7	157.3
MD80, MD90	122.0	148.6	139.7	117.9
A319, A320	12.8	25.3	27.9	39.3
171-240 Seats				
B757-200	64.9	79.4	97.8	117.9
B767-200	6.7	24.5	48.9	70.8
A310, A321	0	6.1	21.0	39.3
241-350 Seats				
A300	8.2	12.2	27.9	39.3
B767-300	8.2	36.7	69.9	94.4
L1011, DC10	40.6	24.4	0	0
A340-200	0	6.1	14.0	15.7
Over 350 Seats				
B747	3.1	3.1	5.6	7.9
MD-11	3.1	3.1	5.6	7.9
A340-400, A330	0	3.0	4.9	7.9
B777, MD-12	0	3.0	4.9	7.8
Total Air Carrier Passenger Aircraft	515.1	611.0	698.6	786.3

TABLE 5-18
FORECAST OF AVERAGE DAILY OPERATIONS BY TYPE OF AIRCRAFT AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

Aircraft Category [b]	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
Average Daily Operations by All-Cargo Aircraft				
Under 60,000 Pounds	15.8	17.0	15.8	14.8
60,000-250,000 Pounds	17.5	23.6	29.6	37.0
Over 250,000 Pounds	10.5	14.2	17.6	22.2
Total	43.8	54.8	63.0	74.0
Average Daily Operations by Other Aircraft				
General Aviation	22.2	24.4	26.0	28.2
Military	0.8	0.8	0.8	0.8
Total Average Daily Aircraft Operations				
Airport Total	930.0	1038.9	1111.7	1209.8

[a] Source: P&D Aviation

[b] Aircraft models shown are representative of types in the forecasted fleet. Some aircraft in later years will be new aircraft models, but are projected to be of the same size as those listed.

2020.

In Table 5-18, the fleet mix percentages in Table 5-17 have been multiplied times the number of passenger and all-cargo operations to obtain the forecast of average daily operations by aircraft type.

The Airport Master Plan Update forecasts of average daily passengers are compared with forecasts developed in the 1991 FAR Part 150 Noise Exposure Map Update in Table 5-19. The fleet mix for 2000 contained in the Airport Master Plan Update contains approximately 24 average daily departures of Stage II (nosier) aircraft, which is within the limits established under the Final Package of Mediated Noise Abatement Actions, Noise Budget, Dated January 1, 1991.

PEAK HOUR AND DAY/NIGHT OPERATIONS FORECASTS

In future years, the percentage of peak month to annual operations of each type is projected to remain at the same level as the average of the past 5 years (Table 3-12). Similarly, the percentage of operations in the peak hour of the average day peak month (ADPM) to peak month operations is expected to remain at the 1993 level for each type of operation. Because the hourly distribution of operations was relatively flat in 1993, the peak hour percentages are not projected to decrease in spite of increases in operations over time. Applying this methodology, the total number of operations in the peak hour of the ADPM is projected to increase from 76 in 1993 to 85 in 2000, 91 in 2010 and 101 in 2020 (Table 5-20). The percent of operations by air carrier aircraft in the peak hour is expect to increase from 63 percent in 1993 to 72 percent in 2020. The number of peak hour operations will be an important factor in comparing annual peak hour aircraft demand with annual airfield peak hour operating capacity.

In Table 5-21 the day-night distribution of aircraft operations by type for 1993 is shown. Passenger aircraft operations data for this table are based on the published schedule from Official Airline Guide for August 1993. Other operations data are based on reports from the FAA air traffic control tower for August 1993. This data will be considered in evaluating aircraft noise at the airport. Aircraft noise generated from night-time (10 p.m. to 7:00 a.m.) operations is weighted more heavily than from daytime operations. Under the Final Package of Mediated Noise Abatement Actions, Nighttime Limitations Program, dated October 1, 1990, Stage II aircraft may not operate at the airport between 10:00 p.m. and 7:00 a.m. after October 1, 1995.

TABLE 5-19
COMPARISON OF FLEET MIX FORECAST FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT WITH 1991 NOISE EXPOSURE MAP UPDATE, 1993 TO 2000

Aircraft Type	Average Daily Aircraft Operations		
		Forecast for Year 2000	
	Actual 1993 [a]	Master Plan Update (1994) [b]	Noise Exposure Map Update (1991) [c]
Stage III Jets			
A300	8.2	12.2	17.7
A310	0	6.1	10.6
A320	12.8	25.3	30.1
A340	0	6.1	0
B737-300, 400	127.1	159.1	157.0
B747	3.1 [d]	3.1 [d]	54.9
B757	64.9	79.4	106.2
B767	6.7	24.5	21.2
B777/MD12	0	3.0	0
DC10/L1011	40.6	24.4	28.3
MD11	3.1	3.1	26.6
MD80/MD90	122.0	148.6	182.3
Stage II Jets			
B727	63.3	15.3	17.7
B737-200	[e]	[e]	9.7
DC9	0	0	3.5
F28	30.9	9.1	2.5
Turboprop Commuter Aircraft			
All Types	347.9	354.0	383.2

[a] Source: P&D Aviation analysis based on Official Airline Guide, August 1993, data.

[b] Source: P&D Aviation analysis.

[c] Source: Port of Seattle, Seattle-Tacoma International Airport, Noise Exposure Map Update: 1991, April 15, 1993.

[d] Excludes air cargo flights.

[e] Combined with B737-500, which is a Stage III aircraft.

TABLE 5-20
FORECAST OF PEAK HOUR OPERATIONS IN THE AVERAGE DAY OF THE PEAK MONTH AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 TO 2020 [a]

Type of Operation	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
Peak Month Operations (Thousands)				
Air Carrier	19.7	23.5	26.9	30.6
Air Taxi/Commuter	11.6	11.6	10.8	10.6
General Aviation	0.9	1.0	1.1	1.2
Military	[b]	[b]	[b]	[b]
Total	32.2	36.1	38.8	42.4
Operations on Average Day of Peak Month (ADPM)				
Air Carrier	666	757	869	987
Air Taxi/Commuter	390	373	348	342
General Aviation	39	32	35	39
Military	1	1	1	1
Total	1,056	1,163	1,253	1,369
Operations in the Peak Hour of ADPM				
Air Carrier	48	57	65	74
Air Taxi/Commuter	26	26	24	24
General Aviation	2	2	2	3
Military	0	0	0	0
Total	76	85	91	101

[a] Source: P&D Aviation.

[b] Value is rounded to zero.

TABLE 5-21
ESTIMATED PERCENTAGE OF OPERATIONS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT BY TIME OF DAY, 1993

Type of Operation	Total	Day (7:00 a.m. to 7:00 p.m.)	Night (10:00 p.m. to 7:00 a.m.
Air Carrier Passenger Operations [a]	100.0	85.6	14.4
Air Taxi/Commuter Passenger Operations [a]	100.0	89.7	10.3
Air-Cargo Operations [a]			
Aircraft Under 60,000 Pounds Gross Weight	100.0	72.2	27.8
Aircraft of 60,000 Pounds Gross Weight and Over	100.0	53.1	46.9
Military Operations [b]	100.0	100.0	0.0
General Aviation Operations [b]	100.0	90.6	9.4

[a] Based on data from Official Airline Guide for August 1993.

[b] Based on data from the FAA Air Traffic Control Tower for August 1993.

Section 6
GROUND ACCESS FORECASTS

SECTION 6
GROUND ACCESS FORECASTS

INTRODUCTION

This section describes the process, methodology and results of the ground access forecasts for Seattle-Tacoma International Airport. Activity is based on existing conditions (1992-93 records) and most recent aviation demand forecasts for 2000, 2010, and 2020. Ground access patterns reflect existing travel behavior projected to each of the analysis years. Travel patterns are based on the findings of the Task 4 Inventory Report and reflect mode split, vehicle occupancy rates, diurnal travel patterns, vehicle recirculation, and parking data provided by the Port of Seattle for this study. Data for ground access to cargo facilities and non-terminal employment has not been provided, nor has future terminal employment levels or parking policies. Thus, current levels of these activities are incorporated for the basic 2020 conditions forecast without looking at future employment level or cargo/ delivery activities, but retaining compatibility with the Puget Sound Regional Council's (PSRC) 2020 long-range transportation planning efforts.

The P&D team used a computer simulation model known as Airport Landside Planning System (ALPS). ALPS can synthesize ground access data in a comprehensive and somewhat interactive method to address the related issues of passenger, vehicular and daily ground access travel patterns in a unified way of addressing ground access and developing future ground access forecasts. The existing roadway system was the basis for forecasting adequacy of facilities and travel volumes grow.

PURPOSE

These forecasts have been prepared as an element of the Airport Master Plan Update to be used to develop requirements for ground access facilities and estimate the time frame when improvements are needed. These forecasts will also be used in developing future terminal options and examining regionwide long-range transportation plans developed by the Puget Sound Regional Council for 2020 travel conditions required by the Federal Intermodal System Transportation Efficiency Act (ISTEA).

These projections serve as overall estimates of future conditions rather than precise predictions. These estimates, as well as the actual ground access activity at the terminal and the Sea-Tac site, should be reviewed frequently in coming years. To the degree possible, a regular reporting system covering all important ground access information should be developed to assist in updating future forecasts and allow existing deficiencies to be corrected in a timely manner. This reporting system should cover vehicular traffic, freight traffic, and other key ground access modes.

ALPS FORECAST METHODOLOGY - TERMINAL ACCESS CONDITIONS

The ALPS model uses existing conditions to establish a "calibrated" system that can replicate existing ground access conditions. Once the model can replicate existing conditions it can be used to forecast future ground access conditions based on levels of terminal passenger activity, ground travel assumptions, and the terminals access facilities and configuration. In the case of the Sea-Tac terminal, two critical steps were to produce estimates of passenger activity for August 1993 (the base period for analysis) and to determine passenger/visitor/employee travel behavior patterns since August is the peak passenger demand month through the terminal. Tables 6-1 and 6-2 show the data and basic assumptions used as inputs to the ALPS model to replicate base period conditions.

Table 6-1 is based on the enplaned (boarding) and deplaned (arriving) air passenger activity for 1993 through 2020. To predict ground activity properly, interconnecting passengers transferring from one flight to another were excluded from this estimate so that only passengers arriving or departing the airport by ground were calculated. This ground access estimate reduces passenger demand by about 30% from total enplaned and deplaned travelers (reflecting actual arriving and departing passengers at the terminal curb, excluding transfers).

To replicate actual conditions, the model works with hourly and fifteen minute passenger travel patterns. Thus, departing passengers are assumed to be at the terminal before a plane departs, while arriving passengers quickly leave the terminal after a plane lands. Both arriving and departing passengers may be greeted or seen off by well wishers and these terminal visitors are also calculated based on actual shifts. Airport employees working in the terminal are also calculated for ground access conditions. These "profiles" are adjusted to meet actual conditions at Sea-Tac based on data collected earlier or from "default" values based on values from studies of other air terminals in the United States. Table 6-2 lays out some of the values used in the calibrated ALPS model.

P&D Aviation staff worked with the ALPS model to develop a forecast tool that could replicate August 1993 conditions, plus estimate future conditions. Figure 6-1 and Table 6-3 show the results of the model output and count locations with regard to the terminal site. The upper and lower roadway totals and short-term parking activity compare closely with data for actual August terminal vehicular activity. The data for the access roads allows the terminal to "fit" into regional projections and are based on Average Daily Traffic (ADT) increased by about 30% to match August travel conditions on-site. Table 6-4 shows ADT on-site for an average day during the year.

Other travel forecasts estimate traffic to the terminal based on existing travel patterns, behavior and characteristics used to develop the 1993 model. However, it is possible that changing conditions or policies (public policy or general behavioral changes) could alter ground access forecasts for 2000, 2010 or 2020.

AREA GROUND ACCESS FACILITIES AND TRENDS

In the period from 1988 to 1992 the Sea-Tac terminal handled an increase of over 18% in daily enplaned and deplaned passengers, or about 33,000 passengers arriving or departing the terminal building on an average day in 1992. This increase might be presumed to have resulted in a proportional increase in ground traffic. Table 6-5 includes a summary of recent traffic counts for ADT on surface streets near the terminal leading to terminal entrances from SR 99 or arterial streets connecting to I-5 or SR 509 or 518. While counts were not available at each point for each year for the 1988-1991/92 period, enough traffic counts at the same points were made to show that actual traffic volumes increased very little during the four year period. Overall, traffic counts for the area showed very little change, representing less than one-half of one percent traffic increase annually for the period. The reasons for the disparity in increase in vehicle trips to the airport compared to passenger activity is not clear. Port policy changes in encouraging vans, for-hire shuttles, parking policies in the garage, and courtesy

TABLE 6-1
SEA-TAC TOTAL AUGUST PASSENGER GROUND ACTIVITY FOR EXISTING AND PROJECTED TRAVEL DEMAND [a] (EXCLUDES CONNECTING PASSENGERS)

Actual 1993					Year 2000				
	Hourly		15 Minute Share			Hourly		15 Minute Share	
Hour	Boarding	Arriving	Boarding	Arriving	Hour	Boarding	Arriving	Boarding	Arriving
2400	189	651	47	163	2400	239	824	60	206
100	147	0	37	0	100	186	0	47	0
200	0	0	0	0	200	0	0	0	0
300	0	70	0	18	300	0	89	0	22
400	0	0	0	0	400	0	0	0	0
500	0	413	0	103	500	0	523	0	131
600	1,365	518	341	130	600	1,728	656	432	164
700	2,268	889	567	222	700	2,871	1,125	718	281
800	2,527	1,050	632	263	800	3,199	1,329	800	332
900	1,253	889	313	222	900	1,586	1,125	397	281
1000	1,225	2,023	306	506	1000	1,551	2,561	388	640
1100	1,505	2,387	376	597	1100	1,905	3,022	476	755
1200	1,967	1,624	492	406	1200	2,490	2,056	623	514
1300	2,842	1,323	711	331	1300	3,598	1,675	899	419
1400	1,113	994	278	249	1400	1,409	1,258	352	315
1500	1,407	1,281	352	320	1500	1,781	1,622	445	405
1600	945	784	236	196	1600	1,196	993	299	248
1700	973	1,638	243	410	1700	1,232	2,074	308	518
1800	1,582	1,519	396	380	1800	2,003	1,923	501	481
1900	1,386	1,582	347	396	1900	1,755	2,003	439	501
2000	721	2,464	180	616	2000	913	3,119	228	780
2100	637	2,016	159	504	2100	806	2,552	202	638
2200	763	798	191	200	2200	966	1,010	241	253
2300	728	644	182	161	2300	922	815	230	204
Total	25,543	25,557	6,386	6,389	Total	32,337	32,355	8,084	8,089

[a] Source: P&D Aviation. Numbers may be slightly different in other exhibits due to program "rounding".

TABLE 6-1 (Continued)
SEA-TAC TOTAL AUGUST PASSENGER GROUND ACTIVITY FOR EXISTING AND PROJECTED TRAVEL DEMAND [a] (EXCLUDES CONNECTING PASSENGERS)

Year 2010					Year 2020				
	Hourly		15 Minute Share			Hourly		15 Minute Share	
Hour	Boarding	Arriving	Boarding	Arriving	Hour	Boarding	Arriving	Boarding	Arriving
2400	308	1060	77	265	2400	356	1,308	89	327
100	239	0	60	0	100	280	0	70	0
200	0	0	0	0	200	0	0	0	0
300	0	114	0	28	300	0	144	0	36
400	0	0	0	0	400	0	0	0	0
500	0	672	0	168	500	0	828	0	207
600	2,222	843	556	211	600	2,740	1,044	685	261
700	3,692	1,447	923	362	700	4,556	1,784	1,139	446
800	4,114	1,709	1,029	427	800	5,072	2,112	1,268	528
900	2,040	1,447	510	362	900	2,516	1,784	629	446
1000	1,994	3,294	499	823	1000	2,460	4,068	615	1,017
1100	2,450	3,886	613	972	1100	3,020	4,796	755	1,199
1200	3,202	2,644	801	661	1200	3,952	3,264	988	816
1300	4,627	2,154	1,157	538	1300	5,698	2,650	1,425	665
1400	1,812	1,618	453	405	1400	2,236	2,000	559	500
1500	2,291	2,086	573	521	1500	2,828	2,572	707	643
1600	1,539	1,276	385	319	1600	1,896	1,576	474	394
1700	1,584	2,667	396	667	1700	1,952	3,296	488	824
1800	2,576	2,473	644	618	1800	3,184	3,052	796	763
1900	2,257	2,576	564	644	1900	2,788	3,184	697	796
2000	1,174	4,012	293	1003	2000	1,446	4,952	362	1,238
2100	1,037	3,282	259	821	2100	1,284	4,052	321	1,013
2200	1,242	1,299	311	325	2200	1,536	1,608	384	402
2300	1,185	1,048	296	262	2300	1,464	1,292	366	323
Total	41,586	41,609	10,396	10,402	Total	51,266	51,376	12,816	12,844

[a] Source: P&D Aviation. Numbers may be slightly different in other exhibits due to program "rounding".

TABLE 6-2
SEA-TAC MASTER PLAN UPDATE
POPULATION CLASSIFICATIONS, ACCESS PATTERNS AND EXISTING CONDITIONS MODEL ASSUMPTIONS [a]

Type	Vehicle Classification	Occupancy
Curb User	Automobile - curbside pick-up/drop-off	1.25
Courtesy Vehicle	Free courtesy van	1.8
Taxi	For-hire taxi	1.5
Arrival Visitor	Meets arriving passengers	1.2
Departing Visitor	Departing wellwishers	1.2
Workers	On-site workers - garage parkers	1.2
Employees	On-site workers - south lot users	1.2
Metro	Metro public transit users	6.0
Bus	For hire airporter service	8.0
Hire	For hire vans	2.5
Passengers	On-site short-term parking	1.2

Type	Share	By Access Point and Direction		
		SR 99 (S) [b]	SR 99 (N) [b]	Freeway (Both Ways)
Curb User	12.1%	3.03%	1.82%	7.26%
Courtesy Vehicle	11.9%	2.98	1.79	7.14
Taxi	2.6%	.65	.39	1.56
For Hire Van	1.7%	.43	.26	1.02
Metro Bus	1.4%	.35	.21	.84
For Hire Buses	6.6%	1.65	.99	3.96
On-Site/STP	38.0%	9.50	5.70	22.80
On-Site/LTP	0.5%	.13	.08	.30
Car Rental	5.2%	1.30	.78	3.12
Off-Site Parking	20.0%	5.00	11.00	4.00
Total	100.0%	24.94%	23.01%	52.05%

[a] Source: P&D Aviation. Assumptions, based on previous reports:

Ground access is used by 70% of passengers; the balance are transfers.
30% of departing passengers are accompanied by well wishers.
40% of arriving passengers are met by greeters.
25-30% of short-term parkers also pick-up or drop-off passengers at the curb.

[b] S - from south of SR99 entrance to terminal.
N - from north of SR99 entrance to terminal.

FIGURE 6-1
TRAFFIC COUNT POINTS

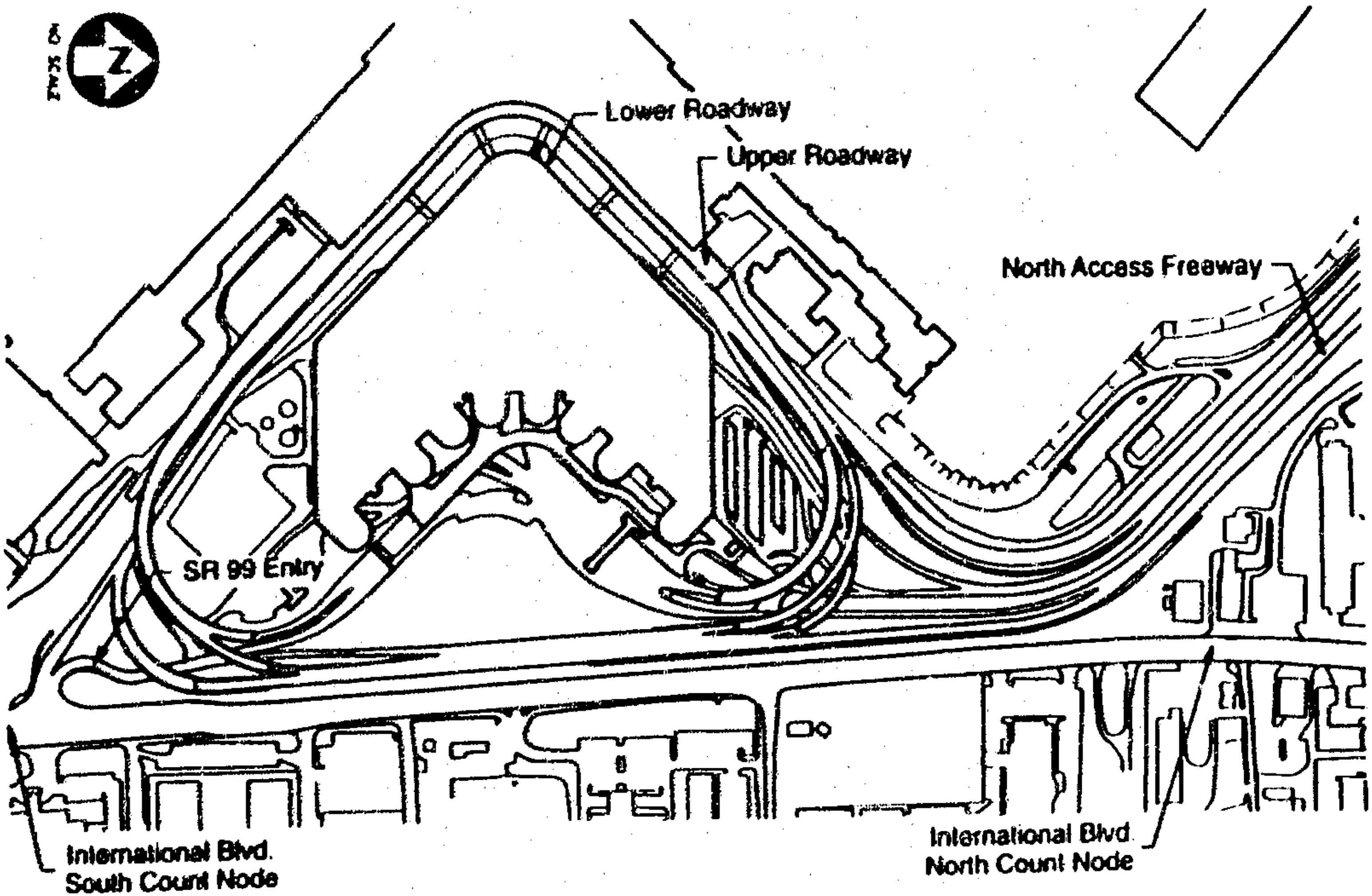


TABLE 6-3
CHANGES IN AUGUST DAILY TRAFFIC - CURRENT TRENDS
EXISTING TO 2020 CONDITIONS [a]
(ADT - Average Daily Traffic)

Count Point	Estimated Existing ADT [b]	Projected 2000 ADT	Projected 2010 ADT	Projected 2020 ADT
North Access Freeway				
Southbound	20,114	24,777	31,436	34,812
Northbound	23,587	28,476	35,457	39,168
Upper Terminal Roadway	11,585	14,144	17,817	20,828
Lower Terminal Roadway	15,409	16,908	20,681	26,223
SR 99 - Entry Road	16,022	18,522	22,194	25,176
Short-Term Parking (Noon-1:00 PM)	1,042	1,274	1,579	1,631
International Boulevard North Count Node				
Southbound	5,705	7,165	9,260	11,185
Northbound	6,188	7,639	9,712	11,612
International Boulevard South Count Node				
Southbound	7,650	9,154	11,292	12,828
Northbound	11,589	13,293	15,733	17,579

[a] Source: P&D Aviation

[b] Existing ADT records from Washington State DOT and the City of Sea-Tac are the bases for existing conditions. August ADT on-site at Sea-Tac is 30-35 percent greater than average ADT counts.

TABLE 6-4
CHANGES IN AVERAGE DAY FLOW - CURRENT TRENDS
AVERAGE DAY EXISTING AND 2020 CONDITIONS [a]
(ADT - Average Daily Traffic)

Count Point	Estimated Existing ADT [b]	2020 Projected ADT
North Access Freeway		
Southbound	14,876	27,657
Northbound	18,104	31,501
Upper Terminal Roadway	8,819	15,701
Lower Terminal Roadway	12,197	18,538
SR 99 - Entry Road	13,296	20,698
Short-Term Parking (Noon-1:00 PM)	457	692
International Boulevard North Count Node		
Southbound	4,064	8,076
Northbound	4,557	8,534
International Boulevard South Count Node		
Southbound	5,965	10,007
Northbound	9,673	14,350

[a] Source: P&D Aviation.

[b] Existing ADT records from Washington DOT and the City of Sea-Tac are the bases for existing conditions.

TABLE 6-5
LOCAL ACCESS ROAD TRAFFIC COUNT SUMMARY
SEA-TAC INTERNATIONAL AIRPORT VICINITY [a]
(TOTAL AVERAGE DAILY TRAVEL - VEHICLE COUNTS)

Location	Direction	Year	
		1991/92	1988
S. 200 St/International Blvd.	East	16,235	17,088
	North	33,700	No Count
	South	33,925	No Count
	West	10,129	10,799
S. 200 St/28th Ave. South	East	10,129	10,799
	North	2,652	2,436
	South	3,418	2,678
	West	9,530	9,928
S. 188 St/28th Ave. South	East	28,628	25,865
	North	5,687	7,223
	South	6,690	5,714
	West	25,239	25,363
S. 188 St/International Blvd.	East	27,752	28,221
S. 170 St/International Blvd.	East	6,812	6,110
	North	23,860	No Count
	South	27,370	No Count
	West	13,646	12,556
S. 176 St./International Blvd.	East	15,107	14,649
S. 160 St./International Blvd.	East	8,571	8,328
	West	4,732	4,598
S. 154 St./24th South	East	8,059	7,907
	North	5,984	5,681
	Southeast	7,475	6,800
	West	9,100	9,143
Totals for sites with 2 counts	Annual Change +0.425%		

[a] Source: Washington State DOT, Annual traffic count program records 1983-1992. City of Sea-Tac, Annual traffic count program records 1985-1992.

vehicle access since 1988 could be responsible for the minimal increases in traffic in the terminal area.

Traffic on the limited access roads surrounding the airport area also showed a somewhat different growth in traffic patterns since 1988. As shown in Table 6-6 traffic growth on freeways surrounding the Sea-Tac terminal also grew well below the growth in terminal passenger traffic at about 2.6% annually, reflecting traffic patterns throughout the region.

The important observation is that traffic growth at the terminal has not grown proportionately to passenger traffic and that future terminal traffic may need to be projected differently than overall regional traffic trends.

In addition, Table 6-7 and Figures 6-2 show the existing ADT of regional and arterial roads in the Sea-Tac terminal vicinity and their capacity of operation to handle existing traffic.

Figures 6-3, 6-4, 6-5, 6-6, 6-7 and 6-8 show ALPS assignments for existing and future operating terminal conditions. Case 1 and Case 3 show existing conditions for August and average day operations. Case 2 and Case 4 show conditions projected for 2020, August and average day operations, respectively. Case 5 and Case 6 show projections for August operations for the years 2000 and 2010, respectively. The figure colors show on-site projected levels of service, with existing facilities in place.

FUTURE FORECAST ALTERNATIVES - PSRC 2020 TRANSPORTATION PLANNING

The Sea-Tac terminal and airfield complex exist within the greater Seattle-Tacoma regional transportation system. While the airport may behave somewhat differently than the surrounding community, overall ties to the Puget Sound area require that these connections be examined.

The Puget Sound Regional Council (PSRC) is undertaking its own examination of future regional transportation conditions for the 2020 period. Using economic and demographic forecasts for the region, PSRC is developing alternatives to satisfy regional transportation needs. Alternative ground access studies being performed for the Sea-Tac Airport Master Plan are being designed to compliment the PSRC's regional transportation planning approach. Thus, as part of the examination of future alternatives the P&D team will develop ground access strategy options that are consistent with the larger regional alternatives being studied.

Figure 6-9 shows the PSRC's approach toward defining regional alternatives and investment strategies. The 2020 traffic estimates included in this report can be considered a response to the defined strategy Alternative 1 - Baseline: Current Conditions. Further work will address how this baseline state (existing trends) works in the future and how it complies with regional fiscal and environmental constraints and requirements. In addition, P&D will work to define how Alternative 2 - System Management Emphasis and Alternative 3 - Expanded Travel Options work with the PSRC's strategy analysis and emphasis on improving transportation productivity, meeting air quality standards, and using pricing mechanisms, etc. to address the transportation needs of the Puget Sound area.

The objective of the PSRC long range plan approach is to examine how trade-offs between investments in added capital facilities versus traffic control strategies work and to see the effectiveness of different concepts. In Figure 6-9, the Baseline concept sets the stage for examining future travel conditions with few changes to the regional travel system (e.g., Only High Occupancy Vehicle lanes in I-5 are

TABLE 6-6
REGIONAL ACCESS ROAD TRAFFIC COUNT SUMMARY
SEA-TAC INTERNATIONAL AIRPORT VICINITY [a]

Route	Location	Year	
		1992	1989
I-5	South 174th St.	153,989	133,363
	South 188th St.	174,636	153,670
SR 509	North of SR 518	53,800	47,100
	South of SR 518	38,400	30,400
SR 518	East of SR 509	55,300	54,700
	SR 99 Ramp	83,000	85,100
Totals for sites with 2 counts	Annual Change +2.6%		

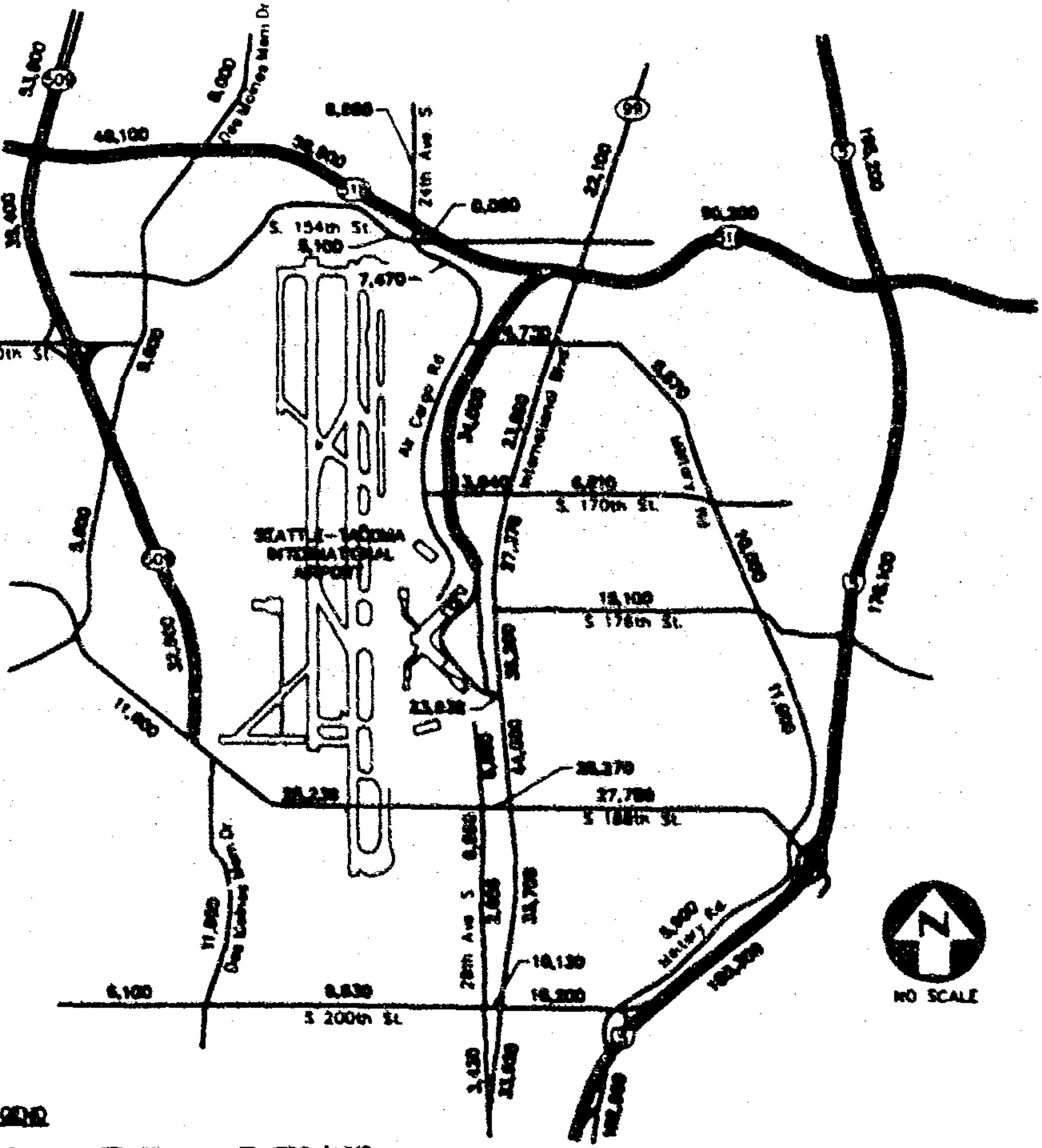
[a] Source: Washington DOT Annual Traffic Report, 1992.

TABLE 6-7
EXISTING VOLUME TO CAPACITY SUMMARY FOR SEA-TAC VICINITY ROADWAYS [a]

Roadway	From	To	Lanes	Capacity	Volume	V/C
I-5	N. of SR 518	SR 518	8	120,000	195,200	1.63
	SR 518	S. 188th St.	8	120,000	178,100	1.48
	S. 188th St.	S. 200th St.	8	120,000	180,300	1.50
	S. 200th St.	South of S. 200th St.	8	120,000	182,500	1.52
SR 509	North of SR 518	SR 518	4	66,000	53,800	0.82
	SR 518	S. 160th St.	4	66,000	38,400	0.58
	S. 160th St.	S. 188th St.	4	66,000	32,600	0.49
SR 518	SR 509	Des Moines Dr.	4	66,000	48,100	0.73
	Des Moines Dr.	24th Ave. S.	4	66,000	58,900	0.89
	24th Ave. S.	N. Airport Access Rd.	4	66,000	na	na
	N. Airport Access Rd.	I-5	5	78,000	90,200	1.16
N. Airport Access Rd.	SR 518	Airport Terminal	6	90,300	34,000	0.38
24th Ave. S.	North of S. 154th St.	S. 154th St.	2	16,000	6,983	0.44
Air Cargo Rd.	S. 154th St.	Military Rd.	2	16,000	7,470	0.47
Des Moines Mem. Dr.	North of SR 518	SR 518	4	24,000	8,000	0.33
	SR 518	S. 160th St.	4	24,000	9,600	0.40
	S. 160th St.	Normandy Rd.	4	24,000	5,600	0.23
	SR 509	S. 200th St.	4	24,000	11,900	0.50
International Blvd.	North of SR 518	SR 518	4	29,000	22,100	0.76
	SR 518	S. 170th St.	4	29,000	23,860	0.82
	S. 170th St.	S. 176th St.	4	29,000	27,370	0.94
	S. 176th St.	S. Airport Entrance	4	29,000	36,200	1.25
	S. Airport Entrance	S. 188th St.	4	29,000	44,000	1.52
	S. 188th St.	S. 200th St.	4	29,000	33,700	1.16
	S. 200th St.	South of S. 200th St.	4	29,000	33,925	1.17
Military Rd.	International Blvd.	S. 170th St.	2	16,000	8,570	0.54
	S. 170th St.	S. 176th St.	2	16,000	10,000	0.63
	S. 176th St.	S. 188th St.	2	16,000	11,600	0.73
	S. 188th St.	S. 200th St.	2	16,000	5,900	0.37
South 154th St.	Des Moines Mem. Dr.	24th Ave. S.	2	16,000	5,100	0.32
	24th Ave. S.	International Blvd.	2	16,000	7,470	0.47
South 170th St.	N. Airport Access Rd.	International Blvd.	2	16,000	13,640	0.85
	International Blvd.	Military Rd.	2	16,000	6,810	0.43
South 176th St.	International Blvd.	Military Rd.	2	16,000	15,100	0.94
South 188th St.	Des Moines Mem. Dr.	28th Ave. S.	4	24,000	25,239	1.05
	28th Ave. S.	International Blvd.	4	24,000	28,270	1.18
	International Blvd.	I-5	4	29,000	27,750	0.96
South 200th St.	W of Des Moines Mem. Dr.	Des Moines Mem. Dr.	2	16,000	6,100	0.38
	Des Moines Mem. Dr.	28th Ave. S.	2	16,000	9,530	0.60
	28th Ave. S.	International Blvd.	2	16,000	10,130	0.63
	International Blvd.	I-5	2	16,000	16,200	1.01

[a] Sources Washington DOT ADT records - 1992; City of Sea-Tac ADT records - 1992; and King County Highway Capacity Guidelines

FIGURE 6-2
REGIONAL HIGHWAY SYSTEM TRAFFIC VOLUMES, 1992



LEGEND

10,000 - AVERAGE DAILY TRAFFIC (ADT)

SOURCES: 1. CITY OF SEATAC COMPREHENSIVE TRANSPORTATION PLAN, THE TRANSPO GROUP, 1991
2. WASHINGTON STATE DOT COUNTS (1983-1992)
3. CITY OF SEATAC - ANNUAL COUNTS 1985-1992

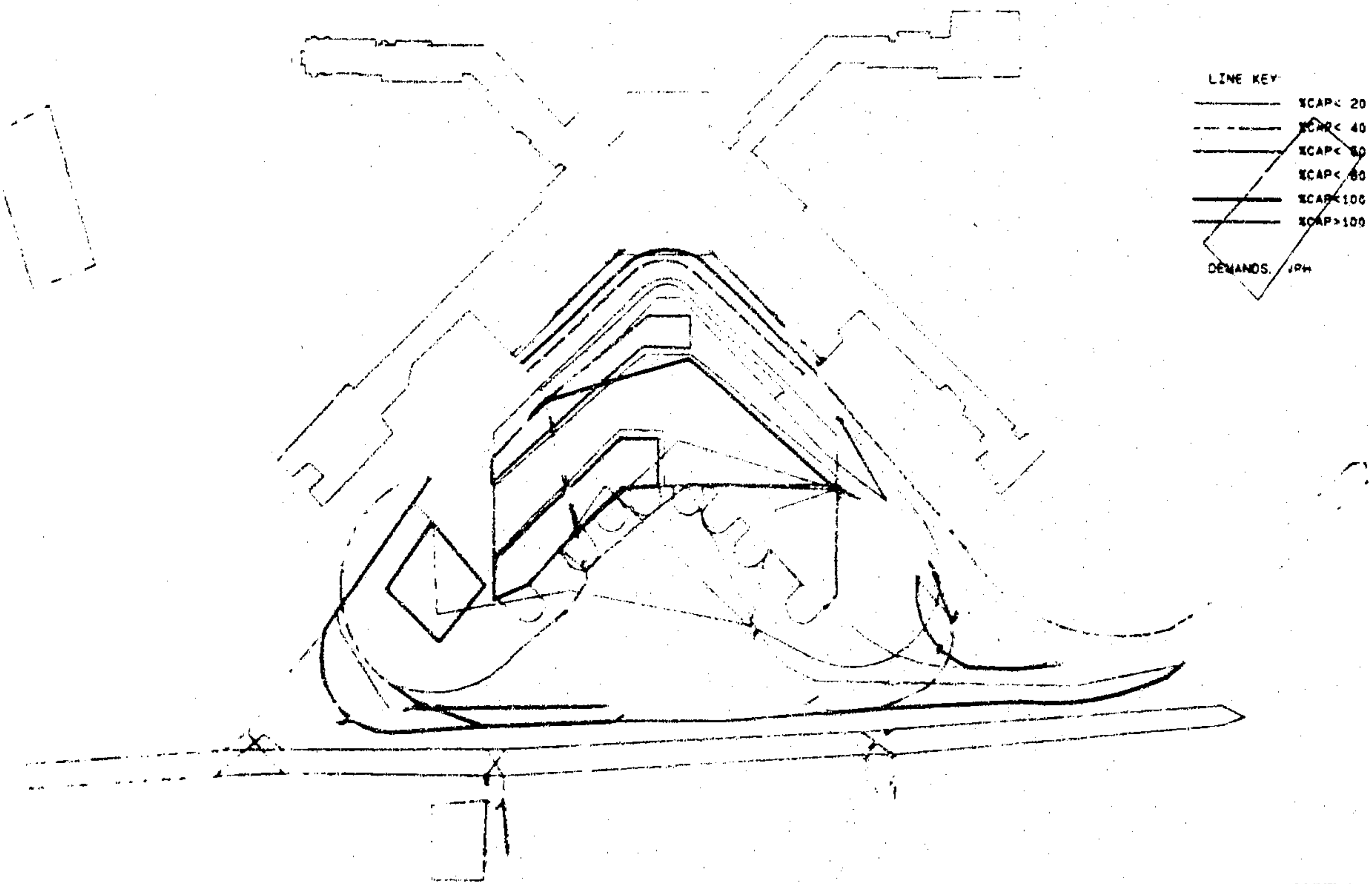


FIGURE 6-3
CASE 1
EXISTING CONDITIONS - AUGUST / AVERAGE DAY
12:00 PM - 1:00 PM

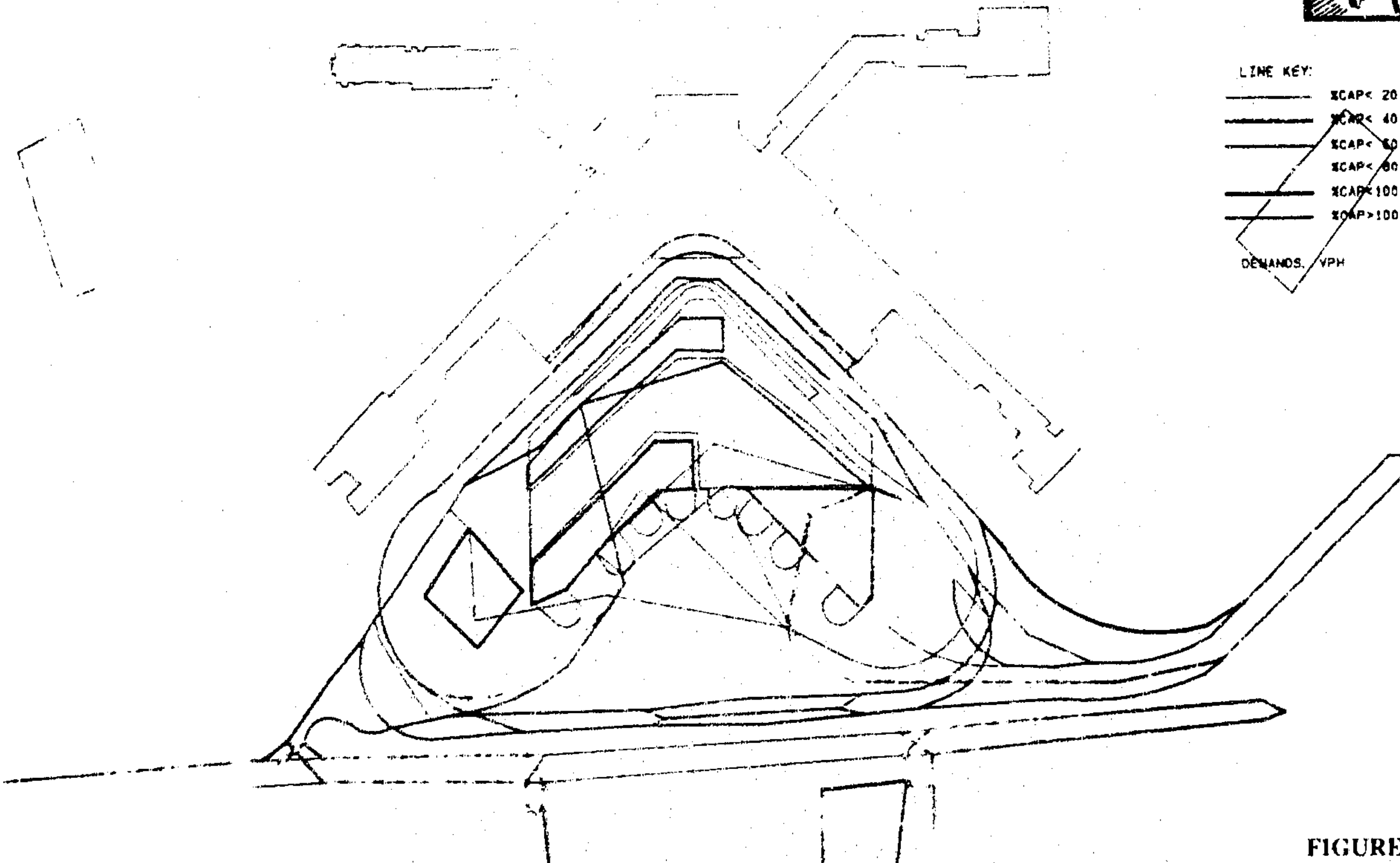


FIGURE 6-4
CASE 2
2020 AUGUST / AVERAGE DAY
12:00 PM - 1:00 PM

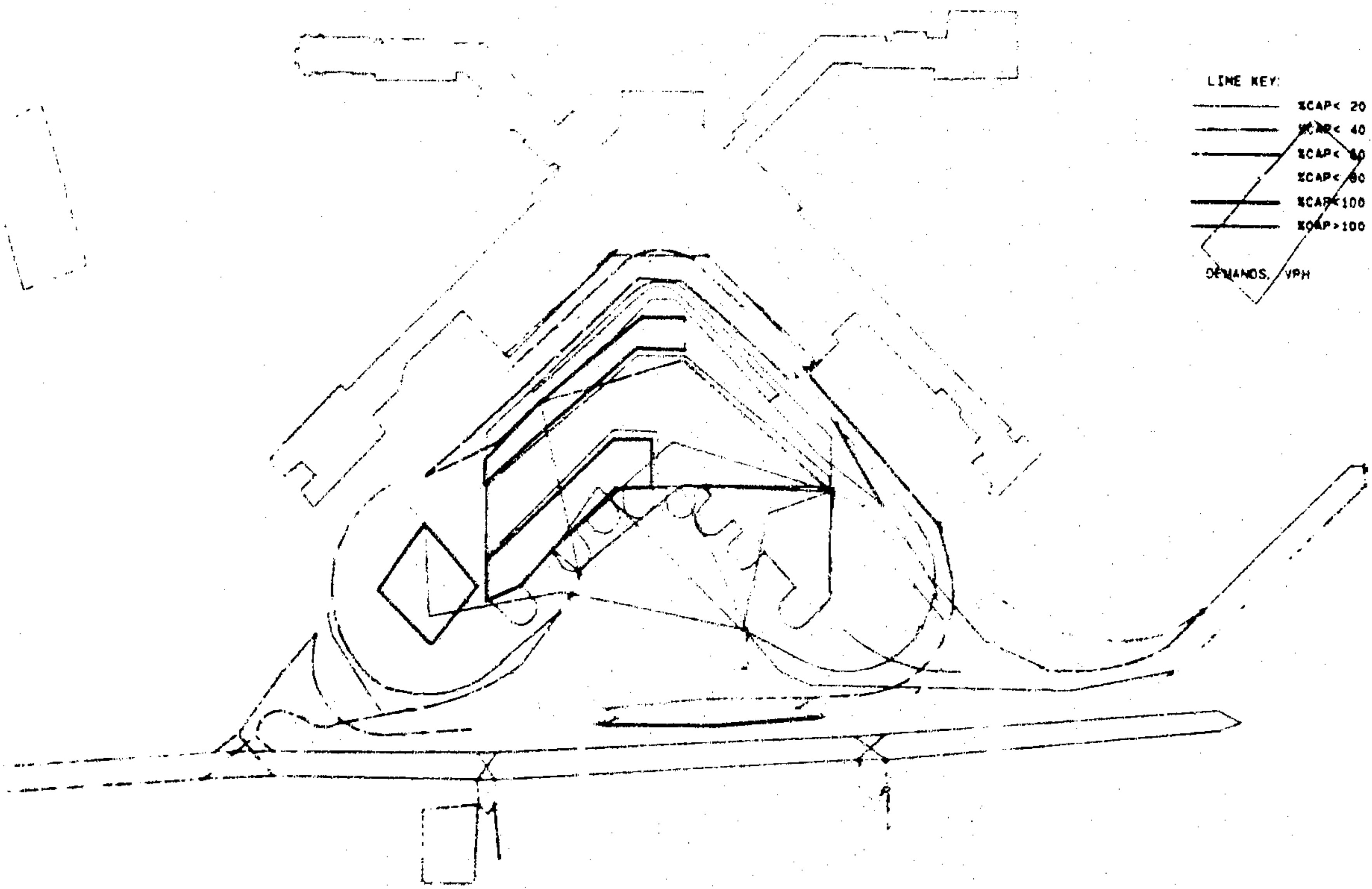


FIGURE 6-5
CASE 3
EXISTING CONDITIONS - AVERAGE MONTH / DAY
12:00 PM - 1:00 PM

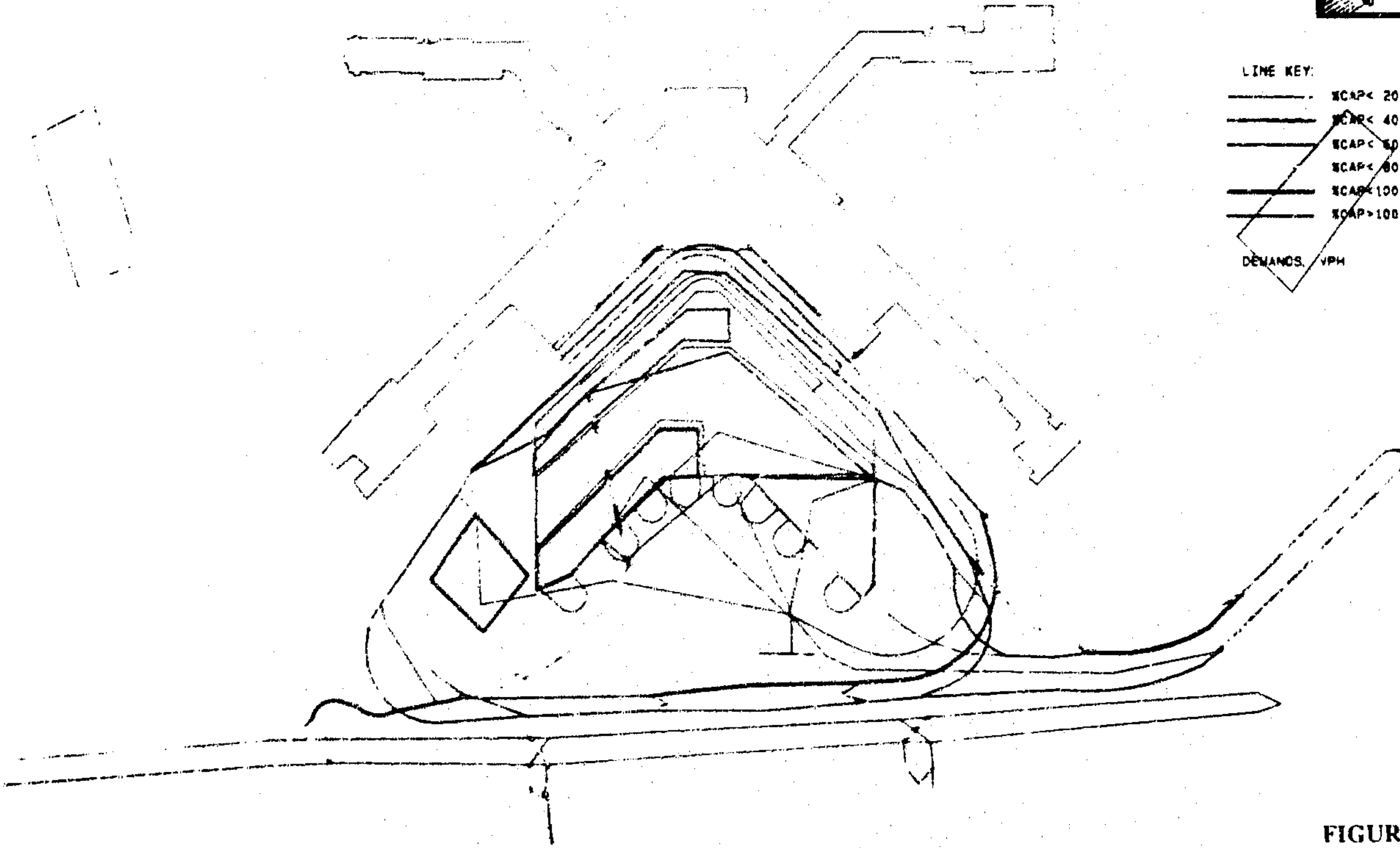


FIGURE 6-6
CASE 4
2020 AVERAGE MONTH / AVERAGE DAY
12:00 PM - 1:00 PM

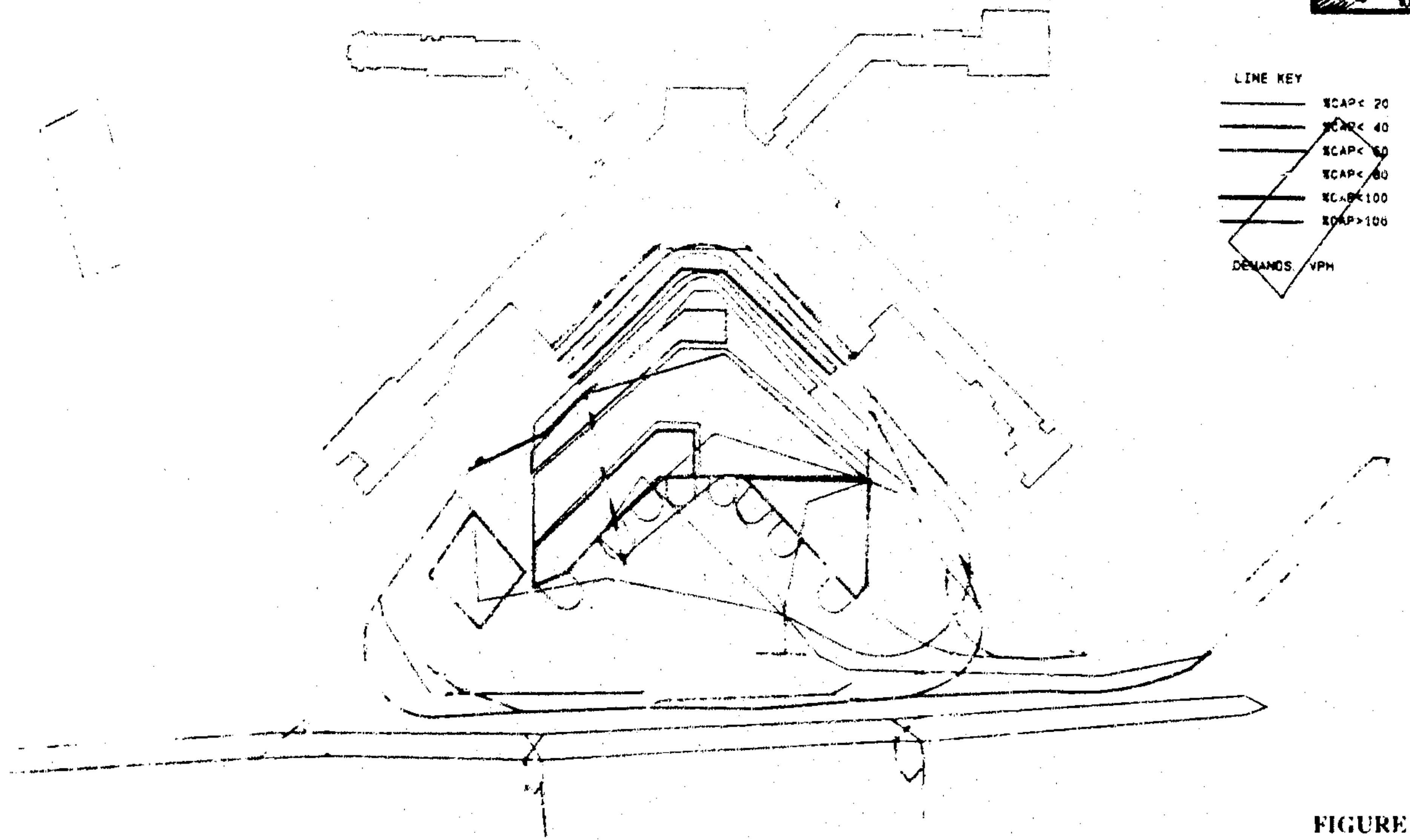


FIGURE 6-7
CASE 5
2000 AUGUST AVERAGE DAY
12:00 PM - 1:00 PM

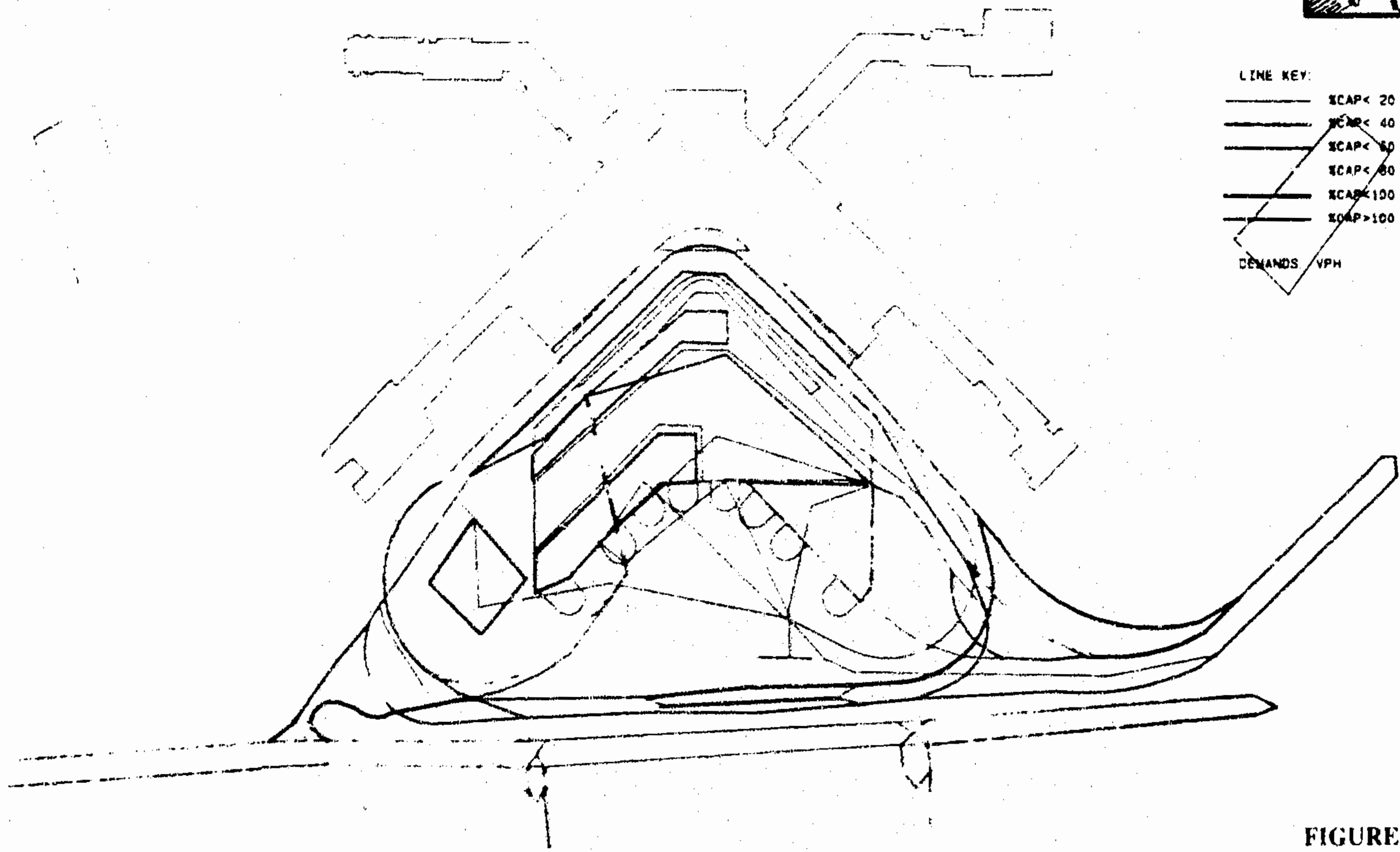


FIGURE 6-8
CASE 6
2010 AUGUST AVERAGE DAY
12:00 PM - 1:00 PM

FIGURE 6-9
FRAMEWORK STRATEGY FOR
TRANSPORTATION SYSTEM DEVELOPMENT/EVALUATION

1. **BASELINE: CURRENT REVENUE (Projected as Trend)**

1A. OPTIMIZE EXISTING SYSTEMS:

- ***Seek efficient operation of existing and committed system - foundation for Congestion Management System (CMS) and major investment studies***

1B. AIR QUALITY CONFORMITY OPTION:

- ***Potential additional policy/regulatory actions to assure Air Quality Conformity compliance***

2. **SYSTEM MANAGEMENT EMPHASIS**

BASELINE (1A) +

CONSERVATION REVENUE INCREASES FOR VARIATIONS OF:

- ***New TSM/TDM/non-motorized options***
- ***CMS with "pricing" options***
- ***Moderate transit expansion (bus/rail; local and RTA)***
- ***Moderate HOV development***
- ***Minimal new highway expansion***

3. **EXPANDED TRAVEL OPTIONS**

INCLUDES ALTERNATIVE 2 +

ADDITIONAL REVENUE INCREASES FOR:

- ***Variable transit capacity options (RTA)***
- ***Complete HOV system development***

Source: Puget Sound Regional Council, March 10, 1994.

provided). This physical system, plus regulatory changes to vehicles (cleaner national emission standards) will establish the base condition for future travel conditions in the region in 2020. In the "System Management Approach," TSM (Transportation System Management) and TDM (Travel Demand Management) represent two ways to alter the transportation without major physical plant improvements: TSM - by obtaining better capacity or operations from existing facilities; or TDM - by altering behavioral patterns that cause travel congestion. The third set of future forecasts, "Expanded Travel Options," will examine a traditional approach to future transportation planning by increasing the supply of transportation facilities in conjunction with strategies evolved in the System Management Approach.

APPENDIX A
GLOSSARY OF TERMS

GLOSSARY OF TERMS

"A"

A-WEIGHTED SOUND LEVEL - The sound pressure level which has been filtered or weighted to reduce the influence of low and high frequency (dBA).

AC - Advisory Circular published by the Federal Aviation Administration.

ADPM - Average Day of the Peak Month

AFB - Air Force Base

AIA - Annual Instrument Approaches

AICUZ - Air Installation Compatible Use Zones define areas of compatible land use around military airfields.

AIR CARRIER AIRCRAFT - Aircraft with more than 60 seats operated by an air carrier airline.

AIR CARRIER AIRLINE - An airline certificated in accordance with FAR Part 121 or 127 to conduct scheduled services on specified routes operating aircraft with more than 60 seats. These air carriers may also provide nonscheduled or charter services as a secondary operation. Four carrier groupings have been designated for statistical and financial data aggregation and analysis.

1. MAJORS; Air carriers with annual operating revenues greater than $1 billion.

2. NATIONALS: Air Carriers with annual operating revenues between $100 million and $1 billion.

3. LARGE REGIONAL: Air carriers with annual operating revenues between $10 million and $99,999,999.

4. MEDIUM REGIONALS: All carriers with annual operating revenues less than $10 million.

AIRCRAFT MIX - The relative percentage of operations conducted at an airport by each of four classes of aircraft differentiated by gross takeoff weight and number of engines.

AIRCRAFT TYPES - An arbitrary classification system which identifies and groups aircraft having similar operational characteristics for the purpose of computing runway capacity.

AIR NAVIGATIONAL FACILITY (NAVAID) - Any facility used for guiding or controlling flight in the air or during the landing or takeoff of aircraft.

AIR ROUTE SURVEILLANCE RADAR (ARSR) - Long-range radar which increases the capability of air traffic control for handling heavy enroute traffic. An ARSR site is usually located at some distance from the ARTCC it serves. Its range is approximately 200 nautical miles. Also called ATC Center Radar.

AIR TAXI/COMMUTER AIRCRAFT - Aircraft with 60 seats or less operated by a commuter carrier, air taxi operator, or air carrier.

AIR TAXI OPERATOR - An operator certificated in accordance with FAR Part 135 and authorized to provide, on demand, public transportation of persons and property by aircraft. Generally operates small aircraft "for hire" for specific trips.

AIRPORT AVAILABLE FOR PUBLIC USE - An airport available for use by the public with or without a prior request.

AIRPORT ENVIRONS - The area surrounding an airport that is affected by airport operations.

AIRPORT LAYOUT PLAN (ALP) - The current and planned airport development portrayal, which may be part of an airport master plan.

AIRPORT MASTER PLAN (AMP) - A long term development plan for an airport, adopted by the airport proprietor.

AIRPORT NOISE COMPATIBILITY PROGRAM - A program developed in accordance with FAR Part 150, including measures proposed or taken by the airport operator to reduce existing incompatible land use and to prevent the introduction of additional incompatible land uses within the area.

AIRPORT SURVEILLANCE RADAR (ASR) - Radar providing position of aircraft by azimuth and range of data without elevation data. It is designed for a range of 50 miles. Also called ATC Terminal Radar.

AIR ROUTE TRAFFIC CONTROL CENTER (ARTCC) - A facility established to provide air traffic control service to aircraft operating on an IFR flight plan within controlled airspace and principally during the enroute phase of flight.

AIRSPACE - The space lying above the earth or above a certain area of land or water which is necessary to conduct aeronautical operations.

ALERT AREA - Airspace which may contain a high volume of pilot training activities or unusual type of aerial activity.

ALP - Airport Layout Plan

ALSF-1 - Approach Light System with Sequence Flasher Lights.

AGL - Above Ground Level

ALS - Approach Light System

AMBIENT SOUND LEVELS - Ambient noise is the total noise associated with a given environment and usually comprises sounds from many different sources both near and far. Ambient noise is often defined in terms of the following statistical indicators:

L10 - the sound pressure level exceeded 10 percent of the time
L50 - the sound pressure level exceeded 50 percent of the time
L90 - the sound pressure level exceeded 90 percent of the time

ANCLUC - Airport Noise and Compatible Land Use Control plan; an FAA sponsored land use compatibility planning program preceding Part 150 Airport Noise Compatibility Program.

APPROACH CONTROL SERVICE - Air traffic control service provided by a terminal area traffic control facility for arriving and departing IFR aircraft and, on occasion, VFR aircraft.

APPROACH FIX - The point from or over which final approach (IFR) to an airport is executed.

APPROACH LIGHTING SYSTEM - Approach lighting systems (ALS) are configurations of lights positioned symmetrically along the extended runway threshold and extend towards the approach. An ALS augments the electronic navigational aids.

APPROACH SLOPE - Imaginary areas extending out and away from the approach ends of runways which are to be kept clear of obstructions.

APPROACH SURFACE - An element of the airport imaginary surfaces, longitudinally centered on the extended runway centerline, extending upward and outward from the end of the primary surface at a designated slope.

AREA NAVIGATION(RNAV) - A method of navigation that permits aircraft operations on any desired course within the coverage or stationed-reference navigation systems or within the limits of self-contained system capability.

ARFF - Airport Rescue and Fire Fighting.

ARTS-III - Automated Radar Terminal Service - Phase III. A terminal facility in the air traffic control system using air ground communications and radar intelligence to detect and display pertinent data such as flight identification, altitude and position of aircraft operating in the terminal area.

ASDE - Airport Surface Detection Equipment

ASV - Annual Service Volume - a reasonable estimate of the airfield's annual capacity.

ATCT - Airport Traffic Control Tower

ATC - Air Traffic Control

ATIS - Automatic Terminal Information Service

AVERAGE DAY PEAK MONTH (ADPM) ACTIVITY - Activity (passengers or aircraft operations) in the average day of the peak month of the activity. Average day activity is obtained by dividing the peak month activity by the number of days in the month. ADPM activity is used for planning airport requirements.

AVIGATION AND HAZARD EASEMENT - An easement which provides right of flight at any altitude above the approach surface, prevents any obstruction above the approach surface, provides a right to cause noise vibrations, prohibits the creation of electrical interferences, and grants right-of-way entry to remove trees or structures above the approach surface.

"B"

BASED AIRCRAFT - An aircraft permanently stationed at the airport, usually by some form of agreement between the aircraft owner and airport management.

BIT - Bituminous Asphalt Pavement

BUSINESS JET - Any of a type of turbine powered aircraft carrying six or more passengers and weighing less than approximately 70,000 pounds gross takeoff weight.

"C"

CARGO - Originating and/or terminating.

CAT I - Category I Instrument Landing System. (Minimums: decision height of 200 feet; Runway visual range 1,800 feet).

CAT II - Category II Instrument Landing System. (Minimums: decision height of 100 feet; Runway visual range 1,200 feet).

CAT III - Category III Instrument Landing System. (Minimums: no decision height; Runway visual range of from 0 to 700 feet depending on type of CAT III facility).

CALIBRATION - The procedure used to adjust an urban area traffic model so that it matches base year of present day conditions.

CAPACITY - The maximum number of vehicles which have a reasonable expectation of passing over a given section of a lane or a roadway during a given period under a specified speed or level of service.

CAPACITY MANUAL - Special Report 87 published by the Highway Research Board (now Transportation Research Board). Current issue is 1985.

CAPACITY RESTRAINT - See Trip Assignment.

CENTER'S AREA - The specified airspace within which an air route traffic control center provides air traffic control and advisory service.

CFR - Crash, Fire and Rescue (now called Airport Rescue and Fire Fighting (ARFF)

CIRCLING APPROACH - A maneuver initiated by the pilot to align the aircraft with a runway for landing when a straight-in instrument approach is not possible. This maneuver requires ATC clearance and that the pilot establish visual reference to the airport.

CL - Centerline

CLEARWAY - A defined rectangular area beyond the end of a runway cleared or suitable for use in lieu of runway to satisfy takeoff distance requirements.

CNEL - Community Noise Equivalent Level - a noise metric used in California to describe the overall noise environment of a given area from a variety of sources.

COLLECTOR - A roadway with no control of access providing movement between residential areas and the arterial system.

COMMERCIAL SERVICE AIRPORT - A public airport which received scheduled passenger service and enplanes annually 2,500 or more passengers.

COMMUTER CARRIER - An airline certificated in accordance with FAR Part 135 or 121 that operates aircraft with a maximum of 60 seats, and that provides at least five scheduled round trips per week between two or more points, or that carries mail.

CONC. - Portland Cement Concrete Pavement.

CONICAL SURFACE - An imaginary surface extending upward and outward from the periphery of the horizontal surface at a slope of 20 to 1 for a horizontal distance of 4,000 feet.

CONNECTION - A passenger who boards an aircraft directly after deplaning from another flight. On-line single carrier connections involve flights of the same carrier, while interline or off-line connections involve flights of two different carriers. This term can also be applied to freight shipments.

CONTINENTAL CONTROL AREA - This includes the airspace at and above 14,500 feet MSL of the 48 contiguous states, the District of Columbia, and Alaska, excluding the Alaskan peninsula west of longitude 160 degrees west. It does not include the airspace less than 1,500 feet above the surface of the earth nor most prohibited or restricted areas.

CONTROL AREAS - These consist of the airspace designated as VOR Federal Airways, additional Control Area Extensions but do not include the Continental Control Area. Control zones that do not underlie the continental control area have no upper limit. A control zone may include one or more airports and is normally a circular area with a radius of 5 statute miles and any extensions necessary to include instrument departure and arrival paths.

CONTROLLED AREA - Airspace within which some or all aircraft may be subject to air traffic control.

CONTROL TOWER - A central operations facility in the terminal air traffic control system consisting of a tower cab structure (including an associated IFR room if radar equipped) using air/ground communications and/or radar, visual signaling and other devices to provide safe and expeditious movement of terminal air traffic.

CONTROL ZONES - These are areas of controlled airspace which extend upward from the surface and terminate at the base of the continental control area. Control zones that do not underlie the continental control area have no upper limit. A control zone may include one or more airports and is normally a circular area with a radius of 5 statute miles of any extensions necessary to include instrument departure and arrival paths.

CONTROLLED AIRSPACE - Airspace designated as continental control area, control area, control zone or transition area within which some or all aircraft may be subject to air traffic control.

CORRIDOR - A swath of area surrounding a proposed facility that encompasses all the possible locations for that facility that would still serve the originally intended purpose for that facility.

CRITICAL LANE VOLUME ANALYSIS - A short-cut technique for relating the level of service at intersections to traffic volumes in the "critical lane."

CROSSWIND RUNWAY - A runway aligned at an angle to the prevailing wind which allows use of an airport when crosswind conditions on the primary runway would otherwise restrict use.

CURFEW - A restriction placed upon all or certain classes of aircraft by time of day, for purposes of reducing or controlling airport noise.

CYCLE - The time period required for one complete sequence of signal indications .

"D"

D - Dual Gear Aircraft

DECISION HEIGHT (DH) - With respect to the operation of aircraft, this means the height at which a decision must be made, using an ILS or PAR instrument approach, to either continue the approach or to execute a missed approach.

DECLARED DISTANCES - The distances the airport owner declares available and suitable for satisfying the airplane's takeoff urn, takeoff distance, accelerate-stop distance, and landing distance requirements. The distances are:

- *Takeoff run available (TORA)* - the runway length declared available and suitable for the ground run of an airplane taking off.
- *Takeoff distance available (TODA)* - the TORA plus the length of any remaining runway and/or clearway beyond the far end of the TORA.
- *Accelerate-stop distance available (ASDA)* - the runway plus stopway length declared available and suitable for the acceleration and deceleration of an airplane aborting a takeoff; and
- *Landing distance available (LDA)* - the runway length declared available and suitable for a landing airplane.

DEMAND - The actual number of persons, aircraft or vehicles currently using a facility if that facility is operating at or below capacity or the number of persons, aircraft or vehicles who want to use the facility when the facility is operating above capacity.

DEPLANEMENT - Any passenger getting off an arriving aircraft at an airport. Can be both a terminating and connecting passenger. Also applies to freight shipments.

DESIGN HOUR VOLUME (DHV) - The number of vehicles expected to use a road section, intersection, etc. in the design hour, which is usually the 30th highest hour of the year for commuter roads, the 150th highest hour for recreational roads, twice the average for shopping center facilities, etc.

DESIGN SPEED - The maximum safe speed for which the various physical features of the roadway were designed.

DISPLACED THRESHOLD - A threshold that is located at a point on the runway other than the designated beginning of the runway.

DISTANCE MEASURING EQUIPMENT (DME) - An electronic installation established with either a VOR or ILS to provide distance information from the facility to pilots by reception of electronic signals. It measures, in nautical miles, the distance of an aircraft from a NAVAID.

DIRECTIONAL SPLIT - The proportional distribution between access and egress flows of traffic into and out of a development or between opposite flows of traffic on two-way streets or highways.

DNL (Ldn) - Ldn is based upon the Leq with the aircraft operations occurring during the period 10 p.m. to 7 a.m. weighted by a 10 dB penalty.

"E"

EA (Environmental Assessment) - A document prepared under the National Environmental Policy Act of 1969 to determine whether potential impacts appear to be significant. The completion of an EA often precedes the decision to prepare and EIS.

ENPLANEMENT - Any passenger boarding a departing aircraft at an airport. Can be both a local origin and a connecting passenger. Applies also to freight shipments.

ENROUTE - The route of flight from point of departure to point of destination, including intermediate stops (excludes local operations).

ENROUTE AIRSPACE - Controlled airspace above and/or adjacent to terminal airspace.

ENVIRONMENTAL IMPACT STATEMENT (EIS) - A document prepared under the National Environmental Policy Act of 1969 to describe the social, economic, and physical impacts of proposed federal projects or projects requiring federal money or approval.

EQUIVALENT SOUND LEVEL (LEQ) - The steady A-weighted sound level over a specified period that has the same acoustic energy as the fluctuating noise during that period.

ERG - Effective Runway Gradient

EXPRESSWAY - A divided highway for through traffic with full or partial control of access generally using grade separated interchanges and some well spaced at-grade intersections.

"F"

F&E - Facilities and Equipment Programming - FAA

FAR Part 36 - A regulation establishing noise certification standards for aircraft.

FAR Part 77 - Establishes standards for determining obstructions in navigable airspace, sets forth requirements for notice of proposed construction or alteration and provides for aeronautical studies of obstructions to air navigation.

FAR Part 150 (Federal Aviation Regulation Part 150, 14 CFR 150) - The regulation describing the requirements and procedures for conducting a voluntary aircraft noise and land use compatibility study.

FEDERAL AIRWAYS - See Low Altitude Airways.

FEDERAL AVIATION ADMINISTRATION (FAA) - The federal agency charged with regulating air commerce to promote its safety and development, encouraging and developing civil aviation, air traffic control, and air navigation and promoting the development of a national system of airports.

FEDERAL AVIATION REGULATIONS (FAR) - Regulations issued by the FAA to regulate air commerce; issued as separate "Parts," e.g., Part 77

FINAL APPROACH IFR - The flight plan of landing aircraft in the direction of landing along the extended runway centerline from the base leg to the runway.

FIXED BASE OPERATOR (FBO) - An airport service operation, normally consisting of fuel sales, aircraft rentals, charter aircraft sales and maintenance with a fixed base of operation at the airport.

FLEET MIX - The proportion of aircraft types or models expected to operate at an airport.

FLIGHT SERVICE STATION (FSS) - A facility operated by the FAA to provide flight assistance service.

FREEWAY - A divided highway for through traffic with full control of access at grade separated interchanges.

FY - Fiscal Year

"G"

GENERAL AVIATION (GA) - All segments of aviation except air carrier and military. Included are corporate, industrial, agricultural, public and emergency services, business, charter, personal and sport flying.

GENERATION - See trip generation.

GLIDE SCOPE (GS) - The vertical guidance component of an Instrument Landing System (ILS).

GND CON. - Ground Control

GRAVITY MODEL - Newton's Law of Gravitation used to simulate traffic movements by distributing trips among zonal pairs in direct proportion to the number of trips originating in those zones and in inverse proportion to a measure of the spatial separation between the zones, such as travel time.

"H"

HIGH ALTITUDE AIRWAYS - See Jet Routes.

HIRL - High Intensity Runway Lighting

HOLDING - A predetermined maneuver which keeps an aircraft within a specified airspace while awaiting further clearance.

HORIZONTAL SURFACE - An imaginary surface constituting a horizontal plane 150 feet above the airport elevation.

"I"

IMAGINARY SURFACE - An area established in relation to the airport and to each runway consistent with FAR Part 77 in which any object extending above these imaginary surfaces is, by definition, an obstruction.

INDUCED TRIPS - See Trip.

INSTRUMENT APPROACH - A series of predetermined maneuvers for the orderly transfer of an aircraft under instrument flight conditions from the beginning of the initial approach to a landing or to a point from which a landing may be made visually.

INSTRUMENT FLIGHT RULES (IFR) - FAR rules that govern the procedures for conducting instrument flight (FAR Part 91).

INSTRUMENT LANDING SYSTEM (ILS) - A precision landing aid consisting of localizer (azimuth guidance), glide slope (vertical guidance), outer marker (final approach fix) and approach light system.

INSTRUMENT OPERATION - A landing or takeoff conducted while operating on an instrument flight plan.

INSTRUMENT RUNWAY - A runway equipped with electronic and visual navigation aids for which a precision or non-precision approach procedure having straight-in landing minimums has been established.

INTEGRATED NOISE MODEL (INM) - A computer-based airport noise exposure modelling program developed for the FAA.

ISOPLETH - A line on a map connecting points at which a given variable (ground travel time) has a specified constant value.

ITINERANT OPERATIONS - All aircraft arrivals and departures other than local operations.

INTERNATIONAL OPERATIONS - Aircraft operations performed by air carriers engaged in scheduled international service.

"J"

JET ROUTES - A route designed to serve aircraft operating from 18,000 feet MSL up to and including flight level 450.

"L"

LAT - Latitude

LDA - Localizer Type Directional Aid

LDN - Day-Night Average Sound Level. The 24-hour average sound level, in decibels, from midnight to midnight, obtained after the addition of ten decibels to sound levels for periods between 10 p.m. and 7 a.m.

LDNG. AIDS - Landing Aids

LENGTH OF HAUL - The non-stop airline route distance from a particular airport.

LEQ - Leq is the equivalent continuous sound level defined as the steady state sound pressure level dB(A) which, over a given period of time, has the same total energy as the actual fluctuating noise.

LEVEL OF SERVICE (LOS) - A standardized index of the relative service provided by street or intersection, ranging from A (extremely farmable) to E (oversaturation).

LIRL - Low Intensity Runway Lighting

LOAD FACTOR - Ratio of the number of passenger miles to the available seat miles flown by an airline representing the proportion of aircraft seating capacity that is actually sold and utilized. Load factors are also referred to in air cargo and can be determined by weight or volume.

LOC - Localizer (part of a ILS)

LOCAL OPERATION - Operations performed by aircraft which: (a) operate in the local traffic pattern or within the sight of the tower; (b) are known to be departing for, or arriving from, flight in local practice areas located within a 20-mile radius of the control tower, or (c) execute simulated instrument approaches or low passes at the airport.

LOM - Compass locator at an outer marker (part of an ILS). Also call COMLO.

LONG - Longitude

LOW ALTITUDE AIRWAYS - Air routes below 18,000 feet MSL. They are referred to as Federal Airways.

LRR - Long-Range Radar

"M"

MALS - Medium Intensity Approach Light System

MALSF - Medium Intensity Approach Light System with sequence flashing lights.

MALSR - MALS with Runway Alignment Indicator Lights (RAIL)

MARKER BEACON - An electronic navigation facility which transmits a fan or boneshaped radiation pattern. When received by compatible airborne equipment they indicate to the pilot that he is passing over the facility. Beacons are used to advise pilots of their position during an ILS approach. Marker beacons are of three types: Outer Marker, Middle Marker, and Inner Marker.

MASTER PLAN - Long-range plan of airport development requirements.

MEAN MAX - Normal maximum temperature of hottest month.

MGW - Maximum Gross Weight

MILITARY OPERATION - An operation by military aircraft.

MINIMUM DESCENT ALTITUDE (MDA) - The lowest altitude, expressed in feet above mean sea level, to which descent is authorized on final approach or during circling-to-land maneuvering in execution of a standard instrument approach procedure where no electronic glide slope is provided.

MIRL - Medium Intensity Runway Lighting

MISSED APPROACH - A prescribed procedure to be followed by aircraft that cannot complete an attempted landing at an airport.

MITL - Medium Intensity Taxiway Lighting

MLS - Microwave Landing System

MM - Middle Marker (part of an ILS)

MOA - Military Operations Area

MODAL SPLIT - The distribution of trips among competing travel modes, such as walk, auto, bus, etc.

MODE - A particular form or method of travel such as walk, auto, carpool, bus, rapid transit, etc.

MOVEMENT - Synonymous with the term operation, i.e., a takeoff or a landing.

MSL - Mean Sea Level

"N"

NA - Not applicable

NARROWBODY AIRCRAFT - A commercial passenger jet having a single aisle and a maximum of three seats on each side of the aisle. Narrowbody aircraft include the B727, B737, B757, DC9, MD80, MD90 and A320.

NAS - NATIONAL AIRSPACE SYSTEM - The common system or air navigation and air traffic encompassing communications facilities, air navigation facilities, airways, controlled airspace, special use airspace and flight procedures authorized by Federal Aviation Regulations for domestic and international aviation.

NAVAID - Any facility used for guiding or controlling flight in the air or during the landing or takeoff of aircraft.

NDB - NON-DIRECTIONAL BEACON - An electronic ground station transmitting in all directions in the L/MF frequency spectrum; provides azimuth guidance to aircraft equipped with direction finder receivers. These facilities are often established with ILS outer markers to provide transition guidance to the ILS system.

NEPA - National Environmental Policy Act

NM - Nautical Mile

NOISE ABATEMENT - A procedure for the operation of aircraft at an airport which minimizes the impact of noise on the environs of the airport.

NOISE CONTOUR - A noise impact boundary line connecting points on a map where the level of sound is the same.

NOISE EXPOSURE MAP (NEM) - A scaled, geographic depiction of an airport, its noise contours and surrounding area, as described in FAR Part 150.

NOISE LEVEL REDUCTION (NLR) - The amount of noise level reduction achieved through incorporation of noise attenuation (between outdoor and indoor levels) in the design and construction of a structure.

NON-PRECISION APPROACH - A standard instrument approach procedure in which no electronic glide slope is provided.

NPI - Non-Precision Instrument Runway

"O"

OAG - Official Airline Guide

OBSTRUCTION - Any structure, growth, or other object, including a mobile object, that exceeds a limiting height established by federal regulations or by a hazard zoning regulation.

OM - Outer Marker (part of an ILS)

OPERATING SPEED - The maximum average speed for a given set of roadway and traffic conditions.

OPERATION - An aircraft arrival at or departure from an airport.

ORIGIN AND DESTINATION PASSENGERS (O&D) - Those passengers--whether visitors or residents-- whose trips begin or end in the region.

OUTER FIX - A point in the destination terminal area from which aircraft are cleared to the approach fix or final approach course.

"P"

PAPI - Precision Approach Path Indicator

PAR - Precision Approach Radar

PAX - Passenger

PEAK HOUR FACTOR - The ratio of the average flow rate during the peak hour to the highest short-term (say 15 minutes) rate within the peak hour.

PEAK HOUR ACTIVITY - Activity (passengers or aircraft operations) in the busiest hour of the average day peak month (ADPM).

PEAK HOUR PERCENTAGE - The percentage of total daily trips or traffic occurring in the highest or "peak" hour. Frequently confused with Peak Hour Factor.

PERSON TRIP - A trip made by a person by any travel mode or combination of travel modes. A carpool of four persons entails one vehicle trip and four person trips.

PHASE - A part of the cycle allocated to any traffic movement or any combination of traffic movements.

PI - Precision Instrument Runway marking.

POSITIVE CONTROL AREA - Airspace wherein aircraft are required to be operated under Instrument Flight Rules.

PRECISION APPROACH - A standard instrument approach procedure in which an electronic glideslope/glidepath is provided; eg., ILS/MLS and PAR.

PRIMARY COMMERCIAL SERVICE AIRPORT - A commercial service airport which enplanes .01 percent or more of the total annual U.S. enplanements.

PRIMARY RUNWAY - The runway on which the majority of operations take place. On large, busy airports, there may be two or more parallel primary runways.

PRIMARY SURFACE - An area longitudinally centered on a runway with a width ranging from 250 to 1,000 feet and extending 200 feet beyond the end of a paved runway.

PRODUCTION - A trip end associated with a dwelling unit or other trip "producer."

PROHIBITED AREA - Airspace of defined dimensions identified by an area on the surface of the earth within flight is prohibited.

PU - Publicly owned airport.

PVC - Poor visibility and ceiling.

PVT - Privately owned airport.

"Q"

QUEUE - A line of pedestrians or vehicles waiting to be served.

"R"

RADAR SEPARATION - Radar spacing of aircraft in accordance with established minima.

RAIL - Runway Alignment Indicator Lights

RCAG - Remote Center Air/Ground Communications

REIL - Runway End Identification Lights

RELIEVER AIRPORT - An airport which, when certain criteria are met, relieves the aeronautical demand on a high density air carrier airport.

RESTRICTED AREAS - Airspace of defined dimensions identified by an area on the surface of the earth within which the flight of aircraft, while not wholly prohibited, is subject to restrictions.

RNAV - See Area Navigation.

ROTATING BEACON - A visual NAVAID displaying flashes of white and/or colored light used to indicate location of an airport.

RPZ - Runway Protection Zone (inner portion of runway approach zone; formerly called Clear Zone)

RUNWAY SAFETY AREA - An area symmetrical about the runway centerline and extending beyond the ends of the runway which shall be free of obstacles as specified.

RVR - Runway Visual Range

RVV - Runway Visibility Value

R/W - Runway

"S"

SALS - Short Approach Light System

SCREEN LINE - A line dividing a study area into two parts and used for a detailed comparison of measured and simulated traffic or travel during a model calibration process.

SDF - Simplified Directional Facility landing aid providing final approach course.

SEGMENTED CIRCLE - An airport aid identifying the traffic pattern direction.

SEPARATION MINIMA - The minimum longitudinal, lateral, or vertical distances by which aircraft are spaced through the application of air traffic control procedures.

SMSA - Standard Metropolitan Statistical Area.

SOCIOECONOMIC - Data pertaining to the population and economic characteristics of a region.

SOUND EXPOSURE LEVEL - That constant sound level which has the same amount of energy in one second as the original noise event.

SSALF - Simplified Short Approach Light System with Sequence Flashing lights.

SSALS - Simplified Short Approach Light System.

SSALR - Simplified Short Approach Light System with Runway Alignment Indicator Lights (RAIL)

STANDARD LAND USE CODING MANUAL (SLUCM) - A standard system for identifying and coding land use activities published by the U.S. Department of Housing and Urban Development and the Federal Highway Administration.

STOPWAY - A defined rectangular surface beyond the end of a runway prepared or suitable for use in lieu of runway to support an airplane, without causing structural damage to the airplane, during an aborted takeoff.

STRAIGHT-IN APPROACH - A descent in an approved procedure in which the final approach course alignment and descent gradient permits authorization of straight-in landing minimums.

STOL - Short Takeoff and Landing

STOVL - Short Takeoff Vertical Landing

SWL - Single Gear Aircraft

SYSTEM PLAN - A representative of the aviation facilities required to meet the immediate and future air transportation needs and to achieve the overall goals.

"T"

TACAN - Tactical Air Navigation

TDZ - Touchdown Zone

TERMINAL AIRSPACE - The controlled airspace normally associated with aircraft departure and arrival patterns to/from airports within a terminal system and between adjacent terminal systems in which tower enroute air traffic control service is provided.

TERMINAL CONTROL AREA (TCA) - This consists of controlled airspace extending upward from the surface or higher to specified altitudes within which all aircraft are subject to positive air traffic control procedures.

TERPS - Terminal Instrument Procedures

T-HANGAR - A T-shaped aircraft hangar which provides shelter for a single airplane.

THRESHOLD - The beginning of that portion of the runway usable for landing.

TIME ABOVE - Time above indicates the time in minutes that a given dB(A) levels is exceeded during a 24-hour period.

TOUCH-AND-GO OPERATION - An operation in which the aircraft lands and begins takeoff roll without stopping.

TRAFFIC ANALYSIS AREA OR ZONE - A subdivision of a study area used to aggregate dispersed data items, such as population, employment, etc., in preparation for estimating the trips attracted or produced by these data items and for loading such attractions and productions onto a simulation network.

TRAFFIC CONTROL DEVICE - Any sign, signal, marking or device placed or erected for the purpose of regulating, wording or guiding vehicular traffic and/or pedestrians.

TRAFFIC PATTERN - The traffic flow that is prescribed for aircraft landing at, taxiing on, and taking off from an airport. The usual components of a traffic pattern are upwind leg, crosswind leg, downwind leg and final approach.

TRANSIENT OPERATIONS - See Itinerant Operations.

TRANSITION SURFACE - An element of the imaginary surfaces extending outward at right angles to the runway centerline and from the sides of the primary and approach surfaces to where they intersect the horizontal and conical surfaces.

TRANSITIONAL AIRSPACE (TRANSITION AREA) - Areas designated to contain IFR operations in controlled airspace during portions of the terminal operations and while transitioning between the terminal and enroute environment.

TRAVEL SHED - The total contributing area that generates trips which ultimately concentrate at a selected study point. Also called a travel sector.

TRIP - The one-way unit of travel between an origin and a destination.

TRIP ASSIGNMENT - That portion of the transportation planning process where distributed trips are allocated among the actual routes they can be expected to use.

TRIP DISTRIBUTION - That portion of the transportation planning process that estimates the spatial distribution of trips estimated during the trip generation phase.

TRIP END - The beginning or end of a trip.

TRIP GENERATION - That portion of the transportation planning process concerned with developing an estimate of the total number of trips attracted or produced by each traffic analysis zone in a study area.

TRIP PURPOSE - The primary reason for making a trip, i.e., work, shop.

TW & T/W - Taxiway

TWR - Control Tower

TVOR - Terminal Very High Frequency Omnirange Station

"U"

UHF - Ultra High Frequency

UNCONTROLLED AIRSPACE - That portion of the airspace that has not been designated as continental control area, control area, control zone, terminal control area or transition area and within which ATC has neither the authority nor the responsibility for exercising control over air traffic.

UNICOM - Radio communications station which provides pilots with pertinent airport information (winds, weather, etc.) at specific airports.

UTILITY RUNWAY - A runway intended to be used by propeller driven aircraft of 12,500 pounds maximum gross weight or less.

"V"

VASI - Visual Approach Slope Indicator providing visual glide path.

VASI-2 - Two Box Visual Approach Slope Indicator

VASI-4 - Four Box Visual Approach Slope Indicator

VECTOR - A heading issued to an aircraft to provide navigational guidance by radar.

VEHICLE MILES OF TRAVEL (VMT) - A measure of total travel within a study area, usually estimated as the total number of trips multiplied by the average length of a typical trip.

VFR - Visual Flight Rules that govern flight procedures in good weather.

VFR AIRCRAFT - An aircraft conducting flight in accordance with Visual Flight Rules.

VHF - Very High Frequency

VISUAL APPROACH RUNWAY - A runway intended for visual approaches only.

VOR - Very High Frequency Omnirange Station. A ground-based radio (electronic) navigation aid transmitting radials in all directions in the VHF frequency spectrum; provides azimuth guidance to pilots by reception of electronic signals.

VORTAC - Co-located VOR and TACAN.

V/STOL - Vertical/Short Takeoff and Landing

VTOL - Vertical Takeoff and Landing (includes, but is not limited to, helicopters).

"W"

WARNING AREA - Airspace which may contain hazards to non-participating aircraft in international airspace.

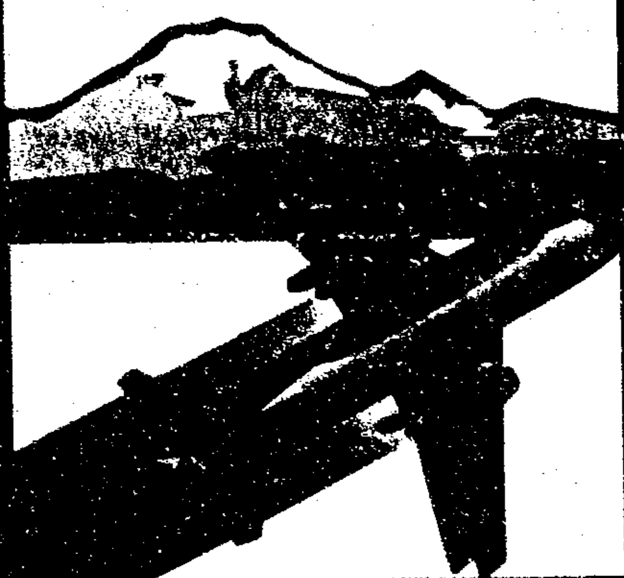
WIND CONE (WIND SOCK) - Conical wind directional indicator.

WIND TEE - A visual device used to advise pilots about wind direction at an airport.

Attachment B
to Port Resolution 3245

TECHNICAL REPORT NO. 6

AIRSIDE OPTIONS EVALUATION



AIRPORT MASTER PLAN UPDATE

FOR

SEATTLE-TACOMA
INTERNATIONAL AIRPORT

P&D Aviation

TECHNICAL REPORT NO. 6

AIRSIDE OPTIONS EVALUATION

AIRPORT MASTER PLAN UPDATE
FOR
SEATTLE - TACOMA INTERNATIONAL AIRPORT

Prepared by:

P&D AVIATION

Prepared for:

The Port of Seattle
SEATTLE - TACOMA INTERNATIONAL AIRPORT

SEPTEMBER 19, 1994

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AIRSIDE OPTIONS EVALUATION

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SECTION 1
EXECUTIVE SUMMARY

BACKGROUND

During the past several years numerous studies have concluded Sea-Tac's runways will reach capacity near the turn of the century. Preliminary results of the most recent delay studies described herein have determined aircraft delays will quadruple over the next two decades. The additional aircraft operating cost resulting from these delays is estimated to reach $245 million per year in 20 years. Dramatic growth of projected delays at Sea-Tac occurs since only one of Sea-Tac's two runways can be used for landings during bad weather, which occurs up to 44 percent of the time.

In response to continuing growth demands, plans are being evaluated to improve the capacity and efficiency and to mitigate environmental impact at Sea-Tac. This work is being accomplished through an update to the Airport Master Plan and a detailed Environmental Impact Statement (EIS). The Sea-Tac Master Plan Update is being conducted to develop a plan for improving the efficiency of the runway and taxiway (airside) system as well as the terminal, roadway and parking (landside) facilities. Of particular importance to the airside studies is the work being accomplished by an FAA sponsored Capacity Enhancement Task Force. This group is overseeing a computer simulation of Sea-Tac's existing and future airside operations. Final results of the simulation analysis should be available in early 1995. Preliminary results of this simulation analysis are used in this report to quantify potential future aircraft delays.

REPORT OBJECTIVE

The objective of this report is to describe the evaluation of options for the airfield, including a range of new runway options. Topics covered include airside facility requirements, aircraft delays, runway development costs, and preliminary runway environmental screening studies. The delay, cost, and environmental studies have been conducted for a wide range of airside options as listed below.

AIRFIELD IMPROVEMENTS

In addition to describing the evaluation of new runway options, this report recommends and includes the costs for several other airfield improvements designed to improve the safety and efficiency of aircraft operations. Recommended airfield improvements not associated with a new runway are describe below.

Runway Safety Area Improvements

To meet current FAA safety criteria, a clear, graded rectangular area beyond the end of the runway know as a "Runway Safety Area (RSA)", is required. Since the RSAs for the existing runways do not meet new FAA criteria each of the airfield options discussed below, except Option 1, No Action, includes various approaches for meeting the updated RSA requirements. This is accomplished by relocating the existing runway thresholds either 300 or 325 feet to the south or by constructing additional safety areas at the north runway ends and relocating South 154th Street. Options which include a relocated threshold cause the existing west runway to be shortened by 325 feet.

Extension of East Runway

All of the airfield options, except Option 1, No Action, include a net addition of 600 feet to the east runway (16L/34R) to bring the total runway length to 12,500 feet. In cases where the north runway thresholds would be displaced due to the runway safety areas, a total of 900 feet would need to be added to the south end of the runway to make up for the 300 foot displacement. The increased length is designed to allow departures of fully loaded Boeing 747s destined for cities as far away as Hong Kong.

Dual Taxiway Capability

Sea-Tac now has dual parallel taxiways only on the north portion of the airfield east of the runways. Dual parallel taxiways the full length of the airfield are recommended to help improve the flow of aircraft on the ground and particularly in front of the passenger terminal where considerable congestion can occur between taxiing aircraft. This will require limiting the types of aircraft that can be parked at certain gates on Concourses B & C and the relocation of a service road on the aircraft parking apron.

High Speed Exits

Four new high speed exits are recommended for the east runway (16L/34R). The addition of 30 degree exits at about 5,500 feet and 7,700 feet from the beginning of the runway reduces the runway occupancy time by about 30 percent. This will allow departures to be released more quickly when following an arriving aircraft.

NEW RUNWAY OPTIONS

The runway options evaluated in this analysis are classified according to runway configurations. These options are designed to be consistent with the Master Plan Update Scope of Work and to test the effect of changes to length, separation and stagger on the north runway end. The eight runway options are described below.

Option 1 - Existing Condition. Existing 11,900-foot and 9,425-foot runways with 800 feet of separation between centerlines.

Option 2 - Commuter - Close Spaced. Additional 5,200-foot commuter runway with 1,500 feet of separation from existing Runway 16L-34R.

Option 3 - Commuter - Dependent. Additional 5,200-foot commuter runway with 2,500 feet of separation from Runway 16L-34R.

Option 4A - Dependent - Additional 7,000-foot runway with 2,500 feet of separation from Runway 16L-34R.

Option 4B - Dependent - Staggered. Same as Option 4A except the north end threshold is staggered 1,435 feet to the south.

Option 4C - Dependent - Staggered. Similar to Option 4B but with 7,500-foot runway. North end threshold is staggered 935 feet to the south.

Option 5 - Dependent - Maximum Length. Additional 8,500-foot runway with 2,500 feet of separation from Runway 16L-34R.

Option 6 - Independent - Maximum Length. Same as Option 5 except the runway separation is 3,300 feet from Runway 16L-34R.

Future delays, development costs, and environmental considerations for each of the options listed above are estimated herein with the aim of reducing the number of alternatives to be evaluated in the EIS. Completion of the EIS and the Master plan Update is scheduled for the end of 1995.

PRELIMINARY NEW RUNWAY LENGTH FINDINGS

The required takeoff and landing lengths for the mix of aircraft anticipated to operate at the airport in the future were determined from aircraft performance charts and operations manuals. The significant findings of these studies are:

- A new 5,200-foot commuter runway (Options 2 and 3) would be of sufficient length to accommodate about 31 percent of the takeoffs and 31 percent of the landings in the year 2020.
- A new 7,000-foot runway (Options 4A and 4B) would be able to serve 77 percent of takeoffs and 91 percent of landings in 2020.
- A new 7,500-foot runway (Option 4C) would be able to serve 85 percent of takeoffs and 97 percent of landings in 2020.
- A new 8,500-foot runway (Option 5) would accommodate 90 percent of takeoffs and 99 percent of landings in 2020.

The capability of the new runway to accommodate all aircraft types for landing determines the amount of delay reduction which can be achieved. If approaching aircraft must cross other approaching traffic to lineup for longer runways then additional delays can occur. The following delay analysis confirms the 8,500-foot runway options result in the greatest delay reduction. The fact that the 8,500-foot runway cannot accommodate 10 percent of the aircraft takeoff requirements is not a problem since the new runway would be used very seldom for departures.

PRELIMINARY DELAY ANALYSIS FINDINGS

Measurement of aircraft delays was accomplished using the Federal Aviation Administration's Airport and Airspace Simulation Model (SIMMOD). This model is a sophisticated computer simulation which realistically simulates the movement of every aircraft for a given runway option. The model produces quantitative measures of aircraft air arrival delays, departure delays, and ground taxi delays. Preliminary findings of these studies are summarized below:

- Average aircraft delays are currently estimated to be between 5 to 6 minutes per operation at Sea-Tac. During degraded weather conditions which occur 44 percent of the time at Sea-Tac, delays average 11 minutes per aircraft operation.
- By the year 2015, with no new runway, average annual delays are expected to increase by four times from 5 - 6 minutes to 22 minutes per aircraft operation. About 88 percent of the year 2015 delay can be attributed to arrival delay, 11 percent to departure delay, and 1 percent to taxi delay.
- The commuter runway options (Options 2 and 3) would result in delays in the year 2015 between 14 to 21 minutes per operation.
- The 2,500-foot runway separation options (Options 4A, 4B, 4C and 5) would decrease average delays to between 4 to 6 minutes per operation in the year 2015 assuming the runways are operated in a dependent manner.

- The 3,300-foot runway separation option (Option 6) would also reduce delays to about 4 minutes per operation in the year 2015 assuming independent arrival streams. The added benefit resulting from independent streams is not demonstrated until demand grows beyond the level projected for the year 2015.

As described above the commuter runway options do not reduce delay in the year 2015 below todays levels. In fact delays for these options are projected to increase by 2.5 to 4 times. The 8,500-foot options provide slightly greater delay reductions than the 7,000-foot or 7,500-foot options. The value of the year 2015 saving in annual aircraft operating cost is estimated to be $270 million per year for the 8,500-foot runway options.

PRELIMINARY DEVELOPMENT COST FINDINGS

Development cost estimates have been formulated based on information contained in the first draft of the Preliminary Engineering Report prepared by HNTB and dated March 31, 1994 and on land acquisition costs described by Landrum and Brown in a memorandum dated September 1997. To the extent possible, the same assumptions and unit cost data have been used as described in the Preliminary Engineering Report. The cost model provides estimates for 55 individual items for each runway option evaluated. Total project construction and acquisition costs are summarized as follows:

- Option 1 - $0 million
- Option 2 - $79 - 91 million
- Option 3 - $297 - 341 million
- Option 4A - $411 - 473 million
- Option 4B - $348 - 401 million
- Option 4C - $369 - 425 million
- Option 5 - $456 - 524 million
- Option 6 - $773 - 889 million

It is important to note that Option 6 costs an additional $317 - 365 million over Option 5 but provides no apparent delay savings by the year 2015. Option 5 costs $87 - 99 million more than Option 4C but provides an additional annual delay savings of about $12 million per year by the year 2015. Option 4A is more expensive than Option 4C but also provides $12 million less of a delay savings benefit in the year 2015.

ENVIRONMENTAL SCREENING FINDINGS

A preliminary evaluation of the environmental impacts of each of the airside options was conducted by the EIS consultant team. The purpose of this analysis was to allow environmental impacts to be considered early in the airside evaluation process and prior to the formulation of the EIS alternatives. The results of the preliminary environmental impact screening analysis for each of the airside options are presented in Table 1-1.

Option 6 clearly causes the greatest impact of all the options considered. Approximately 560 homes are displaced and 28 acres of wetlands are impacted. This compares to 360 homes and 5 acres of wetlands estimated for Options 4A, 4B, 4C, and 5. The total area within the 65 DNL noise contour ranges from 7.65 square miles to 7.84 square miles for Options 4A, 4B, 4C, and 5. The Option 6 65 DNL noise contour increases to 8.13 square miles which is the largest of the noise impact areas. Overall the impacts associated with Options 4A, 4B, 4C, and 5 are very similar.

CONCLUSIONS

A graphic comparison of the year 2015 annual aircraft delay savings and estimated construction and acquisition costs are shown for each option

TABLE 1-1
ENVIRONMENTAL IMPACTS SUMMARY
OF MASTER PLAN UPDATE AIRSIDE OPTIONS [a]

	Master Plan Update Airside Options [b]						
	1A	1B	3	4A	4C	5	6
Noise: Impacted Area in year 2020 (sq. mi.)							
65-70 DNL	4.25	4.41	4.26	4.29	4.26	4.40	4.62
70-75 DNL	1.81	1.88	1.85	1.92	1.92	1.91	2.04
75 DNL and greater	1.39	1.44	1.40	1.46	1.47	1.53	1.47
Total	7.45	7.73	7.51	7.67	7.65	7.84	8.13
60-65 DNL	10.12	10.51	10.05	10.06	10.09	10.08	10.17
Noise: Population Impacts in year 2020							
65-70 DNL	11,610	12,250	11,870	12,210	12,150	12,760	13,290
70-75 DNL	1,150	1,360	1,140	1,190	1,180	1,170	1,330
75 DNL and greater	40	40	40	50	50	100	420
Total	12,800	13,650	13,050	13,450	13,380	14,030	15,040
60-65 DNL	40,820	42,370	40,440	40,700	40,770	40,760	41,020
Noise: Housing Impacts in year 2020							
65-70 DNL	4,860	5,100	4,960	5,100	5,080	5,320	5,620
70-75 DNL	520	610	510	530	530	510	580
75 DNL and greater	10	20	20	20	20	40	160
Total	5,390	5,730	5,480	5,650	5,630	5,870	6,360
60-65 DNL	17,910	18,580	17,690	17,870	17,900	17,920	17,980
Air Inventory (tons per day in year 2020)							
Carbon Monoxide	13.86	13.86	10.18	6.82	6.82	5.86	4.86
Nitrogen Oxides	6.82	6.82	6.49	6.19	6.19	6.11	6.02
Particulate Matter (PM10)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sulfur Oxides	0.33	0.33	0.28	0.23	0.23	0.22	0.20
Wetland Impacts (acres)							
Wetland Impacts	0	0	4.2	5.4	5.0	5.4	27.7
100-Year Floodplain Impacts (acres)							
100-Year Floodplain Impacts	0	0	1	7	2	7	30
Stream Relocation (linear feet)							
Stream Relocation	0	0	2,760	2,970	2,760	2,970	12,240
Earth Impacts (million cubic yards)							
Earth Impacts	0	0	12	17	13	17	28
Construction Impact (units displaced)							
Properties	0	0	330	410	400	420	700
Homes	0	0	260	330	300	320	500
Parks	0	0	0	0	0	0	1
Historic/Cultural sites	0	0	1	1	1	1	3
Schools	0	0	0	0	0	0	1

TABLE 1-1
ENVIRONMENTAL IMPACTS SUMMARY
OF MASTER PLAN UPDATE AIRSIDE OPTIONS [a]

	Master Plan Update Airside Options [b]						
	1A	1B	3	4A	4C	5	6
Noise Impacted (65+ DNL in year 2020) [c]							
Parks	6	6	6	6	6	6	6
Historic/Cultural sites	3	4	3	4	4	4	5
Churches	13	13	13	13	13	13	15
Hospitals/Nursing homes	0	0	0	0	0	0	0
Libraries	1	1	1	1	1	1	1
Schools	8	9	3	8	8	8	8

[a] Sources: Landrum & Brown, Shapiro & Associates, and Gambrell Urban - Population and dwelling units using 1990 census. Impacts presented for the preliminary airside options are subject to update as additional information is collected and as the Master Plan Update and Environmental Impact Statement progress.

[b] Option 1A/1B - Do-Nothing (1A assumes existing distribution of traffic. 1B assumes additional night traffic due to delay).

Option 3 - Commuter Dependent (New 5,200 foot long new runway located 2,500 feet west of Runway 16L/34R)

Option 4A - Programmatic Baseline (New 7,000 ft long runway located 2,500 feet west of Runway 16L/34R)

Option 4C - 7,500 ft Staggered (New 7,500 ft long runway located 2,500 feet west of Runway 16L/34R, north end of new runway south of existing)

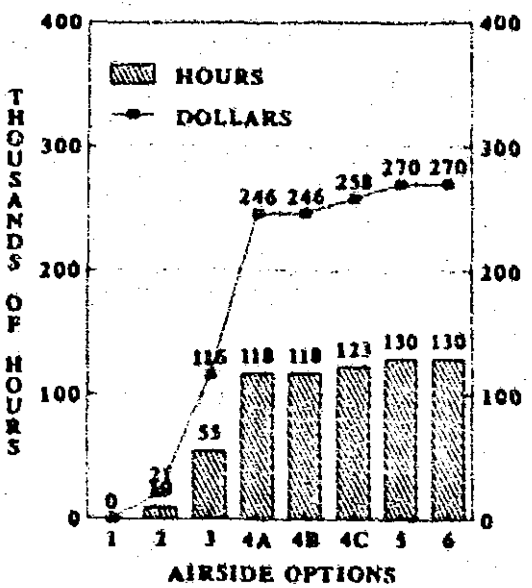
Option 5 - Dependent Maximum Length (New 8,500 ft long runway located 2,500 feet west of Runway 16L/34R)

Option 6 - Independent Maximum Length (New 8,500 ft long runway located 3,300 feet west of Runway 16L/34R)

[c] Noise impacted noise sensitive facilities noted above do not include the units displaced by construction.

in Figures 1-1 and 1-2 respectively. As can be seen, the increases in delay savings are not necessarily proportional with the increases in construction and acquisition costs. For example a two thirds increase in construction and acquisition costs in Option 6 when compared to Option 5 yields no delay improvement until demand exceeds 425,000 operations (about the year 2015).

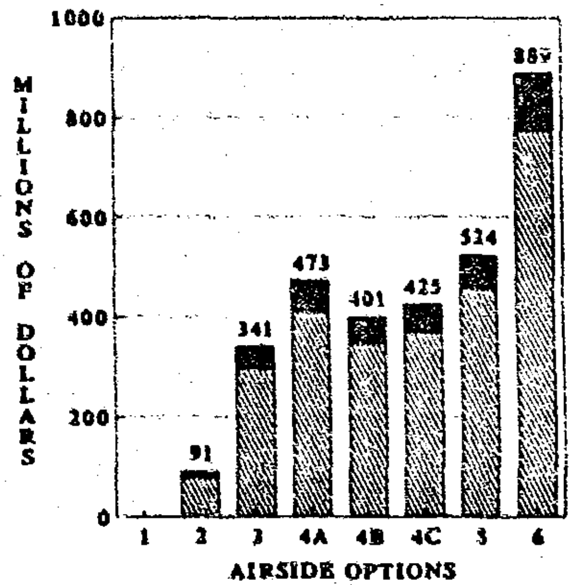
FIGURE 1-1
ANNUAL DELAY SAVINGS
YEAR 2015



Current research and advancements in technology suggest separation requirements for independent approaches will continue to be reduced. It is conceivable that by the year 2015, independent approaches will be possible to runways separated by 2,500 feet (Options 3, 4A, 4B, 4C and 5). Selection of Option 6 with its greater costs and impacts is therefore not recommended.

Although Options 2 and 3 are the least costly of the new runway alternatives and create the least impacts, these options provide a much lower amount of delay reduction when compared to the options with at least 7,000 feet of runway length. The lower benefits of these options is caused by the limited usage of the 5,200-foot long runway. Currently only about a third of the aircraft in the Sea-Tac fleet could use this shorter runway length. In the future this segment of the Sea-Tac aircraft fleet is projected to decrease. Therefore, due to the limited ability to reduce future delays, Options 2 and 3 are not recommended.

FIGURE 1-2
PRELIMINARY DEVELOPMENT COST ESTIMATES



When comparing the options with a 2,500-foot separation, delay savings are seen to increase as runway length increases. The greatest delay savings occur for Option 5 which is about 17 percent better than the next best option, Option 4C. Construction and acquisition costs are about 25 percent higher for Option 5 than for Option 4C. Using the year 2015 computed annual aircraft delay savings, the payback period for the added cost of Option 5 compared to Option 4C is about 6 to 7 years. For these reasons, Option 5 is recommended as the preferred operational alternative.

Specific benefits resulting from the selection of Option 5 are as follows:

- Aircraft delays are reduced to the lowest levels for demand expected through the year 2015.
- Fewer aircraft would be restricted from using the runway due to landing length limitations.
- All aircraft using a longer new runway would have greater takeoff/stopping distance available.
- An 8,500-foot runway length would provide a greater measure of redundancy in that it could accommodate heavy jet aircraft when one of the existing runways is closed for maintenance or emergency.

Section 2
AIRSIDE FACILITY REQUIREMENTS

SECTION 2
AIRSIDE FACILITY REQUIREMENTS

INTRODUCTION

In this section, airside facilities are identified which will be needed to satisfy the projected demand at Sea-Tac to the year 2020. Technical Report No. 5, Preliminary Forecast Report, describes the projections of aviation demand.

The process of determining facility requirements involves the application of established airport planning standards to the various forecast components to identify facility needs. These needs are then compared with existing facility capacities (a demand/capacity analysis) to determine new facility requirements.

The Federal Aviation Administration (FAA) has developed an extensive set of airport regulations and design guidelines and criteria, which are documented in FAA Advisory Circulars and Federal Aviation Regulations. In addition to FAA regulations and standards, various industry standards have been developed to estimate airport facility requirements from activity forecasts.

This report addresses only airside facility components. Landside elements, such as passenger terminal requirements, cargo needs and ground access needs will be addressed in another Technical Report. Airside requirements discussed below include runway length, runway pavement strength, runway safety areas and taxiways.

AIRPORT CLASSIFICATION

The FAA in its current AC 150/5300-13, Airport Design, has developed an airport reference code (ARC) system that relates airport design criteria and planning standards to two components: the operational and the physical characteristics of aircraft operating at or expected to operate at the airport. The first component of the ARC is a letter representing the aircraft approach speed and thus relates to operational characteristics. The aircraft approach category is a grouping of aircraft that is based on the approach speed (1.3 times the stalling speed) as follows:

Category	Approach Speed
A	Less than 91 knots
B	91 knots or more but less than 121 knots
C	121 knots or more but less than 141 knots
D	141 knots or more but less than 166 knots
E	166 knots or more

Current and projected aircraft operating at Sea-Tac are in approach Categories A through D.

The second component of the ARC is the airplane design group and relates to the wingspan of aircraft and therefore is a physical characteristic. The grouping of aircraft by wingspan (Airplane Design Group) is as follows:

Airplane Design Group	Wingspan
I	Up to but not including 49 ft
II	49 ft up to but not including 79 ft
III	79 ft up to but not including 118 ft
IV	118 ft up to but not including 171 ft
V	171 ft up to but not including 214 ft
VI	214 ft up to but not including 262 ft

The aircraft approach speed element of the ARC generally deals with runways and runway related facilities whereas the wingspan (and relevant Airplane Design Group) relates to separations required between airfield elements, such as runway-taxiway separations, taxilane and apron clearances, etc.

Today, the Boeing 747-400 is the critical aircraft in terms of airport geometrics and design, as it is the largest civil transport used at most major airports worldwide. With a 213 foot wingspan, the B747-400 is classified as an ADG V aircraft and thus is presently the most demanding in terms of facility requirements and clearances. Because of the anticipated need for even larger aircraft, with seating capacities from 500 to 800 passengers, airfield geometrics adequate for the B747-400 will not be adequate for the next generation "New Large Airplanes".

The next generation of airplanes is being studied by aircraft manufacturers for transport of high passenger volumes over very long distances, typical of mission requirements for airline routes to the Far East and Asia. While manufacturers are confident that mission requirements and performance specifications can be met, an important design issue is the compatibility of the size of the new large airplanes and existing airfield and terminal geometrics of major airports around the world. For example, the wingspans being considered for new large airplanes are in the 260 to 280 foot range. Based on present planning and design guidelines, such an aircraft would require 200-foot wide runways and runway to taxiway separations of at least 469 feet. This compares to a 150-foot runway width and 394-foot separation requirement for the B747-400.

If Sea-Tac is to compete as a major international airport in the long term, it must be capable of accommodating the next generation, high capacity aircraft. It is therefore recommended that planning and design standards based on projected new large airplane characteristics be applied in this master plan update. For these purposes the following general dimensions will be assumed:

- Wingspan - 280 feet
- Length - 260 feet
- Tail height - 78 feet
- Main landing gear track - up to 55 feet

The ARC resulting from these dimensions exceeds the largest category in the current FAA classification system as the above wingspan is greater than that covered by Aircraft Design Group VI. The FAA currently accommodates this anomaly with the design group designation VI+, and therefore the ARC to be applied will be D-VI+.

Table 2-1 presents the relevant airport planning standards to be used in this study. In some cases, standards based on specific aircraft dimensions differ from those for the aircraft design group. Planning and design standards for both the assumed aircraft dimensions and ARC are shown in Table 2-1. It should be noted that these standards reflect the long term geometric requirements, and that the timing of improvements to meet these standards will be better known after new airplane characteristics are further developed.

RUNWAY TAKEOFF LENGTH REQUIREMENTS

Many factors affect the runway takeoff length requirements at an airport. The current and expected mix of aircraft operating at the airport is a critical factor. Runway takeoff length is also affected by the aircraft stage length (distance of flight), runway slope (gradient), temperature, and wind direction and velocity. The discussion below includes consideration of runway length requirements for the existing

TABLE 2-1
AIRPORT PLANNING STANDARDS [a]

AIRPORT DESIGN AIRPLANE AND AIRPORT DATA (FEET)	
Aircraft Approach Category D and E	
Airplane Design Group VI+	
Airplane wingspan	280
Primary runway end is precision instrument 1/2-statute mile or less	
Other runway end is precision instrument 1/2-statute mile or less	
Airplane undercarriage width (1.15 x main gear track)	41.5
Airport elevation	429
Airplane tail height	78

RUNWAY AND TAXIWAY WIDTH AND CLEARANCE STANDARD DIMENSIONS (FEET)

	New Large Airplane [b]	ARC D-VI+
SEPARATION STANDARDS		
Runway centerline to parallel runway centerline for simultaneous operations when wake turbulence is a factor:		
VFR operations	2,500	2,500
IFR departures	2,500	2,500
IFR approach and departure with approach to near threshold	2,500	2,500
IFR approach and departure with approach to far threshold	2,500 [c]	2,500 [c]
IFR approaches		
Runway centerline to parallel taxiway/taxilane centerline	3,400	3,400
Runway centerline to edge of aircraft parking	469	600
Taxiway centerline to parallel taxiway/taxilane centerline	469	500
Taxiway centerline to fixed or movable object	346	346
Taxilane centerline to parallel taxilane centerline	206	206
Taxilane centerline to fixed or movable object	318	318
	178	178

TABLE 2-1
AIRPORT PLANNING STANDARDS [a]
(Continued)

RUNWAY PROTECTION ZONES		
Runway protection zone Runway 16 end:		
Length	2,500	2,500
Width 200 feet from runway end	1,000	1,000
Width 2,700 feet from runway end	1,750	1,750
Runway protection zone Runway 34 end:		
Length	2,500	2,500
Width 200 feet from runway end	1,000	1,000
Width 1,900 feet from runway end	1,750	1,750
Departure runway protection zone:		
Length	1,700	1,700
Width 200 feet from the far end of TORA	500	500
Width 1,900 feet from the far end of TORA	1,010	1,010
OBSTACLE FREE ZONES		
Runway obstacle free zone (OFZ) width	469	469
Runway obstacle free zone length beyond each runway end	200	200
Approach obstacle free zone width	469	469
Approach obstacle free zone length beyond approach light system	200	200
Approach obstacle free zone slope from 200 feet beyond threshold	50:1	50:1
Inner-transitional surface obstacle free zone slope	3:1	3:1
RUNWAY DESIGN STANDARDS		
Runway width	200	200
Runway shoulder width	40	40
Runway blast pad width	280	280
Runway blast pad length	400	400
Runway safety area (RSA) width	500	620
Runway safety area length beyond each runway end or stopway end, whichever is greater	1,000	1,000
Runway object free area (ROFA) width	800	800
Runway object free area length beyond each runway end or stopway end, whichever is greater	1,000	1,000
Clearway width	500	500
Stopway width	200	200

TABLE 2-1
AIRPORT PLANNING STANDARDS [a]
(Continued)

TAXIWAY DESIGN STANDARDS		
Taxiway width		
Taxiway edge safety margin	103.3	103.3
Taxiway shoulder width	20	20
Taxiway safety area width	40	40
Taxiway object free area width	280	280
Taxilane object free area width	412	412
Taxiway wingtip clearance	356	356
Taxilane wingtip clearance	66	66
	38	38
THRESHOLD SURFACES		
Threshold surface at primary runway end:		
Distance out from threshold to start of surface	200	200
Width of surface at start of trapezoidal section	1,000	1,000
Width of surface at end of trapezoidal section	4,000	4,000
Length of trapezoidal section	10,000	10,000
Length of rectangular section	0	0
Slope of surface	34:1	34:1
THRESHOLD SURFACES (Continued)		
Threshold surface at other runway end:		
Distance out from threshold to start of surface	200	200
Width of surface at start of trapezoidal section	1,000	1,000
Width of surface at end of trapezoidal section	4,000	4,000
Length of trapezoidal section	10,000	10,000
Length of rectangular section	0	0
Slope of surface	34:1	34:1

[a] Source: AC 150/5300-13, Airport Design.

[b] Standards based on a new large airplane with a wingspan of 280 feet. These standards can be used in lieu of ARC D-VI+ standards for wing span up to 280 feet.

[c] Plus 100 feet for each 500 feet of threshold stagger.

runways as well as a new third runway.

Maximum Aircraft Flight Distant

In current or recent service, Sea-Tac Airport has served non-stop markets as far away as Taipei, Taiwan, 6,066 statue miles from Sea-Tac Airport (Table 2-2). In order to estimate the farthest markets which would potentially be served by Sea-Tac Airport over the planning horizon (year 2020), non-stop service from San Francisco International Airport to the most distant cities was examined. The farthest non-stop city from Sea-Tac served by San Francisco International Airport in both passenger and all-cargo service is Hong Kong, which is 6,489 miles from Sea-Tac Airport (Table 2-2). San Francisco International has approximately the passenger traffic that is projected for Sea-Tac Airport between 2000 and 2020. It is concluded that Hong Kong should be considered the most distant market to be served by Sea-Tac Airport over the planning horizon with non-stop passenger and all-cargo service.

Affect of Aircraft Mix

Runway takeoff length requirements for aircraft models expected to operate at the airport between now and 2020 are shown in Table 2-3. Runway lengths are shown for typical maximum flight distances from Sea-Tac for each aircraft type. This table was developed to show the overall affect the aircraft type has on takeoff length requirements and is based on the following general assumptions:

- Zero runway gradient
- Zero winds
- Temperature of 84°F (unless footnoted otherwise)

This table identifies critical aircraft types for takeoff runway length at Sea-Tac.

For flights taking off to the north at Sea-Tac there is an uphill runway gradient of .71 to .72%. For this upward slope, approximately 4 to 7% greater runway length is required for takeoff than shown in Table 2-3. This table illustrates that the wide body aircraft, such as the B747 and MD-11, for long flight distances, require the greatest takeoff length. The critical aircraft is the B747 at maximum gross takeoff weight.

Figure 2-1 illustrates the percent of the projected aircraft takeoffs that would be accommodated by a given runway length for the projected aircraft fleet mixes in years 2000 and 2020 at the airport. The takeoff length requirements in this figure were taken from Table 2-1 and adjusted upward by 3% to account for the upward gradient on departures to the north. As shown in Figure 2-1, approximately 31% of takeoffs in the year 2020 can be accommodated on a runway of 5,200 feet in length, 77% on a 7,000-foot runway and 90% on an 8,500-foot runway.

Takeoff Length for Critical Aircraft

The two aircraft operating at Sea-Tac requiring the greatest runway length are the B747-200 and B747-400 operated at maximum gross takeoff weight. These aircraft are commonly used in long-haul all-cargo service throughout the world. Table 2-4 and Figure 2-2 illustrate the relationship between flight distance and payload weight and runway length. In Table 2-4 the runway length requirement for takeoff on Runways 16L and 16R are compared with Runways 34R and 34L to identify the affect of runway gradient on takeoff length required.

Several conclusions can be drawn from these data. The critical runways for takeoff are Runways 34R and 34L due to the uphill gradient. The critical aircraft is the B747-200, which requires a runway length of 12,500 feet

TABLE 2-2
COMPARISON OF LONGEST SCHEDULED FLIGHT DISTANCES FROM SEATTLE-TACOMA AND SAN FRANCISCO INTERNATIONAL AIRPORTS [a]

Non-Stop Service from San Francisco International Airport			Non-Stop Service from Seattle-Tacoma International Airport	
	Distance (Statute Miles)			
City	From San Francisco	From Seattle-Tacoma	City	Distance From Sea-Tac (Statute Miles)
Passenger Service to Europe				
Amsterdam, Netherlands	5,474	4,886	Amsterdam, Netherlands	4,386
Frankfurt, Germany	5,700	5,108	Copenhagen, Denmark	4,868
London, England	5,375	4,806	London, England	4,806
Paris, France	5,593	5,027		
Passenger Service to Asia				
Hong Kong, Hong Kong	6,913	6,489	Seoul, Korea	5,197
Osaka, Japan	5,389	5,015	Shanghai, China	5,723
Seoul, Korea	5,636	5,197	Taipei, Taiwan	6,066
Shanghai, China	6,154	5,723	Tokyo, Japan	4,797
Taipei, Taiwan	6,458	6,066		
Tokyo, Japan	5,155	4,797		
Cargo Service				
Hong Kong, Hong Kong	6,913	6,489	Amsterdam, Netherlands	4,886
London, England	5,375	4,806	Luxembourg, Luxembourg	5,075
Seoul, Korea	5,636	5,197	Shanghai, China	5,723
Taipei, Taiwan	6,458	6,066		
Tokyo, Japan	5,155	4,797		

[a] Sources: Official Airline Guides, OAG Desktop Flight Guide, OAG Air Cargo Guide, and OAG data files for 1993. Source shown is existing service.

TABLE 2-3
RUNWAY TAKEOFF LENGTH REQUIREMENTS FOR TYPICAL MAXIMUM FLIGHT DISTANCES FROM SEATTLE-TACOMA INTERNATIONAL AIRPORT

Aircraft Type [a]	Typical Maximum Flight Distance from Seattle-Tacoma [b]		Take-off Length Required [c] (Feet)
	Distance (Statute Miles)	City	
120 Seats and Under			
B737-200	679	San Francisco, California	4,900
B373-500	1,736	Chicago, Illinois	6,600
B737-200C [e]	1,448	Anchorage, Alaska	8,500
121 to 170 Seats			
B737-300	2,279	Charlotte, North Carolina	6,600
B737-400	1,533	Fairbanks, Alaska	6,100
MD 83	1,892	Houston, Texas	6,500
B727-100C [e]	1,971	Cincinnati, Ohio	8,600 [i]
171 to 240 Seats			
B757-200	2,408	New York, New York	5,500
B767-200 [f]	2,724	Miami, Florida	5,400
241 - 350 Seats			
B767-300ER	4,868	Copenhagen, Denmark	7,000
	4,886	Amsterdam, Netherlands	7,000
L1011-200	2,677	Honolulu, Hawaii	6,600
DC10-30 [g]	2,677	Honolulu, Hawaii	6,700
Over 350 Seats			
B747-200	4,797	Tokyo, Japan	8,800
B747-400	6,066	Taipei, Taiwan	8,400
B777 [h]	5,723	Shanghai, China	9,400 [i]
MD11	5,723	Shanghai, China	8,900
B747-200F [e]	5,075	Luxembourg, Luxembourg	12,200 [i]
B747-400F [e]	5,075	Luxembourg, Luxembourg	10,300
MD11F [e]	5,723	Shanghai, China	11,000 [i]

[a] Cargo aircraft are shown under the seating category for equivalent-sized aircraft.

[b] Cities and distances are farthest non-stop distances served from Sea-Tac currently or in the past for each aircraft type, unless footnoted otherwise.

[c] Runway take-off length requirements are based on the distance shown in the table, zero winds, temperature of 84°F (unless footnoted otherwise) and a zero runway gradient. Passenger aircraft requirement is based on a full passenger load (200 to 216 pounds per passenger for passenger and baggage) and no cargo. Cargo aircraft requirements are based on maximum aircraft payload if possible. If the flight distance is too great for the maximum payload, the take-off distance is based on the maximum gross take-off weight for the aircraft. For a 0.71 to 0.72 downward slope, approximately 2.5 to 5 percent less runway length is required for take-off. For a 0.71 to 0.72 upward slope, approximately 3 to 7 percent greater runway length is required for take-off.

[d] Runway landing length requirements are based on a zero runway gradient, wet runway, maximum flaps, and maximum landing weight.

TABLE 2-3
RUNWAY TAKEOFF LENGTH REQUIREMENTS FOR TYPICAL MAXIMUM FLIGHT DISTANCES FROM SEATTLE-TACOMA INTERNATIONAL AIRPORT

[e] Cargo aircraft.

[f] Based on 88°F.

[g] Based on 93°F.

[h] Potential future service.

[i] Aircraft is at maximum gross take-off weight.

FIGURE 2-1
CUMULATIVE TAKEOFF LENGTH REQUIREMENT AT SEATTLE-TACOMA INTERNATIONAL AIRPORT

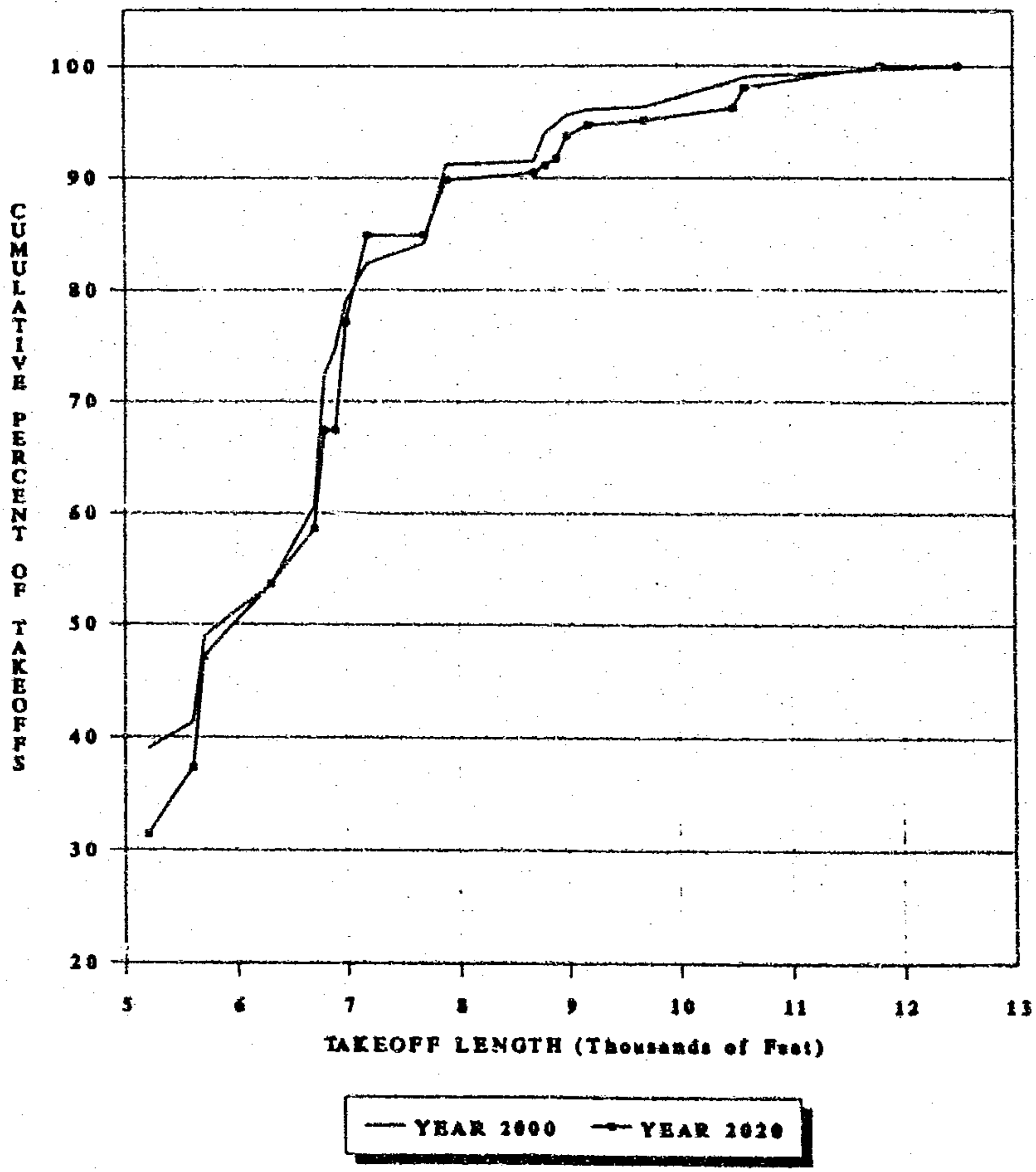


TABLE 2-4
RUNWAY TAKEOFF LENGTH REQUIREMENTS FOR B747-200 AND B747-400 AIRCRAFT AT SEATTLE-TACOMA INTERNATIONAL AIRPORT

Flight Distance (Statute Miles)	City [a]	Take-off Weight [b] (Thousands of Pounds)	Payload Weight [c] (Thousands of Pounds)	Runway Length Required for Takeoff [d] (Feet)	
				Runways 16L & 16R	Runways 34R & 34L
B747-200B (CF6-50E2 Engines) Full Passengers [e]					
4,797	Tokyo, Japan	740	96	8400	8,900
5,108	Frankfurt, Germany	750	96	8,700	9,200
5,723	Shanghai, China	785	96	9,800	10,500
6,066	Taipei, Taiwan	805	96	10,300	11,100
6,489	Hong Kong, Hong Kong	833	96	11,500	12,500
B747-200B (CF5-50E2 Engines) Full Passengers and Cargo [f]					
4,797	Tokyo, Japan	785	133	9,800	10,500
5,108	Frankfurt, Germany	805	133	10,300	11,100
5,723	Shanghai, China	833 [i]	125 [g]	11,500	12,500
B747-400 (CF5-80C2B1F Engines) Full Passengers [e]					
4,797	Tokyo, Japan	695	86	6,800	7,200
5,108	Frankfurt, Germany	705	86	7,000	7,400
5,723	Shanghai, China	740	86	7,800	8,200
6,066	Taipei, Taiwan	755	86	8,100	8,600
6,489	Hong Kong, Hong Kong [i]	775	86	8,500	9,100
7,740	Sydney, Australia [i]	840	86	10,300	11,000
B747-400 (CF6-80C2B1F Engines) Full Passengers and Cargo [f]					
4,797	Tokyo, Japan	745	123	7,900	8,300
5,108	Frankfurt, Germany	760	123	8,300	8,800
5,723	Shanghai, China	790	123	9,000	9,600
6,066	Taipei, Taiwan	810	123	9,400	10,000
6,489	Hong Kong, Hong Kong [i]	830	123	10,000	10,700
7,740	Sydney, Australia [i]	870 [j]	104 [g]	11,200	12,000
B747-200F (CF6-50E2 Engines) All-Cargo Service [h]					
4,797	Tokyo, Japan	833 [j]	164	11,500	12,500
4,856	Amsterdam, Netherlands	833 [j]	161	11,500	12,500
5,075	Luxembourg, Luxembourg	833 [j]	153	11,500	12,500
6,066	Taipei, Taiwan	833 [j]	125	11,500	12,500
4,797	Tokyo, Japan	796	140	10,200	10,900
4,886	Amsterdam, Netherlands	800	140	10,300	11,100
5,075	Luxembourg, Luxembourg	812	140	10,600	11,500
B747-400F (CF6-C2B1F Engines) All-Cargo Service [k]					
4,797	Tokyo, Japan	810	169	9,400	10,100
4,886	Amsterdam, Netherlands	815	169	9,500	10,200
5,075	Luxembourg, Luxembourg	825	169	9,900	10,600
6,066	Taipei, Taiwan [i]	870 [j]	164	11,200	12,000
6,489	Hong Kong, Hong Kong [i]	870 [j]	149	11,200	12,000

TABLE 2-4
RUNWAY TAKEOFF LENGTH REQUIREMENTS FOR B747-200 AND B747-400 AIRCRAFT AT SEATTLE-TACOMA INTERNATIONAL AIRPORT

[a] Service is existing or past service except where footnoted otherwise.

[b] Gross aircraft take-off weight for passenger service is based on a) a full passenger load (452 passengers for B747-200 and 400 passengers for B747-400), and b) full passenger load and maximum belly cargo.

[c] Excludes aircraft empty weight and fuel.

[d] Source: P&D Aviation analysis based on zero winds, a temperature of 76°F, and data contained in aircraft operations manuals. Average runway gradients are: Runway 16L-34R, 0.72 percent upward to the north; Runway 16R-34L, 0.71 percent upward to the north.

[e] Full passengers only with no belly cargo.

[f] Full passengers and full belly cargo.

[g] Distance is too great to allow full passengers and full cargo. Take-off weight is maximum gross take-off weight.

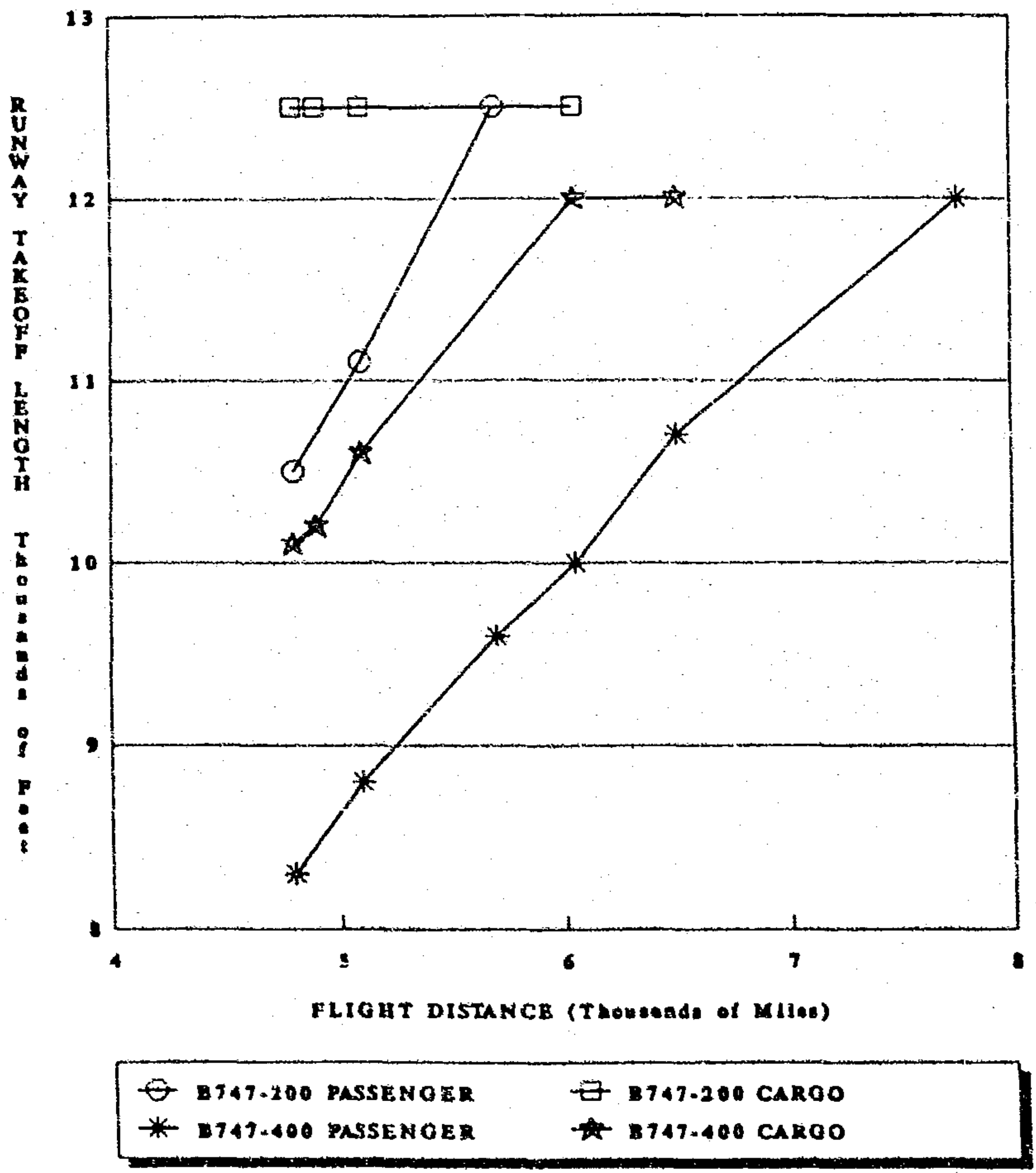
[h] For flight distances over 3,900 statute miles, the B747-200F must carry less than the maximum cargo payload limit of approximately 200,000 pounds. The take-off distances shown are for the maximum gross takeoff weight of the aircraft and the take-off weight required to carry 140,000 pounds, roughly 70 percent of the aircraft's payload limit.

[i] Potential future service.

[j] Maximum gross take-off weight of aircraft.

[k] Maximum payload is 169,000 pounds.

FIGURE 2-2
RUNWAY TAKEOFF LENGTH VS FLIGHT DISTANCE FOR B747-200 AND B747-400 AT SEA-TAC



for full passenger loads to Hong Kong, full passengers and cargo to Shanghai or fully load all-cargo service to Tokyo, Amsterdam, Luxembourg or Taipei. Takeoff runway requirements increase significantly with greater flight distance and payload. The all-cargo service has a greater payload weight and therefore requires a greater runway length for a given flight distance.

Runway length requirements are also significantly affected by temperature, particularly at higher temperatures. Table 2-5 depicts runway takeoff length requirements for the B747-400 for various temperatures and flight distances. For example, for flight distances between 5,500 and 6,000 statue miles, the takeoff length would increase from 12,000 feet at 76°F to 12,700 feet at 95°F. At Sea-Tac Airport, the mean maximum temperature for the hottest month is 76°F.

Due to the combination of high temperature, heavy payload and long flight distance, aircraft must occasionally depart with less than the desired payload. This happens more commonly with all-cargo flights than with passenger flights because of the greater payloads of cargo flights.

It is estimated that in the year 2020, approximately 681 departures will be subject to a takeoff weight penalty (Table 2-6). Over 90% of the weight restricted flights would be all-cargo flights. The total number of flights subject to takeoff weight penalty represent roughly 0.3% of the estimated airline departures at Sea-Tac in 2020.

Conclusions Regarding Runway Takeoff Length

The following conclusions have been drawn from the analyses of runway takeoff length requirements described above:

- **Runway 16L-34R.** The primary departure runway (Runway 16L-34R) should be capable of accommodating the critical aircraft commonly in service at the airport under maximum payload conditions for the current or projected flight distance. The required primary runway length would be 12,500 feet to accommodate the B747-200 at mean maximum temperature of 76°F. This length would accommodate the B747-400 for temperatures up to 90°. Future aircraft types such as the New Large Airplanes are not expected to require runway takeoff lengths greater than the B747. Additionally, the increased runway length would provide a greater margin of safety for aircraft operating on the runway.

- **Runway 16R-34L.** As the secondary takeoff runway, Runway 16R-34L must be used in the event that Runway 16L-34R is closed due to repairs or other circumstances. Consequently, the takeoff length for the secondary runway should be as close as practical to the primary length. Furthermore, with a third runway, Runway 16R-34L will be operated primarily as a takeoff runway under many conditions. As a comparison, Table 2-7 lists existing runway lengths of airport's with enplanements similar to the level of enplanements forecast for Sea-Tac in the 2010 to 2020 timeframe. The second longest runway of these six airports is 10,000 feet or greater. It is recommended that Runway 16R-34L be maintained at its maximum practical length while meeting the Runway Safety Area (RSA) and Runway Object Free Area (ROFA) standards established by the FAA.

- **New Third Runway.** Although a third runway at Sea-Tac would primarily be used for landings it would accommodate a limited number of departures during peak

TABLE 2-5
RUNWAY LENGTH REQUIREMENTS FOR DEPARTURES TO THE NORTH AT SEATTLE-TACOMA INTERNATIONAL AIRPORT [a]

Temperature (Fahrenheit)	Runway Length Required (in feet) for Distance (in Statute Miles)			
	4,500-5,000 Miles	5,000-5,500 Miles	5,500-6,000 Miles	6,000-6,500 Miles
B747-400 (CF6-80C2B1F Engines) Full Passengers and Cargo				
76°	8,500	9,200	9,900	10,700
80°	8,600	9,300	10,000	10,800
85°	8,800	9,400	10,100	10,900
90°	9,000	9,600	10,300	11,100
95°	9,300	10,000	10,800	11,600
B747-400 (CF6-80C2B1F Engines) All-Cargo Service				
76°	10,400	11,000	12,000	12,000 [b]
80°	10,700	11,100	12,100	12,100 [b]
85°	10,000	11,200	12,200	12,200 [b]
90°	10,400	11,400	12,400	12,400 [b]
95°	11,100	11,900	12,700	12,700 [b]

Note: Departures of the B747-400 to the north for temperatures and distance indicated by shaded area require a runway length greater than existing runways.

[a] Source: P&D Aviation analysis, based on data contained in aircraft operating manuals.

[b] All-cargo aircraft must operate at less than maximum payload in this distance range.

TABLE 2-6
ESTIMATED NUMBER OF DEPARTURES ON RUNWAY 34R SUBJECT TO WEIGHT PENALTY DUE TO EXISTING RUNWAY LENGTH, 2020 [a]

Range of Distance and Typical Cities [b]	Estimated Annual Departures [c]		Estimated Percent of Departures Subject to Takeoff Weight Penalty [d]		Estimated Departures Subject to Takeoff Weight Penalty		
	Passenger	All-Cargo	Passenger	All-Cargo	Passenger	All-Cargo	Total
Boeing 747-400							
6,000-6,500 miles Hong Kong Taipei	154	202	0	100	0	202	202
5,500-6,000 miles Shanghai	309	202	0	100	0	202	202
5,000-5,500 miles Paris Frankfurt Seoul	464	608	0	2	0	12	12
4,500-5,000 miles Tokyo London Amsterdam	618	1,013	0	0	0	0	0
Other Widebody Aircraft							
4,500-6,000 miles	3,090	2,025	2	10	62	203	265
Total Aircraft Departures Potentially Subject to Weight Penalty							
Total - Year 2020	4,635	4,050	1.3	15.3	62	619	681

[a] Source: P&D Aviation analysis. Based on 11,900 foot runway.

[b] Indicates the range of distances (statute miles) and the cities which potentially could be served by Sea-Tac.

[c] Based on forecast of departures for 2020 and aircraft fleet mix forecast (Technical Report No. 5, Table 5-17).

[d] Estimated based on temperature, flight distance and runway length requirement.

TABLE 2-7
RUNWAY LENGTHS OF AIRPORTS SIMILAR IN ENPLANEMENTS TO FORECAST FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1993 [a]

City and State	Existing Runway Lengths [b] (Feet)			
	Runway 1	Runway 2	Runway 3	Runway 4
Airports with Enplanements Similar to Sea-Tac in 1993				
Washington National, DC	6,869	5,189	4,505	--
Philadelphia, PA	10,499	9,500	5,460	--
Houston Intercontinental, TX	12,001	9,999	9,401	6,038
Seattle-Tacoma, WA	11,900	9,425		
Charlotte, NC	10,000	7,845	7,501	--
Orlando, FL	12,004	12,004	10,000	--
Pittsburgh, PA	11,500	10,502	8,100	8,039
Airports with Enplanements Similar to Sea-Tac Forecasts for 2010 to 2020				
Miami, FL	13,000	10,502	9,355	--
J.F. Kennedy, NY	14,572	11,351	10,000	8,400
Denver, CO (New)	12,000	12,000	12,000	12,000
San Francisco, CA	11,870	10,600	8,901	7,001
Atlanta, GA	11,889	10,000	9,000	9,000
Los Angeles International, CA	12,091	11,096	10,285	8,925

[a] Source: U.S. Department of Commerce, U.S. Terminal Procedures, January 6, 1994.

[b] Runway length requirements depend upon many local factors, including: temperature, airport elevation, winds and runway gradient, as well as aircraft type and distance flown. Therefore, these factors must be considered when comparing runway lengths of airports.

departure periods and other circumstances required by Air Traffic Control to maintain flexibility in the traffic flow at the airport. A runway length between 5,200 feet and 8,500 feet would accommodate from 39 to 91% of aircraft departures in the year 2000 and from 31% to 90% in the year 2020. For the third runway to operate effectively and efficiently, it should be capable of accommodating a share of departures within this range.

THIRD RUNWAY LANDING LENGTH ANALYSIS

Introduction

An analysis of landing length requirements for the proposed third runway was undertaken for the purpose of determining the optimum runway length in consideration of both aircraft operations and construction costs. It was assumed that the runway's primary role would be for landings although takeoffs would be performed during departure peak periods.

Factors affecting the runway landing length requirement include the aircraft mix, the condition of the pavement (wet versus dry), wind direction and velocity, and type of instrument approach (i.e., greater length requirement for Category IIIb approach).

The forecast aircraft mix for the years 2000 and 2020 was used in the analysis. Typical rather than maximum landing weights were used for each aircraft in the fleet. Typical landing weights were calculated at 90% of maximum landing weights based upon information supplied by two of the major carriers serving Sea-Tac.

Landing lengths were based upon wet pavements (plus 15% of base length) and an allowance (plus 15%) for accommodating CAT IIIb operations in accordance with FAR Part 121.195 and FAA AC 120/28C, respectively.

Aircraft Mix

The aircraft mix appearing in the demand forecast report was aggregated by ranges of the number of seats. This was disaggregated into individual aircraft models. The percent of total operations by aircraft model was calculated for the years 2000 and 2020. All commuter, general aviation and military aircraft were grouped into a single type since none of the aircraft in these categories were considered to be critical for runway length determination. Only Stage III aircraft were utilized in the analysis, since all Stage II aircraft will be phased out by the year 2000. Table 2-8 summarizes the aircraft fleet mix for 2000 and 2020 used in the runway landing length calculations together with the percent of total operations forecast to be performed by each aircraft type.

Runway Landing Length

Table 2-9 summarizes the data used and the results of landing length analysis for the aircraft models in the fleet mix. Figure 2-3 is a plot of runway lengths compared to percent of operations. Data were taken from Tables 2-8 and 2-9 to construct the graph.

An analysis of the data in Tables 2-8 and 2-9 can be summarized as follows:

Runway Length (Feet)	Percent of Operations Accommodated 2000	2020
7,000	94%	91%
7,500	98%	96%
8,500	99%	99%
11,000	100%	100%

TABLE 2-8
AIRCRAFT MIX AND PERCENT OF TOTAL OPERATIONS [a]

Aircraft	Percent of Total Operations	
	2000	2020
Commuter/GA/Military	38.4	30.8
F100	0.6	0.6
B727-200	3.5	0.0
B737-300	9.4	6.5
B737-400	4.7	6.5
B737-500	2.3	2.3
B747-400	0.3	0.7
B757-200	7.6	9.8
B767-200	2.3	5.9
B767-300	3.5	7.8
B777-200	0.2	0.4
MD80	7.0	5.0
MD90	7.0	4.9
MD11	0.3	0.7
MD12	0.2	0.3
DC 10-30	2.4	0.0
A300-600	1.2	3.2
A310-200	0.6	3.2
A319	1.8	1.8
A320-200	0.6	1.5
A340-200	0.6	1.3
A340-300	0.2	0.7
DC9F	0.8	0.6
B727F	0.8	0.6
DC8F	2.3	1.1
DC10F	0.7	2.0
B747F	0.7	1.8
TOTALS	**100.0**	**100.0**

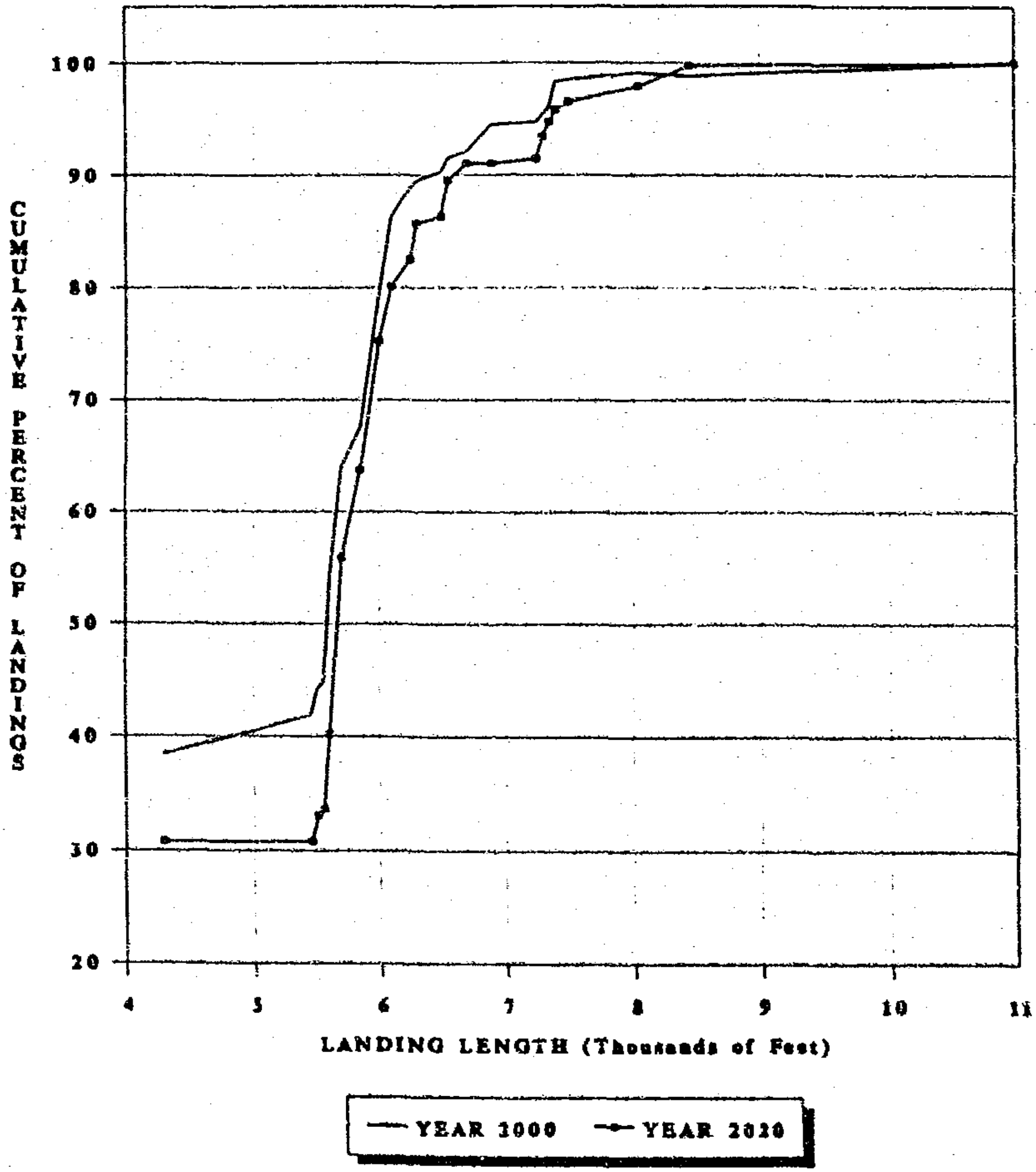
[a] Source: P&D Aviation analysis.

TABLE 2-9
RUNWAY LANDING LENGTH ANALYSIS [a]

Aircraft	Range (Nautical Miles)	Typical Landing Weight (Pounds)	Landing Lengths (Feet)		
			Base	Wet	CAT IIIb
Commuter/GA/Military	500-1,300	30,000-75,000	3,300	3,800	4,300
F100	1,310	79,200	4,270	4,900	5,550
B727-200	1,900	135,000	4,200	4,830	5,460
B737-300	2,200	102,600	4,300	4,945	5,590
B737-400	2,100	111,600	4,600	5,290	5,980
B737-500	2,400	99,000	4,250	4,885	5,525
B747-400	6,700	567,000	6,200	7,130	8,060
B757-200	4,000	178,200	4,400	5,060	5,720
B767-200	3,900	243,000	4,400	5,060	5,720
B767-300	3,500	270,000	4,500	5,175	5,850
B777-200	4,600	400,500	5,600	6,440	7,280
MD80	2,100	117,000	4,600	5,290	5,980
MD90	2,000 [b]	127,800	4,700	5,405	6,110
MD11	6,800	387,000	6,200	7,130	8,060
MD12	8,000	577,000	8,450	9,715	10,985
DC 10-30	4,300	362,700	5,300	6,095	6,890
A300-600	3,680	273,815	5,040	5,795	6,550
A310-200	4,225	244,100	4,850	3,580	6,300
A319	2,800	121,030	4,800	5,520	6,240
A320-200	2,870	145,835	5,150	5,920	6,700
A340-200	8,450	367,070	5,650	6,500	7,350
A340-300	7,650	376,990	5,750	6,600	7,500
DC9F	1,000	89,000	5,000	5,750	6,500
B727F	1,800	126,000	4,800	5,500	6,250
DC8F	3,200	225,000	5,700	6,555	7,400
DC10F	3,200	370,000	5,600	6,440	7,280
B747F	4,700	567,000	6,500	7,475	8,450

[a] Source: Individual aircraft manufacturers planning manuals and Jane's All the World's Aircraft - 1993-94.
[b] Estimated.

FIGURE 2-3
CUMULATIVE LANDING LENGTH REQUIREMENT FOR CATEGORY IIIB AT SEA-TAC AIRPORT



RUNWAY SYSTEM REQUIREMENTS

This section deals with runway requirements other than runway length needed to satisfy the forecast demand, such as pavement strength requirements, crosswind coverage and safety areas. Planning and design standards set forth in FAA AC 150/5300-13, Airport Design, for Airport Reference Code D-VI+ form the basis of this analysis. This should provide satisfactory facilities for the new large commercial aircraft models expected to use the Airport.

Crosswind Runway

The present runway orientation (16-34) provides 99.7% coverage for a 20 knot (23 mph) crosswind during all weather periods. This meets the FAA recommendations of 95% cross-wind coverage. Use of a 20 knot crosswind is consistent with FAA recommendations for Aircraft Design Groups IV through VI. Additional runways for improved crosswind coverage are not needed.

Runway Width

Runway width is a dimensional standard that is based upon the physical characteristics of aircraft using the airport (or runway). Based on the FAA ADG system, the physical characteristic of importance is wingspan and, in this case, wingspans up to 280 feet are used. FAA AC 150/5300-13 specifies a runway width of 200 feet for Design Group VI, and this requirement will be assumed for aircraft with a 280 foot wingspan. The width of the landing gear track is also critical in the determination of runway width. It is noted that the International Civil Aviation Organization (ICAO) recommends considering runway widths up to 200 feet for planning to accommodate future aircraft developments. Therefore, the airport should be planned to allow for ultimate runway widths of 200 feet. Both runways are presently 150 feet wide but can be expanded to 200 feet if necessary.

The width of a third runway would depend on the runway option under consideration. Some options, described in Section 3, provide for only a commuter runway for the third runway. Under these options, the width of the third runway (100 feet) has been sized to accommodate up to ADG III aircraft (which includes commuter aircraft and smaller commercial jets such as the B737, DC9, MD82 and A320). For all other new runway options, the runway width is initially planned to be 150 feet (ADG IV and V) but could be widened to 200 feet if necessary.

Runway/Taxiway Shoulders

Unprotected soils adjacent to runway and taxiway pavements are susceptible to erosion from runoff and jet blast. While a turf cover can prevent erosion and support the occasional passage of emergency vehicle traffic, FAA recommends that paved shoulders be provided for runways and taxiways that serve aircraft in Design Group III and greater. For Aircraft Design Group VI, the design standard calls for 40 foot wide shoulders for runways and taxiways. The same is recommended for the new large airplane assumed as the critical aircraft. Current shoulder widths vary from 25 to 50 feet. Thus widening of shoulders along various sections of runways would be required to meet new large airplane standards.

Runway Grades

The maximum longitudinal grade is 1.5% for runways serving Aircraft Approach Category C and D aircraft. The runway should have adequate transverse slopes to prevent the accumulation of water on the surface. A maximum transverse grade of 1.5% is recommended for the airport by FAA with the acceptable range being 1.0% to 1.5%. The existing runway grades at the airport comply with these standards.

Pavement Strength

Future critical aircraft in terms of pavement design represented by the new large aircraft may be designed with maximum gross weights up to 1,700,000 pounds and have different landing gear configurations. The B777 for example has six wheel bogies. The runways at Sea-Tac are generally rated at 100,000 pounds for single wheel loads, 200,000 pounds for dual wheel loads, 350,000 pounds for dual tandem wheel loads, and 800,000 pounds for double dual tandem landing gears. Evaluation of runway pavements has been the subject of recent studies and is discussed below.

Runway 16L-34R. Runway 16L-34R was rehabilitated in 1993 through the construction of a 5-inch asphalt overlay. The rehabilitation project did not change the weight bearing capacity of the runway stated above. Based on a 20 year design life of the newly constructed overlay and use by existing aircraft, it is expected that another rehabilitation program will be required towards the end of the planning period of the master plan (year 2020). Long term pavement needs must consider future aircraft models, including new large airplanes currently under study.

Runway 16R-34L. An evaluation of Runway 16R-34L pavement, drainage, and safety areas was conducted in 1992. (Preliminary Engineering Report Runway 16R-34L Seattle-Tacoma International Airport, Pavement Consultants Inc., August 1992). The allowable loads for different sections of the runway are shown in Table 2-10. The evaluation concluded that certain sections of the runway cannot withstand projected traffic at maximum aircraft load levels and suggested the need to strengthen the runway. Additionally, the evaluation projected pavement conditions in 1996 and 2001 if no major improvements were completed (see Table 2-11). The evaluation was based on consideration of the present aircraft fleet and landing gear configurations. For the Master Plan Update it is recommended that future pavement strengthening and rehabilitation programs be planned and consider present aircraft models, as well as the projected fleet mix including new large aircraft being studied for possible development.

Runway Safety Areas

A runway safety area (RSA) is defined as a rectangular area centered about the runway that is cleared, drained, graded and usually turfed. Under normal conditions, this area should be capable of accommodating occasional aircraft that may veer off the runway, as well as fire fighting equipment. For Sea-Tac, the requirement for the RSA is an area 500 feet wide centered on the runway centerline and extending 1,000 feet beyond each runway end.

The existing runway safety areas do not meet FAA criteria (Table 2-12). The existing RSA for Runway 34R is 535 feet long and 500 feet wide. The Runway 16L RSA is 700 feet long with varying widths from 180 to 500 feet. The RSA for Runway 34L is 775 feet long and 500 feet wide. The RSA for Runway 16R is 645 feet long with the width varying from 180 to 500 feet. The reasons for not meeting the FAA standards are steep terrain and/or the presence of roads at the ends of the runways (Table 2-12).

In addition to dimensional standards, FAA has established longitudinal and transverse gradient standards for safety areas. For the first 200 feet of RSA beyond runway ends the longitudinal grade must be between zero and three percent

TABLE 2-10
ALLOWABLE LOADS FOR RUNWAY 16R-34L [a]

Runway Section	Allowable Load (Kips)					
	Single Wheel	Dual Wheel	Dual Tandem	MD-11	B747	L1011
1	over 75	160	240	540	740	420
2	over 75	145	240	460	700	420
3	over 75	160	280	540	760	460
4	over 75	140	280	500	720	430
5	over 75	150	300	540	800	460
6	over 75	170	280	560	790	450
7	over 75	150	260	560	780	440
8	over 75	170	380	540	800	460
Percent Maximum Takeoff	over 100	67	69	76	84	90
Percent Maximum Landing	over 100	87	80	98	114	114

[a] Source: Pavement Consultants, Inc., Preliminary Engineering Report Runway 16R-34L, August 1992.

TABLE 2-11
PROJECTED PAVEMENT CONDITION FOR RUNWAY 16R-34L
IN 1996 AND 2001, WITH NO MAJOR IMPROVEMENTS COMPLETED [a]

Section	1991		1996		2001	
	PCI	Rating	PCI	Rating	PCI	Rating
1B	59	Good	45	Fair	20	Very Poor
2B	76	Very Good	62	Good	37	Poor
3B	82	Very Good	68	Good	43	Fair
4B	73	Very Good	59	Good	34	Poor
5B	77	Very Good	63	Good	38	Poor
6B	78	Very Good	64	Good	39	Poor
7B	68	Good	54	Fair	29	Poor
8B	68	Good	54	Fair	29	Poor

[a] Source: Pavement Consultants, Inc., Preliminary Engineering Report Runway 16R-34L, August 1992.

TABLE 2-12
EXISTING AND REQUIRED RUNWAY SAFETY AREAS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT, 1994

Description	Runway Safety Area Dimension (Feet)			
	Runway 16L	Runway 34R	Runway 16R	Runway 34L
Existing Safety Area				
Length Beyond Runway End Width Length at Full Width (500 Feet)	700 180-500 500	535 500 535	645 180-500 230	775 500 775
Required Safety Area				
Length Beyond Runway End Width	1,000 500	1,000 500	1,000 500	1,000 500
Constraints				
Primary Constraints to Runway Safety Area Expansion	1. 154th Street is 800 feet north of runway end.	1. Steep terrain to the south of existing safety area.	1. 154th Street is 900 feet north of runway end.	1. An airport service road is located 800 feet south of runway end.
	2. 154th Street is 50 feet lower in elevation than runway end.		2. 154th Street is 100 feet lower in elevation than runway end.	

with any slope being downward from the runway end. For the remainder of the extended RSA the maximum longitudinal grade is such that no part of the runway safety area penetrates the approach surface as specified in FAR Part 77. The maximum negative grade allowed is 5%. Transverse grades are limited to between 1.5 and 5% with the maximum recommended to promote drainage.

It is recommended that all runway safety areas be modified to fully comply with FAA criteria. In all initial airfield options, with the exception of Option 1 - Do Nothing, described in Section 3, the RSAs meet FAA standards. FAA compliance would be obtained by either relocating roads, adding fill material, and/or shortening the runway.

Object Free Areas

The runway object free area (ROFA) is a two dimensional ground area surrounding the runway. Its clearing standard precludes parked aircraft and objects, except objects whose location is fixed by function. As such, it replaces former criteria for aircraft parking limit lines and was the result of an agreement that a minimum 400 foot separation be provided between the runway centerline and equipment shelters (except localizer equipment shelters). At Sea-Tac, the ROFAs extend 400 feet on either side of the runway centerlines, along the entire length of runways and 1,000 feet beyond each end.

The following objects are located within the ROFA at Sea-Tac:

- Runway 16R - road (South 154th Street).
- Runway 16L - road (South 154th Street), localizer transmitter building and ALS regulator building.
- Runway 34L - localizer antenna and equipment shelter, RVR transmissometer and receiver, VORTAC and rotating beam ceilometer (RBC).
- Runway 34R - ALS substation.

With the exception of the road, all object locations are fixed by function and related to navaids and airport electronic equipment. Therefore, the navaids and electronic equipment are allowed to be within the ROFAs by FAA standards. Under all airfield development options to be considered, the ROFAs would be modified to fully comply with FAA criteria.

Approach Surfaces and Runway Protection Zones

The approach surface and the runway protection zone (formerly called clear zone) are important elements in the design of runways which help to ensure the safe operations of aircraft. A brief description of these two areas follows:

- *The Approach Surface* is an imaginary inclined plane beginning at the end of the primary surface (which extends 200 feet from the end of the runway) and extending outward to distances up to 10 miles depending on runway use and navaids (i.e., size of aircraft and instrument or visual approaches). The width and slope of the approach surface are also dependent on runway use and navaids. Objects should not penetrate or extend above the approach surface. If they do, they are classified as obstructions and must be either marked or removed.
- *The Runway Protection Zone (RPZ)* is an area at ground level that provides for the unobstructed passage of landing aircraft through the above airspace. The runway protection zone begins at the end

of the primary surface and has a size which varies with the designated use of the runway.

Federal Aviation Regulations Part 77 indicates that the approach surface should be kept free of obstructions to permit the unrestricted flight of aircraft in the vicinity of the airport. As the type of instrument approach to a runway becomes more precise, the approach surface increases in size and the required approach slope becomes more restrictive.

The runway protection zone is the most critical safety area under the approach path. No structure should be permitted nor the congregation of people allowed within the runway protection zone. Control of the runway protection zone by the airport owner is essential. It is desirable, therefore, that the airport owner acquire adequate property interests, preferably in fee title, in the runway protection zone to ensure compliance with the above.

For the existing runways at Sea-Tac, the approach surface and RPZ dimensional standards are for precision instrument runways.

Approach surface dimensions are:

Length	50,000 feet
Inner Width	1,000 feet
Outer Width	4,000 feet
Slope	
First 10,000 feet	50:1
Next 40,000 feet	40:1

Runway protection zone dimensions are:

Length	2,500 feet
Inner Width	1,000 feet
Outer Width	1,750 feet
Area	78.9 acres

Under all third runway development options described in Section 3, except a new close-in commuter runway, the third runway would be designed to meet the same dimensional standards as for the existing runways. The approach surface and RPZ dimensions for the close-in commuter runway option will be different due to different navaids for that option.

TAXIWAYS

While an essential element of this master plan update is the third runway and its impact on airfield capacity, the ability of the taxiway system to efficiently serve aircraft on the ground is equally important. The function of the taxiway system is to facilitate access from the runways to various terminal elements. In doing so, interference between arriving and departing aircraft should be minimized.

The planning and design standards previously presented in this section defined the recommended geometric criteria for planning future runway and taxiway facilities. In light of the objective of planning the airport to accommodate the next generation large aircraft in the future, these standards must be considered when evaluating the existing airfield and terminal development area.

The discussion of taxiway requirements is organized into three subsections which address the parallel taxiway requirement on the east side (passenger terminal side) of the airfield, exits for the existing runways, and taxiway requirements for a new runway. Taxiway design criteria are shown in Table 2-1.

Parallel Taxiways

The separation between Runway 16L-34R and Taxiway A North (400 feet) is adequate for aircraft up to the B747-400. The separation between Taxiways A and B North (300 feet) is also adequate for the B747-400. However, adequate separation between the runway and Taxiway A North to support operations by the assumed new large airplanes (Aircraft Design Group VI+) is not provided. This suggests either a long term realignment of the taxiway, or use of Taxiway B North by new large aircraft. The latter would preclude use of Taxiway A North when a new large aircraft is operating on the runway and dual taxiway capability during those times when Taxiway B North is utilized by new large aircraft. In order to maintain dual taxiway capability for new large aircraft both taxiways would have to be relocated. On the south end of the airfield, the existing runway-taxiway separation is sufficient to accommodate the new large aircraft.

Dual parallel taxiways are required at airports where simultaneous taxiing in opposite directions frequently occurs. By providing unidirectional dual parallel taxiways, interference with opposite flow traffic is minimized. A partial dual parallel system exists for the north half of the airfield (Taxiways A and B North). The depth of the terminal apron is sufficient to also provide a dual taxiway capability for aircraft up to ADG IV, provided that aircraft parking at certain gates in Concourses B and C are limited to certain aircraft models. Pertinent criteria for aircraft design group IV leading to this conclusion are:

Taxiway centerline to parallel taxiway/taxi-lane centerline . . . . . 215 feet

Taxiway centerline to fixed or movable object . . . . 130 feet

The density of traffic in the terminal area suggests that dual taxiway capability on the terminal apron would be beneficial. The apron presently is used as a dual taxiway for narrow-body aircraft, however, the apron pavement is not marked for dual taxiways. A factor that limits the provision of dual taxiway capability on the terminal apron is the presence of a service road. The road is used by various ground vehicles for servicing parked aircraft. The significance of the road is that as it is currently aligned, it violates clearance criteria for the Taxiway Object Free Area (TOFA). Relocation of the service road outside the TOFA is possible but would impact the extent of the aircraft parking area at the terminal concourses.

Table 2-13 indicates the affected gates and the aircraft that could be parked with dual parallel taxiways on the apron designed to ADG IV standards. The aircraft models indicated as being accommodated are based on the mix of aircraft contained in the forecasts of air traffic activity previously presented in Technical Report No. 5.

Determination of parallel taxiway requirements are critical in that the required clearances and set backs will impact the ability to site buildings, facilities and aircraft parking areas. Regarding larger, ADG V aircraft, the ultimate strategy may be to restrict the terminal area as a single taxiway when taxiing by aircraft from ADG V and larger is conducted.

Exit Taxiways

An in-depth analysis of exit taxiway requirements was conducted by the Port of Seattle in 1991 (Taxiway Improvements Study Seattle-Tacoma International Airport, Aviation Planning, Port of Seattle, September 1991). This study recommended a number of new exit taxiways for Runway 16R-34L as follows:

New Taxiway	Distance From Approach End (Feet)
South Flow	
C7	4,495
C10/B10	7,020

TABLE 2-13
AIRCRAFT PARKING RESTRICTIONS FOR DUAL PARALLEL APRON TAXIWAYS

Gate	Accommodated Aircraft
B7	B727, B737-500/300/400, MD80, MD90, A319, A320, B757-200, B767-200, A310, A321
B9	B737-500/300/400, MD80, A319, A320, A321
B11	B727, B737-500/300/400, MD80, MD90, A319, A320, A321, A310
C6	B737s, B727, MD80, MD90, A320, A319
C8	B737-500/300/400, A319, A320, A321
C10	B737-500/300/400, MD80, A319, A320, A321
C12	B737-500/300/400, B727, A319, A320
C14	B737-500
C16	ATR 72, RJ 70/85
S12	B727, B737-500/300/400, MD80, MD90, A319, A320, A321, A310, B757-200

Note: Aircraft accommodated assumes airport service road is relocated outside taxiway object free area for a parallel apron taxiway designed to ADG IV standards.

North Flow

C6	3,172
C1A/B1A	6,430

The recommendations were based on the current airport layout and the premise that Runway 16R-34L would continue to serve primarily arrivals until a third runway is available. The four new exit taxiways are currently under construction.

Under a two-runway configuration, Runway 16L-34R will serve primarily departures. However, under a three-runway configuration, Runway 16L-34R is expected to be used frequently as an arrival runway, especially during poor weather conditions and peak arrival periods. In light of this, enhancements of exits to Runway 16L-34R were explored. An assessment of exits was conducted for Runway 16L-34R using the Runway Exit Design Interactive Model (REDIM), a simulation model developed at the Center for Transportation Research (CTR), Virginia Tech University under NASA and FAA sponsorship.

The model determines the optimal location of exits on a runway to minimize runway occupancy time. The model incorporates airport environmental factors and physical characteristics such as airfield elevation, runway configuration, weather conditions, and operational factors such as aircraft mix, and aircraft piloting techniques to determine the potential location of high-speed exits. REDIM then quantifies a weighted average runway occupancy time (WAROT).

The model was applied to assess the existing runway efficiency and potential benefits in terms of additional exits. A mix of aircraft based on the long range forecast fleet mix was assumed. Findings of the analysis are presented below.

Runway 16L. In south traffic flows, the WAROT for Runway 16L and its existing system of turnoffs is 75.9 seconds. Most aircraft are able to exit at the "Broad Ramp", except the B747 and MD-11, especially during wet runway conditions. Wet runways are estimated to exist 55% of the time. By adding 30° exits at 5,568 and 7,756 feet, the WAROT is reduced to 54.1 seconds, a reduction of almost 29%. The shorter exit would allow many aircraft currently turning off at Broad Ramp to exit earlier, while the longer exit would serve most of the B747s and MD-11s.

Runway 34R. The existing exit performance of the runway measured in WAROT is 83.5 seconds. Adding 30° exit taxiways at approximately 5,500 and 7,700 feet will reduce WAROT to 57.3 seconds or by about 31%.

The four additional 30° exits described above were also reviewed with FAA air traffic personnel. It was felt these exits would allow aircraft to clear the runway sooner, and thus provide greater opportunities to release departures. The proposed future full length parallel taxiway will also encourage frequent use of these exits.

Taxiways for New Runway

Taxiway requirements for a new parallel runway will vary depending on its role and size. Potential lengths for the new runway, discussed in greater detail later in this report, include commuter use (5,200 foot long runway), 7,000 feet, 7,500 feet and 8,500 feet. Since each runway length will accommodate different aircraft types, the configuration and design criteria for the taxiway system will vary. The various requirements are highlighted in the following paragraphs.

Commuter Runway. A 5,200 foot long commuter runway would be expected to accommodate aircraft up to Design Group III, with Fokker F-28s such as those operated by Horizon representing the critical aircraft in this scenario. Taxiway widths of 50 feet and runway-to-taxiway centerline separation of 400 feet will be adequate for commuter operations. Acute angle turnoffs at approximately 4,000 feet from the landing threshold, plus a midfield right angle exit represent an effective complement of exits in this scenario.

7,000 foot Runway. This size runway would be expected to accommodate most air carrier transports except the B747 and MD-11. Taxiway widths of 75 feet will be satisfactory for the mix of aircraft accommodated on the runway and will compliment the assumed runway width of 150 feet. An acute angle exit taxiway located at 5,200 feet from the landing threshold and a midfield right angle taxiway would effectively serve this runway.

7,500 foot Runway. An extension of the 7,000 foot runway option increases the percent of landing operations accommodated from 94.7% to 96.5%. A 7,500 foot runway can also be positioned to avoid some of the fill requirement and road relocations caused by the 8,500 foot runway option. Taxiway locations for this option are very similar to the 7,000 foot runway option.

8,500 foot Runway. An evaluation of the exit taxiway system for an 8,500 foot long runway as proposed by the runway design consultant (HNTB, Inc.) was conducted by P&D Aviation using REDIM. The proposed exit taxiway system consists of high speed exits at 5,200 and 6,400 feet and right angle exits at 3,500 and 5,000 feet. For the long range forecast mix, the WAROT is calculated at 56 seconds. The series of exits is adequate for most aircraft under most conditions, with the exceptions being large aircraft (B747 and MD-11). It was noted that the longest high speed exit (6,400 feet) was suitably located to serve approximately two-thirds of the B747 and MD-11 mix in dry conditions. During wet runway conditions, most B747 and MD-11 aircraft will not make the 6,400 foot turnoff, and in fact the model indicates some (approximately 15%) have difficulty landing within the available runway length (8,500 feet), indicating potentially limited use of the runway by these heavy aircraft in wet weather.

In terms of facilitating access to the terminal for those heavy aircraft using the runway, the option of a high speed exit at the end of the runway may be considered. This is not to suggest use of the taxiway as a substitute for available runway landing distance. However, for those heavy aircraft capable of landing on the available runway, a high speed exit at the end will expedite flow of traffic from the runway.

NAVIGATIONAL AIDS

Sea-Tac is presently equipped with instrument landing systems (ILS) on Runways 34L, 34R and 16R. Runway 16R accommodates Category IIIb ILS approaches down to weather conditions (visibility) of RVR 300 feet. The Sea-Tac VORTAC is also located on the south end of the airfield. Non-directional radiobeacons located to the north and south of the airport are used for navigational purposes.

For the period 1988 through 1992, instrument approaches at the airport averaged 43,500 a year, or approximately 13% of annual operations. Applying this relationship to forecast operations indicates that annual instrument approaches in the year 2020 will increase to approximately 58,000, with 71% being in a south flow and 29% in north flow traffic configurations.

Existing Airfield

Installation of an ILS on Runway 16L is

planned for construction in the 1996-1997 time frame. Touchdown zone lighting is already in place in anticipation of the ILS. Category IIIb minimums are planned and an initial feasibility assessment conducted by the Port did not identify any fatal flaws. The ILS improvement for 16L is assumed to be common to each airfield option described in Section 3. Additional navigational aid (navaid) requirements for each runway development option are discussed in the next section.

Other Considerations

The construction of a new runway will impact two installations used for air traffic control. These are the Airport Surveillance Radar (ASR) and Airport Surface Detection Equipment. Both are critical to the flow of traffic, particularly during periods of poor visibility, and should be relocated.

Section 3
INITIAL AIRSIDE OPTIONS

SECTION 3
INITIAL AIRSIDE OPTIONS

INTRODUCTION

This section describes the seven initial airside options which were developed for purposes of a preliminary airside screening analysis. Options which pass this preliminary evaluation (or derivations of these options) will be the subject of further study, in which environmental and other considerations will be addressed. The Airport Master Plan Update will also consider non-airfield options (such as terminal and roadway options) as well as alternatives relating to demand management, diversion of demand to high speed rail, and supplemental airports.

Types of Considerations

The airside options considered here generally consist of alternatives for the improvement of the existing airfield and third runway improvements. Improvements to the existing airfield include measures to obtain RSA and ROFA compliance with FAA standards, and taxiway improvements. Third runway considerations focus primarily on runway length and separation standards.

Range of Options

Airfield options were chosen to represent the widest practical range of alternatives for a third runway. Runway lengths were sized to existing site constraints and aircraft operating requirements. Runway separations were determined on the basis of FAA requirements for various visual and instrument operating conditions. The initial development options range from a 5,200-foot runway 700 feet west of Runway 16R-34L to an 8,500-foot runway 2,500 feet west of Runway 16R-34L.

MEASURES TO IMPROVE EXISTING AIRFIELD

Section 2 described several potential improvements to the existing runway/taxiway system to improve the safety and efficiency of aircraft operations. Recommended improvements are in compliance with FAA standards for the RSAs and ROFAs, and additional exit taxiways for Runway 16L-34R.

Compliance with RSA and ROFA Standards

Runway 16L-34R. Three documents by the Port of Seattle describe recent studies of extending the RSAs of Runway 16L-34R to comply with FAA standards ("Sea-Tac International Airport, Runway 16L-34R Safety Area Expansion," Port of Seattle Memorandum, December 2, 1992; Seattle-Tacoma International Airport, Runway 16L Safety Area Expansion, Engineering Report, March 29, 1993; and Runway 34R Safety Area Expansion, Sea-Tac International Airport, August 1993). It was concluded by these studies that the RSA of Runway 16L could be lengthened to 700 feet beyond the existing runway by the addition of fill material and the construction of retaining walls along the north perimeter road adjacent to South 154th Street. To obtain the full 1,000-foot safety area, under this configuration, the take-off threshold of Runway 16L would be relocated 300 feet to the south, and South 154th Street would remain outside the ROFA and would not have to be relocated.

An alternate approach to compliance would be a full 1,000 foot RSA and ROFA beyond the present Runway 16L end. This approach would require relocating South 154th Street to the north but would allow the take-off threshold of Runway 16L to remain in its present location.

The Port of Seattle studies cited above concluded that the RSA for Runway 34R can be extended to the south. To accomplish this, additional fill material will be required to maintain the necessary grades. Furthermore, the existing approach light towers and electrical systems in the RSA area must be modified.

Runway 16R-34L. A report prepared for the Port describes alternatives for achieving RSA compliance of Runway 16R-34L (Pavement Consultants, Inc., Preliminary Engineering Report, Runway 16R-34L, Seattle-Tacoma International Airport, August 13, 1992). For Runway 16R that study recommended, in order of preference: 1) providing the full 1,000 foot RSA north of the existing threshold and relocating South 154th Street to the north, 2) providing 550 feet of RSA beyond the existing threshold and relocation the threshold 450 feet to the south, thereby avoiding the relocation of South 154th Street, or 3) providing 750 feet of RSA beyond the existing threshold and relocating the threshold 250 feet to the south and construction a retaining wall at the north end of the RSA to avoid relocating south 154th street. The runway 16R threshold would have to be relocated approximately 325 feet to the south if South 154th Street, in its present alignment, is not to penetrate the ROFA.

The study cited above concluded that the RSA for Runway 34L could be extended to 1,000 feet. This will require the relocation of the airport service road and minor grading to meet FAA standards. The end of the extended RSA would be approximately 175 feet from 188th Street.

Taxiway Exit Improvements

Section 2 described taxiway improvements underway to Runway 16R-34L (four additional exit taxiways) and recommended improvements to Runway 16L-34R (four additional exit taxiways). The improvements will enhance the flow of aircraft operations and improve the efficiency of the existing airfield under the new runway development alternatives. Therefore, they will be included in the airfield development options.

THIRD RUNWAY CONCEPTS

Based on the results of earlier studies, six third runway concepts were developed jointly by P&D Aviation and the Port of Seattle and included in the Scope of Work for the Airport Master Plan Update project:

- Existing conditions (existing 11,900-foot and 9,425 foot runways with 800-foot separation). No third runway would be built under this concept.

- Close-in Commuter Runway (new 5,200-foot runway 1,500 feet west of Runway 16L-34R). This runway would serve primarily commuter operations and would be too closely spaced to allow two arrival streams under IFR weather conditions. The 5,200-foot runway length is required for the F-28 under maximum gross takeoff weight conditions. Although the F-28 seats up to 65 passengers, it was used as the critical aircraft for the commuter runway because it is in use by airlines typically flying commuter aircraft (60 seats or less).

- Dependent Commuter runway (new 5,200-foot runway 2,500 feet west of Runway 16L-34R). This runway would serve primarily commuter operations, but the 2,500-foot separation would allow two dependent IFR radar-controlled arrival streams, simultaneous radar-controlled departures, and simultaneous radar-controlled approaches and departures. Additionally, a 2,500-foot separation of parallel runways minimizes the need for air traffic control personnel to implement wake turbulence avoidance procedures. Aircraft in dual arrival streams (for dependent runways) would be subject to a diagonal separation of no less than two nautical miles.

- Dependent Runway-Programmatic Baseline (new 7,000-foot runway, 2,500 feet west of Runway 16L-34R). The length of 7,000 feet originates form the Puget Sound Air Transportation Committee Flight Plan Study. The baseline runway length proposed by the Flight Plan Study was 7,000 feet.

  Two variations of this concept have been considered in the airside evaluations: a staggered 7,000 foot runway (with the north threshold staggered 1,435 feet to the south) and a staggered 7,500-foot runway. The staggered 7,000-foot runway would eliminate the need to relocate South 156th Way to accommodate the new runway. The 7,500-foot runway would be staggered approximately 935 feet south of the existing north thresholds and would require the relocation of South 156th Way.

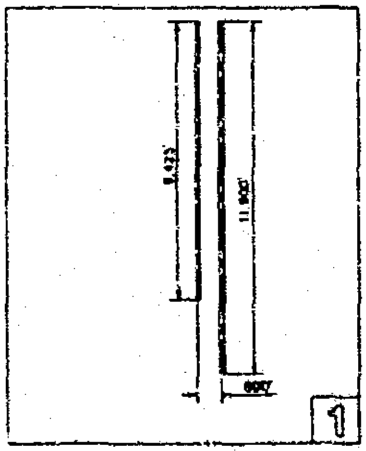
- Dependent Runway-Maximum Length (new 8,500-foot runway 2,500 feet west of Runway 16L-34R). The 8,500-foot length is the maximum that can be obtained while meeting the FAAs, RSA and ROFA criteria and aligning the north end of the new runway with the existing runway ends.

- Independent Runway-Maximum Length (new 8,500-foot runway 3,300 feet west of Runway 16L-34R). This configuration would allow dual IFR arrival streams on the two westerly runways. Under this configuration, the long runway, Runway 16L-34R, would be primarily a departure runway and aircraft needing the larger takeoff length of Runway 16L-34R would not have to interrupt a landing stream.

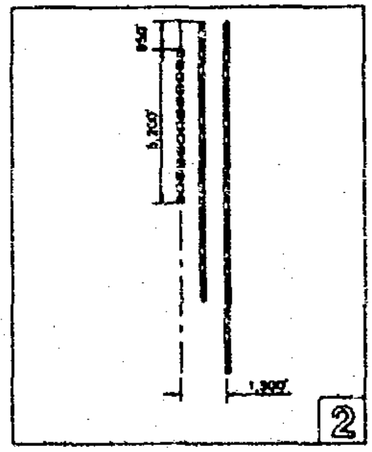
  This option also would presumably allow, in the future, two independent arrival streams under IFR conditions. Independent arrival streams do not have diagonal separation limits as do dual independent arrival streams. Although FAA standards currently require a 3,400-foot separation between parallel runways for independent arrivals (with the use of special radar and monitoring equipment), a 3,300-foot separation for independent arrivals is being tested now by the FAA. Due to the increasing precision of navaids over the past 25 years, the standard for independent arrivals has been successively reduced from 5,000 feet to 4,300 feet to 3,400 feet, and it is expected that the runway separation requirement will be reduced further through future technological improvements. In the delay analysis described in Section 4, it is assumed that runways with a 3,300 separation will be able to support independent arrival streams by the year 2020.

INITIAL AIRSIDE OPTIONS

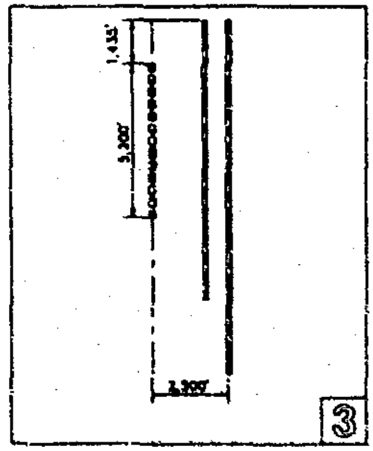
Initial airfield options were developed by combining the features of the alternatives for improving the existing airfield and alternatives for adding a third runway. Seven options were identified. These options are illustrated schematically in Figure 3-1 and shown in greater detail in Figures 3-2 through 3-9. The four new exits to Runway 16R-34L are shown as existing because construction of these taxiways is in progress. The takeoff and landing lengths of each runway under the options evaluated are shown in Table 3-1.



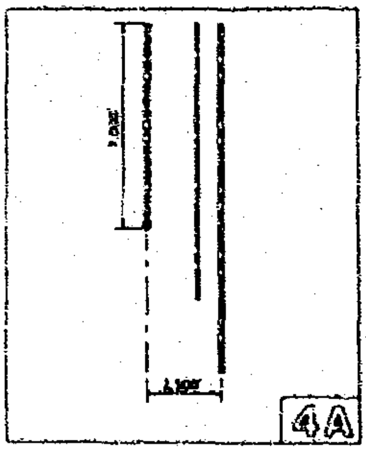
Option1. Existing Conditions



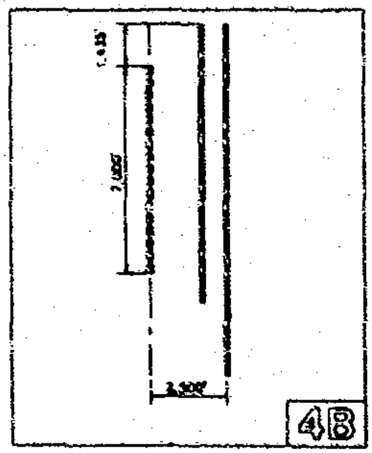
Option 2. Commuter -- Close



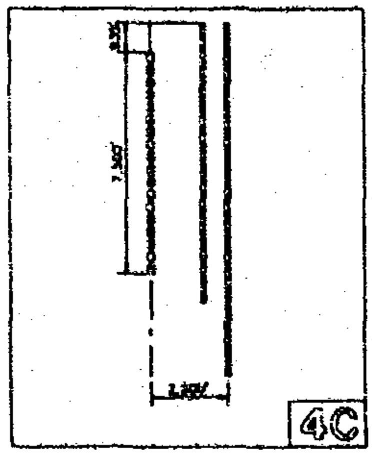
Option 3. Commuter -- Dependent



Option 4A. Programatic Baseline



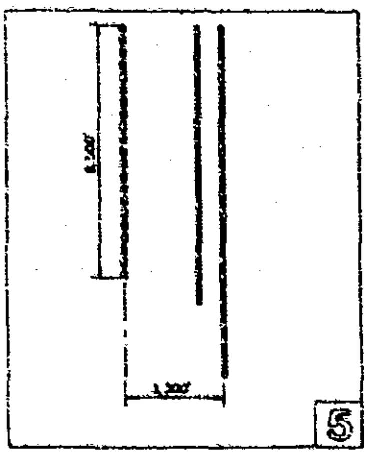
Option 4B. Programatic Baseline -- Staggered



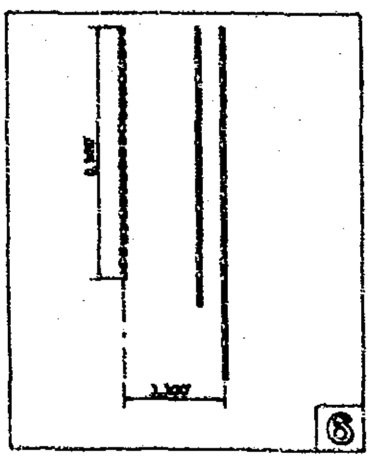
Option 4C. Staggered 7,500 - Foot Runway

Existing Runway

Proposed Runway (to be revised)



Option 6. Dependent -- Maximum Length



Option 6. Independent -- Maximum Length

Figure 3-1

THIRD RUNWAY OPTIONS

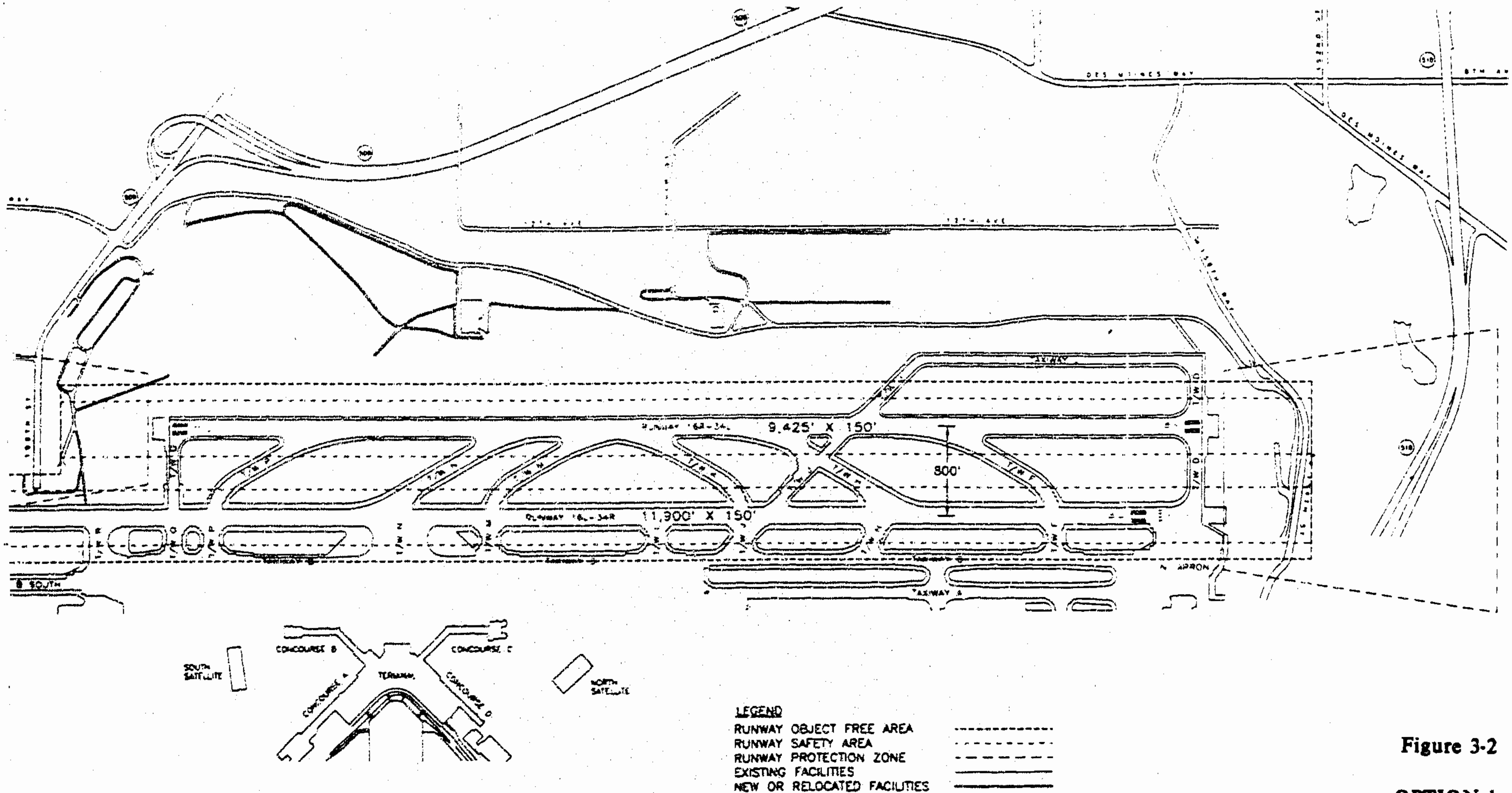
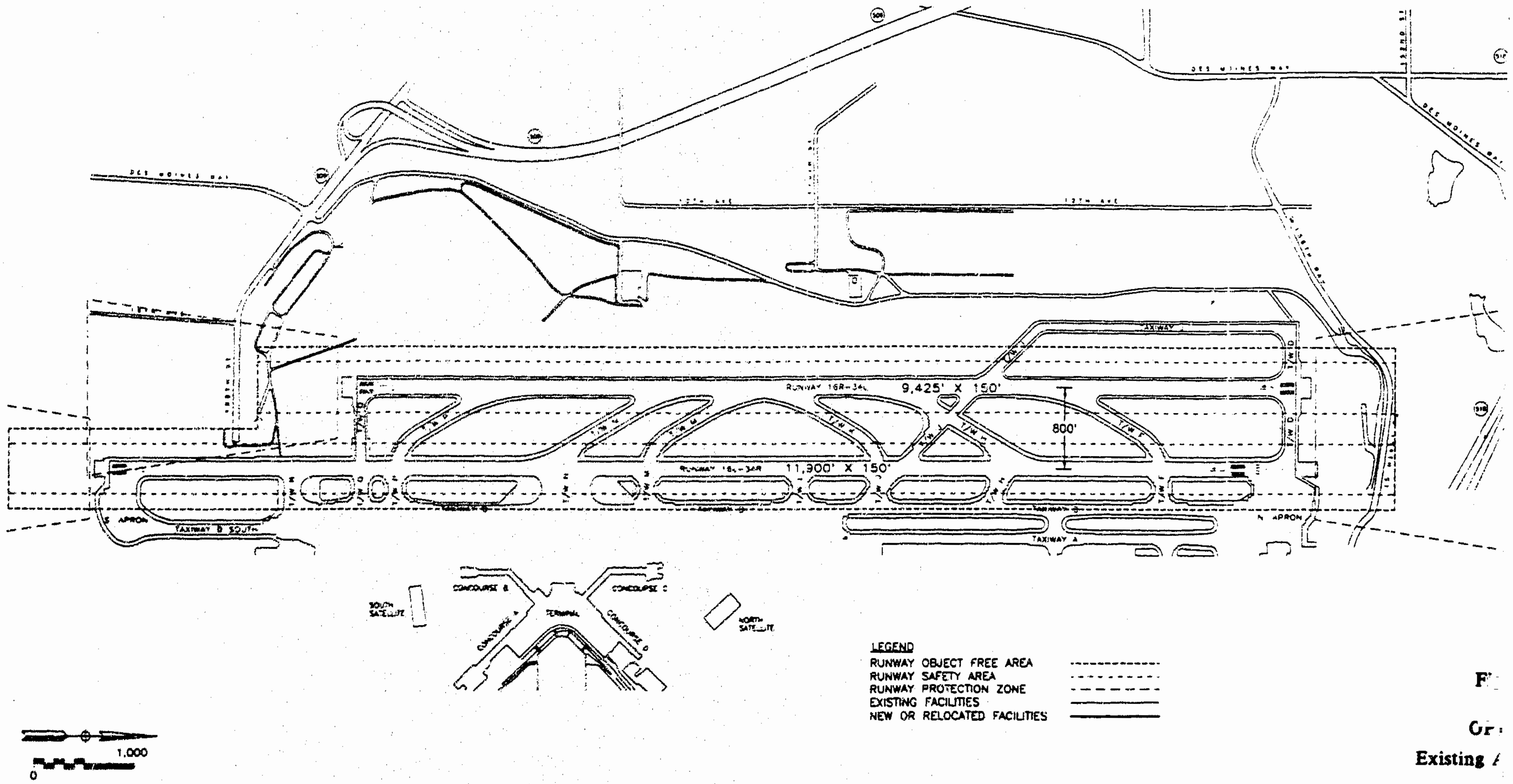


Figure 3-2

OPTION 1

Existing Airfield



LEGEND
RUNWAY OBJECT FREE AREA
RUNWAY SAFETY AREA
RUNWAY PROTECTION ZONE
EXISTING FACILITIES
NEW OR RELOCATED FACILITIES

F

Existing

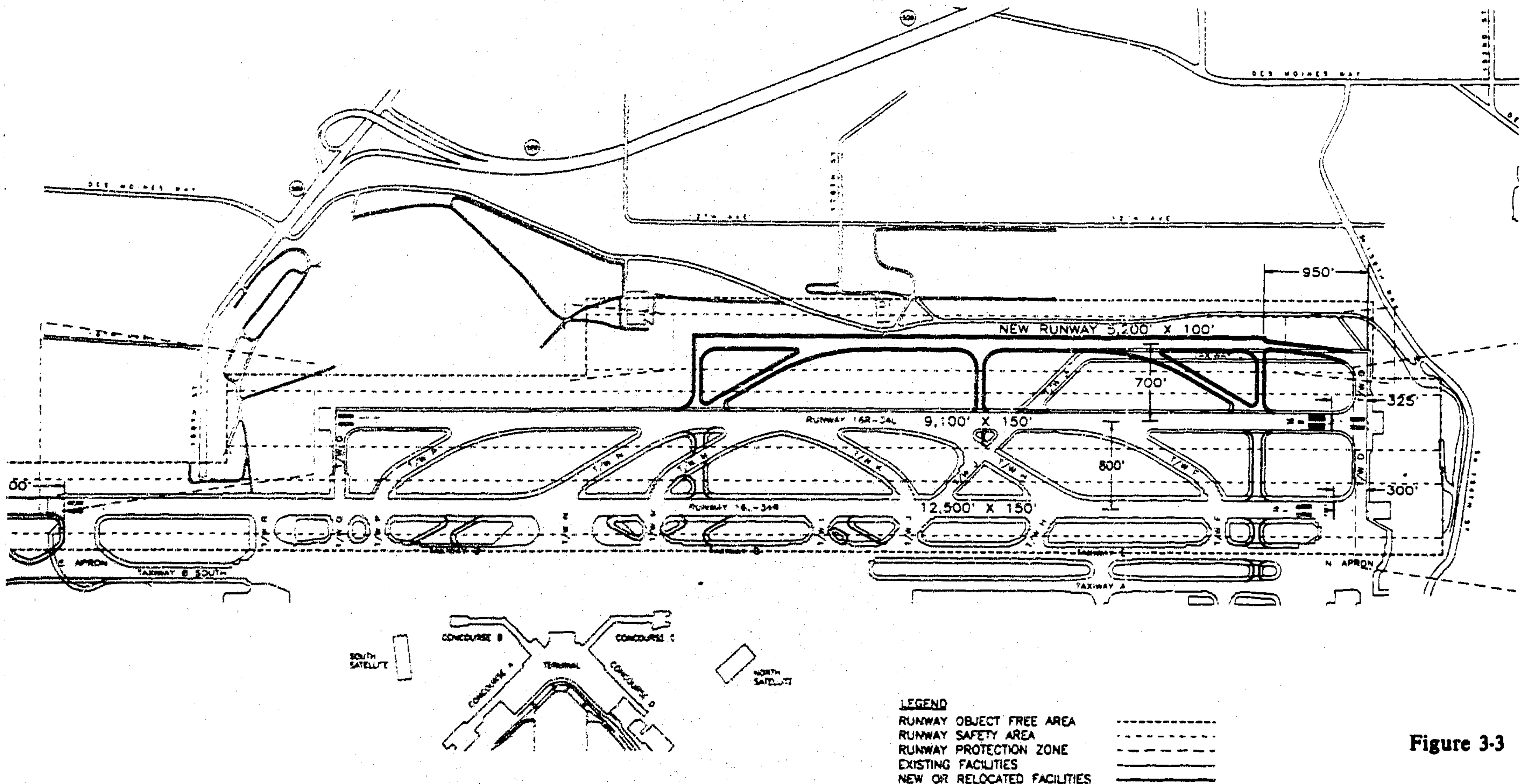
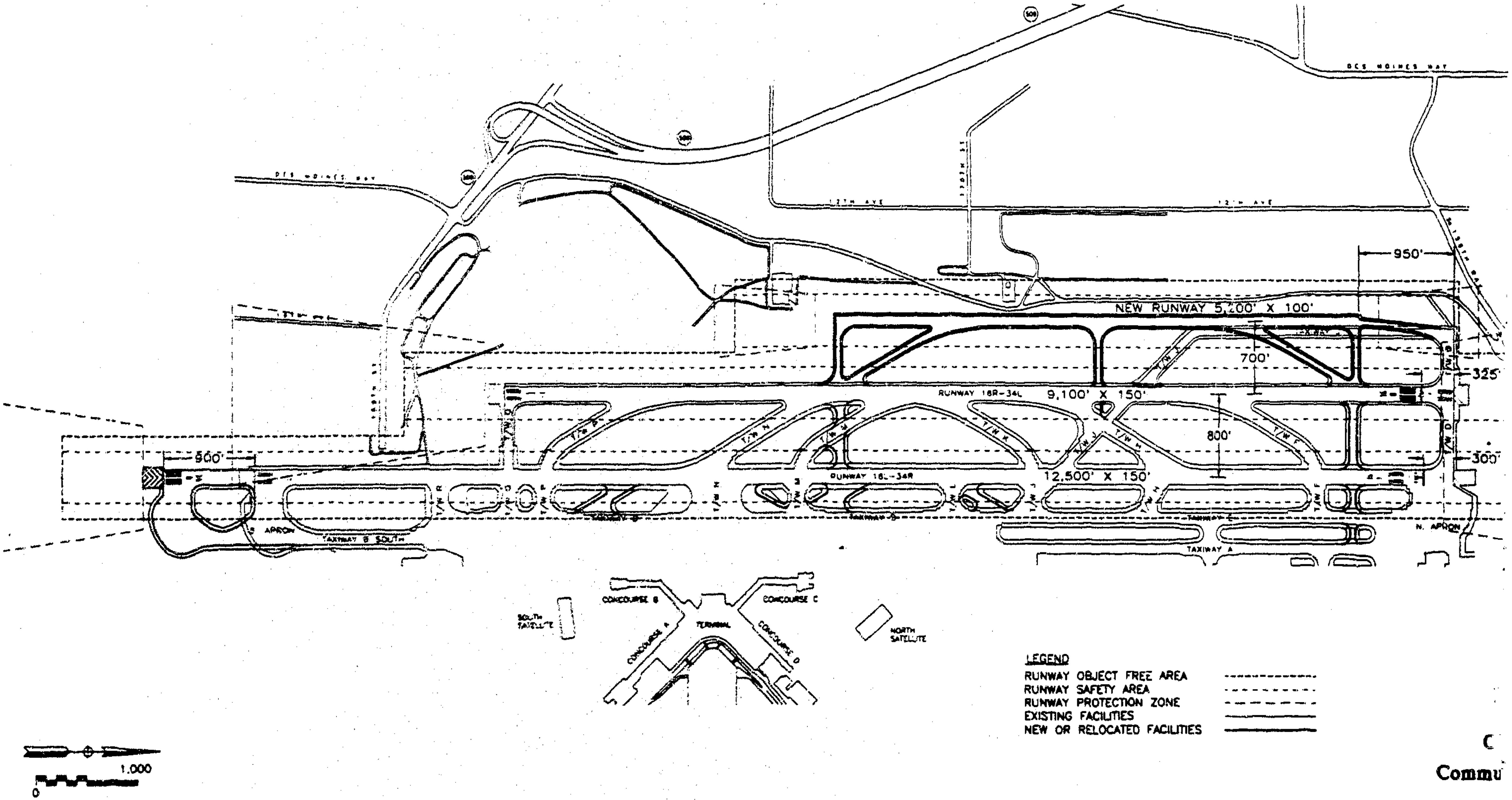


Figure 3-3

OPTION 2

Commuter-Close


NEW RUNWAY 5,200' X 100'
950'
700'
325'
RUNWAY 16R-34L
9,100' X 150'
800'
300'
900'
RUNWAY 16L-34R
12,500' X 150'
TAXIWAY B SOUTH
TAXIWAY A
N. APRON
CONCOURSE B
CONCOURSE C
TERMINAL
CONCOURSE A
CONCOURSE D
SOUTH SATELLITE
NORTH SATELLITE
LEGEND
RUNWAY OBJECT FREE AREA
RUNWAY SAFETY AREA
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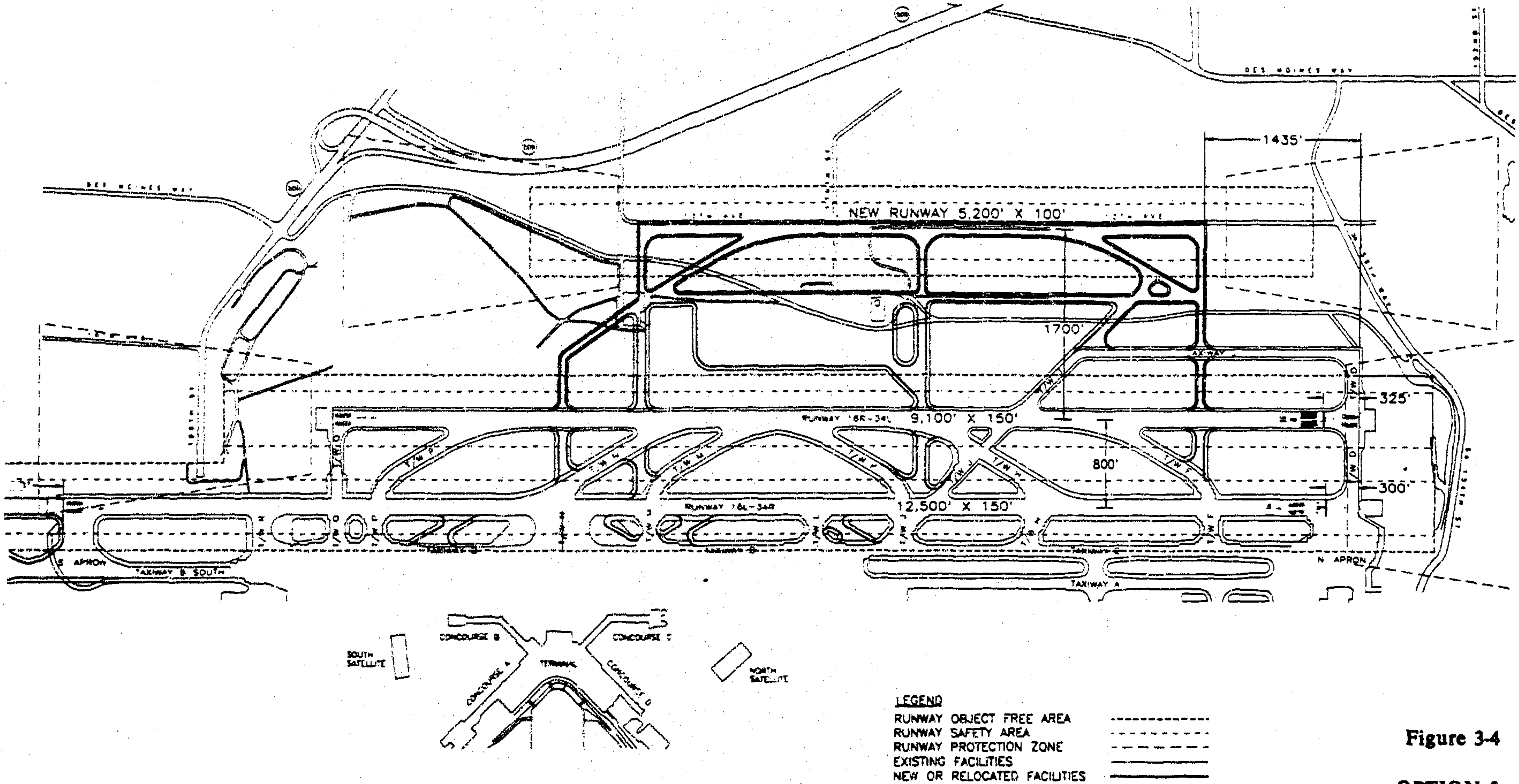
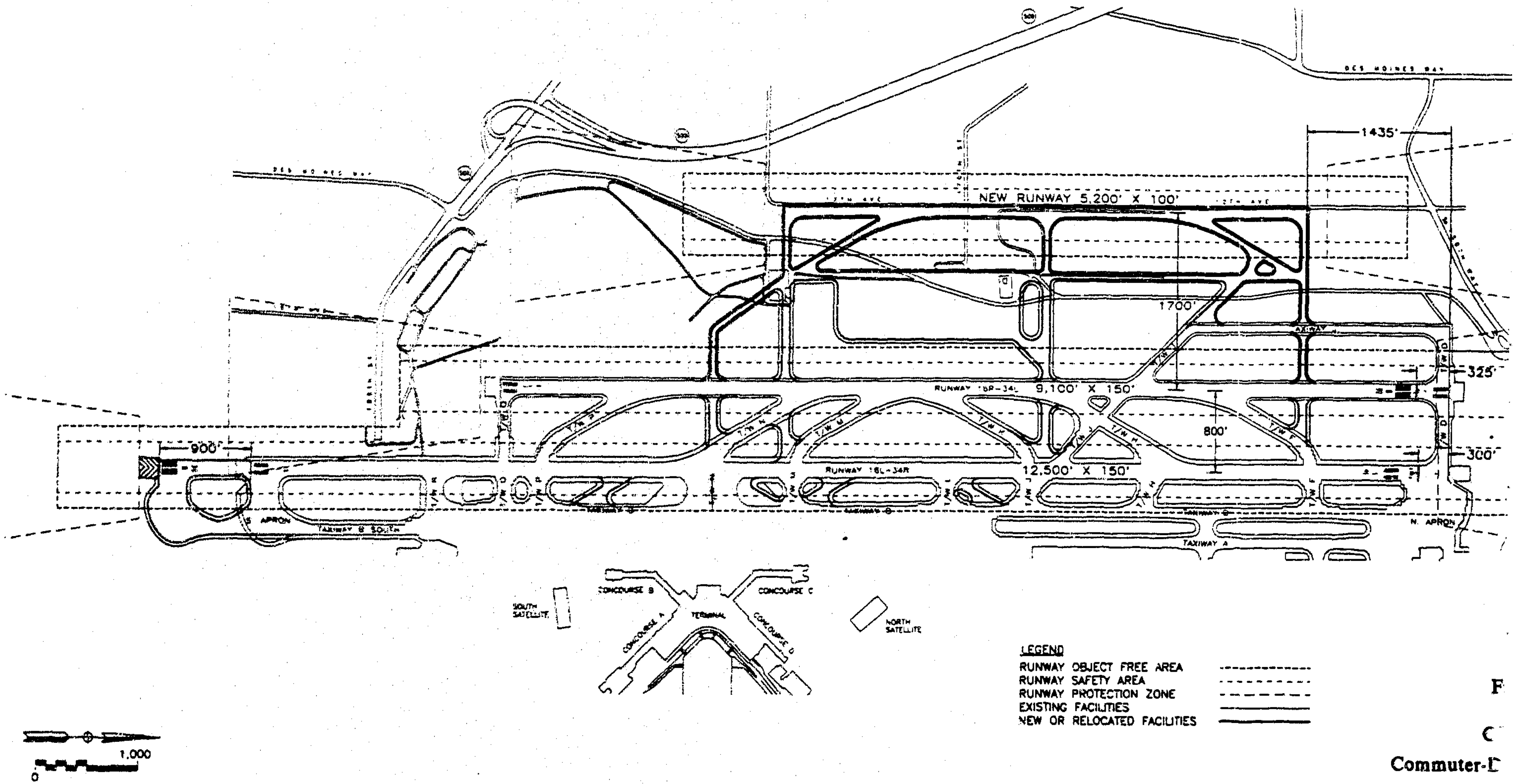


Figure 3-4

OPTION 3

Commuter-Dependent



F

C

Commuter-D

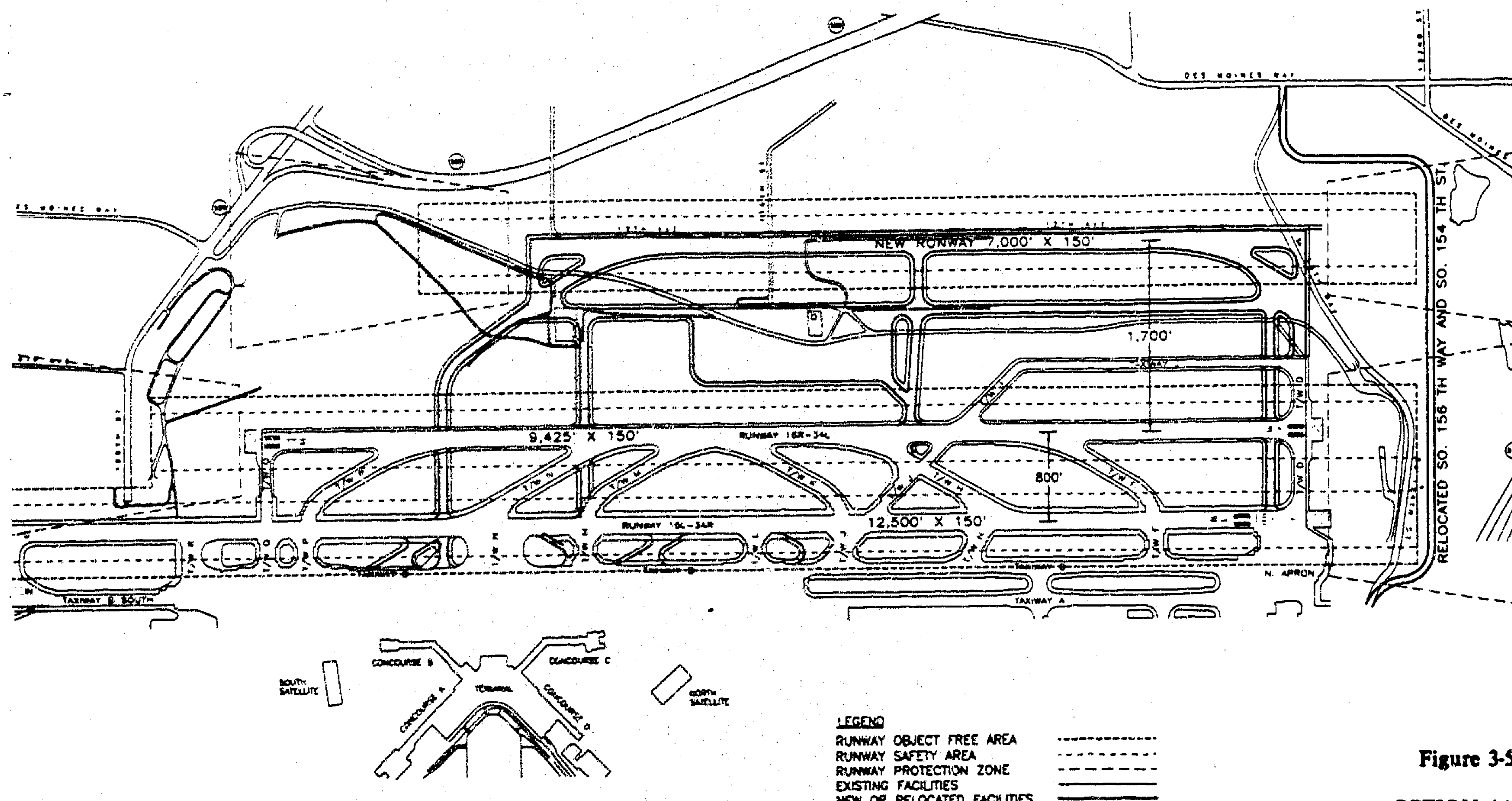
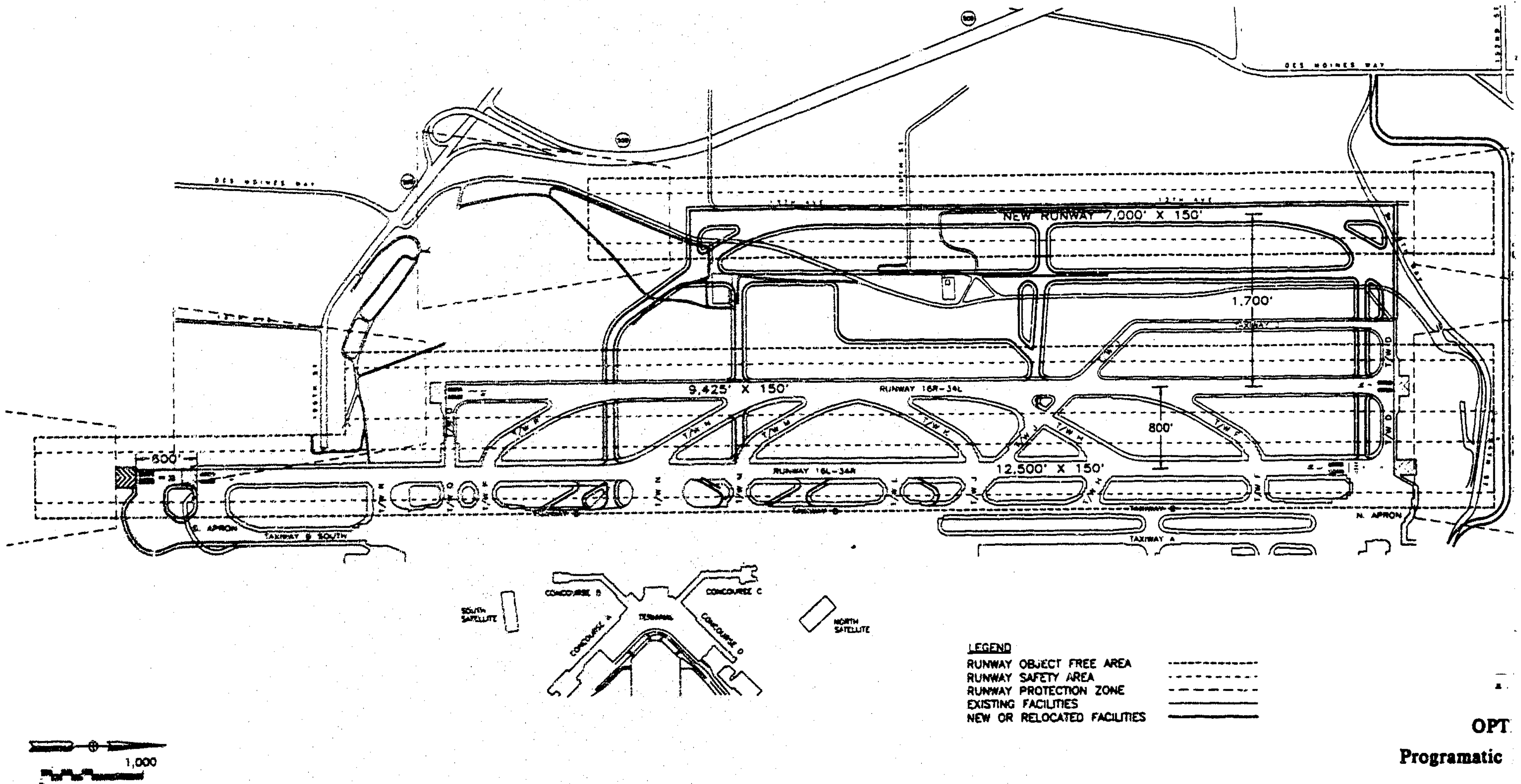


Figure 3-5

OPTION 4A

Programatic Baseline



OPT

Programatic

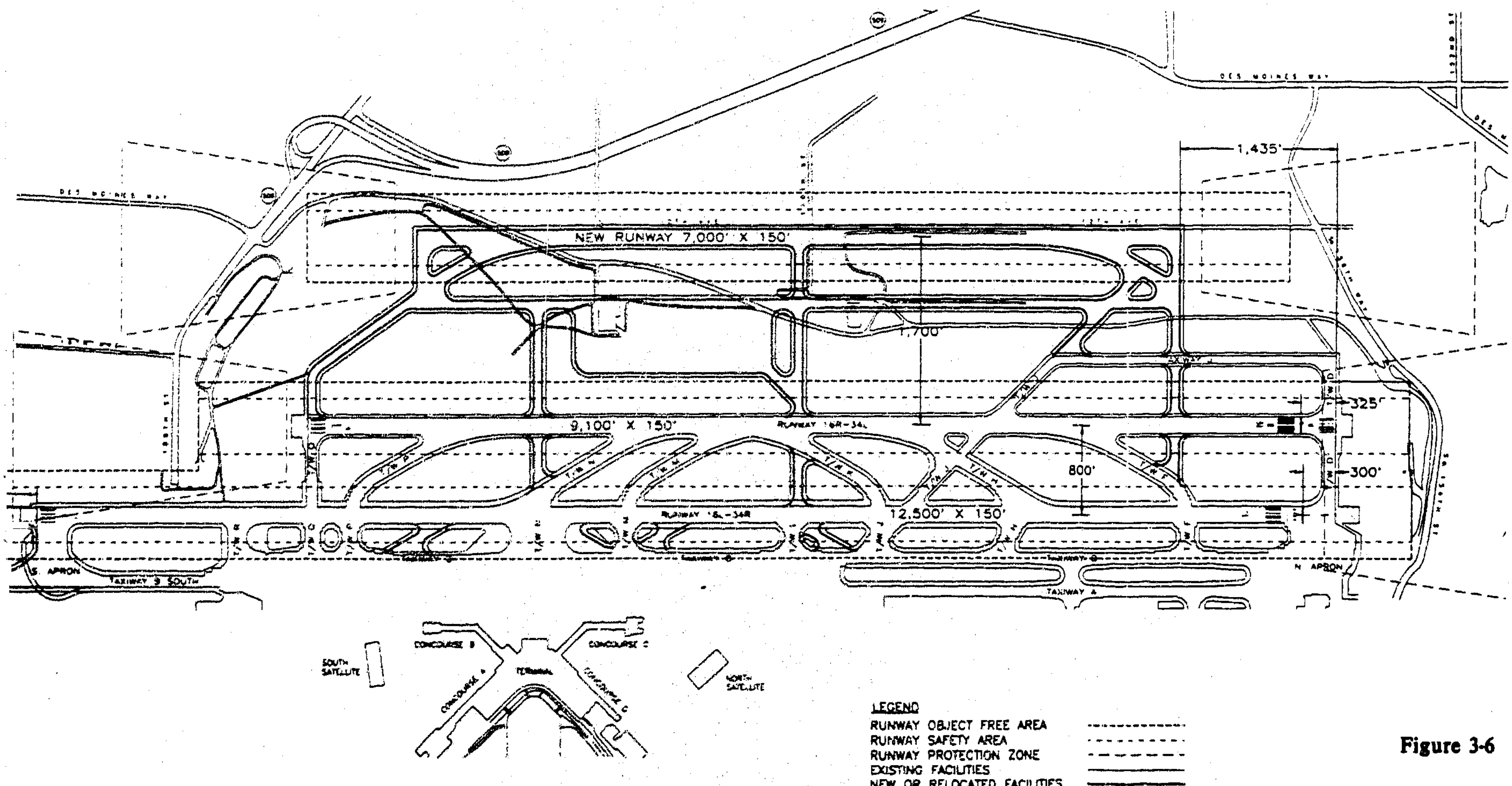
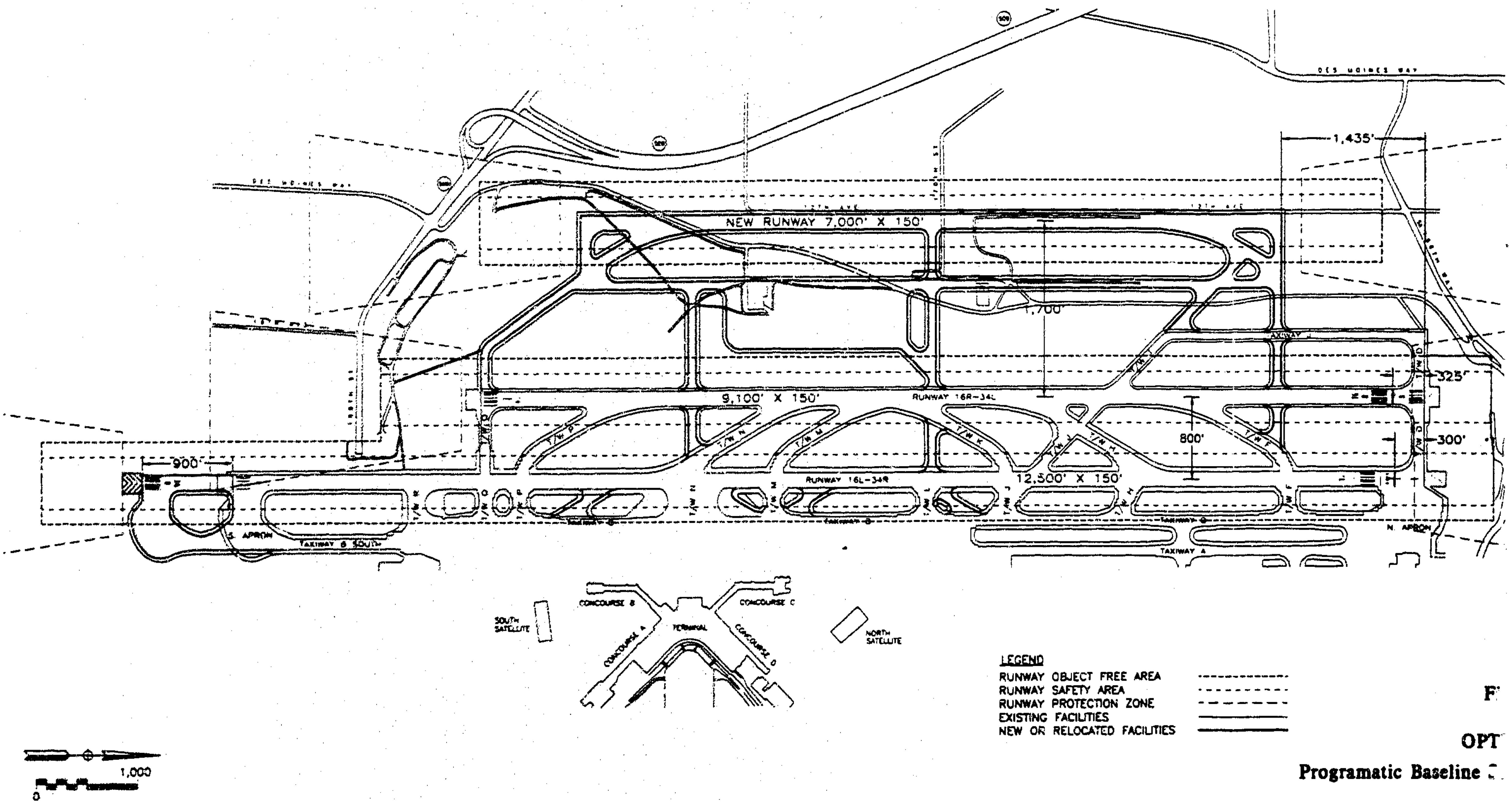


Figure 3-6

OPTION 4B

Programatic Baseline Staggered



F

OPT

Programatic Baseline

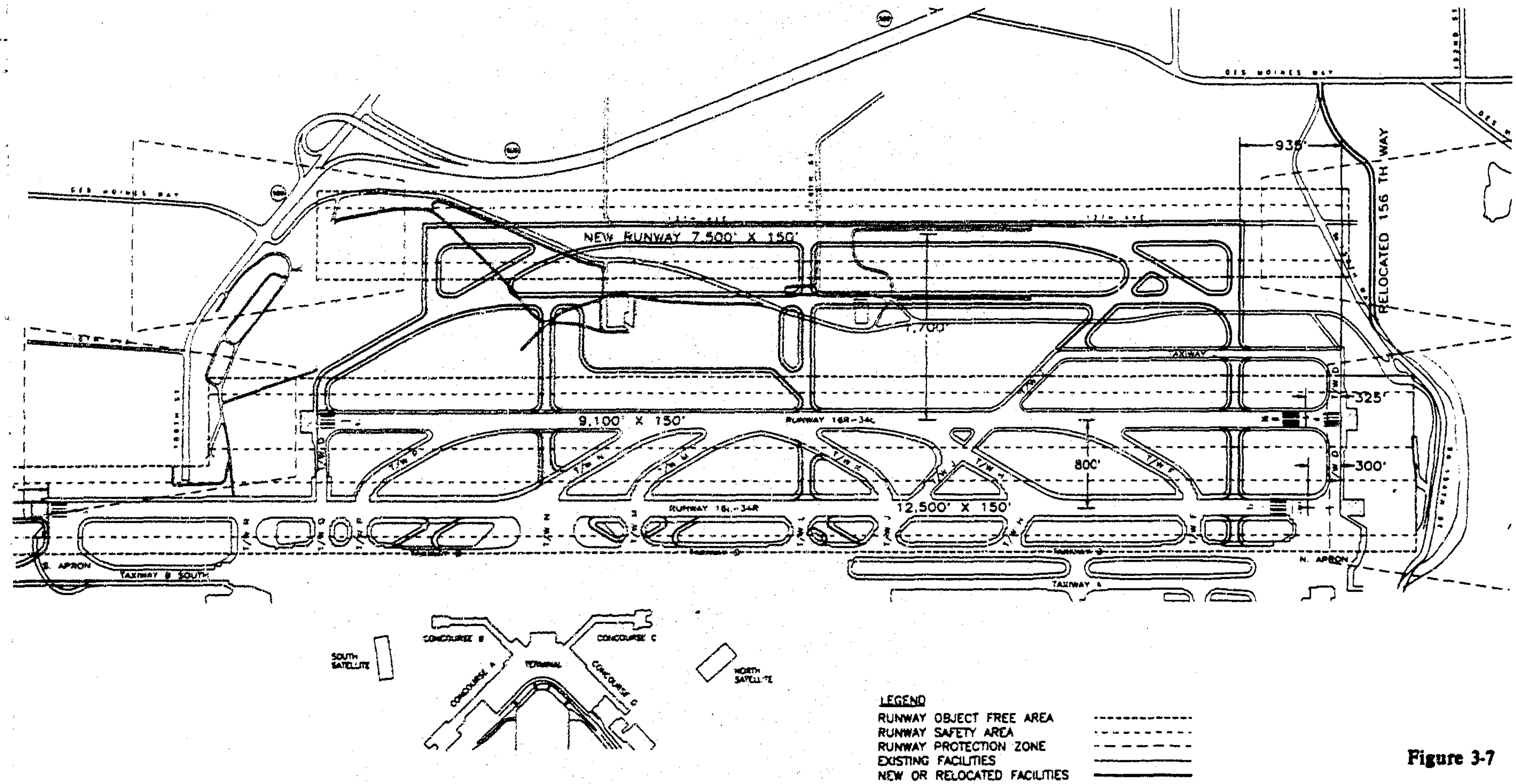
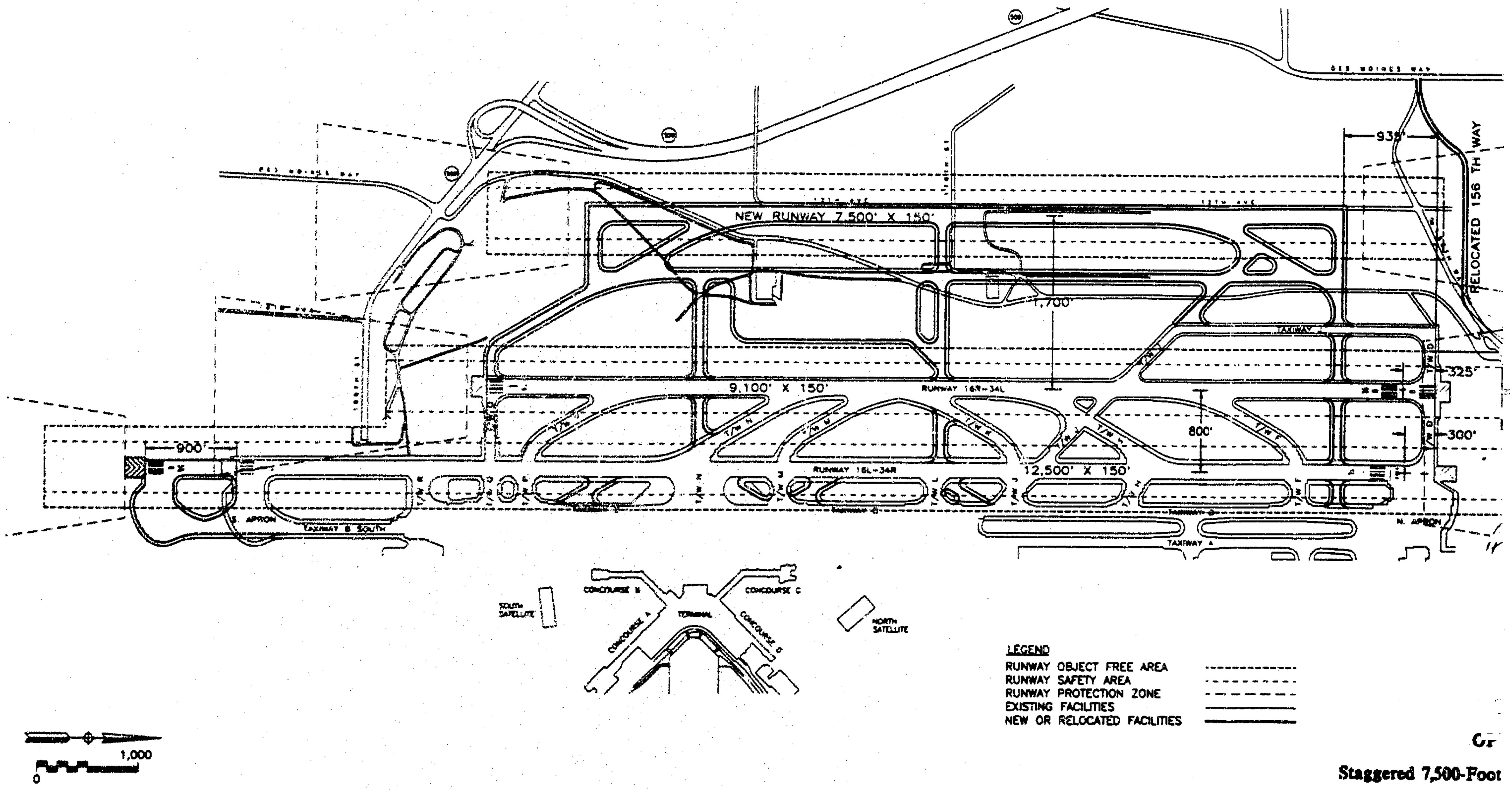


Figure 3-7

OPTION 4C

Staggered 7,500-Foot Runway



Staggered 7,500-Foot

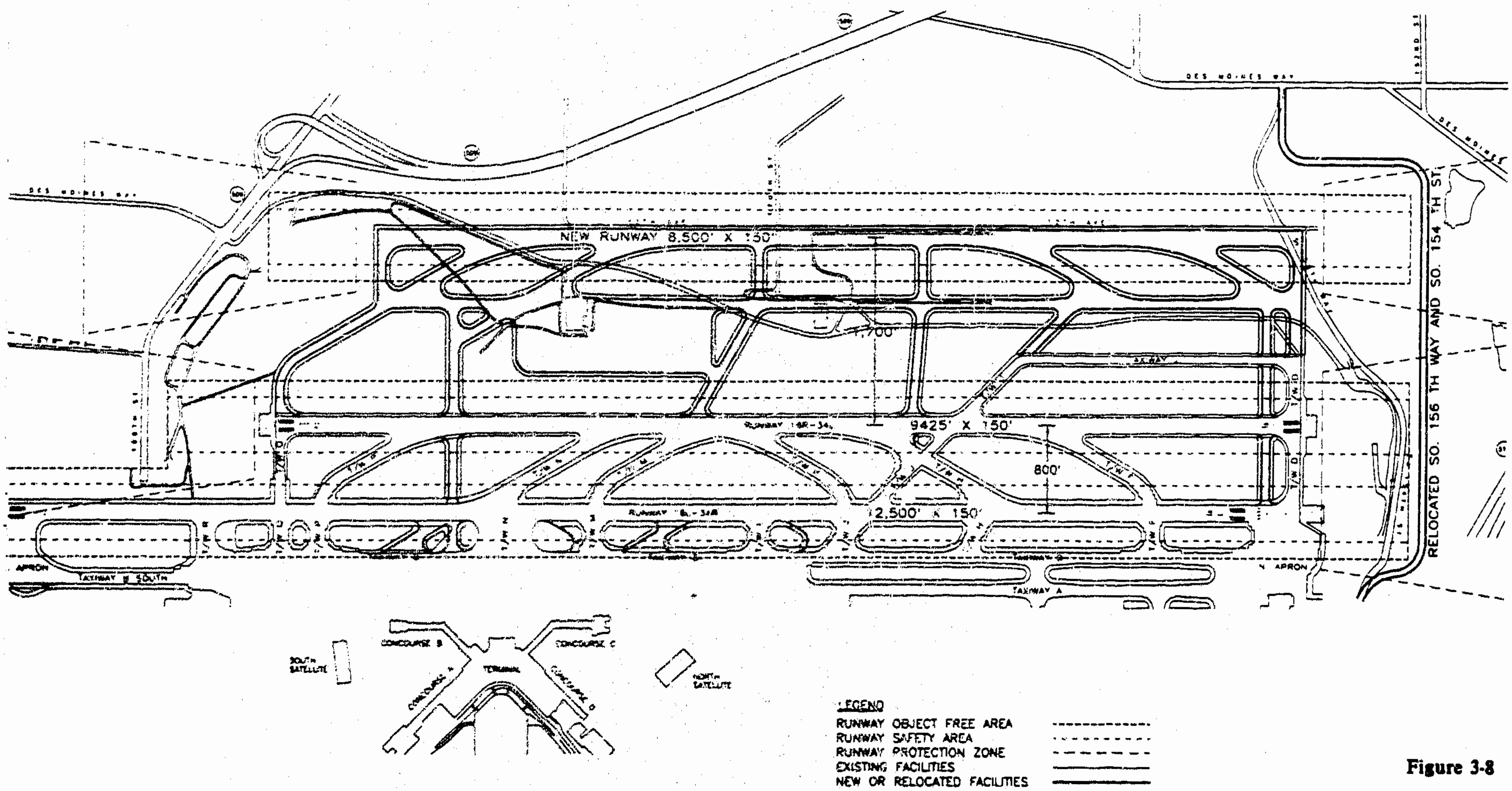
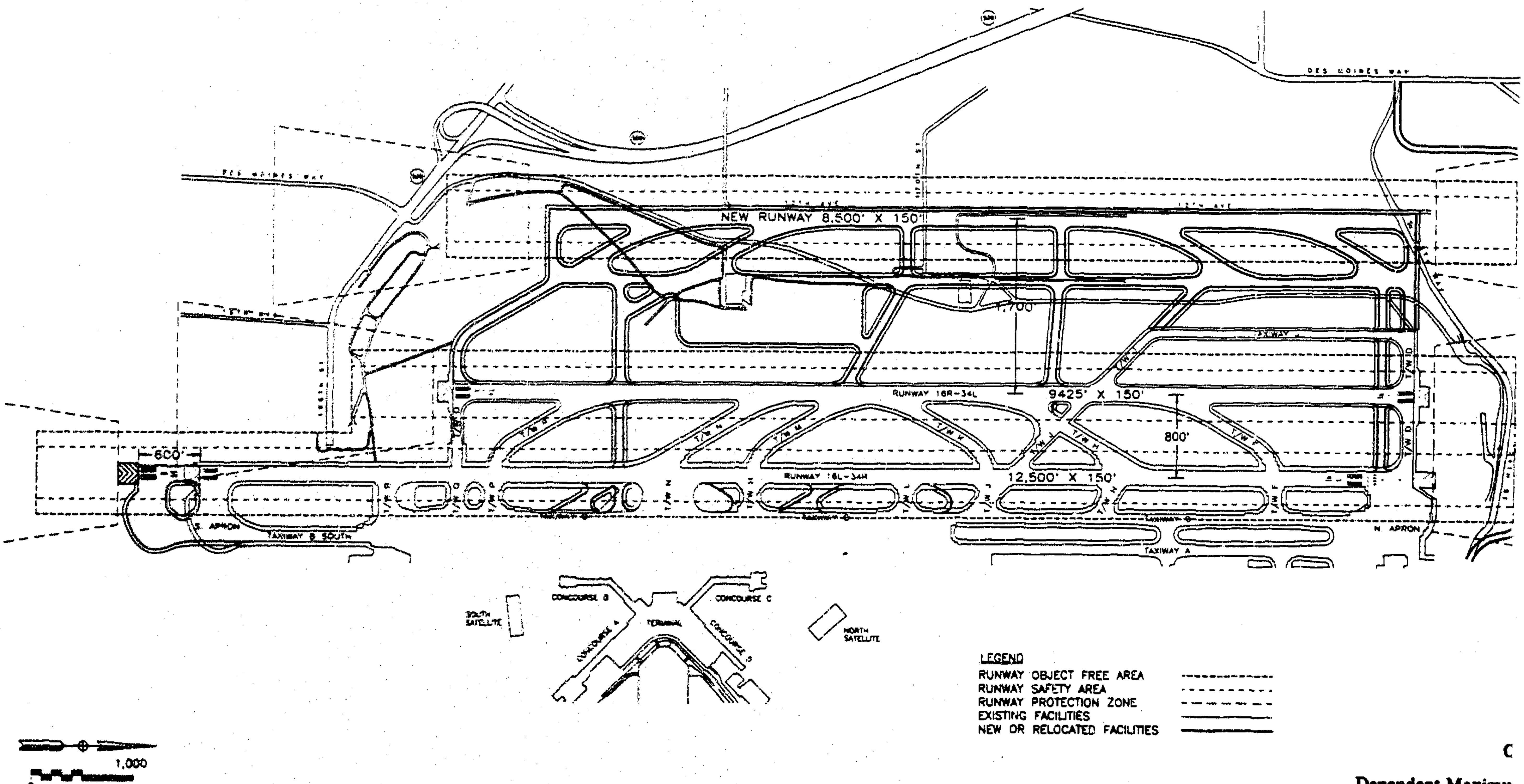


Figure 3-8

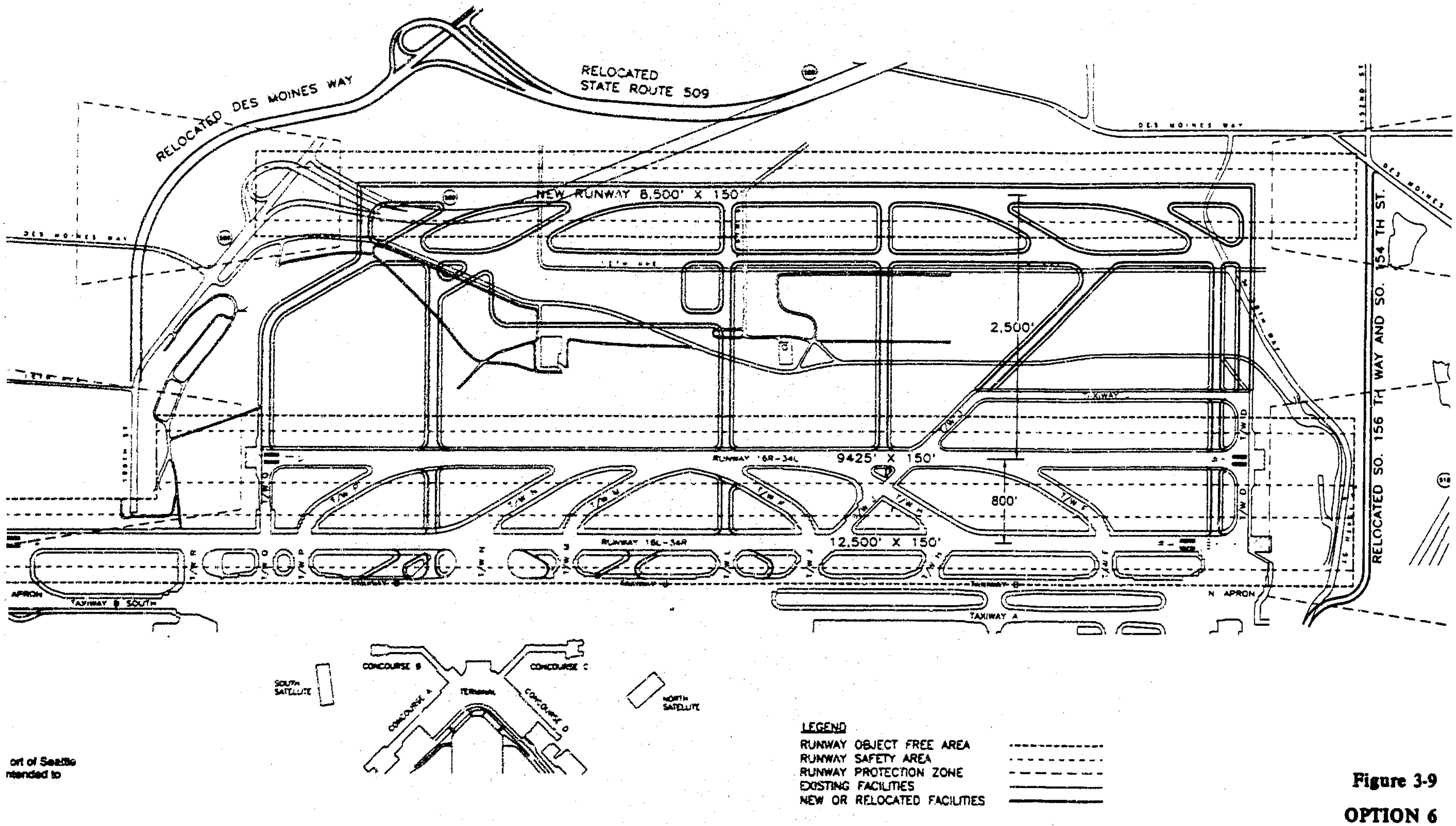
OPTION 5

Dependent-Maximum Length



C

Dependent-Maximu



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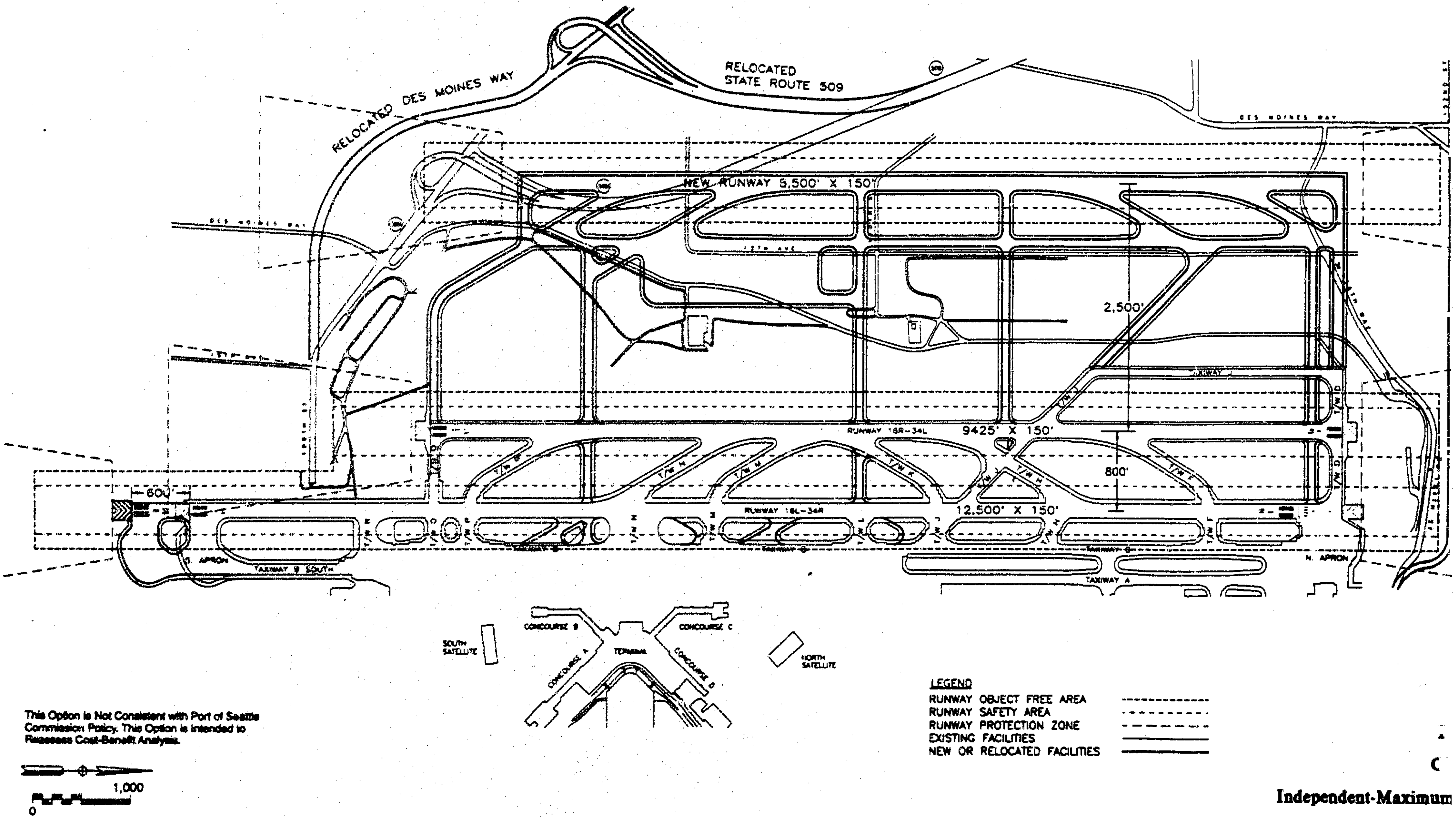
ntended to

Figure 3-9

OPTION 6

Independent-Maximum Length



This Option is Not Consistent with Port of Seattle Commission Policy. This Option is intended to Reassess Cost-Benefit Analysis.

C

Independent-Maximum

TABLE 3-1
RUNWAY LENGTHS FOR INITIAL AIRSIDE OPTIONS
AT SEATTLE-TACOMA INTERNATIONAL AIRPORT [a]

Item	Takeoff or Landing Length (Feet)						
	Option 1 Existing Airfield	Option 2 Commuter Close	Option 3 Commuter Dependent	Option 4A Programmatic Baseline	Option 4B Programmatic Baseline Staggered	Option 5 Dependent Maximum	Option 6 Independent Maximum
Runway 16L-34R							
Runway 16L							
Landing Length	11,410	12,310	12,310	12,010	12,310	12,010	12,010
Takeoff Length	11,900	12,500	12,500	12,500	12,500	12,500	12,500
Runway 34R							
Landing Length	11,900	12,500	12,500	12,500	12,500	12,500	12,500
Takeoff Length	11,900	12,500	12,500	12,500	12,500	12,500	12,500
Runway 16R-34L							
Runway 16R							
Landing Length	9,425	9,100	9,100	9,425	9,100	9,425	9,425
Takeoff Length	9,425	9,100	9,100	9,425	9,100	9,425	9,425
Runway 34L							
Landing Length	9,425	9,100	9,100	9,425	9,100	9,425	9,425
Takeoff Length	9,425	9,100	9,100	9,425	9,100	9,425	9,425
New Runway							
Runway 16 New							
Landing Length	-	5,200	5,200	7,000	7,000	8,500	8,500
Takeoff Length	-	5,200	5,200	7,000	7,000	8,500	8,500
Runway 34 New							
Landing Length	-	5,200	5,200	7,000	7,000	8,500	8,500
Takeoff Length	-	5,200	5,200	7,000	7,000	8,500	8,500

[a] Source: P&D Aviation analysis.

Option 1: Existing Airfield

Under this option, no improvements would be made to the airfield beyond those already underway (new taxiways). This "do nothing" option is included in the analysis of alternatives to estimate the likely effects (for example, additional aircraft delays) of not providing additional airfield capacity. It will provide a benchmark by which the other options are measured.

The following options have several development items in common. Improvements to the existing airfield under the remaining options include four new taxiway exits to Runway 16L-34R, extending Runway 16L-34R to 12,500 feet, and extending the RSAs and ROFAs of all four runway ends to meet FAA's standards.

The method of achieving FAA compliance with the RSAs and ROFAs varies among the options. In some cases, compliance would be obtained by relocating the runway thresholds; in other cases RSA and ROFA area would be added at the end of the runway. In the options in which the RSA and ROFA were extended to the north without relocating the runway thresholds, the relocation of South 154th Street and 156th Way would be necessary. Under all options, Runway 16L-34R would be extended to 12,500 feet (takeoff length) because it was concluded, as described in Section 2, that this is the maximum runway length required for departures at Sea-Tac.

Option 2: Commuter-Close

Under Option 2, a new 5,200 foot by 100 foot commuter runway would be constructed 1,500 feet west of Runway 16L-34R (Figure 3-3). The new runway would serve primarily commuter and general aviation operations. However, it would be capable of accommodating Airplane Design Group III Aircraft which include small air carrier jets such as the B737 and MD82. The north threshold of the new runway would be 950 feet south of the existing north runway ends.

Option 2 represents the lowest cost approach of all options considered. There would be no relocation of adjacent roadways (other than airport service roads) and safety area standards would be met by relocating the north threshold of Runway 16L-34R 300 feet to the south and Runway 16R-34L 325 feet to the south. This would result in the shortening of Runway 16R-34L to 9,100 feet.

Precision instrument approach navaids would not be installed under Option 2 because the separation between the runways would not permit an additional IFR arrival stream. The new runway would be used primarily for VFR traffic conditions.

Option 3: Commuter Dependant

Airfield improvements under Option 3 would be similar to Option 2, with the exception that the new commuter runway would be 2,500 feet west of Runway 16L-34R (Figure 3-4). This greater separation would allow for two arrival streams under IFR conditions. The north threshold of the new runway would be located 1,435 feet south of the north ends of the existing runways. The greater runway separation would allow for an aircraft parking area to be located between Runway 16R-34L and the new runway. This area would be used to park aircraft which remain overnight at the airport or which must be temporarily parked for maintenance reasons.

Compliance with RSA and ROFA standards would be achieved by relocating to the south the thresholds at the north end of the existing runways.

The landing threshold of Runway 16L is

currently displaced 490 feet to the south of the runway end. With the 300 foot relocation of the runway end to the south, the landing threshold will be displaced 190 feet. Although this displacement could be eliminated, it is assumed for purposes of this analyses that the displacement would be maintained to prevent relocating the approach light system to Runway 16L.

In this scenario, there would be sufficient separation (2,500 feet) between outboard runways to conduct simultaneous IFR approaches and departures, and parallel (staggered but not simultaneous) ILS approaches. The runway configuration permits the use of two IFR arrival streams and therefore the new runway would function in an IFR capacity. As such, precision approach capability should be provided for both south and north traffic flow conditions. It is assumed for purposes of this comparison that a Category I ILS systems would be installed on both ends of the new runway under this option.

Option 4A: Programmatic Baseline

With Option 4A, a new 7,000 foot by 150 foot runway would be constructed 2,500 feet west of Runway 16L-34R (Figure 3-5). The north end of the new runway would be aligned with the north ends of the existing runways. To achieve RSA and ROFA compliance, South 154th Street and South 150th Way would be relocated to the north around the new and existing runways. Because the roads would be relocated, the north thresholds of the existing runways do not need to be relocated. Therefore, Runway 16R-34L could be maintained at its present 9,425 foot length. Runway 16L-34R would be extended 600 feet to the south to achieve an overall length of 12,500 feet.

The 2,500-foot separation between outboard runways is sufficient to permit parallel (staggered) ILS approaches. To provide maximum IFR benefits, each end of the new runway would be equipped for precision instrument approaches. Since Runway 16L will soon accommodate Category IIIb approaches and adequate separation will exist between it and the new runway, it is recommended that the new runway also be equipped for Category IIIb approaches. This will permit parallel Category IIIb ILS approaches and thus enhance capacity during periods of extremely low visibility. Use of Runway 16R as the Category IIIb runway can continue until such time that demand indicates the need for dual, low visibility arrival streams. It is also recommended that the new runway be planned for Category IIIb capability for north flow operations.

The layout of the runway and taxiway system for the new runway, under Option 4A, was developed by the HNTB Corporation (Seattle-Tacoma International Airport, Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994). The HNTB Preliminary Engineering Studies have include topography and soils investigations, roadway and utility relocations, and other factors which potentially would impact the construction of the new runway.

Option 4B: Programmatic Baseline Staggered

Option 4B is similar to Option 4A, except the north threshold of the new runway would be staggered approximately 1,435 feet to the south to eliminate the need to relocate South 156th Way and to reduce the fill requirements at the north end of the runway (Figure 3-6). The terrain at the north end of the new runway drops steeply to the north and offsetting the new runway to the south would substantially reduce the amount of fill material required and the construction cost. Under this option, the relocation of South 154th Street as well as South

156th Way would not be necessary.

Accordingly, the north thresholds of the existing runways would be relocated to provide RSAs and ROFAs which meet FAA standards. Note that a 7,000 foot runway is approximately the longest runway which can be accommodated at this separation without relocating existing public roadways and achieving RSA and ROFA standards. The new runway would be equipped with Category IIIb precision instrument landing systems at each end, as in Option 4A.

Option 4C: Staggered 7,500-foot Runway

Under this option, the new runway would be 7,500 feet long. This length was chosen to provide an option in which the runway length would be between that of Options 4A/4B and Option 5. To allow the necessary RSA and ROFA at the south end of the new runway, it could be staggered at most about 935 feet to the south of the existing runway thresholds. For this reason, South 156th Way would need to be relocated to the north to accommodate the RSA and ROFA at the north end of the new runway. In other respects, this option is similar to Option 4B.

Option 5: Dependent-Maximum Length

Option 5 includes the construction of a new 8,500 foot by 150 foot runway, 2,500 feet west of Runway 16L-34R (Figure 3-7). The north end of this runway would be in alignment with the north ends of the existing runways. South 154th Street and South 156th Way would be relocated to the north as in Option 4A. With the north threshold of the new runway located as described above, 8,500 feet is the maximum length obtainable to comply with RSA and ROFA standards.

The layout of the runway and taxiway system for the new runway, under Option 5, was developed by the HNTB Corporation (Seattle-Tacoma International Airport, Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994). The HNTB Preliminary Engineering Studies have include topography and soils investigations, roadway and utility relocations, and other factors which potentially would impact the construction of the new runway.

Because dual arrival streams are possible, the navaids described for Options 4A and 4B are applicable to this option. Therefore, each end of the new runway would be capable of Category IIIb approaches.

Option 6: Independent-Maximum Length

In Option 6, a new 8,500 foot by 150 foot runway would be constructed 3,300 feet west of Runway 16L-34R (Figure 3-8). Due to the greater separation of the new runway from the existing runways under this option, extensive road relocations would be necessary. In addition to the relocation of South 156th Way and South 154th Street, approximately one mile of State Route 509 and one mile of Des Moines Way would have to be relocated. The relocations would include the 2 level interchange between State Route 509 and Des Moines Way.

In addition, this option would require substantial property acquisition and the relocation of many more homes and businesses than under the other options. The estimated costs of land acquisitions and relocations under each option are included in Section 5.

Due to the proximity of the new runway to Des Moines Way west of the airport, the relocated South 156th Way would join 152nd Street at its intersection with Des Moines Way rather than retaining the connection with 156th Street at Des Moines Way (Figure 3-8).

The advantage of Option 6 is that it would provide for dual dependent IFR arrival streams on the two westerly runways, leaving the long runway, Runway 16L-34R, available for departures. Furthermore, the two outboard runways would be separated by 3,300 feet, which in the future will presumably permit simultaneously independent ILS approaches. Thus, this option has the greatest capacity for handling air traffic under IFR conditions and would result in fewer aircraft operational delays than the other options. Navaids for Option 6 would be the same as those for Options 3 through 5, Category IIIb approaches for both north and south operating conditions.

RUNWAY USES FOR INITIAL AIRSIDE OPTIONS

The use (arrivals vs. departures) of new and existing runways would vary according to the option and weather conditions (wind direction and ceiling and visibility minimums). Figure 3-10 depicts generalized runway uses of options under various weather conditions. Future runway use patterns for the airfield options were obtained from the FAA air traffic control tower at Sea-Tac.

The runway use patterns have been generalized to show only the primary flow patterns. For example, under most configurations, the new runway is shown as primarily a landing runway but the runway would occasionally be used for departures under some of these configurations when conditions permit.

The weather conditions shown in Figure 3-10 are:

- VMC -- visual meteorological conditions (visibility at least 5 statute miles; ceiling at least 5,000 feet)
- MMC -- marginal meteorological conditions (visibility less than VMC, but at least 2.5 statute miles; ceiling below VMC, but at least 900 feet)
- IMC -- instrument meteorological conditions (visibility and/or cloud ceiling below MMC)

South Flow

Under VMC south flow conditions, which occur 49 percent of the time, the third runway would be used primarily for arrivals in all development options. The existing runways would be operated as they are today (Runway 16L for departures and Runway 16R for arrivals) under Options 2, 3, and 6. Under Options 4A, 4B and 5, Runway 16L would become primarily an arrival runway and Runway 16R would be used primarily for departures.

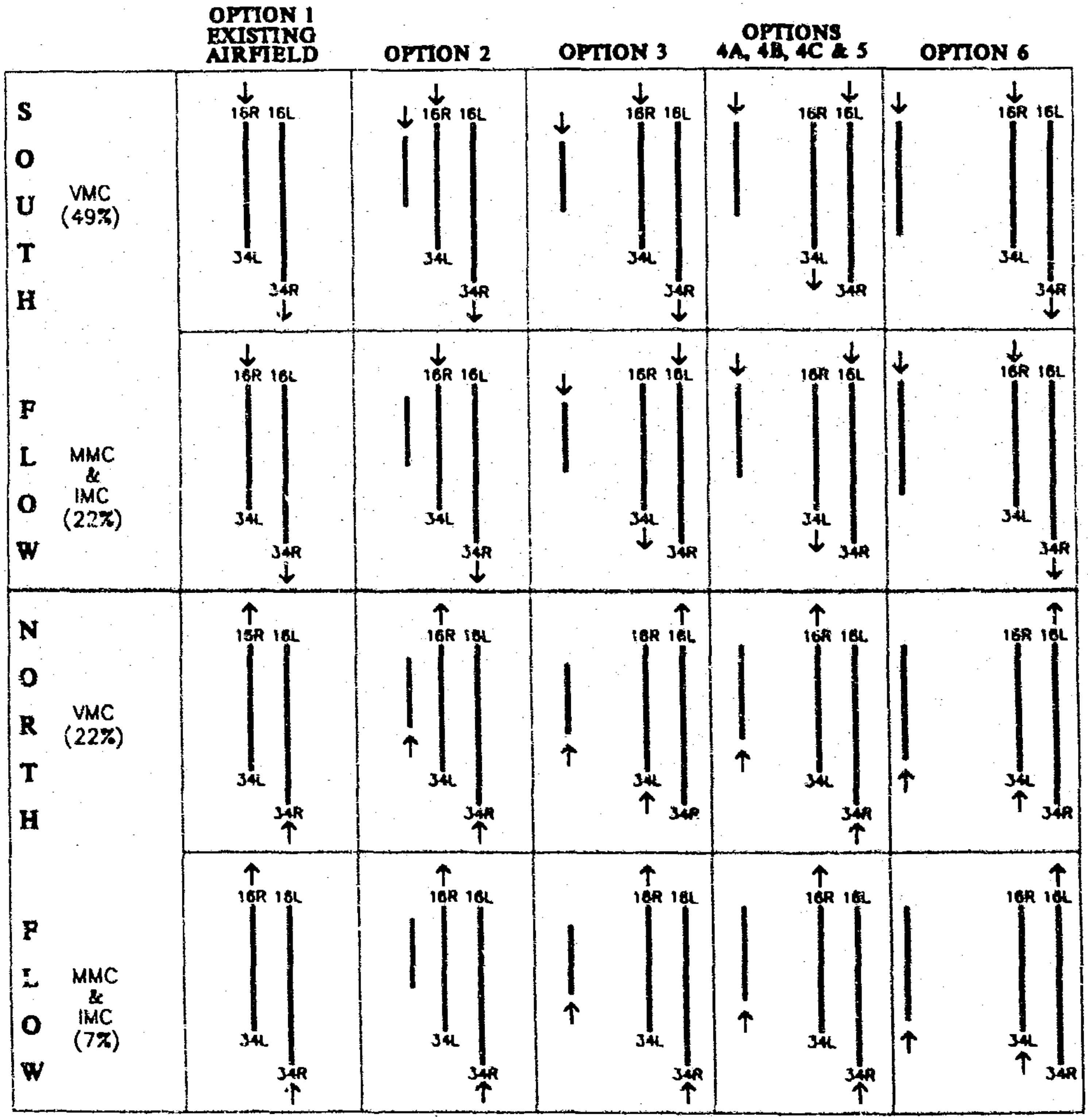
During MMC and IMC south flows (22 percent of the time), assignments would be as under VMC conditions except under Options 2 and 3. Under Option 2, the third runway would normally not be used because the separation would not allow two arrival streams. Under Option 3, the assignments of the existing runways would be reversed.

North Flow

In VMC north flow conditions (22 percent of the time), the third runway would be primarily used for arrivals. The existing runways would be used as they are today (Runway 34R for arrivals and Runway 34L for departures) except under Options 3 and 6. Under those options, the primary assignments of the existing runways would be reversed.

During MMC and IMC north flow (seven percent of the time), the runway use would be the same as under VMC except for Options 2 and 3. In Option 2, the third runway would normally not be used because the separation

FIGURE 3-10
PRIMARY RUNWAY ASSIGNMENTS FOR INITIAL AIRFIELD OPTIONS



would not allow dual arrival streams. Under Option 3, the existing runways would be used as they are today.

In the next two sections, the eight initial airfield options described in this section are evaluated in terms of airfield delay and taxi times (Section 4) and construction and property acquisition costs (Section 5).

Section 4
AIRSIDE OPERATIONS ANALYSIS

SECTION 4
AIRSIDE OPERATIONS ANALYSIS

INTRODUCTION

This section describes the results of the operational analyses of the initial airfield options identified in Section 3. The operational analyses consists of estimating average airfield approach and departure delays and average taxiing times.

AIRFIELD DELAYS

Methodology

The Federal Aviation Administration's Airport and Airspace Simulation Model (SIMMOD) was used in this analysis. SIMMOD is a sophisticated computer simulation model which realistically simulates the movement of every aircraft, step by step, resolving conflicts and monitoring time along each segment of a flight or taxi path. These capabilities allow existing and future flight schedules to be input and used to forecast the effects of proposed runway changes. The model produces quantitative measures of aircraft air arrival delays, departure queue delays, and ground taxi delays.

The conduct of these studies was overseen by the Seattle-Tacoma Airport Capacity Design Team. This team was formed to evaluate means of increasing capacity and efficiency at Sea-Tac and reducing costly aircraft delays. The Capacity Team was composed of representatives from the Port of Seattle, FAA, airlines, and consultants.

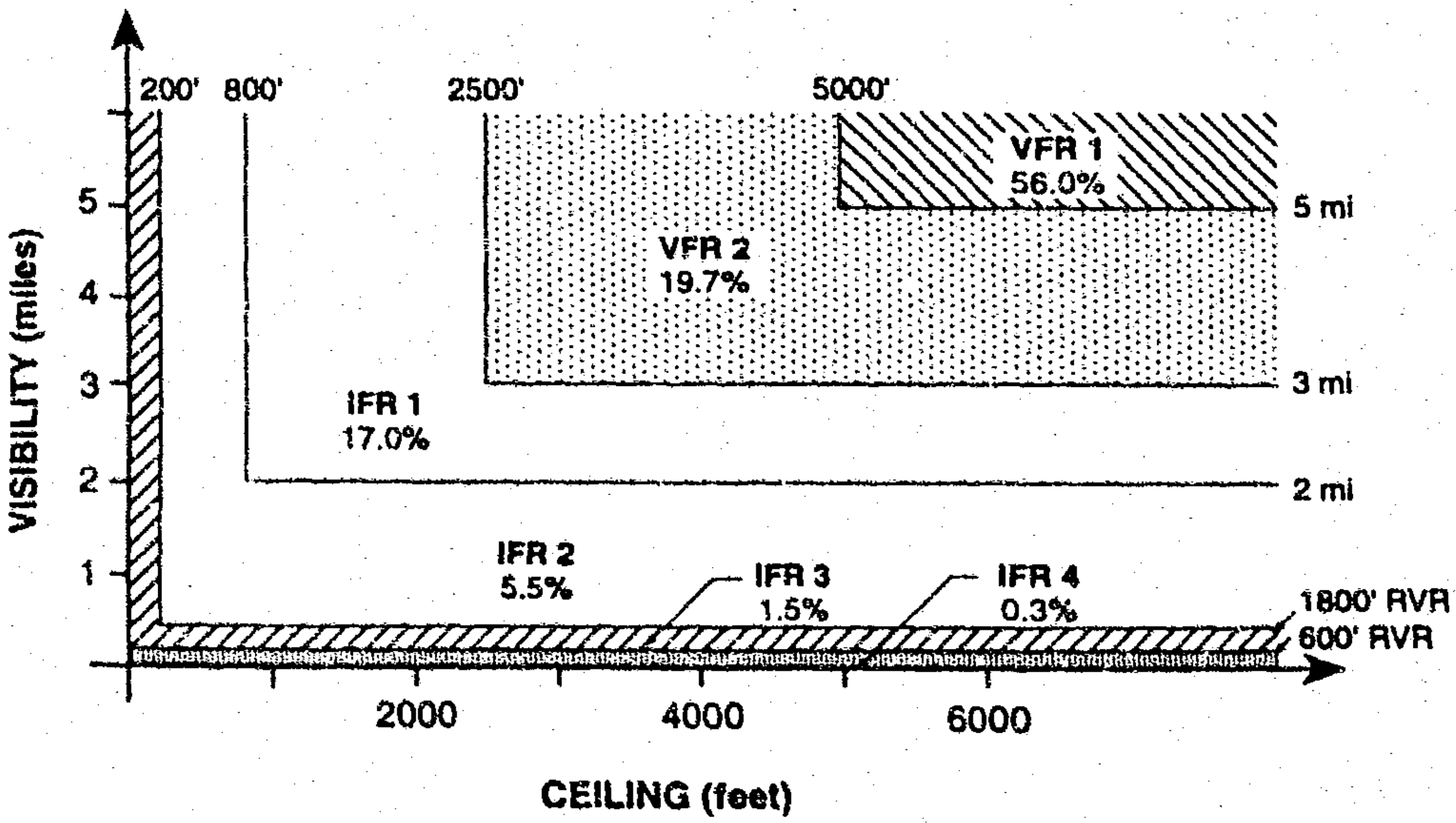
The prime objective of the Capacity Team was to identify and assess various actions at Sea-Tac which would increase airport capacity, improve efficiency of operations, and reduce aircraft delays. The purpose of the process was to ascertain the technical merits of each alternative action and its impact on aircraft delay. The Team began these studies in October 1993 and will complete this work in early 1995. The results presented herein are therefore preliminary and subject to further refinement.

Inputs and assumptions used in the analysis are described below.

Weather Conditions. Weather conditions and their patterns of occurrence are important considerations when calculating airport capacity and aircraft delays. The spacing between aircraft specified by the FAA and the applicable air traffic control (ATC) operational rules, differ depending on the weather, i.e., the cloud ceiling and visibility. For example, when the cloud ceiling and visibility are high enough to permit aircraft pilots to maintain visual separation from each other, aircraft can land simultaneously on the two closely spaced parallel runway at the Airport. During less-favorable weather conditions, radar separation must be provided by ATC, resulting in a single aircraft arrival stream and greater in-trail spacing between arriving aircraft. The time of occurrence of various weather conditions versus the demand for landing and take-offs is also important.

Figure 4-1 illustrates the frequency of occurrence of various types of weather conditions at Sea-Tac. During VFR 1 (Visual Flight Rules) weather, simultaneous visual approaches can be conducted to both existing runways or to a third parallel runway at the Airport. -- i.e., up to three arrival streams. During VFR 2 conditions dual arrival streams

FIGURE 4-1
SEA-TAC WEATHER CONDITIONS



Source: Sea-Tac Airport Weather Station, Hourly Observations from 1/1/82 to 3/31/92.

can be maintained only if pilots can make visual contact with other approaching aircraft. Thus, dual arrival streams can only be guaranteed at Sea-Tac 56 percent of the time.

During IFR (Instrument Flight Rules) conditions, only a single arrival stream and a single runway can be used because of the existing 800 foot spacing between runways. Current rules require at least a 2,500 foot spacing between parallel runway centerlines for two "staggered," or "dependent" aircraft arrival streams during IFR and VFR 2 conditions. These conditions occur 44 percent of the time at Sea-Tac.

With 2,500 foot spacing between runway centerlines, FAA permits a minimum diagonal spacing between arriving aircraft of 1.5 nautical miles. On the basis of conversations with control tower representatives, it was determined this minimum spacing cannot be realistically maintained on a continuous basis. The simulation studies therefore assume an average diagonal spacing between aircraft arrivals of about 2 nautical miles. Airside Options 3, 4A, 4B, 4C, and 5 meet this criteria.

Under current FAA rules, for two simultaneous independent arrival streams, at least a 3,400 foot spacing is required between runway centerlines, along with fast update precision radar monitoring equipment (PRM). For purposes of this analysis, it is assumed that future technology will permit the runway spacing for independent approaches to be reduced to 3,300 feet as provided in Option 6.

Arrival Aircraft Separation. The FAA's SIMMOD model enforces minimum separation requirements between successive arriving aircraft over the length of the common approach path to each arrival runway. This separation enforcement considers runway occupancy times, weather condition, and the approach category of the lead and following aircraft. The minimum separations between arrival aircraft used in the analysis are listed in Table 4-1.

Common Approach Path Lengths. For modelling purposes, the common final approach course length is assumed to be that portion of the arrival flight path where airspeed and maneuvering adjustments required to maintain in-trail spacing between successive arriving aircraft are minimal. When visual approaches can be conducted (i.e., during VFR 1), aircraft can turn onto the final approach course closer to the airport at higher speeds and with reduced in-trail spacing than under VFR 2 and IFR. Therefore, for runway capacity and aircraft delay calculation purposes, the most important categorization of weather conditions is the split between VFR 1 and VFR 2/IFR.

The common final approach course lengths (as identified in the FAA Capacity Enhancement Plan Update "Seattle-Tacoma International Airport Data Package No. 6," August 1994) used in the analysis are as follows:

- VFR 1 -- 6 nautical miles for approach Category B, C, and D aircraft and 3 nautical miles for approach Category A aircraft.

- VFR 2 and IFR -- 6 nautical miles for all aircraft categories.

Runway Occupancy Times. The runway occupancy times (ROT) for arrival aircraft used in the analysis are based on observations conducted by the FAA Technical Center at the Airport during the weeks of October 25 and November 1, 1993 as described in the FAA Capacity Enhancement Plan Update "Seattle-Tacoma International Airport Data Package No. 2," January 1994). For purposes of this analysis, it is assumed that these ROTs will not differ materially in the future for the proposed new runways. The ROTs used in the analysis

TABLE 4-1
MINIMUM SEPARATIONS BETWEEN ARRIVAL AIRCRAFT [a]
(Nautical Miles)

Approach Category of Leading Aircraft Arrival [b]	Approach Category of Trailing Aircraft [a] (Nautical Miles)			
	A	B	C	D
VFR Separations				
A	2.7	3.0	3.2	3.4
B	3.4	3.0	3.2	3.4
C	3.4	3.0	3.2	3.4
D	5.0	4.7	5.0	4.8
IFR Separations				
A	4.0	4.1	4.2	4.3
B	5.0	4.1	4.2	4.3
C	5.0	4.1	4.2	4.3
D	7.0	6.1	5.2	5.3

[a] Source: FAA Airport Capacity Enhancement Plan Update, "Seattle-Tacoma International Airport Data package No. 6", August 1994. Note: Spacings listed in the data package have been rounded to one decimal place for model input.

[b] Approach categories are defined as follows; A = Single-engine and small twin-engine propeller aircraft weighing less than 12,500 lbs; B = Twin engine aircraft weighing 12,500 lbs or more; C = All non-heavy jet aircraft; D = heavy aircraft with takeoff weigh of 300,000 lbs or more.

are as follows:

Aircraft Approach Category	ROT (Seconds)
A	54
B	49
C	52
D	68

Annual and Daily Demand. Several demand levels were selected for the delay analysis. These are shown in Table 4-2. The baseline is intended to represent current conditions at the airport. Future 1 corresponds to traffic levels which are expected to occur about the year 2015 based on the Master Plan Update forecasts. Future 2 is not expected to occur until well after the year 2020 but has been selected to test the capability of the runways to perform under significantly higher demand levels.

Fleet Mix. Table 4-3 illustrates the fleet mix assumptions which are being used in the delay analysis studies. As can be seen a constant fleet mix is currently being assumed to simplify the number of cases which are analyzed. The Master Plan Update forecasts project a greater percentage of Category D (Heavy) aircraft in the future than is shown in Table 4-3. This will cause the delays estimated in the future to be slightly higher for all options since aircraft separations will be increased. As the percentage of heavy aircraft increase, delays for the existing runway and commuter runway configurations (Options 1, 2, and 3) will increase most among the options being considered. In these options wake vortex required separations of at least 2500 feet between two arrival streams is not achieved and thus greater in-trail separations will be necessary.

Traffic Distribution Assumption. For delay calculations, it is important to know when demand occurs and the composition of arrivals and departures within the demand periods. Hourly traffic distribution assumptions used in this analysis are summarized in Table 4-4. According to airline representatives, previous attempts by airlines to schedule operations during off-peak times have not proven economically successful. Therefore, for purposes of this analysis, it is assumed that the demand patterns will remain essentially unchanged in the future, although some natural flattening of peaks may occur.

Airfield Delay Findings

The estimated average annual aircraft delays for each of the options analyzed are summarized in Table 4-5 and are depicted graphically in Figure 4-2 for the Baseline and Future 1 conditions. The delay estimates represent weighted average annual values for six basic weather conditions and the two flow directions as they occur throughout the year. Estimated delays are shown in terms of both minutes and dollars of delay savings in Table 4-5. Delay savings are stated in terms of 1992/1993 dollars. Delay costs were computed from average aircraft operating costs per hour for the baseline and Master Plan Update forecast year 2015 fleet mix ($2,094 per hour or $34.90 per minute). Aircraft operating costs were obtained from Quarterly Aircraft Operating Costs and Statistics, Quarter and Year Ending March 31, 1993, 1994 by Avmark, Inc. Findings of this analysis for the various options are summarized below.

Option 1 (Existing Conditions). As shown in Table 4-5, average annual aircraft delays at Sea-Tac Airport are presently on the order of 5.5 minutes per aircraft operation ($51 million per year). With no additional runways, average annual aircraft delays could be expected to increase to about 22.0 minutes by the year 2015 ($352 million per year).

TABLE 4-2
ANNUAL AND DAILY DEMAND

Year	Annual Operations	Daily Operations	Equivalent Days
Baseline	345,000	1,040	332
Future 1	425,000	1,280	332
Future 2	525,000	1,581	332

Source: Airport Capacity Enhancement Plan Update, "Seattle-Tacoma International Airport, Data Package 6", August 1994.

TABLE 4-3
FLEET MIX ASSUMPTIONS

	Category D	Category C	Category B	Category A
Baseline	8.6%	54.2%	31.3%	5.9%
Future 1	8.6%	54.2%	31.3%	5.9%
Future 2	8.6%	54.2%	31.3%	5.9%

Source: Airport Capacity Enhancement Plan Update, "Seattle-Tacoma International Airport, Data Package 6", August 1994.

TABLE 4-4
HOURLY DISTRIBUTION OF DEMAND [a]

Hour	Arrivals [b]	Departures [c]	Totals
00:00 - 00:59	6	6	12
01:00 - 01:59	1	2	3
02:00 - 02:59	0	0	0
03:00 - 03:59	4	0	4
04:00 - 04:59	1	0	1
05:00 - 05:59	8	4	12
06:00 - 06:59	13	24	37
07:00 - 07:59	21	43	64
08:00 - 08:59	20	42	62
09:00 - 09:59	33	21	54
10:00 - 10:59	40	31	71
11:00 - 11:59	38	30	68
12:00 - 12:59	29	38	67
13:00 - 13:59	32	39	71
14:00 - 14:59	26	32	58
15:00 - 15:59	33	26	59
16:00 - 16:59	20	30	50
17:00 - 17:59	32	23	55
18:00 - 18:59	42	34	76
19:00 - 19:59	35	30	65
20:00 - 20:59	33	24	57
21:00 - 21:59	23	16	39
22:00 - 22:59	22	10	32
23:00 - 23:59	8	15	23
Totals	530	520	1,040

[a] Source: Airport Capacity Enhancement Plan Update, "Seattle-Tacoma International Airport, Data Package 6", August 1994, Port of Seattle.

[b] Arrival time is time at 30 nautical miles for Sea-Tac.

[c] Departure time is time at push-back from gate.

TABLE 4-5
DELAY ANALYSIS RESULTS [a]

Runway Description	Demand	New Runway Use	Average Delay (Minutes/Operation)				Annual Delay Savings	
			Arrival	Departure	Taxi	Total	Time (Hours)	Amount ($Millions)
Existing	Baseline	NA	4.3	1.1	0.1	5.5	NA	NA
Existing	Future 1	NA	19.4	2.4	0.2	22.0	0	0
Close Commuter	Future 1	Limited Use [b]	18.0	2.4	0.2	20.6	10,000	21
Dependent	Future 1	Full Use [c]	1.6	2.0	0.2	3.8	130,000	270
Independent	Future 1	Full Use	1.5	2.0	0.3	3.8	130,000	270

[a] Source: Preliminary Results, Airport Capacity Enhancement Plan Update, "Seattle-Tacoma International Airport, Data Package No. 6" plus amendments, August, September 1994.

[b] Limited Use = Used by Category A and B aircraft only.

[c] Full Use = Used by Categories A, B, C, and D aircraft.

Options 2 and 3 (Commuter Runway). Options 2 and 3, an additional commuter runway, would result in relatively modest savings compared to the other options. By the Year 2015 Option 2 would result in average annual delays of about 20.6 minutes per operation whereas Option 3 would lower this figure to 14.2 minutes per operation. These comparisons are shown in Figure 4-2.

Options 4A, 4B, and 4C (Dependent Air Carrier Runway 7000 feet and 7500 feet in length). Options 4A, 4B, and 4C, which include a third air carrier runway spaced 2,500 feet west of Runway 16L/34R, would provide more significant delay savings. For Options 4A and 4B, annual aircraft delays would be on the order of 5.4 minutes per operation. For Option 4C, the longer runway length would accommodate a greater percentage of the fleet and the average delay would be slightly lower, or about 4.6 minutes per operation.

Options 5 and 6. Options 5 and 6 would provide the greatest delay reduction. Both of these options reduce the average annual aircraft delay to about 3.8 minutes per operation by the Year 2015. This results in an annual delay savings of about $290 million when compared to Option 1.

At a demand level of 425,000 operations, the independent runway option (Option 6) does not show an advantage over the dependent runway option (Option 5) based on the results of the SIMMOD computer simulation analysis. This is explained by the fact that with the independent option, the greater flexibility in positioning arriving aircraft is offset by the longer taxi distance. As demand increases beyond 425,000 operations however, the independent runway option could result in improved delay savings. If this does not occur until the Year 2015 then it is possible that advances in technology may allow independent approaches to be made to parallel runways separated by less than 3,400 feet.

CONCLUSIONS

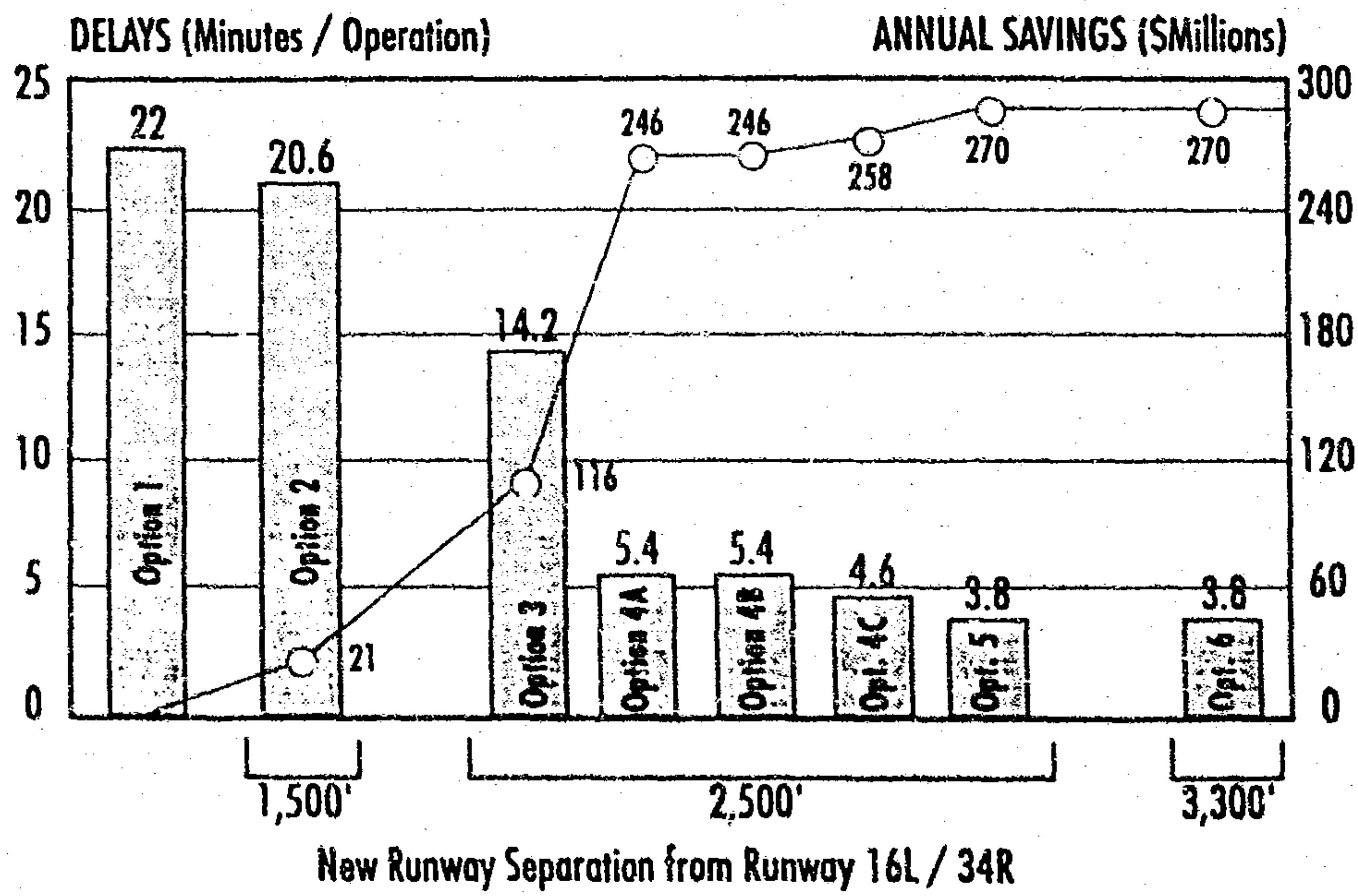
As shown in Table 4-5 and Figure 4-2, Option 1, No New Runway, would result in very high aircraft delays as demand approaches 425,000 operations. The delay at this activity level would average 22 minutes per operation and result in additional aircraft operating costs of about $245 million per year.

Option 2, an additional closely spaced commuter aircraft runway, would provide only nominal delay savings compared with Option 1. Option 2 would be useful primarily to provide a third aircraft arrival stream for commuter and general aviation aircraft during visual weather conditions. Under these favorable weather conditions, additional capacity is least needed. Two other factors weigh against further consideration of Option 2: (1) the airborne delay savings with this option would be largely offset by additional taxiing distances and runway crossing delays, and (2) the percentage of aircraft able to use a commuter runway is forecast to decline.

Option 3, a commuter runway spaced 2,500 feet from the east runway, would provide a second "dependent," aircraft arrival stream under both visual and instrument weather conditions. Although, as in Option 2, it would primarily serve only commuter aircraft, it would allow delay savings compared with Options 1 and 2.

Of the alternatives analyzed, Options 4A/B/C and 5, a dependent air carrier runway and Option 6, an independent air carrier runway, would provide the greatest reduction in future aircraft delays. In addition to delay and cost savings, the 8,500-foot runway length proposed for Options 5 and 6 would provide an additional margin of ATC operational flexibility and

FIGURE 4-2
RUNWAY OPTION DELAY COMPARISONS



Source: Table 4-5, plus interpolated estimates for Options 3, 4A, 4B, and 4C efficiency and potential safety, because (1) heavy jet aircraft would not be restricted to the existing two runways, (2) all aircraft using a longer runway would have a greater takeoff/stopping distance available, (3) the number of heavy jet aircraft operations is forecast to increase at Sea-Tac, and (4) an 8,500-foot runway length would provide a greater measure of redundancy in that it could accommodate heavy jet aircraft when one of the existing runways is closed for maintenance or emergency.

Options 5 and 6 provide the greatest delay improvement since the 8,500-foot runway length can accommodate the highest percentage of the fleet for landings. This greater capability will result in fewer aircraft crossing on approach. The seemingly greater delay benefit offered by the independent arrival capability in Option 6 does not occur until demand increases beyond 425,000 operations. By this time, independent arrivals may be possible to runways spaced closer than 3,400 feet. While not an assumption of this analysis, it is conceivable that technological advances, for example, differential global positioning system (DGPS) procedures currently being evaluated by the FAA, will permit future simultaneous independent approaches to parallel runway with 2,500-foot spacing (Options 3, 4A, 4B., 4C, and 5).

In the next section, the options are further evaluated on the basis of construction and acquisition costs.

Section 5
DEVELOPMENT COSTS AND CONSIDERATIONS

SECTION 5
DEVELOPMENT COSTS AND CONSIDERATIONS

Cost estimates were prepared for each of the airfield development options. Estimated costs include all costs associated with the development of each airside option discussed in this report: construction of airfield and related facilities, installation of radar and navaids, property acquisition and reimbursement for relocation assistance. The methodology, assumptions and resulting cost estimates are discussed in this section.

ESTIMATED CONSTRUCTION COSTS

The construction cost estimates that are developed herein should be considered as order of magnitude conceptual costs and be used for comparison purposes only. As much as possible, the same assumptions and unit costs are used as those presented in the Preliminary Engineering Report, Volumes 1 and 2, prepared by HNTB, dated March 31, 1994 (First Draft). Other sources used in developing these construction costs are: Port of Seattle, Runway 16L-34R Safety Area Expansion Study, dated December 2, 1992; Reid Middleton, Runway 34R Safety Area Expansion Conceptual Design Report; PCI, Runway 16R-34L Preliminary Engineering Report, dated August 13, 1992; Seattle-Tacoma International Airport, Runway 16L Safety Area Expansion Engineering Report, dated March 29, 1993.

Construction costs were estimated for each airside option as depicted in Figures 3-2 through 3-9. The total construction costs, including Runway Safety Area extensions, are summarized as follows:

Option 1	$0
Option 2	$79,000,000
Option 3	$255,000,000
Option 4A	$347,000,000
Option 4B	$279,000,000
Option 4C	$294,000,000
Option 5	$364,000,000
Option 6	$596,000,000

The construction costs fall under thirteen categories:

1. Mobilization
2. Relocation Items
3. Demolition
4. Earthwork
5. Drainage
6. On-Site Water
7. Electrical
8. Paving
9. Miscellaneous
10. Existing R.S.A.'s and Cross Taxiways
11. Other Construction Items (20 percent of subtotal)
12. Engineering and Contingencies (15 percent of Subtotal)
13. Radar and Navaids

These construction costs for each of the options are presented by category in Table 5-1. Detailed costs for the development options are shown in Tables 5-2 through 5-8. Tables 5-9 and 5-10 give cost estimates for runway safety area improvements.

TABLE 5-1
SUMMARY OF CONSTRUCTION COST ESTIMATES FOR INITIAL AIRSIDE OPTIONS AT SEATTLE-TACOMA INTERNATIONAL AIRPORT

Item	Estimated Construction Cost (Millions of 1994 Dollars)						
	Option 2 Commuter Close-in	Option 3 Commuter Dependent	Option 4A Program-matic Baseline	Option 4B Program-matic Baseline Staggered	Option 4C Staggered 7,500-Foot Runway	Option 5 Dependent Maximum Length	Option 6 Independent Maximum Length
Mobilization	4.0	13.0	15.0	15.0	15.0	15.0	25.0
Relocation	0.1	2.3	8.9	3.2	3.2	8.9	16.3
Demolition	0.3	1.1	1.4	1.1	1.3	1.4	3.5
Earthwork	2.0	75.7	112.9	81.6	91.0	118.6	198.3
Drainage	2.7	27.1	27.3	27.3	27.4	28.6	33.8
On-Site Water	0.2	0.5	0.8	0.8	0.8	0.8	1.1
Electrical	5.4	7.5	8.4	8.8	9.0	10.4	10.8
Paving	4.6	13.1	18.3	18.3	19.0	21.8	46.2
Miscellaneous	0.1	3.4	4.2	4.1	4.1	4.3	10.1
Ex. R.S.A.'s	36.0	36.0	48.0	36.0	36.0	48.0	48.0
Subtotal	55.4	179.8	245.2	196.2	206.9	257.8	393.1
All Other (20%)	11.1	36.0	49.0	39.2	41.4	51.6	117.9 [a]
Subtotal	66.5	215.8	294.2	235.4	248.3	309.4	511.0
Engineering & Contingencies (15%)	10.0	32.4	44.1	35.3	37.2	46.4	76.7
Radar and Navaids	2.5	6.9	8.5	8.5	8.5	8.5	8.5
Total	79.0	255.0	346.8	279.2	294.0	364.3	596.2

[a] All other (30%).

TABLE 5-2
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 2: COMMUTER - CLOSE [a]

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	Estimated Cost
1	MOBILIZATION	1 LS	$4,000,000	$4,000,000
	RELOCATION ITEMS			
2	Southwest Suburban Miller Creek Interceptor	1 LS	$0	$0
3	Sewer Dist. Local Service Abandonment	1 LS	$0	$0
4	Seattle Water Dept. Watermain Protection	1 LS	$100,000	$100,000
5	Port of Seattle Sanitary Sewer Relocation	1 LS	$0	$0
6	Water Dist. No.20 Local Service Abandonment	1 LS	$0	$0
7	Water Dist. No.49 Local Service Abandonment	1 LS	$0	$0
8	Water Dist. No.125 Local Service Abandonment	1 LS	$0	$0
9	Wash. Natural Gas Local Service Abandonment	1 LS	$0	$0
10	Miller Creek	1 LS	$0	$0
	SUBTOTAL			$100,000
	DEMOLITION			
11	Demolition of Small Structures	0 EA	$2,500	$0
12	Demolition of Hanger	1 LS	$178,500	$178,500
13	Demolition of Airfield Pavement	32,000 SY	$4	$128,000
14	Demolition of Streets and Roads	0 SY	$2	$0
15	Demolition of Miscellaneous Utilities	1 LS	$10,000	$10,000
	SUBTOTAL			$316,500
	EARTHWORK			
16	Clearing and Grubbing	116 Acre	$500	$58,000
17	Erosion Control	1 LS	$10,000	$10,000
18	Common Excavation	200,000 CY	$3	$600,000
19	Borrow - Zone A	113,000 CY	$12	$1,356,000
20	Borrow - Zone B	0 CY	$8	$0
21	Borrow - Zone C	0 CY	$5	$0
	SUBTOTAL			$2,024,000
	DRAINAGE			
22	Conveyance System	1 LS	$500,000	$500,000
23	Flow Diversion	1 LS	$150,000	$150,000
24	Detention Ponds	1 LS	$2,000,000	$2,000,000
	SUBTOTAL			$2,650,000
	ON-SITE WATER			
25	Lateral Water Lines	3,000 LF	$36	$108,000
26	Trunk Water Lines	2,000 LF	$58	$116,000
27	Hydrants	5 EA	$380	$1,900
	SUBTOTAL			$225,900

TABLE 5-2
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 2: COMMUTER - CLOSE [a]
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	1994 Dollars Estimated Cost
	ELECTRICAL			
28	Restoration of Sea-Tac Third Metering Point	1 LS	$0	$0
29	Rerouting of Main Telephone Service	1 LS	$0	$0
30	Modifications to Airfield Lighting in Control Tower	1 LS	$100,000	$100,000
31	Modifications to Stop Bar in Control Tower	1 LS	$250,000	$250,000
32	Rearrangement of Control Panels in Control Tower	1 LS	$75,000	$75,000
33	Vault Building	1 LS	$150,000	$150,000
34	Vault Building Generators	1 LS	$230,000	$230,000
35	Vault Building Regulators	1 LS	$270,000	$270,000
36	Electrical System	1 LS	$1,140,000	$1,140,000
37	Runway Lighting	1 LS	$2,185,000	$2,185,000
38	Taxiway Lighting	1 LS	$500,000	$500,000
39	Stop Bar/Hold Bar Lighting	1 LS	$229,000	$229,000
40	Airfield Signs	1 LS	$250,000	$250,000
41	Utility Work	1 LS	$0	$0
	SUBTOTAL			$5,379,000
	PAVING			
42	Runway Pavement	57,800 SY	$35	$2,023,000
43	Taxiway Pavement	54,900 SY	$35	$1,921,500
44	A.C.P. Runway Shoulder Pavement	4,124 Ton	$35	$144,340
45	A.C.P.Taxiway Shoulder Pavement	6,458 Ton	$35	$226,030
46	A.C.P.Blast Pad Pavement	1,500 Ton	$35	$52,500
47	A.C.P. Perimeter Road and Access Roads	9,000 Ton	$22	$198,000
48	P.C.C. Parking Apron Pavement	0 SY	$40	$0
49	A.C.P. Road and Street Pavement	0 SY	$30	$0
	SUBTOTAL			$4,565,370
	MISCELLANEOUS			
50	Bridge Structures	0 SF	$100	$0
51	Retaining Walls	0 SF	$45	$0
52	Fencing	0 LF	$10	$0
53	Seeding	116 Acre	$500	$58,000
54	Landscaping	0 Acre	$2,000	$0
	SUBTOTAL			$58,000
	RUNWAY SAFETY AREAS AND CROSS			
55	900' Extension (See Table 5-9)	1 LS	$36,000,000	$36,000,000
	All Other Construction Items @ 20%			$11,063,754
	SUBTOTAL			$66,382,524
	Engineering and Contingencies @ 15%			$9,957,379

TABLE 5-2
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 2: COMMUTER - CLOSE [a]
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	1994 Dollars Estimated Cost
	SUBTOTAL (THIRD RUNWAY CONSTRUCTION)			$76,339,903
	RADAR AND NAVAIDS			
	ASR Relocation	1 LS	$2,000,000	$2,000,000
	ASDE Relocation	1 LS	$350,000	$350,000
	North Approach Glide Slope	1 LS	$0	$0
	South Approach Glide Slope	1 LS	$0	$0
	North Approach Localizer	1 LS	$0	$0
	South Approach Localizer	1 LS	$0	$0
	RVR Facilities	1 LS	$0	$0
	North Approach Markers (Inner, Middle, Outer)	1 LS	$0	$0
	South Approach Markers	1 LS	$0	$0
	PAPI	1 LS	$100,000	$100,000
	Approach Lighting - North Approach (ALSF-II)	1 LS	$0	$0
	Approach Lighting - South Approach (ALSF-II)	1 LS	$0	$0
	RADAR AND NAVAIDS SUBTOTAL			$2,450,000
	PROJECT TOTAL (THIRD RUNWAY)			$78,789,903
	Rounded to Nearest $1 Million			$79,000,000

[a] Source: P&D Aviation analysis. Many of the quantities and unit costs were taken from: HNTB Corporation, Seattle-Tacoma International Airport Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994.

[b] Abbreviation used in this table are:

CY = cubic yards
EA = each
LF = lineal feet
LS = lump sum
SY = square yards

TABLE 5-3
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 3: COMMUTER - DEPENDENT [a]

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	1994 Dollars Estimated Cost
1	MOBILIZATION	1 LS	$13,000,000	$13,000,000
	RELOCATION ITEMS			
2	Southwest Suburban Miller Creek Interceptor	1 LS	$500,000	$500,0000
3	Sewer Dist. Local Service Abandonment	1 LS	$38,000	$38,0000
4	Seattle Water Dept. Watermain Protection	1 LS	$1,744,000	$1,744,000
5	Port of Seattle Sanitary Sewer Relocation	1 LS	$0	$0
6	Water Dist. No.20 Local Service Abandonment	1 LS	$16,900	$16,900
7	Water Dist. No.49 Local Service Abandonment	1 LS	$17,900	$17,900
8	Water Dist. No.125 Local Service Abandonment	1 LS	$15,000	$15,000
9	Wash. Natural Gas Local Service Abandonment	1 LS	$15,500	$15,500
10	Miller Creek	1 LS	$0	$0
	SUBTOTAL			$2,347,300
	DEMOLITION			
11	Demolition of Small Structures	256 EA	$2,500	$640,500
12	Demolition of Hanger	1 LS	$178,500	$178,500
13	Demolition of Airfield Pavement	8,500 SY	$4	$34,000
14	Demolition of Streets and Roads	35,000 SY	$2	$70,000
15	Demolition of Miscellaneous Utilities	1 LS	$200,000	$200,000
	SUBTOTAL			$1,122,500
	EARTHWORK			
16	Clearing and Grubbing	260 Acre	$500	$130,000
17	Erosion Control	1 LS	$10,000	$100,000
18	Common Excavation	2,600,000 CY	$3	$7,800,000
19	Borrow - Zone A	972,000 CY	$12	$11,664,000
20	Borrow - Zone B	5,550,000 CY	$8	$44,400,000
21	Borrow - Zone C	2,320,000 CY	$5	$11,600,000
	SUBTOTAL			$75,694,000
	DRAINAGE			
22	Conveyance System	1 LS	$6,500,000	$6,500,000
23	Flow Diversion	1 LS	$1,265,000	$1,265,000
24	Detention Ponds	1 LS	$19,350,000	$19,350,000
	SUBTOTAL			$27,115,000
	ON-SITE WATER			
25	Lateral Water Lines	1,600 LF	$36	$57,600
26	Trunk Water Lines	7,500 LF	$58	$435,000
27	Hydrants	8 EA	$380	$3,040
	SUBTOTAL			$493,640

TABLE 5-3
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 3: COMMUTER - DEPENDENT [a]
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	1994 Dollars Estimated Cost
	ELECTRICAL			
28	Restoration of Sea-Tac Third Metering Point	1 LS	$419,000	$419,000
29	Rerouting of Main Telephone Service	1 LS	$350,000	$350,000
30	Modifications to Airfield Lighting in Control Tower	1 LS	$100,000	$100,000
31	Modifications to Stop Bar in Control Tower	1 LS	$250,000	$250,000
32	Rearrangement of Control Panels in Control Tower	1 LS	$75,000	$75,000
33	Vault Building	1 LS	$150,000	$150,000
34	Vault Building Generators	1 LS	$230,000	$230,000
35	Vault Building Regulators	1 LS	$270,000	$270,000
36	Electrical System	1 LS	$1,140,000	$1,140,000
37	Runway Lighting	1 LS	$2,185,000	$2,185,000
38	Taxiway Lighting	1 LS	$1,240,000	$1,240,000
39	Stop Bar/Hold Bar Lighting	1 LS	$229,000	$229,000
40	Airfield Signs	1 LS	$496,000	$496,000
41	Utility Work	1 LS	$400,000	$400,000
	SUBTOTAL			$7,534,000
	PAVING			
42	Runway Pavement	58,000 SY	$35	$2,030,000
43	Taxiway Pavement	141,390 SY	$37	$5,231,430
44	A.C.P. Runway Shoulder Pavement	4,124 Ton	$35	$144,340
45	A.C.P.Taxiway Shoulder Pavement	17,345 Ton	$35	$607,075
46	A.C.P.Blast Pad Pavement	1,500 Ton	$35	$52,500
47	A.C.P. Perimeter Road and Access Roads	12,300 Ton	$22	$270,600
48	P.C.C. Parking Apron Pavement	116,500 SY	$40	$4,660,000
49	A.C.P. Road and Street Pavement	3,500 SY	$30	$105,000
	SUBTOTAL			$13,100,945
	MISCELLANEOUS			
50	Bridge Structures	0 SF	$100	$0
51	Retaining Walls	67,800 SF	$45	$3,051,000
52	Fencing	19,000 LF	$10	$190,000
53	Seeding	260 Acre	$500	$130,000
54	Landscaping	15 Acre	$2,000	$30,000
	SUBTOTAL			$3,401,000
	RUNWAYS SAFETY AREAS & CROSS TAXIWAYS			
55	900' Extension (See Table 5-9)	1 LS		$36,000,000
	All Other Construction Items @ 20%			$35,962,077
	SUBTOTAL			$215,772,462
	Engineering and Contingencies @ 15%			$32,365,869
	TOTAL FOR THIRD RUNWAY CONSTRUCTION			$248,138,331

TABLE 5-3
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 3: COMMUTER - DEPENDENT [a]
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars	
			Unit Cost	Estimated Cost
	RADAR AND NAVAIDS			
	ASR Relocation	1 LS	$2,000,000	$2,000,000
	ASDE Relocation	1 LS	$350,000	$350,000
	North Approach Glide Slope	1 LS	$400,000	$400,000
	South Approach Glide Slope	1 LS	$400,000	$400,000
	North Approach Localizer	1 LS	$375,000	$375,000
	South Approach Localizer	1 LS	$375,000	$375,000
	RVR Facilities	1 LS	$200,000	$200,000
	North Approach Markers (Inner, Middle, Outer)	1 LS	$350,000	$350,000
	South Approach Markers	1 LS	$350,000	$350,000
	PAPI	1 LS	$100,000	$100,000
	Approach Lighting - North Approach (ALSF-II)	1 LS	$1,000,000	$1,000,000
	Approach Lighting - South Approach (ALSF-II)	1 LS	$1,000,000	$1,000,000
	RADAR AND NAVAIDS SUBTOTAL			$6,900,000
	PROJECT TOTAL (THIRD RUNWAY)			$255,038,331
	Rounded to nearest $1 Million			$255,000,000

[a] Source: P&D Aviation analysis. Many of the quantities and unit costs were taken from: HNTB Corporation, Seattle-Tacoma International Airport Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994.

[b] Abbreviation used in this table are:

CY = cubic yards
EA = each
LF = lineal feet
LS = lump sum
SY = square yards

TABLE 5-4
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 4A: PROGRAMMATIC BASELINE [a]

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	1994 Dollars Estimated Cost
1	MOBILIZATION	1 LS	$15,000,000	$15,000,000
	RELOCATION ITEMS			
2	Southwest Suburban Miller Creek Interceptor	1 LS	$1,962,000	$1,962,000
3	Sewer Dist. Local Service Abandonment	1 LS	$38,000	$38,000
4	Seattle Water Dept. Watermain Protection	1 LS	$1,744,000	$1,744,000
5	Port of Seattle Sanitary Sewer Relocation	1 LS	$155,000	$155,000
6	Water Dist. No.20 Local Service Abandonment	1 LS	$16,900	$16,900
7	Water Dist. No.49 Local Service Abandonment	1 LS	$17,900	$17,900
8	Water Dist. No.125 Local Service Abandonment	1 LS	$15,000	$15,000
9	Wash. Natural Gas Local Service Abandonment	1 LS	$15,500	$15,500
10	Miller Creek	1 LS	$4,960,000	$4,960,000
	SUBTOTAL			$8,924,300
	DEMOLITION			
11	Demolition of Small Structures	335 EA	$2,500	$837,500
12	Demolition of Hanger	1 LS	$178,500	$178,500
13	Demolition of Airfield Pavement	8,500 SY	$4	$34,000
14	Demolition of Streets and Roads	51,000 SY	$2	$102,000
15	Demolition of Miscellaneous Utilities	1 LS	$250,000	$250,000
	SUBTOTAL			$1,402,000
	EARTHWORK			
16	Clearing and Grubbing	380 Acre	$500	$180,000
17	Erosion Control	1 LS	$100,000	$100,000
18	Common Excavation	2,900,000 CY	$3	$8,700,000
19	Borrow - Zone A	1,350,000 CY	$12	$16,200,000
20	Borrow - Zone B	8,370,000 CY	$8	$66,980,000
21	Borrow - Zone C	4,150,000 CY	$5	$20,750,000
	SUBTOTAL			$112,910,000
	DRAINAGE			
22	Conveyance System	1 LS	$6,711,000	$6,711,000
23	Flow Diversion	1 LS	$1,265,000	$1,265,000
24	Detention Ponds	1 LS	$19,350,000	$19,350,000
	SUBTOTAL			$27,326,000
	ON-SITE WATER			
25	Lateral Water Lines	3,800 LF	$36	$108,600
26	Trunk Water Lines	12,500 LF	$58	$725,000
27	Hydrants	13 EA	$380	$4,940
	SUBTOTAL			$838,540

TABLE 5-4
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 4A: PROGRAMMATIC BASELINE [a]
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	Estimated Cost
	ELECTRICAL			
28	Restoration of Sea-Tac Third Metering Point	1 LS	$419,000	$419,000
29	Rerouting of Main Telephone Service	1 LS	$350,000	$350,000
30	Modifications to Airfield Lighting in Control Tower	1 LS	$100,000	$100,000
31	Modifications to Stop Bar in Control Tower	1 LS	$250,000	$250,000
32	Rearrangement of Control Panels in Control Tower	1 LS	$75,000	$75,000
33	Vault Building	1 LS	$150,000	$150,000
34	Vault Building Generators	1 LS	$230,000	$230,000
35	Vault Building Regulators	1 LS	$270,000	$270,000
36	Electrical System	1 LS	$1,140,000	$1,140,000
37	Runway Lighting	1 LS	$2,941,000	$2,941,000
38	Taxiway Lighting	1 LS	$1,370,000	$1,370,000
39	Stop Bar/Hold Bar Lighting	1 LS	$229,000	$229,000
40	Airfield Signs	1 LS	$496,000	$496,000
41	Utility Work	1 LS	$400,000	$400,000
	SUBTOTAL			$8,420,000
	PAVING			
42	Runway Pavement	116,700 SY	$40	$4,668,000
43	Taxiway Pavement	149,000 SY	$40	$5,960,000
44	A.C.P. Runway Shoulder Pavement	12,500 Ton	$35	$437,500
45	A.C.P Taxiway Shoulder Pavement	34,500 Ton	$35	$1,207,500
46	A.C.P Blast Pad Pavement	3,500 Ton	$35	$122,500
47	A.C.P. Perimeter Road and Access Roads	14,000 Ton	$22	$308,000
48	P.C.C Parking Apron Pavement	118,000 SY	$40	$4,720,000
49	A.C.P Road and Street Pavement	30,000 SY	$30	$900,000
	SUBTOTAL			$18,323,500
	MISCELLANEOUS			
50	Bridge Structures	7,500 SF	$100	$750,000
51	Retaining Walls	67,800 SF	$45	$3,051,000
52	Fencing	20,000 LF	$10	$200,000
53	Seeding	380 Acre	$500	$190,000
54	Landscaping	20 Acre	$2,000	$40,000
	SUBTOTAL			$4,231,000
	RUNWAY SAFETY AREAS & CROSS TAXIWAYS			
55	600' Extension (See Table 5-10)	1 LS	$48,000,000	$48,000,000
	All Other Construction Items @ 20%			$49,000,000
	SUBTOTAL			$294,200,000
	Engineering and Contingencies @ 15%			$44,100,000
	TOTAL FOR THIRD RUNWAY CONSTRUCTION			$338,300,000

TABLE 5-4
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 4A: PROGRAMMATIC BASELINE [a]
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	Estimated Cost
	RADAR AND NAVAIDS			
	ASR Relocation	1 LS	$2,000,000	$2,000,000
	ASDE Relocation	1 LS	$350,000	$350,000
	North Approach Glide Slope	1 LS	$600,000	$600,000
	South Approach Glide Slope	1 LS	$600,000	$600,000
	North Approach Localizer	1 LS	$600,000	$600,000
	South Approach Localizer	1 LS	$600,000	$600,000
	RVR Facilities	1 LS	$300,000	$300,000
	North Approach Markers (Inner, Middle, Outer)	1 LS	$175,000	$175,000
	South Approach Markers	1 LS	$175,000	$175,000
	PAPI	1 LS	$100,000	$100,000
	Approach Lighting - North Approach (ALSF-II)	1 LS	$1,500,000	$1,500,000
	Approach Lighting - South Approach (ALSF-II)	1 LS	$1,500,000	$1,500,000
	RADAR AND NAVAIDS SUBTOTAL			$8,500,000
	PROJECT TOTAL (THIRD RUNWAY)			$346,800,000
	(Rounding to the nearest $1 Million)			$347,000,000

[a] Source: HNTB Corporation, Seattle-Tacoma International Airport Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994. Costs for Runway Safety Area improvements, extension of Runway 16L-34R and additional taxiway exits for Runway 16L-34R were added by P&D Aviation.

[b] Abbreviation used in this table are:

CY = cubic yards
EA = each
LF = lineal feet
LS = lump sum
SY = square yards

TABLE 5-5
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 4B: PROGRAMMATIC BASELINE STAGGERED (7,000' RUNWAY) [a]

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	1994 Dollars Estimated Cost
1	MOBILIZATION	1 LS	$15,000,000	$15,000,000
	RELOCATION ITEMS			
2	Southwest Suburban Miller Creek Interceptor	1 LS	$500,000	$500,0000
3	Sewer Dist Local Service Abandonment	1 LS	$38,000	$38,0000
4	Seattle Water Dept. Watermain Protection	1 LS	$1,744,000	$1,744,000
5	Port of Seattle Sanitary Sewer Relocation	1 LS	$0	$0
6	Water Dist. No.20 Local Service Abandonment	1 LS	$9,000	$9,000
7	Water Dist. No.49 Local Service Abandonment	1 LS	$17,900	$17,900
8	Water Dist. No.125 Local Service Abandonment	1 LS	$15,000	$15,000
9	Wash. Natural Gas Local Service Abandonment	1 LS	$15,500	$15,500
10	Miller Creek	1 LS	$820,000	$820,000
	SUBTOTAL			$3,159,400
	DEMOLITION			
11	Demolition of Small Structures	256 EA	$2,500	$640,000
12	Demolition of Hanger	1 LS	$178,500	$178,500
13	Demolition of Airfield Pavement	8,500 SY	$4	$34,000
14	Demolition of Streets and Roads	35,000 SY	$2	$70,000
15	Demolition of Miscellaneous Utilities	1 LS	$200,000	$200,000
	SUBTOTAL			$1,122,500
	EARTHWORK			
16	Clearing and Grubbing	400 Acres	$500	$200,000
17	Erosion Control	1 LS	$100,000	$100,000
18	Common Excavation	3,000,000 CY	$3	$9,000,000
19	Borrow - Zone A	1,350,000 CY	$12	$16,200,000
20	Borrow - Zone B	5,600,000 CY	$8	$44,800,000
21	Borrow - Zone C	2,250,000 CY	$5	$11,250,000
	SUBTOTAL			$81,550,000
	DRAINAGE			
22	Conveyance System	1 LS	$6,711,000	$6,711,000
23	Flow Diversion	1 LS	$1,265,000	$1,265,000
24	Detention Ponds	1 LS	$19,350,000	$19,350,000
	SUBTOTAL			$27,326,000
	ON-SITE WATER			
25	Lateral Water Lines	3,000 LF	$36	$108,000
26	Trunk Water Lines	12,500 LF	$58	$725,000
27	Hydrants	13 EA	$380	$4,940
	SUBTOTAL			$837,940

TABLE 5-5
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 4B: PROGRAMMATIC BASELINE STAGGERED (7,000' RUNWAY)
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	Estimated Cost
	ELECTRICAL			
28	Restoration of Sea-Tac Third Metering Point	1 LS	$523,000	$523,000
29	Rerouting of Main Telephone Service	1 LS	$600,000	$600,000
30	Modifications to Airfield Lighting in Control Tower	1 LS	$100,000	$100,000
31	Modifications to Stop Bar in Control Tower	1 LS	$250,000	$250,000
32	Rearrangement of Control Panels in Control Tower	1 LS	$75,000	$75,000
33	Vault Building	1 LS	$150,000	$150,000
34	Vault Building Generators	1 LS	$230,000	$230,000
35	Vault Building Regulators	1 LS	$270,000	$270,000
36	Electrical System	1 LS	$1,140,000	$1,140,000
37	Runway Lighting	1 LS	$2,941,000	$2,941,000
38	Taxiway Lighting	1 LS	$1,370,000	$1,370,000
39	Stop Bar/Hold Bar Lighting	1 LS	$229,000	$229,000
40	Airfield Signs	1 LS	$496,000	$496,000
41	Utility Work	1 LS	$400,000	$400,000
	SUBTOTAL			$8,774,000
	PAVING			
42	Runway Pavement	116,700 SY	$40	$4,668,000
43	Taxiway Pavement	173,000 SY	$40	$6,920,000
44	A.C.P. Runway Shoulder Pavement	12,500 Ton	$35	$437,500
45	A.C.P. Taxiway Shoulder Pavement	28,700 Ton	$35	$1,004,500
46	A.C.P. Blast Pad Pavement	3,500 Ton	$35	$122,500
47	A.C.P. Perimeter Road and Access Roads	12,300 Ton	$22	$270,600
48	P.C.C. Parking Apron Pavement	118,000 SY	$40	$4,720,000
49	A.C.P. Road and Street Pavement	6,300 SY	$30	$189,000
	SUBTOTAL			$18,332,100
	MISCELLANEOUS			
50	Bridge Structures	6,000 SF	$100	$600,000
51	Retaining Walls	67,800 SF	$45	$3,051,000
52	Fencing	20,400 LF	$10	$204,000
53	Seeding	400 Acre	$500	$200,000
54	Landscaping	20 Acre	$2,000	$40,000
	SUBTOTAL			$4,095,000
	RUNWAYS SAFETY AREAS & CROSS TAXIWAYS			
55	900' Extension (See Table 5-9)	1 LS	36,000,000	36,000,000
	All Other Construction Items @ 20%			$39,239,388
	SUBTOTAL			$235,436,328
	Engineering and Contingencies @ 15%			$35,315,449
	TOTAL FOR THIRD RUNWAY CONSTRUCTION			$270,751,777

TABLE 5-5
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 4B: PROGRAMMATIC BASELINE STAGGERED (7,000' RUNWAY)
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	1994 Dollars Estimated Cost
	RADAR AND NAVAIDS			
	ASR Relocation	1 LS	$2,000,000	$2,000,000
	ASDE Relocation	1 LS	$350,000	$350,000
	North Approach Glide Slope	1 LS	$600,000	$600,000
	South Approach Glide Slope	1 LS	$600,000	$600,000
	North Approach Localizer	1 LS	$600,000	$600,000
	South Approach Localizer	1 LS	$600,000	$600,000
	RVR Facilities	1 LS	$300,000	$300,000
	North Approach Markers (Inner, Middle, Outer)	1 LS	$175,000	$175,000
	South Approach Markers	1 LS	$175,000	$175,000
	PAPI	1 LS	$100,000	$100,000
	Approach Lighting - North Approach (ALSF-II)	1 LS	$1,500,000	$1,500,000
	Approach Lighting - South Approach (ALSF-II)	1 LS	$1,500,000	$1,500,000
	RADAR AND NAVAIDS SUBTOTAL			$8,500,000
	PROJECT TOTAL (THIRD RUNWAY)			$279,251,777
	(Rounding to the nearest $1 Million)			$279,000,000

[a] Source: P&D Aviation analysis. Many of the quantities and unit costs were taken from: HNTB Corporation, Seattle-Tacoma International Airport Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994.

[b] Abbreviation used in this table are:

CY = cubic yards
EA = each
LF = lineal feet
LS = lump sum
SY = square yards

TABLE 5-6
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 4C: STAGGERED 7,500-FOOT RUNWAY [a]

Item No.	Item	Quantity [b]	1994 Dollars	
			Unit Cost	Estimated Cost
1	MOBILIZATION	1 LS	$15,000,000	$15,000,000
	RELOCATION ITEMS			
2	Southwest Suburban Miller Creek Interceptor	1 LS	$500,000	$500,000
3	Sewer Dist. Local Service Abandonment	1 LS	$38,000	$38,000
4	Seattle Water Dept. Watermain Protection	1 LS	$1,744,000	$1,744,000
5	Port of Seattle Sanitary Sewer Relocation	1 LS	$0	$0
6	Water Dist. No.20 Local Service Abandonment	1 LS	$12,000	$12,000
7	Water Dist. No.49 Local Service Abandonment	1 LS	$17,900	$17,900
8	Water Dist. No.125 Local Service Abandonment	1 LS	$15,000	$15,000
9	Wash. Natural Gas Local Service Abandonment	1 LS	$15,500	$15,500
10	Miller Creek	1 LS	$820,000	$820,000
	SUBTOTAL			$3,162,400
	DEMOLITION			
11	Demolition of Small Structures	298 EA	$2,500	$745,000
12	Demolition of Hangar	1 LS	$178,500	$178,500
13	Demolition of Airfield Pavement	8,500 SY	$4	$34,000
14	Demolition of Streets and Roads	48,000 SY	$2	$96,000
15	Demolition of Miscellaneous Utilities	1 LS	$250,000	$250,000
	SUBTOTAL			$1,303,500
	EARTHWORK			
16	Clearing and Grubbing	410 Acre	$500	$205,000
17	Erosion Control	1 LS	$100,000	$100,000
18	Common Excavation	3,000,000 CY	$3	$9,000,000
19	Borrow - Zone A	1,398,000 CY	$12	$16,776,000
20	Borrow - Zone B	6,450,000 CY	$8	$51,600,000
21	Borrow - Zone C	2,670,000 CY	$5	$13,350,000
	SUBTOTAL			$91,031,000
	DRAINAGE			
22	Conveyance System	1 LS	$6,800,000	$6,800,000
23	Flow Diversion	1 LS	$1,265,000	$1,265,000
24	Detention Ponds	1 LS	$19,350,000	$19,350,000
	SUBTOTAL			$27,415,000
	ON-SITE WATER			
25	Lateral Water Lines	3,000 LF	$36	$108,000
26	Trunk Water Lines	12,500 LF	$58	$725,000
27	Hydrants	13 EA	$380	$4,940
	SUBTOTAL			$837,940

TABLE 5-6
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 4C: STAGGERED 7,500-FOOT RUNWAY [a]
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars	
			Unit Cost	Estimated Cost
	ELECTRICAL			
28	Restoration of Sea-Tac Third Metering Point	1 LS	$523,000	$523,000
29	Rerouting of Main Telephone Service	1 LS	$600,000	$600,000
30	Modifications to Airfield Lighting in Control Tower	1 LS	$100,000	$100,000
31	Modifications to Stop Bar in Control Tower	1 LS	$250,000	$250,000
32	Rearrangement of Control Panels in Control Tower	1 LS	$75,000	$75,000
33	Vault Building	1 LS	$150,000	$150,000
34	Vault Building Generators	1 LS	$230,000	$230,000
35	Vault Building Regulators	1 LS	$270,000	$270,000
36	Electrical System	1 LS	$1,140,000	$1,140,000
38	Runway Lighting	1 LS	$3,151,000	$3,151,000
38	Taxiway Lighting	1 LS	$1,420,000	$1,420,000
39	Stop Bar/Hold Bar Lighting	1 LS	$229,000	$229,000
40	Airfield Signs	1 LS	$496,000	$496,000
41	Utility Work	1 LS	$400,000	$400,000
	SUBTOTAL			$9,034,000
	PAVING			
42	Runway Pavement	125,000 SY	$40	$5,000,000
43	Taxiway Pavement	177,000 SY	$40	$7,080,000
44	A.C.P. Runway Shoulder Pavement	13,600 Ton	$35	$476,000
45	A.C.P. Taxiway Shoulder Pavement	29,600 Ton	$35	$1,036,000
46	A.C.P. Blast Pad Pavement	3,500 Ton	$35	$122,500
47	A.C.P. Perimeter Road and Access Roads	14,200 Ton	$22	$312,400
48	P.C.C. Parking Apron Pavement	118,000 SY	$40	$4,720,000
49	A.C.P. Road and Street Pavement	9,100 SY	$30	$273,000
	SUBTOTAL			$19,019,900
	MISCELLANEOUS			
50	Bridge Structures	6,000 SF	$100	$600,000
51	Retaining Walls	67,800 SF	$45	$3,051,000
52	Fencing	20,900 LF	$10	$209,000
53	Seeding	400 Acre	$500	$200,000
54	Landscaping	20 Acre	$2,000	$40,000
	SUBTOTAL			$4,100,000
	RUNWAY SAFETY AREAS & CROSS TAXIWAYS			
55	900' on south end cross taxiways (See Table 5-9)	1 LS	$36,000,000	$36,000,000
	All Other Construction Items @ 20%			$41,380,748
	SUBTOTAL			$248,284,488
	Engineering and Contingencies @ 15%			$37,242,673
	TOTAL FOR THIRD RUNWAY CONSTRUCTION			$285,527,161

TABLE 5-6
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 4C: STAGGERED 7,500-FOOT RUNWAY [a]
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars	
			Unit Cost	Estimated Cost
	RADAR AND NAVAIDS			
	ASR Relocation	1 LS	$2,000,000	$2,000,000
	ASDE Relocation	1 LS	$350,000	$350,000
	North Approach Glide Slope	1 LS	$600,000	$600,000
	South Approach Glide Slope	1 LS	$600,000	$600,000
	North Approach Localizer	1 LS	$600,000	$600,000
	South Approach Localizer	1 LS	$600,000	$600,000
	RVR Facilities	1 LS	$300,000	$300,000
	North Approach Markers (Outer)	1 LS	$175,000	$175,000
	South Approach Markers (Outer)	1 LS	$175,000	$175,000
	VASI	1 LS	$100,000	$100,000
	Approach Lighting - North Approach (ALSF-II)	1 LS	$1,500,000	$1,500,000
	Approach Lighting - South Approach (ALSF-II)	1 LS	$1,500,000	$1,500,000
	RADAR AND NAVAIDS SUBTOTAL			$8,500,000
	PROJECT TOTAL (Third Runway (Rounding to nearest $1 million)			$294,027,161 $294,000,000

[a] Source: P&D Aviation analysis. Many of the quantities and unit costs were taken from: HNTB Corporation, Seattle-Tacoma International Airport Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994.

[b] Abbreviation used in this table are:

CY = cubic yards
EA = each
LF = lineal feet
LS = lump sum
SY = square yards

TABLE 5-7
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 5: DEPENDENT MAXIMUM LENGTH [a]

Item No.	Item	Quantity [a]	1994 Dollars	
			Unit Cost	Estimated Cost
1	MOBILIZATION	1 LS	$15,000,000	$15,000,000
	RELOCATION ITEMS			
2	Southwest Suburban Miller Creek Interceptor	1 LS	$1,962,000	$1,962,000
3	Sewer Dist. Local Service Abandonment	1 LS	$38,000	$38,000
4	Seattle Water Dept. Watermain Protection	1 LS	$1,744,000	$1,744,000
5	Port of Seattle Sanitary Sewer Relocation	1 LS	$155,000	$155,000
6	Water Dist. No.20 Local Service Abandonment	1 LS	$16,900	$16,900
7	Water Dist. No.49 Local Service Abandonment	1 LS	$17,900	$17,900
8	Water Dist. No.125 Local Service Abandonment	1 LS	$15,000	$15,000
9	Wash. Natural Gas Local Service Abandonment	1 LS	$15,500	$15,500
10	Miller Creek	1 LS	$4,960,000	$4,960,000
	SUBTOTAL			$8,924,300
	DEMOLITION			
11	Demolition of Small Structures	335 EA	$2,500	$837,500
12	Demolition of Hanger	1 LS	$178,500	$178,500
13	Demolition of Airfield Pavement	8,500 SY	$4	$34,000
14	Demolition of Streets and Roads	51,000 SY	$2	$102,000
15	Demolition of Miscellaneous Utilities	1 LS	$250,000	$250,000
	SUBTOTAL			$1,402,000
	EARTHWORK			
16	Clearing and Grubbing	440 Acre	$500	$220,000
17	Erosion Control	1 LS	$150,000	$150,000
18	Common Excavation	3,100,000 CY	$3	$9,300,000
19	Borrow - Zone A	1,750,000 CY	$12	$21,000,000
20	Borrow - Zone B	8,650,000 CY	$8	$69,200,000
21	Borrow - Zone C	3,750,000 CY	$5	$18,750,000
	SUBTOTAL			$118,620,000
	DRAINAGE			
22	Conveyance System	1 LS	$6,893,000	$6,893,000
23	Flow Diversion	1 LS	$1,265,000	$1,265,000
24	Detention Ponds	1 LS	$20,456,000	$20,456,000
	SUBTOTAL			$28,614,000
	ON-SITE WATER			
25	Lateral Water Lines	3,000 LF	$36	$108,600
26	Trunk Water Lines	12,500 LF	$58	$725,000
27	Hydrants	13 EA	$380	$4,940
	SUBTOTAL			$838,540

TABLE 5-7
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 5: DE?ENDENT MAXIMUM LENGTH [a]
(Continued)

Item No.	Item	Quantity [a]	1994 Dollars Unit Cost	Estimated Cost
	ELECTRICAL			
28	Restoration of Sea-Tac Third Metering Point	1 LS	$523,000	$523,000
29	Rerouting of Main Telephone Service	1 LS	$600,000	$600,000
30	Modifications to Airfield Lighting in Control Tower	1 LS	$100,000	$100,000
31	Modifications to Stop Bar in Control Tower	1 LS	$250,000	$250,000
32	Rearrangement of Control Panels in Control Tower	1 LS	$75,000	$75,000
33	Vault Building	1 LS	$150,000	$150,000
34	Vault Building Generators	1 LS	$280,000	$280,000
35	Vault Building Regulators	1 LS	$320,000	$320,000
36	Electrical System	1 LS	$1,300,000	$1,300,000
37	Runway Lighting	1 LS	$3,570,000	$3,570,000
38	Taxiway Lighting	1 LS	$1,830,000	$1,830,000
39	Stop Bar/Hold Bar Lighting	1 LS	$316,000	$316,000
40	Airfield Signs	1 LS	$665,000	$665,000
41	Utility Work	1 LS	$400,000	$400,000
	SUBTOTAL			$10,379,000
	PAVING			
42	Runway Pavement	142,000 SY	$40	$5,680,000
43	Taxiway Pavement	206,000 SY	$40	$8,240,000
44	A.C.P. Runway Shoulder Pavement	15,000 Ton	$35	$525,000
45	A.C.P.Taxiway Shoulder Pavement	38,000 Ton	$35	$1,330,000
46	A.C.P.Blast Pad Pavement	3,500 Ton	$35	$122,500
47	A.C.P. Perimeter Road and Access Roads	14,000 Ton	$22	$308,000
48	P.C.C. Parking Apron Pavement	118,000 SY	$40	$4,720,000
49	A.C.P. Road and Street Pavement	30,000 SY	$30	$900,000
	SUBTOTAL			$21,825,500
	MISCELLANEOUS			
50	Bridge Structures	7,500 SF	$100	$750,000
51	Retaining Walls	67,800 SF	$45	$3,051,000
52	Fencing	21,000 LF	$10	$210,000
53	Seeding	450 Acre	$500	$225,000
54	Landscaping	20 Acre	$2,000	$40,000
	SUBTOTAL			$4,276,000
	RUNWAY SAFETY AREAS & CROSS TAXIWAYS			
55	600' Extension (See Table 5-10)	1 LS	$48,000,000	$48,000,000
	All Other Construction Items @ 20%			$51,600,000
	SUBTOTAL			$309,400,000
	Engineering and Contingencies @ 15%			$46,400,000
	TOTAL FOR THIRD RUNWAY CONSTRUCTION			$355,800,000

TABLE 5-7
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 5: DEPENDENT MAXIMUM LENGTH [a]
(Continued)

Item No.	Item	Quantity [a]	1994 Dollars	
			Unit Cost	Estimated Cost
	RADAR AND NAVAIDS			
	ASR Relocation	1 LS	$2,000,000	$2,000,000
	ASDE Relocation	1 LS	$350,000	$350,000
	North Approach Glide Slope	1 LS	$600,000	$600,000
	South Approach Glide Slope	1 LS	$600,000	$600,000
	North Approach Localizer	1 LS	$600,000	$600,000
	South Approach Localizer	1 LS	$600,000	$600,000
	RVR Facilities	1 LS	$300,000	$300,000
	North Approach Markers (Inner, Middle, Outer)	1 LS	$175,000	$175,000
	South Approach Markers	1 LS	$175,000	$175,000
	PAPI	1 LS	$100,000	$100,000
	Approach Lighting - North Approach (ALSF-II)	1 LS	$1,500,000	$1,500,000
	Approach Lighting - South Approach (ALSF-II)	1 LS	$1,000,000	$1,000,000
	RADAR AND NAVAIDS SUBTOTAL			$8,500,000
	PROJECT TOTAL (THIRD RUNWAY)			$364,300,000
	(Rounding to the nearest $1 Million)			$364,000,000

[a] Source: HNTB Corporation, Seattle-Tacoma International Airport Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994. Costs for Runway Safety Area improvements, extension of Runway 16L-34R and additional taxiway exits for Runway 16L-34R were added by P&D Aviation.

[b] Abbreviation used in this table are:

CY = cubic yards
EA = each
LF = lineal feet
LS = lump sum
SY = square yards

TABLE 5-8
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 6: INDEPENDENT - MAXIMUM LENGTH [a]

Item No.	Item	Quantity [b]	1994 Dollars	
			Unit Cost	Estimated Cost
1	MOBILIZATION	1 LS	$25,000,000	$25,000,000
	RELOCATION ITEMS			
2	Southwest Suburban Miller Creek Interceptor	1 LS	$1,962.00	$1,962.00
3	Sewer Dist. Local Service Abandonment	1 LS	$90,000	$90,000
4	Seattle Water Dept. Watermain Relocation	1 LS	$2,442,000	$2,442,000
5	Port of Seattle Sanitary Sewer Relocation	1 LS	$300,000	$300,000
6	Water Dist. No.20 Local Service Abandonment	1 LS	$25,000	$25,000
7	Water Dist. No.49 Local Service Abandonment	1 LS	$50,000	$50,000
8	Water Dist. No.125 Local Service Abandonment	1 LS	$20,000	$20,000
9	Wash. Natural Gas Local Service Abandonment	1 LS	$30,000	$30,000
10	Miller Creek	1 LS	$10,600,000	$10,600,000
11	Seattle City Lights Stripping	1 LS	$400,000	$400,000
12	Puget Power Distribution System	1 LS	$500,000	$500,000
13	6" Gas Line in relocated Des Moines Way	1 LS	$200,000	$200,000
	SUBTOTAL			$16,269,000
	DEMOLITION			
14	Demolition of Small Structures	585 EA	$2,500	$1,462,500
15	Demolition of Commerical Buildings	20 EA	$50,000	$1,000,000
16	Demolition of Hangar	1 LS	$178,500	$178,500
17	Demolition of Airfield Pavement	8,500 SY	$4	$34,000
18	Demolition of Streets and Roads	180,000 SY	$2	$360,000
19	Demolition of Miscellaneous Utilities	1 LS	$500,000	$500,000
	SUBTOTAL			$3,535,000
	EARTHWORK			
20	Clearing and Grubbing	700 Acre	$500	$350,000
21	Erosion Control	1 LS	$200,000	$200,000
22	Common Excavation	8,210,000 CY	$3	$24,630,000
23	Borrow - Zone A	2,000,000 CY	$12	$24,000,000
24	Borrow - Zone B	14,700,000 CY	$8	$117,600,000
25	Borrow - Zone C	6,300,000 CY	$5	$31,500,000
	SUBTOTAL			$198,280,000
	DRAINAGE			
26	Conveyance System	1 LS	$8,500,000	$8,500,000
27	Flow Diversion	1 LS	$1,265,000	$1,265,000
28	Detention Ponds	1 LS	$24,000,000	$24,000,000
	SUBTOTAL			$33,765,000
	ON-SITE WATER			
29	Lateral Water Lines	7,800 LF	$36	$280,800
30	Trunk Water Lines	14,100 LF	$58	$817,800
31	Hydrants	13 EA	$380	$4,940
	SUBTOTAL			$1,103,540

TABLE 5-8
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 6: INDEPENDENT - MAXIMUM LENGTH [a]
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars Unit Cost	1994 Dollars Estimated Cost
	ELECTRICAL			
32	Restoration of Sea-Tac Third Metering Point	1 LS	$523,000	$523,000
33	Rerouting of Main Telephone Service	1 LS	$600,000	$600,000
34	Modifications to Airfield Lighting in Control Tower	1 LS	$100,000	$100,000
35	Modifications to Stop Bar in Control Tower	1 LS	$250,000	$250,000
36	Rearrangement of Control Panels in Control Tower	1 LS	$75,000	$75,000
37	Vault Building	1 LS	$150,000	$150,000
38	Vault Building Generators	1 LS	$280,000	$280,000
39	Vault Building Regulators	1 LS	$320,000	$320,000
40	Electrical System	1 LS	$1,300,000	$1,300,000
41	Runway Lighting	1 LS	$3,570,000	$3,570,000
42	Taxiway Lighting	1 LS	$2,300,000	$2,300,000
43	Stop Bar/Hold Bar Lighting	1 LS	$316,000	$316,000
44	Airfield Signs	1 LS	$665,000	$665,000
45	Utility Work	1 LS	$400,000	$400,000
	SUBTOTAL			$10,849,000
	PAVING			
46	Runway Pavement	141,700 SY	$40	$5,668,000
47	Taxiway Pavement	312,000 SY	$40	$12,480,000
48	A.C.P. Runway Shoulder Pavement	13,520 Ton	$35	$473,200
49	A.C.P. Taxiway Shoulder Pavement	46,650 Ton	$35	$1,632,750
50	A.C.P. Blast Pad Pavement	5,000 Ton	$35	$175,000
51	A.C.P. Perimeter Road and Access Roads	16,000 Ton	$22	$352,000
52	P.C.C. Parking Apron Pavement	116,500 SY	$40	$4,660,000
53	A.C.P. Road and Street Pavement	20,000 SY	$30	$600,000
54	Relocated Des Moines Way	1 SY	$1,200,000	$1,200,000
55	Relocated SR 509 (see attachment)	1 SY	$19,000,000	$19,000,000
	SUBTOTAL			$46,240,950
	MISCELLANEOUS			
56	Bridge Structures	42,000 SF	$100	$4,200,000
57	Retaining Walls	120,000 SF	$45	$5,400,000
58	Fencing	23,000 LF	$10	$230,000
59	Seeding	500 Acre	$500	$250,000
60	Landscaping	20 Acre	$2,000	$40,000
	SUBTOTAL			$10,120,000
	RUNWAY SAFETY AREAS & CROSS TAXIWAYS			
61	600' Extension (see Table 5-10)	1 LS	$48,000,000	$48,000,000
	All Other Construction Items @ 30%			$117,948,747
	Subtotal			$511,111,237
	Engineering and Contingencies @ 15%			$76,666,686
	TOTAL FOR THIRD RUNWAY CONSTRUCTION			$587,777,923

TABLE 5-8
CONCEPTUAL CONSTRUCTION COST ESTIMATE
FOR OPTION 6: INDEPENDENT - MAXIMUM LENGTH [a]
(Continued)

Item No.	Item	Quantity [b]	1994 Dollars	
			Unit Cost	Estimated Cost
	RADAR AND NAVAIDS			
	ASR Relocation	1 LS	$2,000,000	$2,000,000
	ASDE Relocation	1 LS	$350,000	$350,000
	North Approach Glide Slope	1 LS	$600,000	$600,000
	South Approach Glide Slope	1 LS	$600,000	$600,000
	North Approach Localizer	1 LS	$600,000	$600,000
	South Approach Localizer	1 LS	$600,000	$600,000
	RVR Facilities	1 LS	$300,000	$300,000
	North Approach Markers (Outer)	1 LS	$175,000	$175,000
	South Approach Markers (Outer)	1 LS	$175,000	$175,000
	VASI	1 LS	$100,000	$100,000
	Approach Lighting - North Approach (ALSF-II)	1 LS	$1,500,000	$1,500,000
	Approach Lighting - South Approach (ALSF-II)	1 LS	$1,500,000	$1,500,000
	RADAR AND NAVAIDS SUBTOTAL			$8,500,000
	PROJECT TOTAL (Third Runway)			$596,277,923
	(Rounding to nearest $1 million)			$596,000,000

[a] Source: P&D Aviation analysis. Many of the quantities and unit costs were taken from: HNTB Corporation, Seattle-Tacoma International Airport Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994.

[b] Abbreviation used in this table are:

CY = cubic yards
EA = each
LF = lineal feet
LS = lump sum
SY = square yards

TABLE 5-9
CONCEPTUAL CONSTRUCTION COST ESTIMATE FOR RUNWAY SAFETY AREAS AND CROSS TAXIWAYS FOR OPTIONS 2, 3, 4B AND 4C

34R RSA AND CROSS TAXIWAYS	
Order of Magnitude Cost, for extending existing RSA by 465' to meet 1,000' requirement	$10,000,000 [a]
EXTENDING RUNWAY AND PARALLEL TAXIWAY BY 900'	
Mobilization	$1,000,000
Earthwork	$14,000,000
Paving	$3,100,000
Electrical	$500,000
Approach Lighting	$1,500,000
Glide Slope	$600,000
Other Items	$300,000
SUBTOTAL	$21,000,000
ADJUST FOR DUPLICATION OF ITEMS	
Earthwork	$3,000,000
Approach Lighting	$500,000
SUBTOTAL	$3,500,000
ADJUSTED PROJECT TOTAL	$27,500,000
16L RSA	
Order of Magnitude Cost for extending existing RSA to 700' from Rwy end	$2,200,000 [a]
16R AND 34L RSA's	
Order of Magnitude Cost for displacing threshold at north end and providing full RSA's at both ends	$6,000,000 [b]
PROJECT TOTAL	$36,000,000

[a] Source: Port of Seattle Runway 16L-34R Safety Area Expansion Study, December 2, 1992.
[b] Source: Reid Middleton Runway 34R Safety Area Expansion, Conceptual Design Report, August 1993.

Note: This project applies to Options 2, 3, 4B, and 4C.

TABLE 5-10
CONCEPTUAL CONSTRUCTION COST ESTIMATE FOR RUNWAY SAFETY AREAS AND CROSS TAXIWAYS FOR OPTIONS 4A, 5 AND 6

34R RSA AND CROSS TAXIWAYS	
Order of Magnitude Cost for extending existing RSA by 465' to meet 1,000' requirement	$10,000,000 [a]
EXTENDING RUNWAY AND PARALLEL TAXIWAY BY 600'	$1,000,000
Mobilization	$10,000,000
Earthwork	$2,400,000
Paving	$400,000
Electrical	$1,500,000
Approach Lighting	$600,000
Glide Slope	$300,000
Other Items	$16,200,000
SUBTOTAL	
ADJUST FOR DUPLICATION OF ITEMS	
Earthwork	$3,000,000
Approach Lighting	$500,000
SUBTOTAL	$3,500,000
ADJUSTED PROJECT TOTAL	$22,700,000
16L RSA	
Order of Magnitude Costs for extending existing RSA to 700' from Rwy end	$2,200,000 [A]
EXTENDING RSA ADDITIONAL 300'	$1,400,000
Earthwork (280,000 CY)	$350,000
Utility Relocations (City Lights Transmission)	$150,000
S. 154th St. Relocation Paving (4,444 SY)	$600,000
S. 154th St. Relocation Earthwork (125k CY)	$300,000
Other Items	$2,800,000
SUBTOTAL	
PROJECT TOTAL	$5,000,000
16R AND 34L RSA's	
Order of Magnitude Cost for extending existing RSA to meet 1,000' requirement	$20,000,000 [b]
PROJECT TOTAL	$45,000,000

[a] Source: Port of Seattle Runway 16L-34R Safety Area Expansion Study, December 2, 1992.
[b] Source: Reid Middleton Runway 34R Safety Area Expansion, Conceptual Design Report, August 1993.

Note: This project applies to Options 4A, 5, and 6.

BASIS OF CONSTRUCTION COST ESTIMATES

In developing the comparable costs for Options 2, 3, 4B, 4C and 6 the construction cost items identified in the Preliminary Engineering Report for Options 4A and 5 for the third runway, have been evaluated and the associated costs adjusted where appropriate. Costs were similarly developed and included herein for construction of additional cross field taxiways between existing runways, for improving the existing runway safety areas and for extending Runway 34R. The costs for the relocation of SR509, and for the construction of some other items unique to Option 6 were developed from field observations, review of as-built plans, utility atlas sheets and contract documents and interviews with several agencies having jurisdiction over the items involved.

Option 2 - Commuter-Close

Construct a 5,200-foot commuter runway with a 700-foot centerline separation with Runway 16R-34L, and associated cross-field taxiways.

- Mobilization. Mobilization cost is calculated based on a percentage of the overall cost of construction and consistent with the amounts used in the Preliminary Engineering Report.

- Demolition. This option negates the need to extend into non airport property. Demolition items are therefore only restricted to airport structures and pavement.

- Earthwork. The commuter runway elevation was set at the same elevation as Runway 16R-34L and the infield graded to a 2 percent slope (Available topography indicates the existing slope to be at about a 1 percent slope). This is a conservative approach as common excavation could be increased, in an effort to minimize borrow quantities, by steepening the slopes of the infield.

- Drainage. These costs were developed by performing some modifications to the existing conveyance system and adding two small detention ponds with corresponding flow diversion costs.

- On-Site Water. The hydrant system and related water lines would be significantly smaller than the systems laid out for Options 4A and 5 and calculated accordingly using the same unit costs.

- Electrical. There is no need to restore the Sea-Tac Third Metering Point as well as rerouting the telephone service. Otherwise all modifications to the Control Tower due to the additional runway as well as construction costs for a vault building and related equipment is left the same as those developed in the Preliminary Engineering Report for Options 4A and 5. The runway and taxiway lighting cost is reduced proportionately by its length, while signage is based on the number of airfield intersections. The difference in cost of fixtures between CAT I and CAT III runway lighting (edge lighting vs center flush mounted) is considered offset by the difference in amount of fixtures.

- Paving. The geometry of the runway, taxiways and related shoulders were calculated in order to determine the respective quantities. The unit costs were also adjusted to take into consideration the thinner structural section required by this option.

- Miscellaneous. No bridge structures, retaining walls, fencing or landscaping is anticipated.

- Runway Safety Area Improvements and Cross Taxiways. Costs were developed with the aid of past reports and earthwork, paving and electrical cost calculations. Costs were not included for possible golf course mitigation.

- Radar and Navaids. This option does not require an ILS system. PAPI is required as well as the relocations of the ASR and ASDE.

Option 3 - Commuter-Dependent

Construct a 5,200-foot commuter runway with a 1,700-foot centerline separation with Runway 16R-34L, and parallel taxiway, associated cross taxiways and overnight parking apron.

- Mobilization. Mobilization cost is calculated based on a percentage of the overall cost of construction and consistent with the amounts used in the Preliminary Engineering Report.

- Demolition. A lesser amount of property acquisition west of the airport would be required compared with Options 4A and 5. South 156th Street does not need to be relocated.

- Earthwork. The same elevations are assumed for the proposed runway and parallel taxiway as developed by HNTB for Options 5 and 4A. The embankment criteria are also similar. The area of grading however is somewhat smaller. Less excavation will be generated due to less construction to the south. The embankment requirement to the north will be reduced by having the threshold about 1,450 feet further south than Options 5 and 4A. Borrow zone A is calculated as being proportional to the area of paving. The reduction in embankment is shared proportionately between Zones B and C.

- Drainage. The reduced estimated cost for the conveyance system is based on the reduced area of improvements. The same costs are used for the flow diversions and detention ponds.

- On-Site Water. A modified version of the systems laid out for Options 4A and 5 was developed.

- Electrical. The Sea-Tac Third Metering Point and the rerouting of the telephone service is estimated to cost the same as for Option 4A. All modifications to the Control Tower due to the additional runway as well as construction costs for a vault building and related equipment is left the same as those developed by HNTB for Options 4A and 5. The runway and taxiway lighting cost is reduced proportionately by its length, while signage is based on the number of airfield intersections.

- Paving. The geometry of the runway, taxiways and related shoulders were calculated in order to determine the respective quantities. The unit cost of the runway pavement was adjusted to take into consideration the thinner structural section required by this option. The taxiways are proposed with a variety of structural sections and the unit cost selected accordingly.

- Miscellaneous. The same retaining walls have been incorporated in this option as with Options 5 and 4A.

- Runway Safety Area Improvements and Cross Taxiways. Costs were developed with the aid of past reports and earthwork, paving and electrical cost calculations. Costs were not included for possible golf course mitigation.

- Radar and Navaids. The third runway will be equipped with ILS, except a CAT I is assumed since it is a commuter runway, versus CAT III systems associated with air carrier runways (Options 4 - 6).

Option 4A: Programmatic Baseline

Construct a 7,000-foot runway with a 1,700-foot centerline separation with Runway 16R-34L, and parallel taxiway, associated cross taxiways and overnight parking apron. The north threshold of the new runway would be aligned with the ends of the existing runways.

Costs for this alternative were taken from Seattle-Tacoma International Airport Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994, by HNTB Corporation. Costs for the following items were added to the Preliminary Engineering Report cost estimate: Runway Safety Areas at all runway ends to meet FAA standards, extension of Runway 16L-34R by 600 feet and additional exit taxiways for Runway 16L-34R.

Option 4B - Programmatic Baseline Staggered

Construct a 7,000-foot runway with a 1,700-foot centerline separation with Runway 16R-34L, and parallel taxiway, associated cross taxiways and overnight parking apron. The north threshold of the new runway would be staggered 1,435 feet south of the north ends of the existing runways.

- Mobilization. The same mobilization cost is used as estimated by HNTB for Options 4A and 5.

- Demolition. A lesser amount of property acquisition west of the airport would be required compared with Options 4A and 5. South 156th St. does not need to be relocated. A reduced impact on the Southwest Suburban Miller Creek Interceptor is assumed. Reduced impact also occurs on Miller Creek.

- Earthwork. The same elevations are assumed for the proposed runway and parallel taxiway as developed by HNTB for Options 5 and 4A. The embankment criteria are also similar. The main difference is the staggering of the runway threshold by moving it south. This results in less fill required to the north. Borrow Zone A is assumed to be the same as for Option 4A. The reduction in embankment is shared proportionately between Zones B and C.

- Drainage. The drainage costs are

assumed to be similar to Option 4A.

- On-Site Water. These costs are assumed to be similar to Option 4A.

- Electrical. The Sea-Tac Third Metering Point and the rerouting of the telephone service is estimated to cost the same as for Option 5. All modifications to the Control Tower due to the additional runway as well as construction costs for a vault building and related equipment is left the same as those developed by HNTB for Options 4A and 5. The runway and taxiway lighting cost is reduced proportionately by its length, while signage is based on the number of airfield intersections.

- Paving. The geometry of the runway, taxiways and related shoulders were calculated in order to determine the respective quantities. The unit cost used were the same as those developed by HNTB in the Preliminary Engineering Report.

- Miscellaneous. A bridge is assumed for relocated South 156/154th Street.

- Runway Safety Area Improvements and Cross Taxiways. Costs were developed with the aid of past reports and earthwork, paving and electrical cost calculations. Costs were not included for possible golf course mitigation.

- Radar and Navaids. The third runway is assumed to be equipped for CAT III operations.

Option 4C: Staggered 7,500-foot Runway

Construct a 7,500-foot runway with a 1,700-foot centerline separation with Runway 16R-34L, and parallel taxiway, associated cross taxiways and overnight parking apron. The north Threshold of the new runway would be staggered 935 feet to the south of the north ends of the existing runways.

- Mobilization. The same mobilization cost is used as estimated by HNTB for Options 4A and 5.

- Demolition. A lesser amount of property acquisition west of the airport would be required compared with Options 4A and 5. A portion of South 156th St. must be relocated to provide the necessary Runway Safety Area at the north end of the new runway. The impact on the Southwest Suburban Miller Creek Interceptor and on Miller Creek would be the same as under Option 4B.

- Earthwork. The same elevations are assumed for the proposed runway and parallel taxiway as developed by HNTB for Options 5 and 4A. The embankment criteria are also similar. The main difference is the staggering of the runway threshold by moving it south 935 feet. This results in less fill required to the north, compared with Options 4A and 5 but less than under Option 4B.

- Drainage. The drainage conveyance system of Option 4C takes into account the additional 500 feet of runway compared with Option 4B. Flow diversion and detention ponds are the same as Option 4B.

- On-Site Water. These costs are assumed to be similar to Option 4A.

- Electrical. The Sea-Tac Third Metering Point and the rerouting of the telephone service is estimated to cost the same as for Option 5. All modifications to the Control Tower due to the additional runway as well as construction costs for a vault building and related equipment is left the same as those developed by HNTB for Options 4A and 5. The runway and taxiway lighting cost is reduced proportionately by its length, while signage is based on the number of airfield intersections.

- Paving. The geometry of the runway, taxiways and related shoulders were calculated in order to determine the respective quantities. The unit cost used were the same as those developed by HNTB in the Preliminary Engineering Report.

- Miscellaneous. A bridge over Miller Creek is assumed for relocated South 156/154th Street.

- Runway Safety Area Improvements and Cross Taxiways. Costs were developed with the aid of past reports and earthwork, paving and electrical cost calculations. Costs were not included for possible golf course mitigation.

- Radar and Navaids. The third runway is assumed to be equipped for CAT III operations.

Option 5: Dependent-Maximum Length

Construct an 8,500-foot runway with a 1,700-foot centerline separation with Runway 16R-34L, and parallel taxiway, associated cross taxiways and overnight parking apron. The threshold of the new runway would be aligned with the north ends of the existing runways.

Costs for this alternative were taken from Seattle-Tacoma International Airport Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994, by HNTB Corporation. Costs for the following items were added to the Preliminary Engineering Report cost estimate: Runway Safety Areas at all runway ends to meet FAA standards, extension of Runway 16L-34R by 600 feet and additional exit taxiways for Runway 16L-34R.

Option 6 - Independent - Maximum Length

Construct an 8,500-foot runway with a 2,500-foot centerline separation with Runway 16R-34L, and parallel taxiway, associated cross taxiways and overnight parking apron.

- Mobilization. Mobilization cost is calculated based on a percentage of the overall cost of construction and consistent with the amounts used in the Preliminary Engineering Report.

- Demolition. A new limit of property acquisition was developed based on the toe of the embankment and provisions for space made for a relocated Miller Creek and new wetlands east of Des Moines Way. To the north, property acquisition limits were affected by modifications to South 152nd Street at Des Moines.

Demolition costs have not been included however for properties within the north runway approach zone since this is considered an area which is likely to be purchased over time and not necessarily as a part of this project.

- Earthwork. The third runway elevations were set based on checking both the Part 77 surfaces and the longitudinal grade of the cross taxiways. The latter was found to control. Earthwork calculations were performed using the topography available assuming the same typical sections used in the Preliminary Engineering Report and assuming 2:1 slopes for the embankment. The raw fill volume was proportioned accordingly into the various zone types.

  Drainage. While the conveyance system was revised to reflect increased coverage and subareas, the flow diversion costs were left similar to those developed for Option 5. Detention pond A, located near SR509, is in an area of higher ground and pond C is bigger. Costs increased by 25 percent.

- On-Site Water. Revised system. Costs were increased accordingly.

- Electrical. Even though the points of connection are not likely to be from 176th Street, the Sea-Tac Third Metering Point and the rerouting of the telephone service is estimated to cost the same as for Option 5. The new connection points are expected to be near the proposed intersection of SR509 and Des Moines. All modifications to the Control Tower due to the additional runway as well as construction costs for a vault building and related equipment is left the same as those developed by HNTB for Options 4A and 5. The runway and taxiway lighting cost is reduced proportionately by its length, while signage is based on the number of airfield intersections.

- Paving. The geometry of the runway, taxiways and related shoulders were calculated in order to determine the respective quantities. The unit costs used were the same as those developed by HNTB in the Preliminary Engineering Report.

- SR509. Construction documents of SR509 were analyzed in obtaining a cost which used actual construction costs in 1978 inflated by using ENR Construction Cost Indexing for Seattle and making provisions for maintaining traffic flows and for additional earthwork required.

- Miscellaneous. A longer bridge is assumed for relocating South 156/154th Street through wetlands. Additional retaining walls used along Des Moines Way.

- Runway Safety Area Improvements and Cross Taxiways. Costs were developed with the aid of past reports and earthwork, paving and electrical cost calculations. Costs were not included for possible golf course mitigation.

- Radar and Navaids. Third runway is assumed to be equipped for CAT III operations.

ESTIMATED COSTS OF PROPERTY ACQUISITION AND RELOCATIONS

Costs of property acquisition and relocations for each airside option were estimated by Landrum & Brown (Table 5-11). Property acquisition costs were estimated from tax assessor's data. The total assessed value of each property affected was increased to market (sales) value using a ratio of assessed value to sales value of 20 percent. For residential relocation cost, the California Relocation Act maximum of $22,500 was used for each residence. Property acquisition costs include the property in the future Runway Protection Zones, at the ends of the new runway.

Total costs of each option are shown in Table 5-11 for a range in which the lower value is the sum of construction, acquisition and relocation costs, and the upper value is 15 percent greater to allow for contingencies. Development costs range from $79-$91 million for Option 2 to $773-$889 million for Option 6.

TABLE 5-11
TOTAL ESTIMATED COSTS OF CONSTRUCTION, PROPERTY ACQUISITION AND RELOCATIONS FOR AIRSIDE OPTIONS

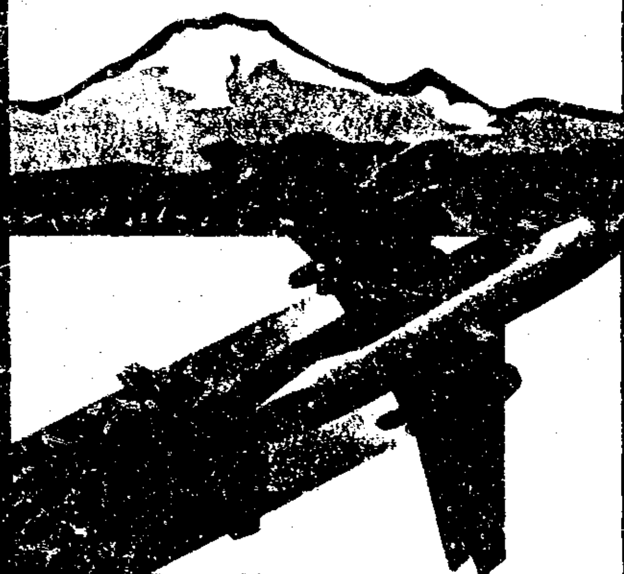
Airside Option	Cost in 1994 Dollars			
	Construction	Property Acquisition and Relocation [b]	Baseline Total	Baseline Plus 15% Contingency
Option 2: Commuter-Close	78,790,000	0	78,790,000	90,609,000
Option 3: Commuter-Dependent	255,038,000	41,531,000	296,569,000	341,054,000
Option 4A: Programmatic Baseline	346,800,000	64,135,000	410,935,000	472,575,000
Option 4B: Programmatic Baseline-Staggered	279,252,000	69,063,000	348,315,000	400,562,000
Option 4C: Staggered 7,500-foot Runway	294,027,000	75,365,000	369,392,000	424,801,000
Option 5: Dependent-Maximum Length	364,300,000	91,420,000	455,720,000	524,078,000
Option 6: Independent-Maximum Length	596,278,000	176,926,000	773,204,000	889,185,000

[a] Sources: Tables 5-2 through 5-10.

[b] Sources: Landrum & Brown, Letter dated August 15, 1994 to Port of Seattle, and revised cost estimates dated September 6, 1994. Costs include acquisition of property in the future Runway Protection Zones. Costs are based on Landrum & Brown's Cost Method 1, which reflects acquisition costs calculated as the sum of assessed value for each property affected, increased to market (sales) value, plus relocation costs. For residential relocation, the Uniform Relocation Act maximum of $22,500 per residence was used.

Attachment B
to Port Resolution 3245

TECHNICAL REPORT NO. 7A
TERMINAL OPTIONS EVALUATION



AIRPORT MASTER PLAN UPDATE

FOR

SEATTLE-TACOMA
INTERNATIONAL AIRPORT

P&D Aviation

TECHNICAL REPORT NO. 7A

TERMINAL OPTIONS EVALUATION

AIRPORT MASTER PLAN UPDATE FOR SEATTLE - TACOMA INTERNATIONAL AIRPORT

Prepared by:

P&D AVIATION

Prepared for:

The Port of Seattle

NOVEMBER 15, 1994
REVISED FEBRUARY 17, 1995

The P&D Aviation Team

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Landrum & Brown • Claire Barrett & Associates

TECHNICAL REPORT NO. 7A
TERMINAL OPTIONS EVALUATION

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Section 1
INTRODUCTION

SECTION 1
INTRODUCTION

BACKGROUND

The genesis of the Seattle-Tacoma International Airport (Sea-Tac) Master Plan Update was the "Comprehensive Planning Review" conducted in 1988. This ten month program evaluated the 1985 Airport Master Plan as well as several other related planning studies. The conclusions of this analysis, as well as the results of the Puget Sound Regional Council's 1988 Regional Airport System Plan, led the Port of Seattle Commissioners to formally acknowledge that Sea-Tac would reach runway saturation near the turn of the century. In response to this challenge, the Commissioners, and the Puget Sound Council of Governments (now Puget Sound Regional Council), entered into a three-year planning effort known as the "Flight Plan" project.

The purpose of Flight Plan was to develop a regional airport system, that would meet the aeronautical needs of the region to the year 2020 and beyond. In the third phase of Flight Plan, alternative airport systems were evaluated. In the end, the 39-member Puget Sound Regional Air Transportation Committee (PSATC) chose as its preferred alternative the construction of a new runway at Sea-Tac and development of two reliever satellite airports. This ultimately led to the adoption by the Port of Resolution No. 3125, which directed that a new runway for Sea-Tac be examined in detail. Subsequently, a planning team led by P&D Aviation was selected for an Airport Master Plan Update and began work on December 3, 1993.

PROJECT OBJECTIVES

The overall objective of this project is to "prepare a comprehensive Airport Master Plan [Update] for the airside, terminal, and landside facilities needed at Sea-Tac to meet air travel demand to the year 2020 and beyond." Specifically, the master plan update study must fulfill each of the relevant objectives stated in Port Resolution 3125. These are as follows:

- Design a mechanism and process to promote [land use and community] compatibility through improved coordination, communication and involvement.
- In addition to the third runway studies, include a reconsideration of a fast rail system together with diversion of all cargo carriers.
- Fully explore the impacts of peak period pricing and other demand management techniques.
- Explore land acquisition and redevelopment to compatible uses.
- Attenuate airport noise through the use of berms and barriers.
- Promote aggressive on-airport emission reductions.
- Promote regional transit and reduction in use of automobiles.
- Improve the aesthetic appearance of the airport boundary.
- Develop a comprehensive stormwater management plan.

SCOPE OF STUDY

The first assignment of the Airport Master Plan Update study was the development of a detailed scope of work designed to fulfill the project objectives. The final scope of work, prepared on December 2, 1993, contains forty-five work tasks. The detailed scope of work is contained in Technical Report No. 1, Scope of Work.

The primary issues addressed in the scope of work include:

- ***Forecasts.*** The master plan update and related Environmental Impact Statement and FAA Part 150 Study must be based on a reliable and generally accepted set of forecasts.
- ***Airside Evaluations.*** An important component of the study is the analysis of a new dependent parallel (minimum runway separation of 2,500 feet) runway. The Airspace Update Study and the FAA Airport Capacity Enhancement Task Force both determined that a substantial capacity improvement can be achieved by constructing a new parallel dependent runway.
- ***Terminal Evaluations.*** A key issue in the terminal development is to achieve a balance between added terminal capacity and additions to airside and landside capacity. Curb frontage, roadway and automobile parking are critical components.
- ***Multi-Modal Evaluations.*** There is considerable interest at the Federal, State and local levels of government to development inter-modal transportation systems that are economically efficient and improve air quality and reduce airport congestion.
- ***Financial Planning.*** A comprehensive financial plan and implementation strategy must be developed to maximize the Port's ability to fund needed capital improvement projects.
- ***Part 150 Issues.*** The Noise Mediation Agreement resulted in substantial noise reduction programs, now being implemented. This agreement plays a vital role in existing and future planning efforts at the airport and has been incorporated into the recently completed FAR Part 150 Study 1993 Amendments. However, those amendments did not consider the implementation of a third runway, and thus the Noise Exposure Maps that were generated in the study will require updating to consider the third runway option.
- ***Process.*** Public involvement in the planning process is an important element of the Airport Master Plan Update. The public involvement program developed for the study allows for better understanding of the sentiments in the surrounding communities and constructively involves the public in focused workshops for the project. Elements of the public involvement program include workshops, public opinion surveys, and dissemination of project information through newsletters and technical reports prepared during the study.

STUDY SCHEDULE AND DOCUMENTATION

The Airport Master Plan Update is scheduled to be completed in December 1995. During 1994, forecasts were prepared, facility requirements were developed and individual options for accommodating projected needs were evaluated. In 1995, option "packages" are being developed and evaluated and concurrently an Environmental Impact Statement is being prepared.

The following documents are scheduled to be delivered to the Port during the course of the project:

- Technical Report No. 1, Final Work Scope
- Technical Report No. 2A, Market Research Results
- Project Brochure
- Technical Report No. 2B, Program Development Report
- Technical Report No. 3, Planning History and Study Relationships
- Technical Report No. 4, Facilities Inventory
- Technical Report No. 5A, Preliminary Forecast Report
- Technical Report No. 5, Final Forecast Report
- Technical Report No. 6, Preliminary Airside Report
- Technical Report No. 7A, Terminal Options Evaluation Report
- Technical Report No. 7B, Other Facilities Requirements and Options
- Demand Management Report
- Technical Report No. 8, "Package" Evaluations Report
- Technical Report No. 9, Draft of Master Plan Update Final Report
- Airport Layout Plan Set
- Final Report

PLANNING TEAM COMPOSITION

The Master Planning Team led by P&D Aviation consists of ten firms which are listed below with their key responsibilities:

- ***P&D Aviation*** - Project Management, Forecasts and Facility Requirements, Airside Planning, Ground Access Planning, Overall Airport Master Planning and Coordination
- ***O'Neill & Company*** - Public Involvement
- ***Parsons Brinckerhoff*** - Multi-Modal Evaluations
- ***Thompson Consultants International*** - Terminal Planning
- ***Barnard Dunkelberg & Company*** - Part 150 Integration
- ***Bark & Associates*** - Financial Planning
- ***Murase Associates*** - Airport Beautification, Landscape Architecture
- ***Mestre Greve Associates*** - Aircraft Noise Impacts
- ***Landrum & Brown*** - Terminal Concepts
- ***Claire Barrett & Associates*** - Demand Management

CONTENTS OF THIS REPORT

The remainder of this report is organized in the following sections:

- Section 5 Development and Evaluation of Terminal Options
- Section 6 Implementation Analysis
- Section 7 Terminal Ground Access and Surface Transportation Element

Section 2
EXECUTIVE SUMMARY

SECTION 2
EXECUTIVE SUMMARY

INTRODUCTION

The development and evaluation of Terminal Options in support of the Sea-Tac Master Plan Update are predicated on studies prepared in 1992 as a part of the Terminal Development Program (TDP) which was, in turn, based on the previous Master Plan Update completed in 1985. The fundamental requirement of this element of the Master Plan Update is that terminal facilities should be developed in a manner which achieve a functional equilibrium with the landside and airside facilities at the airport.

To accomplish this terminal planning component the following methodology was used:

- **Terminal Programming**: Planning criteria were developed based on the demand capacity analysis of the TDP and were updated to reflect the revised Master Plan activity forecast. These planning criteria were used to define the extent of terminal facilities needed to meet demand through the year 2020.

- **Development of Options**: Terminal facilities inventory and options developed in the TDP were updated to form new terminal options. The planning criteria were also re-examined in conjunction with POS staff, airlines, and other terminal users' requirements to determine whether changes or adjustments which would influence the plans were warranted. Terminal plans which addressed both interim/short range and projected long range requirements were developed for evaluation.

- **Evaluation of Options**: The evaluation criteria defined in the Terminal Development Program were revisited with POS staff to determine continued applicability. Adjustments were made as necessary including redefining or modifying criteria as appropriate. An evaluation matrix or other form of evaluation process was identified as the framework used for this evaluation. The benefits and deficiencies of each terminal option were identified and compared. An important component of the evaluation was the ability of an option to expand incrementally to adjust to the phases of airside and landside capacity increases which are contemplated.

- **Refinement of Options**: Following the terminal development and evaluation process the recommended terminal plans were further refined to incorporate additional information or elements of other plans which improved them. This process also integrated additional programs developed concurrently which had an influence on the plan. The scale and functional relationships of major terminal components also underwent some modification. Coordination with appropriate parties, including airlines and other terminal users, regarding their input and review was completed during the refinement process.

- **Documentation of Options**: Because many of the prior tasks focus upon terminal-specific solutions, the recommended plans' relationship to the other major components of the Master Plan Update was considered.

To some extent this was carried out through other prior tasks; however, the documentation of the results was included in this Task. This required coordination with other disciplines and led to some further adjustments and refinements. Results are documented both in narrative and graphic form for inclusion in the Master Plan Update report.

In a departure from the original methodology, over ten terminal options were developed for evaluation. These options addressed planning opportunities to the north, center and south of the existing terminal area. Upon exhaustive review and evaluation, the leading option from each development area was selected for additional refinement. This report provides a summary of the terminal programming, concept development, evaluation, and refinement tasks. It is anticipated that the three preferred terminal options presented in this report will be further evaluated and refined to arrive at a single recommended terminal concept.

As a point of departure for the planning process, the Port of Seattle has adopted the view that the terminal component of the Master Plan must provide sufficient flexibility to adapt to changes in airline service, passenger behavior, regulatory requirements, and other conditions which may develop in the future. Expanded terminal facilities must be capable of simultaneously satisfying the needs of hubbing, non-hubbing, commuter, and international carriers. Opportunities for continued expansion of the existing facilities are limited and expensive, and development of any new facilities must be justified on a logical and cost-effective basis prior to implementation.

Perhaps the single most significant point of new information to emerge since the TDP was completed involves the landside component of the Master Plan and specifically the roadway serving the terminal curb. An analysis of the terminal roadway system as a part of the Master Plan Update has resulted in the determination that the existing enplaning/deplaning terminal curbs are insufficient to accommodate peak forecast demand for the year 2020.

This determination considers both the configuration of the terminal curb as well as the width and the number of lanes. Some of the access/egress ramps are also at or near capacity during peak periods. While there are ways of potentially expanding or modifying the terminal curbfront, the fundamental problem which remains is that the configuration of the terminal curb has evolved from the original terminal plan in which traffic turns at the midpoint of the terminal roadway. This not only creates a point of congestion at the turn itself, but limits the extent to which the terminal curb may be extended in a linear fashion. The adjacency of the terminal building to the parking structure is an additional physical constraint to expanding the width of the terminal curbfront.

Because of the conclusions of the Master Plan's landside analysis, a further major expansion of the existing curbfront sufficient to accommodate the forecast demand in the year 2020 appears to be impractical. Correspondingly, the existing terminal should not be expanded further in the absence of a long-term solution to its existing curbfront problem. This conclusion marks an important departure from the premise upon which the concepts of the 1985 Master Plan and 1992 Terminal Development Plan were based.

In addition, the terminal airside development may be impacted by, and in turn impact, the overall airside and landside improvements yet to be identified in the Master Plan Update. If a significant increase in aircraft gates are provided in the existing terminal area, the development of a second east parallel taxiway will likely be required to insure unconstrained movement of aircraft to and from the runway. Likewise, any facilities displaced by the construction of additional terminal facilities will likely require relocation elsewhere on the airport.

TERMINAL FACILITY REQUIREMENTS

A facilities program has been developed as a part of the master plan in order to quantify the terminal and terminal-related facilities required to accommodate forecast passenger activity well into the next century. The forecasts prepared previously as a part of Technical Report No. 5 have been used as the basis for estimating these future facility needs. These forecasts suggest passenger activity growing from 18.8 million annual passengers (MAP) in 1993 to 23.8 MAP in 2000 and 38.2 MAP in 2020.

This terminal facilities program also anticipates the physical requirements of the terminal concepts being considered in the Master Plan. Depending on the concept being considered, the facilities program may alternatively be required to accommodate passenger traffic within one or several unit terminals at the airport. Because the facility requirements of consolidated vs. multiple terminals may be significantly different, some components of the facility program have been evaluated under several differing scenarios to address this possibility. The terminal program for the single terminal option is predicated on a continuation of the central terminal concept proposed in the 1985 Master Plan in which the existing terminal is expanded to serve all passenger groups at the airport and the international arrivals facilities are relocated to an expansion of the terminal along Concourse A. The multiple terminal option includes consideration of relocating the Federal Inspection Services (FIS) and all new gates to the new terminal facilities as well as approximately 30% of the forecast annual passenger demand.

The need for aircraft parking positions (gates) is a fundamental criteria in the planning of future terminal facilities. Aircraft gate requirements not only determine the number of aircraft which may be loading and unloading simultaneously, but in large part define the configuration of the terminal, the building area required, and the ability of the airport to accommodate changes in the types of aircraft and airlines serving the airport.

The aircraft gate forecast combines various parameters and projects gate requirements on the basis that gate utilization will steadily increase from its current (1994) level of approximately 210,000 passengers/gate/year to achieve a target utilization of somewhat greater than 270,000 passengers/gate/year by the year 2010. After this target increase of 29% is achieved, further increases in utilization will be more difficult to achieve and have been forecast to increase to 320,000 passengers/gate/year by the year 2020, a 52% increase from existing. These forecasts result in the need to provide an increase in ramp frontage from the existing 75 gates to over 100 gates by the year 2020.

In order to judge the impact of the program requirements on the need for new facilities over the forecast timeframe, the forecast of individual terminal elements have been combined to estimate total incremental (new) building area required under both the consolidated terminal scenario and the new unit terminal scenario. The major building elements included in this estimate include the forecasts of concourse, ticketing lobby, baggage claim area, baggage handling areas, and international arrivals processing areas. The forecasts of these individual elements are presented in subsequent sections as Tables 4-1 to 4-15. While preliminary, these estimates suggest a need to add between 500,000 and 650,000 square feet of new terminal area to the existing 1.9 million square foot terminal complex within ten years to support the forecast levels of passengers and aircraft gates. By the year 2020 the existing terminal facilities will need to expand by 1.0 to 1.5 million square feet of new terminal area to support the forecast level of activity.

DEVELOPMENT OF OPTIONS

Both the landside and the airside compatibility issues have a material impact upon the direction that future terminal development will take. As a starting point, a number of terminal airside concepts were developed and reviewed. These airside options outlined the gate development opportunities of a future parallel east taxiway and considered the preservation, partial, and complete replacement of some existing terminal gate facilities. The result of this review was the development of a series of planning assumptions and the organization of terminal landside concepts into three general development areas to the north, south and center of the existing terminal area.

The site to the south of the main terminal is the largest in terms of total area of the three terminal development areas investigated. The site itself is as deep as the entire existing terminal complex and offers the greatest expansion potential of any option. A number of airline maintenance areas would likely require removal or relocation under most of these development options. In addition, the commercial area immediately to the southeast of Concourse A could need to be acquired to provide adequate sufficient area to complete the terminal landside development. South access to the airport needs to be considered in any of these options. Five terminal development options for the south side site were investigated.

The site to the East of the existing main parking structure offers the most central location for supplementary landside facilities. Because of its limited size and configuration, only one option for this site was investigated.

Upon resolution of the requirements for terminal facilities, development opportunities for additional or replacement commercial facilities could then be considered in either of these areas.

A site to the north of existing terminal offers a smaller, but in some ways less constrained location than the south for the development of an expanded terminal/landside interface. This location would provide greater proximity to the main airport entrance, and could be developed without additional property acquisition. Complete development in this area would, however, require the relocation of a significant number of facilities including the main airport entrance road, the airport fire-fighting and rescue (ARFF) facility, the USPS facility and a number of cargo and flight kitchen facilities prior to construction of the north unit terminal. Four options were investigated for this location.

The evaluation of ten preliminary terminal concepts were generated from the three development areas above and combined both subjective and objective elements. Plans of these ten preliminary concepts are presented in subsequent sections as Figures 5-1 to 5-10.

To narrow the terminal development concepts to a manageable and reasonable number, a series of sixteen evaluation criteria were established. These criteria were separated into landside, terminal, airside, and cost categories. The evaluation criteria used in comparing and evaluating the terminal options are defined below.

Airside Criteria

- **Capacity:** Ability to provide sufficient aircraft parking positions to meet or exceed forecast demand.

- **Flexibility:** Ability of the terminal concept to accommodate the number and mix of aircraft parking positions as defined in the forecast and facilitate cross-utilization by different airlines.

- **Access:** Ability of the terminal concept to facilitate unconstrained aircraft access between the terminal area and the taxiway system.

- **Maneuverability:** Ability of the concept to facilitate aircraft maneuvering within the immediate terminal and aircraft parking areas.

Terminal Criteria

- **Balance:** The capability of the terminal concept to conveniently combine sufficient airside and landside capacity and adapt to the functional requirements of each as defined in the Master Plan.

- **Capacity:** Ability of the concept to accommodate the forecast program in an economical, efficient manner with consideration of existing functional and architectural conditions.

- **Convenience:** The ability of the concept to facilitate passenger convenience and enhance the travel experience by optimizing orientation, walking distances, level changes, accessibility , amenities, and connecting times.

- **Constructability:** Ability of the concept to be implemented in a cost effective, incremental fashion. Constructability includes consideration of property relocations and acquisitions which may be required, as well as staging areas and construction access. Equally important is the ability to maintain ongoing operations through construction with a minimum of disruption.

- **Flexibility:** Ability of airport and tenants to adapt to changing marketing and operating requirements with minimal changes to the terminal.

Landside Criteria

- **Capacity:** Ability of the landside development concept to provide sufficient landside area convenient to the terminal to accommodate forecast requirements with minimal or no congestion (level of service 'C' or better).

- **Simplicity:** Ability of the landside concept to provide rapid driver orientation and ease of movement to/from all landside elements.

- **Constructability:** The ability of the landside concept to maintain ongoing operations through various construction phases with minimal disruption and the degree to which it does (or does not) rely on uncertain future easements, acquisitions, and facility relocations.

- **Compatibility:** Compatibility of the landside concept with existing regional access points and flows as well as with future anticipated regional transportation networks and terminal area interface points.

Cost Criteria

- **New Construction:** Anticipated construction cost premiums associated with terminal, landside or airside options including required temporary or interim structures.

- **Special Systems:** Implied capital and operating costs resulting from the development of mechanical systems for the intra- and inter-terminal movement of people or baggage.

- **Facility Relocations:** Costs of relocating/replacing existing facilities, property acquisition, and other site preparation projects prior to construction.

Perhaps the single most important factor to emerge during the evaluation process was the need to incorporate flexibility and adaptability to change as operational requirements at Sea-Tac continue to evolve in the future. In addition to operational flexibility, the need to provide for incremental growth in the terminal is important and to accomplish this the terminal should be designed to accommodate a wide range of aircraft types and sizes in the future. Finally, the potential for future enhancement of the architectural character of the airport as the major international and domestic gateway to the northwestern United States was an important point of consideration.

The preliminary evaluation process was performed on each of the conceptual terminal options, and the three highest scoring development scenarios from each group were identified for further refinement and evaluation. Selected conceptual terminal development scenarios have been based on Option A-2, Option B, and a hybrid of Options C-2, 3 and 4. These options are presented as Figures 2-1 to 2-3 and summarized in Table 2-1.

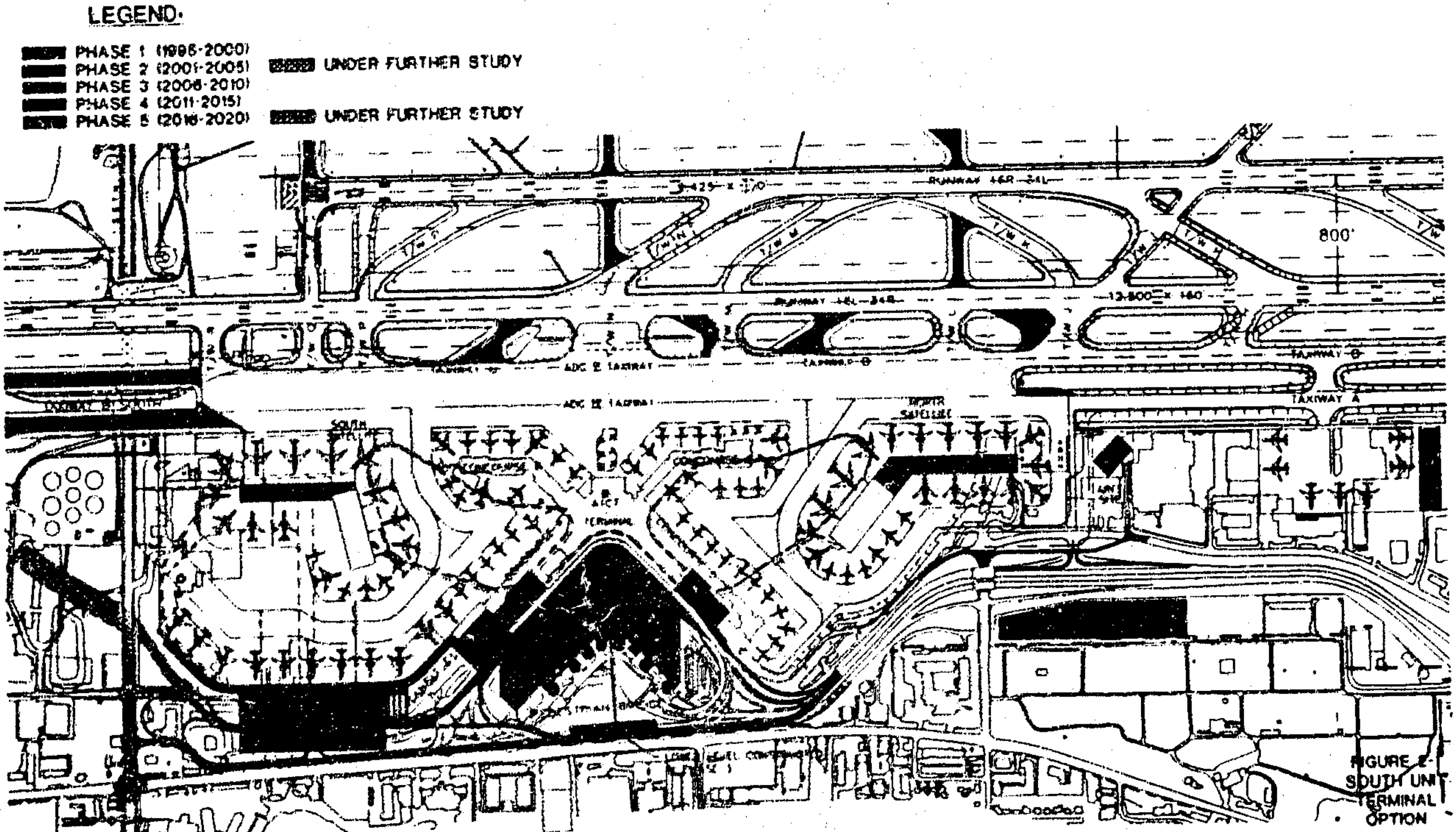
The three shortlisted Options for the Sea-Tac Master Plan Update reflect a number of options which may be appropriate to meet differing operational scenarios which develop in the future. These options are not necessarily mutually exclusive of one another, and may be combined as functional requirements continue to evolve. For example, development of terminal facilities to the south should not necessarily preclude the development of terminal facilities to the north should this prove practical or desirable for additional capacity or functional improvement.

In summary, the key to a successful terminal plan lies in achieving a balance between the airside, terminal and landside elements and to allow these elements to be expanded incrementally in the most cost effective and operationally efficient manner possible and enhance both airline operations, and the passenger convenience.

NEXT STEPS

The next step in the terminal evaluation process will be to consider the differences in environmental impact between the three options, and to assess the effect of each option on the ability to provide other qualitative and quantitative airport improvements. These other needs include but are not limited to cargo, aircraft maintenance, fire and rescue, police, air traffic control, and general aviation.

Once these collateral impacts are identified and resolved, the three terminal concepts will be further refined into one, hybrid alternative which incorporates the most desirable features of each into a single, unified framework for future development.


LEGEND:
PHASE 1 (1996-2000)
PHASE 2 (2001-2005)
PHASE 3 (2006-2010)
PHASE 4 (2011-2015)
PHASE 5 (2016-2020)
UNDER FURTHER STUDY
UNDER FURTHER STUDY
RUNWAY 16R-34L
RUNWAY 16L-34R
13,800' x 160'
800'
TAXIWAY B
TAXIWAY A
ADG III TAXIWAY
NORTH SATELLITE
SOUTH SATELLITE
CONCOURSE
TERMINAL
MAIN TERMINAL
FIGURE 2-
SOUTH UNIT
TERMINAL
OPTION

2-7

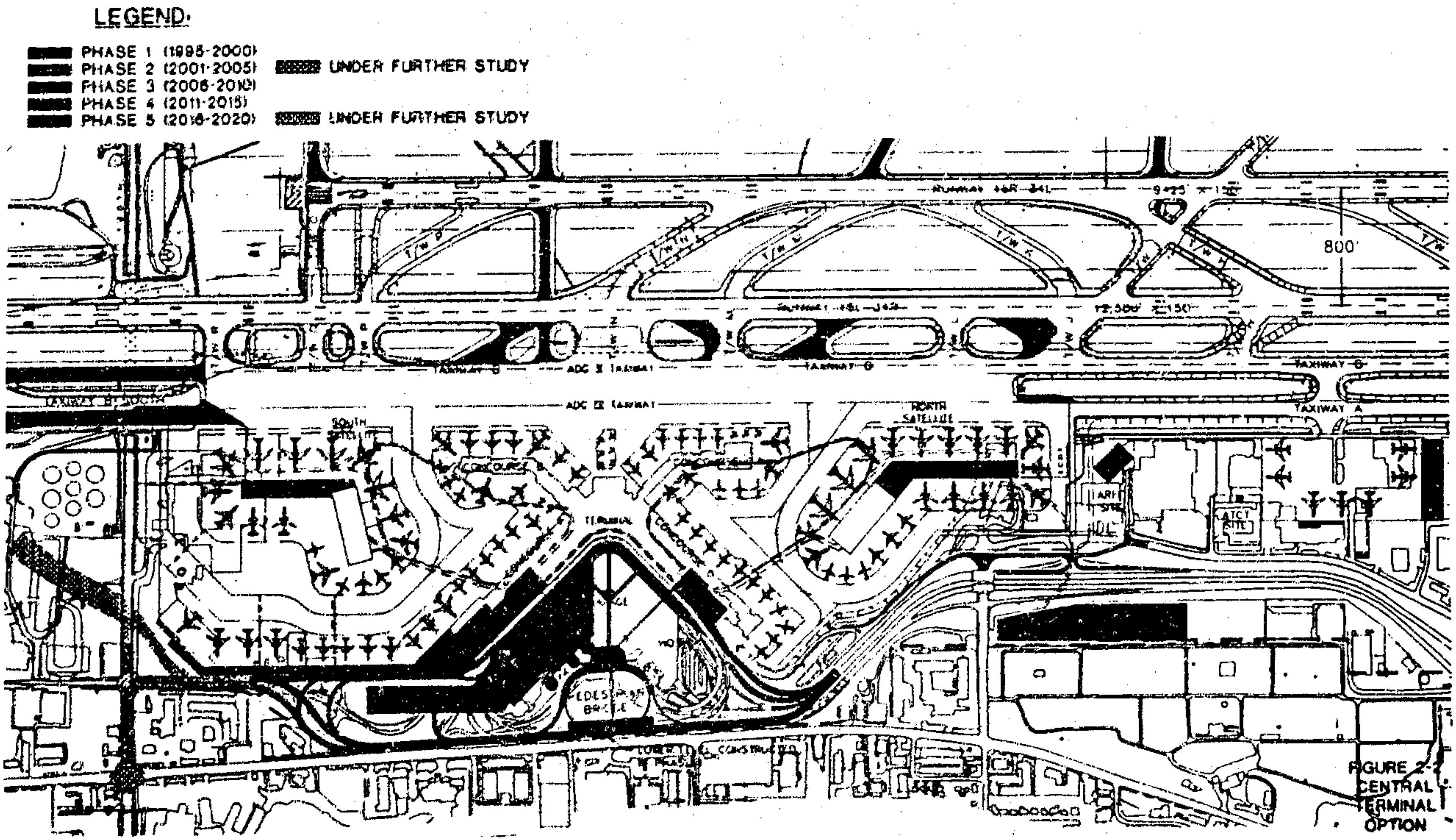


FIGURE 2-2
CENTRAL TERMINAL OPTION

LEGEND

PHASE 1 (1995-2000)
PHASE 2 (2001-2005)
PHASE 3 (2006-2010)
PHASE 4 (2011-2015)
PHASE 5 (2016-2020)

UNDER FURTHER STUDY
UNDER FURTHER STUDY

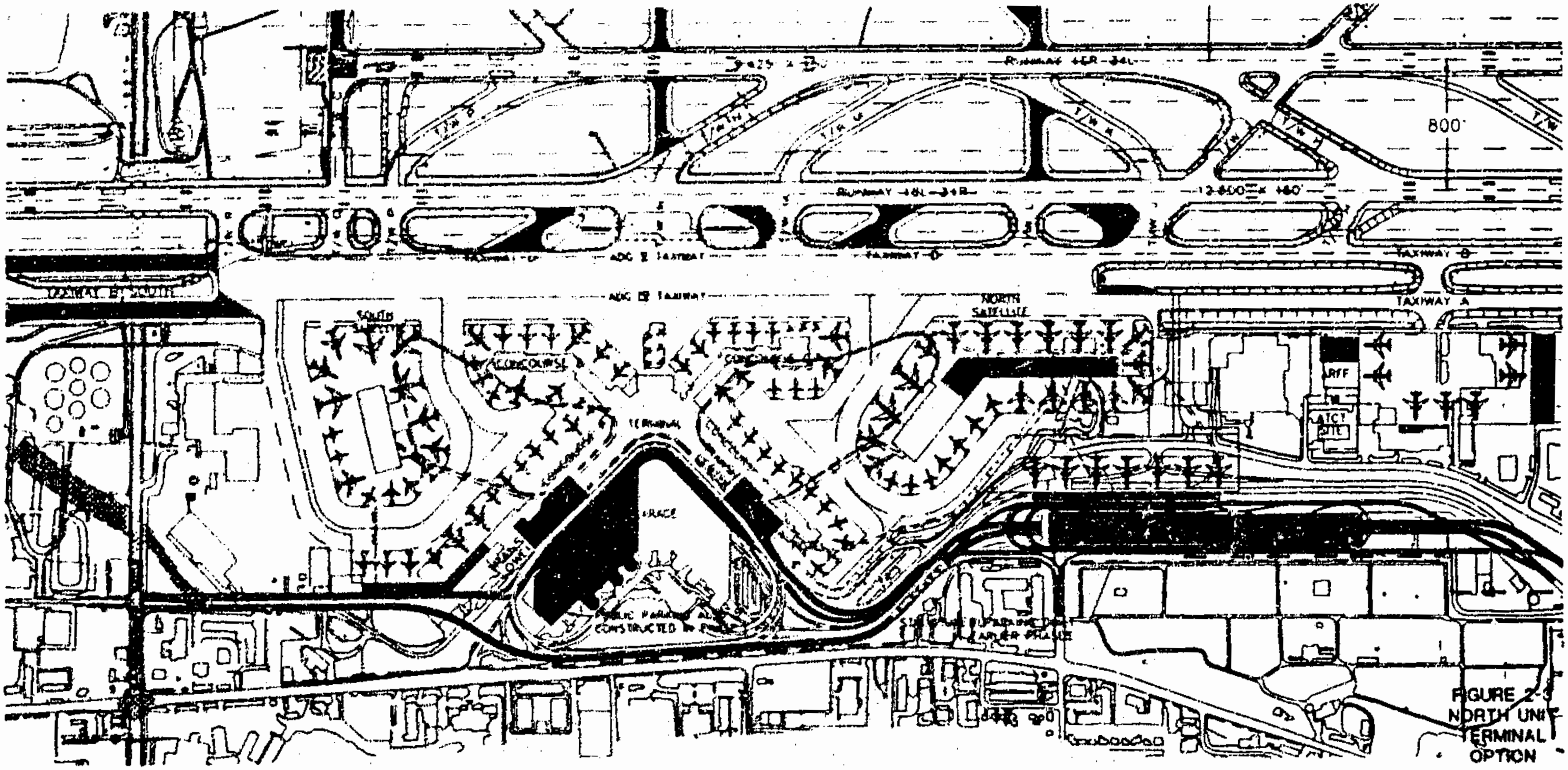


FIGURE 2-3
NORTH UNIT TERMINAL OPTION

TABLE 2-1
Terminal Concept Summary

	Existing 1994	Program 2020	Terminal Option South	Terminal Option Central	Terminal Option North	Units
AIRSIDE						
Gates	90.6	120.6	121.0	121.4	120.1	NBEGate
% widebody	42%	50%	56%	49%	49%	
Flexibility			best	better	good	
TERMINAL						
Terminal Area [1]						
centralized	1,900,000	2,980,000		3,400,000		SF
new unit terminal		3,433,000	3,900,000		3,700,000	SF
Balance			best	good	better	
LANDSIDE						
Curb Frontage	8,446	13,000	11,000	8,000	13,100	LF
Public Parking [2]	9,400	14,850	14,850	14,850	14,850	Spaces
Level of Service	C	C	C	D/E	C	L.O.S.
OVERALL RANK			1	3	2	

[1] Terminal options include extensive tunnels, mezzanines, and transit facilities unique to each concept and which were not included in the terminal program estimates.

[2] From 'Airport Parking System - Long Range Analysis' P&D Aviation, January 1995

Section 3
TERMINAL PLANNING OBJECTIVES

SECTION 3
TERMINAL PLANNING OBJECTIVES

INTRODUCTION

The development and evaluation of terminal development options for the Sea-Tac Master Plan Update are predicated on studies prepared in 1992 as a part of the Terminal Development Program (TDP) which was, in turn, based on the previous Master Plan Update completed in 1985. The fundamental requirement of this element of the Master Plan is that terminal facilities should be developed to achieve and maintain long-term balance with the landside and airside components of the Airport. As defined in the project workscope, three terminal development options are to be considered and evaluated. These options are to focus on the compatibility of the terminal with landside and airside requirements in satisfying the future needs of the Airport. The focus of this master plan terminal development effort will therefore be to identify a broad range of functional and operational improvements required within the terminal area, rather than detail specific improvements to the terminal itself.

Like many airports, Sea-Tac has seen dramatic change over the past several years, with many of these changes occurring since the TDP was completed in early 1992. The TDP identified three important conditions which were expected to have a dramatic impact upon Sea-Tac's future:

- *The uniform and continuing growth of both domestic and international traffic (with international traffic growth approximately 50% greater than domestic).*

  While domestic traffic has continued to grow, international traffic has declined since the TDP was completed and is now approximately half what it was when the TDP was completed. The introduction of longer range international aircraft such as the B747-400 has permitted cities such as Chicago and San Francisco to absorb much of the growth in international traffic that might otherwise have occurred at Seattle.

- *The hubbing of three major carriers with the possibility of a fourth major carrier hub in the future.*

  While domestic traffic growth has remained strong at Sea-Tac, the decline in international traffic has contributed to a leveling-off of east-west hubbing activity. Sea-Tac remains a strong north/south connecting hub. It is unclear as to whether the recent entrance of low-cost, short-haul airlines such as Southwest Airlines to the Sea-Tac market may lead to further changes in the competitive environment at the Airport.

- *The realization that the maximum airside capacity of Sea-Tac as well as its terminal and landside facilities may be reached in the relatively near future.*

  The scope of the TDP was focused on the terminal itself and did not include analysis of either landside or airside capacities, or the constraints these elements might place on future terminal requirements. Recent studies as a part of the Master Plan Update have revealed that landside (primarily curbside and terminal roadway) capacity limitations at peak periods may pose a more immediate constraint to continued development of the existing terminal than was originally considered during the TDP.

The foregoing points highlight only some of the elements which may continue to shape the future of Sea-Tac. The key to achieving the most appropriate terminal planning solution lies in maintaining a long-term balanced capacity between the airside, terminal, and landside elements.

BACKGROUND

Many of the conditions limiting the future planning of the terminal facilities at Sea-Tac may be found in the origins of the airport when two airlines, Northwest and United, served the Airport in 1949. The original terminal provided ground level loading of aircraft and was developed in the apex of two intersecting runways, long since abandoned. This runway configuration lead to the 90° configuration of the terminal, its roadway system, and its resulting impact on landside access/egress.

The original terminal facilities, including support systems and landside/airside interfaces have been modified many times during the past several decades, but all of these essentially built upon the 1949 terminal landside plan. The terminal modification projects of 1959, 1961, 1964-67, and 1970-73 gave the terminal its present size and form including its Satellite Transit System (STS), satellites, roadways and parking structure. While these developments responded to the logical and incremental growth in demand for gate capacity at the terminal, they did not necessarily balance this growth with corresponding airside and landside capacity. Further expansions of the main terminal in 1983 and 1986 responded to the demand for improved international facilities and ticketing, to the point where leasable space in the terminal is virtually fully subscribed and most facilities are now occupied. The only notable exception to this is the 'esplanade' area between the terminal and concourses. The most recent addition to the terminal was the extension of Concourse D, and the Gateway 2000 redevelopment of Concourses B, and C in 1992.

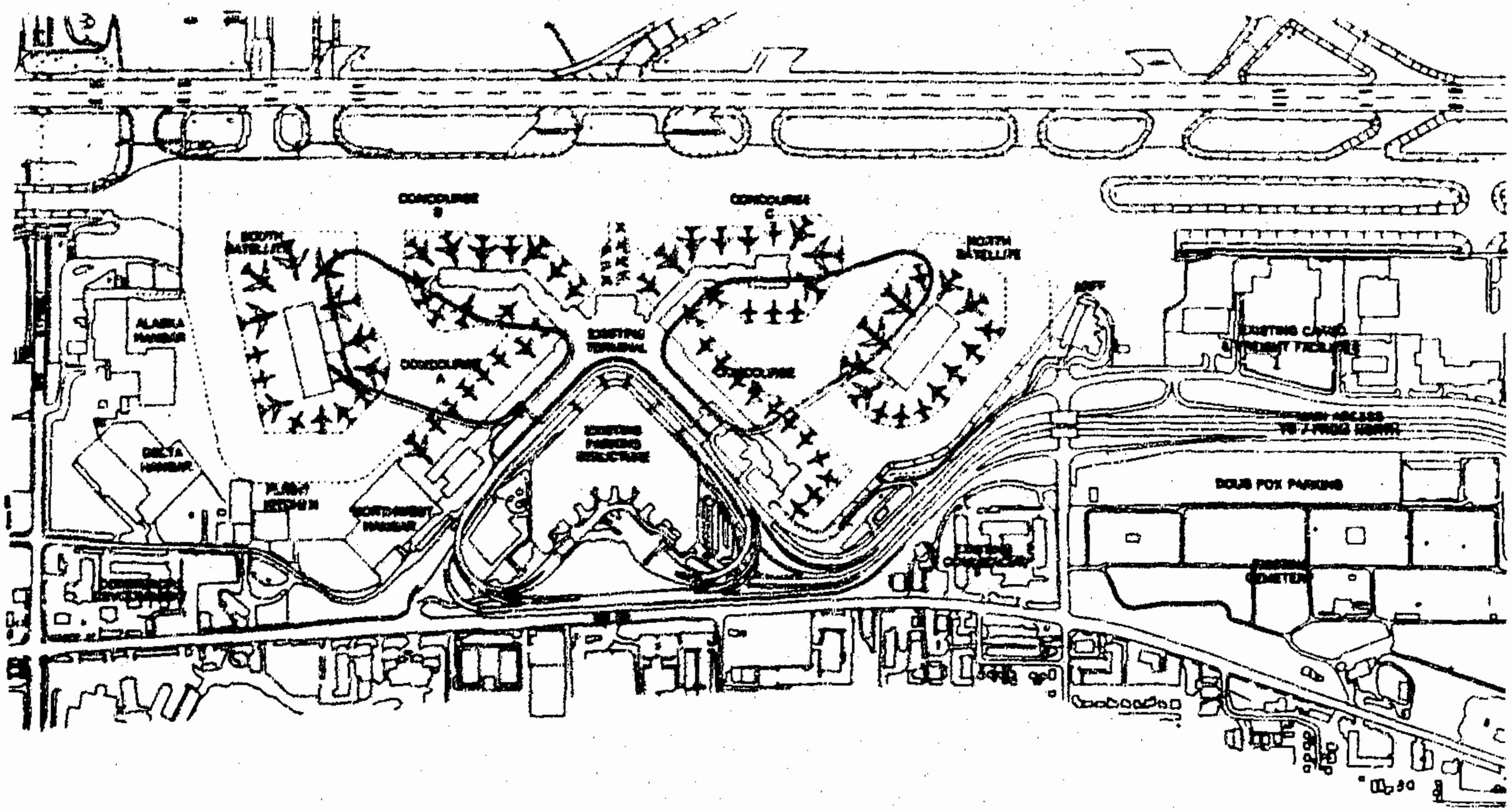
The ongoing studies of the Master Plan Update have revealed that the future operational and area requirements of both airside and landside elements will have a material impact upon the potential for future development of expanded terminal facilities. This necessitates a broader look at wider range of terminal options than was considered during the development of the TDP. A successful future terminal plan will need to address the limitations placed upon gate development by airfield capacity and taxiway improvements, landside capacity limitations resulting from the existing terminal roadway geometry and capacity, and be responsive to Port policy. Figure 3-1 identifies the current terminal configuration.

OVERALL PLANNING GOALS

The Port of Seattle (POS) has concurred with the goal that the terminal component of the Master Plan must provide as much flexibility as possible to meet changes in airline service, passenger behavior, regulatory requirements, and other conditions which may develop in the future. Expanded terminal facilities must be capable of simultaneously satisfying the needs of hubbing, non-hubbing, commuter, and international carriers, their passengers, and other visitors to the facility. Opportunities for continued expansion of the existing facilities are limited and expensive, and development of any new facilities must be justified on a logical and cost-effective basis prior to implementation.

The following general planning and design goals and objectives have been suggested by the planning team for use in developing and evaluating alternative terminal concepts. It is

FIGURE 3-1
EXISTING CONDITIONS



3-3

important to note that, wherever possible, these goals and objectives have been related to the strategic goals of the POS as understood by the Master Plan Team for the Master Plan Update. These goals and objectives are as follows:

- That any future terminal development will take ***maximum advantage of existing facilities*** in order to minimize construction cost and disruption to ongoing operations.

- Any long-term terminal development should ***balance the capacities of its terminal, airside and landside*** components with each other and against the demands of other land uses at the airport. This will become an increasingly important consideration as the terminal grows incrementally to meet short-term requirements leading to an ultimate long range configuration.

- The terminal concepts should permit ***flexibility in design*** to accommodate future variations in the program requirements (i.e. hub scenarios, rapid growth in international traffic, changes in security concepts, etc).

- The terminal should be planned to ***maximize incremental growth opportunities*** while ***minimizing incremental construction costs*** to the maximum extent possible. The terminal recommendations must allow Sea-Tac to remain competitive with other airports from a cost-per-enplanement standpoint.

- Aircraft gates and parking areas should be configured to facilitate ***unconstrained movement and enhance the safety*** of aircraft moving to and from the airfield. Provision of a second east parallel taxiway on the terminal apron has been considered a likely operational requirement by the year 2020 to facilitate aircraft ground maneuvering even though this improvement may limit use of existing gates on the west sides of Concourses B and C.

- The terminal design should continue to provide ***separation of flow*** between enplaning and deplaning functions while allowing ***clarity of orientation*** and ***reasonable distance criteria*** (i.e. passenger flow, baggage flow, vehicular flow and services, etc.). Passenger orientation should rely on good architectural design for "intuitive wayfinding" rather than elaborate signage.

- The terminal concept should endeavor to ***reduce connecting times*** at the Airport. Lengthy connect times increase airline costs, degrade passenger convenience, and impact Sea-Tac's competitiveness with other international airports. Terminal concepts should recognize the need to move both passengers and bags from gate to gate in the least amount of time.

- Surrounding infrastructure should be planned to ***minimize interim development costs*** while providing the framework for orderly growth to accommodate long-range demand. To the extent possible, non-terminal land-uses should be located clear of terminal expansion areas in order to ***avoid creating new constraints*** to future terminal development.

- To the degree possible, vehicular/pedestrian conflicts should be minimized and alternatives to the use of private cars should be encouraged.

- Sea-Tac not only serves the Seattle metropolitan area, but is a major international gateway to the Pacific Rim. For this reason, the terminal should strive to achieve the ***highest standard of user comfort and convenience*** possible, serve as a ***window to the cultural diversity and***

history of the Pacific Northwest, and reflect the ***pride and creativity*** of the residents of the Puget Sound region.

The foregoing goals were carefully considered during the terminal options development process as further defined in the following sections of this report.

BASIC PLANNING PARAMETERS

Fundamental to any terminal development study are certain basic planning criteria which should be established early and applied in a consistent manner to ensure that options are fairly and uniformly developed and evaluated. Central to the success of the recommended terminal plan is an understanding of the physical limitations of the available site as well as the opportunities for development. Figure 3-2 broadly defines some of the major factors affecting future terminal development at Sea-Tac. Identified in this exhibit are important landside, curbside and airside constraints to the east and west of the terminal, as well as facilities and other potential points of conflict to the north and south of the terminal. The area remaining within these constraints has been considered as the development zone for terminal options.

Also fundamental to the terminal planning process are consideration of the four basic terminal concepts as defined in FAA Planning Guidelines (FAA-RD-75-191 and DOT-FA-72-WA 2950). The four basic terminal concepts are pier, satellite, linear and transporter and each was considered during the planning process for Sea-Tac. The concepts are defined as follows.

The Pier Concept (Figure 3-3)

The Pier Concept (Figure 3-3) is defined by aircraft parked along piers extending from the main terminal building. Aircraft are usually arranged around the axis of the pier in a perpendicular nose-in parked relationship. Each pier typically may have a row of aircraft gate positions on one or both sides, with the passenger right-of-way or concourse running along the axis of the pier, which serves as the circulation space for enplaning and deplaning passengers. Access to the terminal area is at the base of the concourse or pier.

The pier concept provides both superior passenger connections within the pier itself, and direct access to the terminal for terminating passengers. The drawbacks of the pier concept are that walking distances may become excessive, and aircraft maneuvering may become constrained in a 'cul-de-sac'.

The Satellite Concept (Figure 3-3)

The Satellite Concept (Figure 3-3) consists of a building providing aircraft gates which is separated from the terminal and is reached by means of either a surface, underground, or above-grade connector. The aircraft are normally parked in a nose-in arrangement around the satellite, which can provide either common or individual departure lounges. Atlanta/Hartsfield and Terminal 1 at Chicago O'Hare are examples of satellite terminal concepts. The satellite concept provides both superior passenger connections within the concourse itself, and generally unconstrained aircraft movement on the apron. The drawbacks of the satellite concept are that walking distances generally require mechanical people movers, and clear passenger orientation between the satellite and the main terminal is often difficult.

The Linear Concept (Figure 3-3)

Aircraft are located directly along the airside face of the main building in a Linear Concept (Figure 3-3). A concourse may be located

FIGURE 3-2
TERMINAL PLANNING SITE - CONSTRAINTS AND OPPORTUNITIES

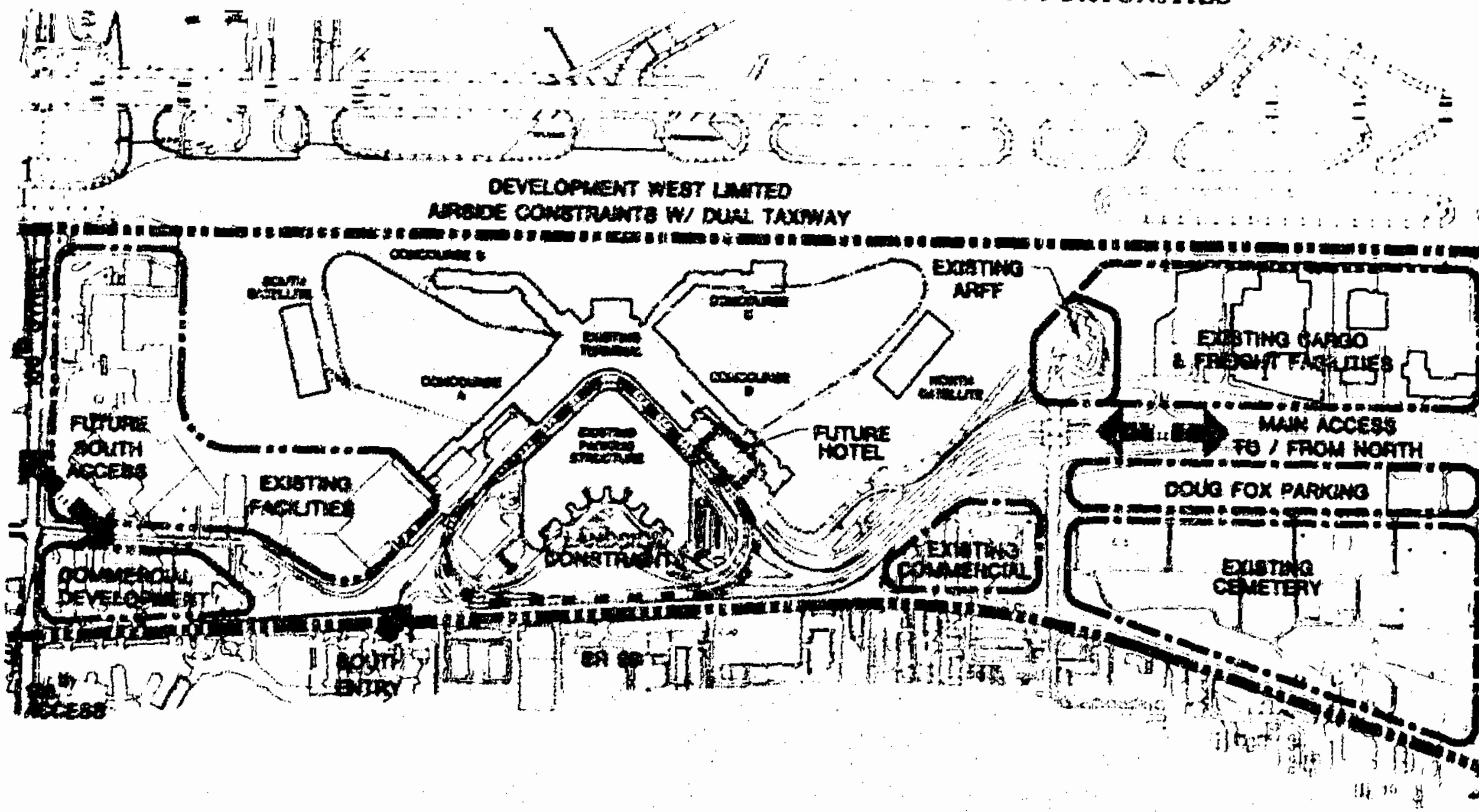
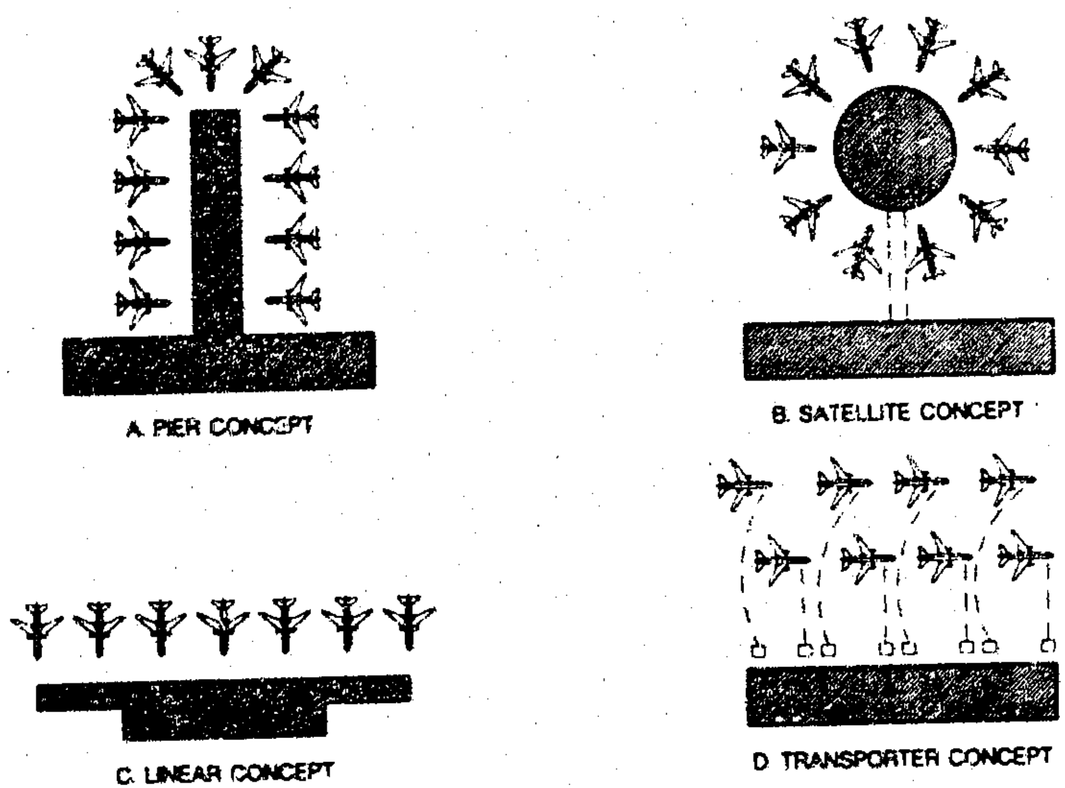


FIGURE 3-3
THE FOUR BASIC TERMINAL CONCEPTS



* THE FOUR BASIC TERMINAL CONCEPTS AS DEFINED IN FAA PLANNING CRITERIA DOT-FA 72 WA 2950 AND FAA-RD-75-191

parallel to, or within the terminal face, nearest the apron, with access to the terminal and aircraft gate positions at regular intervals. The linear configuration may be either centralized or decentralized, depending upon how the concourse connector is extended from the terminal core. With the advent of security checkpoints the Linear Concept lost one of its main advantages; ease of access and relatively short curb-to-gate walking distances for originating and/or terminating passengers. It is, however, ideal for long, thin sites. Also, the recent trend of carriers to hub their operations at an airport often results in longer average walking distances for interline passengers in linear terminals. The best examples of linear terminals are found at Kansas City and Dallas-Ft. Worth.

The Transporter Concept (Figure 3-3)

Aircraft and aircraft-servicing functions in the Transporter Concept (Figure 3-3) are remotely located from the terminal. The connection between the aircraft and the terminal is provided by vehicular transport for enplaning and deplaning passengers. The original transporter concept envisioned the use of the transporter vehicle as the departure lounge although a more common application is a busing operation. In high activity situations, an excessive number of transporter vehicles may be required, resulting in high operating costs, potential congestion during peaks, and low utilization during off-peak periods. For this reason, consideration should be given to the incorporation of large boarding areas or departure lounges in the main terminal element.

Most transporters at U.S. airports are used only as supplementary gates due to the additional transit time involved in the operation and the overall inconvenience of the operation to passengers. Perhaps the most well-known transporter terminal was originally built at Dulles Airport, but this is currently being modified to a satellite arrangement to improve passenger and operational convenience. Apron buses used as transporters are also found in commuter operations where ramp area adjacent to the main terminal is either unavailable or available only at a premium.

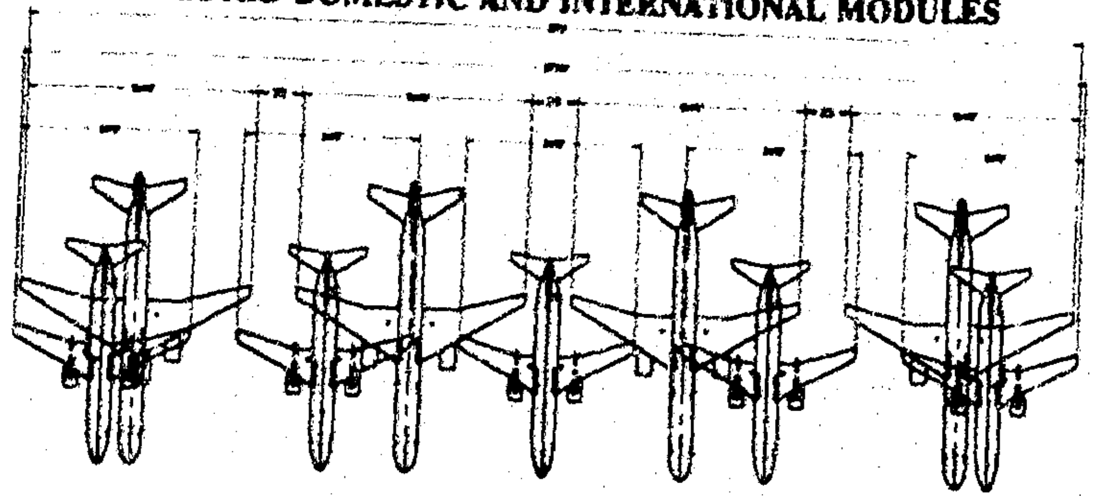
A given terminal plan may incorporate one or more of the four basic terminal concepts simultaneously. The existing facilities at Sea-Tac are a combination of pier, satellite, and linear concepts. The North and South Satellites operate as satellites, with piers at Concourses B and C, and linear gates at Concourses A and D.

To maintain consistency in the comparison of alternative concepts, a series of design aircraft parking modules were developed and used in the examination of each concept of future terminal development. These aircraft parking modules are shown in Figures 3-4 and 3-5, and provide for an interchangeable mix of wide and narrow-bodied aircraft of the type currently used and forecast for Seattle for both domestic and international operations. Because commuters are a significant part of the operation, the ramp depth suggested for these modules also provides for planned interchangeability between commuter and wide and narrow-bodied aircraft types.

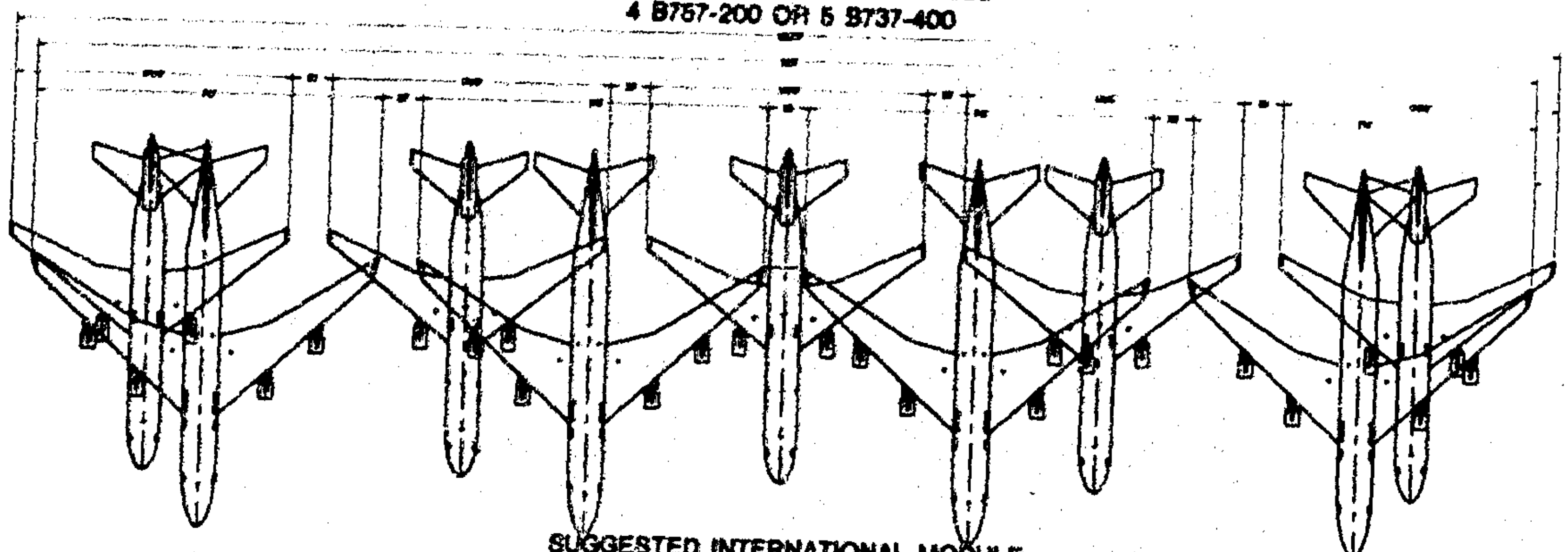
This approach provides a consistent means of measuring the gates among the terminal concepts being examined similar to the NarrowBody Equivalent Gate (NBEG) index used in the terminal programming section. The use of interchangeable aircraft modules for planning purposes also permits a degree of flexibility to accommodate individual airline requirements as they may shift over time. This could involve growth in commuter operations and replacement of smaller aircraft with larger aircraft to serve increasing passenger demand.

The foregoing physical planning parameters, coupled with the space program and overall

FIGURE 3.4
SUGGESTED DOMESTIC AND INTERNATIONAL MODULES

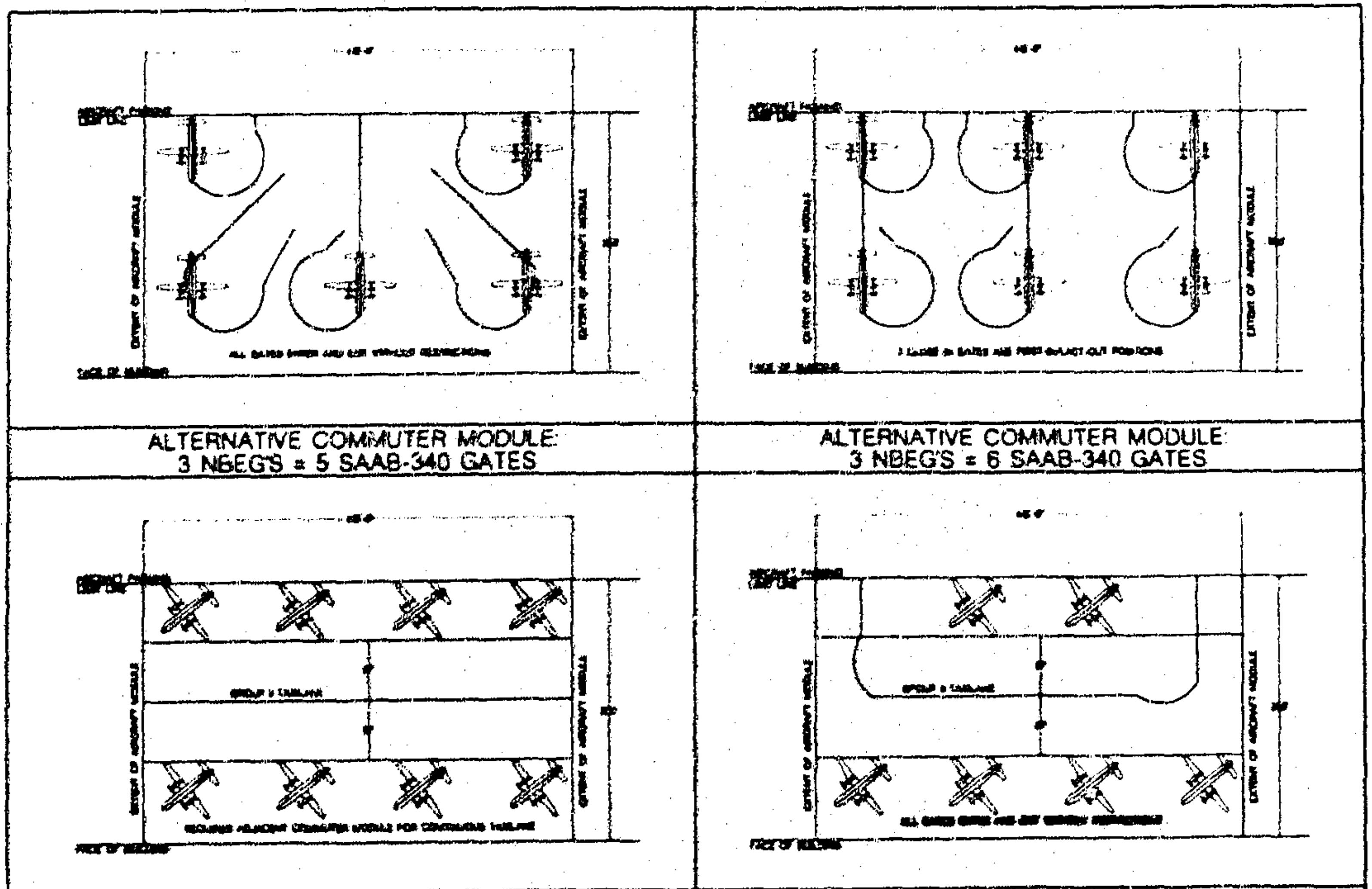


SUGGESTED DOMESTIC MODULE
4 B757-200 OR 5 B737-400



SUGGESTED INTERNATIONAL MODULE
5 MD-11 OR 4 B747-400

FIGURE 3-5
ALTERNATIVE COMMUTER MODULES



ALTERNATIVE COMMUTER MODULE:
3 NBEG'S = 5 SAAB-340 GATES

ALTERNATIVE COMMUTER MODULE:
3 NBEG'S = 6 SAAB-340 GATES

ALTERNATIVE COMMUTER MODULE:
3 NBEG'S = 8 SAAB-340 GATES

ALTERNATIVE COMMUTER MODULE:
3 NBEG'S = 6 SAAB-340 GATES

NBEG = NARROW BODY EQUIVELENT GATES

planning goals serve as the basis for development of future terminal options.

DEVELOPMENT OF TERMINAL OPTIONS

As defined in the work scope of the Master Plan Update, the terminal planning process was to be based upon the findings of the 1992 TDP (which in turn was based on the findings of the 1985 Master Plan Update for Seattle-Tacoma International Airport prepared by Peat Marwick / TRA). It is not the intent of the current Master Plan Update to reinvent terminal options which have previously been investigated, but rather to revisit, refine, and validate, or modify the recommended terminal plan of the TDP.

Because of the uncertainty regarding long term regional airport options, the TDP was split into two components, with a pre-2000 plan accommodating the most likely terminal expansion requirements, and the post-2000 plan providing a range of three options consistent with the regional options being considered. Some of the key features of the pre- and post-2000 plans are summarized below.

Pre-2000 Terminal Development

- Expansion of the main terminal for ticketing and baggage claim.
- Improvements to interline and outbound baggage systems.
- Expansion and refurbishment of Concourse A for additional aircraft parking.
- Expansion of the South Satellite for additional holdroom, in-transit facilities, and public circulation (no FIS expansion).
- Preparation for the relocation of FIS facilities to Concourse A.
- Concourse D office building/hotel

Post-2000 Terminal Development

- Expansion of main terminal providing additional ticketing and baggage claim
- Significant improvements to interline and outbound baggage systems
- Further expansion/refurbishment of Concourse A
- Further expansion of the North and South Satellites
- Expansion of parking structure
- Relocation of international arrivals facilities to Concourse A and extension of the terminal roadway to serve these facilities
- Related utilities, site preparation, and facility relocations

Because all of the foregoing recommendations for both pre- and post-2000 terminal development focused primarily upon the terminal facility as an independent entity, the influence and impact that future landside or airside requirements might have upon the terminal were not fully realized in the TDP. Additionally, it was the intent of the POS that the TDP provide a framework of options and recommendations which may be considered by the POS in developing the terminal during the pre-2000 and post-2000 timeframe. It should be stressed that the TDP report was intended as a "living document" by the POS which could be "adjusted and modified as necessary to accommodate changing conditions at Sea-Tac which are certain to occur in the future." This flexible approach enabled the POS to be responsive to a number of changes which were unanticipated when the TDP was completed in 1992.

Perhaps the most significant point of new information to emerge since the TDP was completed involves the landside component - specifically the roadways serving the terminal curb. An analysis of the terminal roadway system conducted as a part of the Master Plan Update has determined that the existing enplaning/deplaning terminal roadways and on-site parking are insufficient to accommodate forecast demand for the year 2020 and may require substantial modifications to avoid unacceptable congestion and delays between the years 2000 and 2010.

This conclusion considers both the configuration of the terminal curb as well as the width and the number of lanes. Some of the access/egress ramps are currently at or near capacity during peak periods. While there are ways of expanding or modifying the terminal curbfront, the fundamental problem which remains is that the configuration of the terminal curb has evolved from the original terminal plan in which traffic pivots upon a point (or elbow) at the apex of the terminal roadway. This not only creates a point of congestion at the elbow, but limits the extent to which the terminal curb may be extended in a linear fashion. The adjacency of the terminal building to the parking structure is an additional, relatively permanent constraint to expanding the width of the terminal curbfront. Furthermore, the number of lanes, sight distances and turn radii limit the capacity of the existing roadway system.

Based on the findings of the landside analysis, it was determined that a further major expansion of the existing curbfront would provide insufficient capacity to fully accommodate the forecast demand in the year 2020. Correspondingly, the existing terminal should not be expanded indefinitely in the absence of a long-term solution to its existing curbfront capacity problem. This conclusion marks an important amendment to the premise upon which the centralized terminal concepts of the 1985 Master Plan and 1992 TDP were based.

Recent POS development of curbside facilities for shuttle and courtesy vans in the parking garage are of great immediate help. The landside analysis also points out the long-range demands of increased passenger traffic and the need to improve transit services to the terminal complex can not be easily or conveniently accommodated at the present terminal due to access constraints.

In addition, the terminal airside development may be impacted by, and in turn impact, the overall airside improvements to be identified in the Master Plan Update. The development of a second east parallel taxiway to facilitate access to and from the runway may be indicated by further airfield capacity analysis and will be even more desirable if a significant increase in gates are provided in the existing terminal area.

Section 4
TERMINAL FACILITY REQUIREMENTS

SECTION 4
TERMINAL FACILITY REQUIREMENTS

INTRODUCTION

A facilities program has been developed as part of the Master Plan Update in order to quantify the terminal and terminal-related facilities required to accommodate forecast passenger activity over the next twenty years. The forecasts prepared previously as a part of Technical Report No. 5 have been used as the basis for estimating these future facility needs. A summary of the annual, peak month, and average day peak month passenger forecasts from Technical Report No. 5 are presented in Table 4-1.

This terminal facilities program also begins to anticipate the physical requirements of the Terminal Concepts being considered in the Master Plan. Depending on the concept being considered, the facilities program may alternatively be required to accommodate passenger traffic within one or several unit terminals at the airport. Because the facility requirements of single vs. multiple terminals may be significantly different, some components of the facility program have been evaluated under several differing scenarios to address this possibility. The resulting facility programs have been developed to address either expansion of the existing terminal facilities in a single terminal location or development of a new unit terminal.

The terminal program for the single terminal option is predicated on a continuation of the central terminal concept proposed in the 1985 Master Plan in which the existing terminal is expanded to serve all passenger groups at the airport. The multiple terminal option includes consideration of relocating the Federal Inspection Services (FIS) to new terminal facilities as well as the accommodation of approximately 30% of the forecast annual passenger demand for the year 2020.

Program criteria have been selected to reflect the size and operating characteristics of Sea-Tac wherever possible and are a combination of existing supply/demand ratios, common industry planning standards, passenger processing criteria described in the Master Plan, and criteria developed by comparison with other airports around the U.S. and the world. In addition to utilizing the revised passenger forecasts, some assumptions have been made regarding the continuity of activity patterns and the behavior of users of the terminal. In general, it is assumed that the level and composition of passenger service will follow the forecasts prepared in Technical Report No. 5. In the programming of some terminal elements, there is also consideration given to accommodating an increased number of airlines at the terminal in the future.

Finally, planning questionnaires which requested information on their existing and forecast terminal facility requirements were distributed to the airlines serving the airport in April 1994. While these questionnaires provided useful information on individual airline interest in specific terminal improvements, the forecast for most terminal facilities is based upon an aggregated, independent estimate, rather than the summation of individual airline requests. The questionnaires therefore have been used to provide insight, direction, and verification of specific components of the facilities program.

Table 4-1
Passenger Activity Forecasts

	Actual	Forecast			Units
Year	1993	2000	2010	2020	
TOTAL ANNUAL PASSENGERS (millions)					
Originating/Terminating	13.2	16.4	21.2	26.4	
Connecting	5.6	7.4	9.4	11.8	
Total	18.8	23.8	30.6	38.2	
Domestic - Air Carrier	16.2	20.2	26.0	32.6	
Domestic - Commuter	1.2	1.4	1.6	1.8	
Trans-Border (Canada)	0.7	1.2	1.8	2.2	
Other International	0.7	1.0	1.2	1.6	
Total	18.8	23.8	30.6	38.2	
Air Carrier	17.2	21.8	28.6	36.0	
Commmuter	1.6	2.0	2.1	2.2	
Total	18.8	23.8	30.7	38.2	
MONTHLY ENPLANEMENTS (thousands)					
Domestic	1,051	1,304	1,666	2,077	
Trans-Border	42	67	92	116	
'Pure' International	39	62	85	107	
Total	1,131	1,433	1,843	2,300	
AVERAGE-DAY, PEAK-MONTH ENPLANEMENTS					
Domestic	33,900	42,100	53,600	67,000	
Trans-Border	1,300	2,200	3,000	3,700	
'Pure' International	1,200	2,000	2,700	3,500	
Total	36,500	46,200	59,400	74,200	

Source: Technical Report #5, Tables 2.1, 3.5, 3.7

PASSENGER ACTIVITY FORECASTS

As noted previously, the annual passenger forecasts in Technical Report No. 5 have been used as the basis for evaluating future terminal requirements. These passenger forecasts, however, require additional refinement for use in the consideration of terminal facility requirements. The forecasts in Technical Report No. 5 project annual and peak hour air carrier, commuter, and international passenger activity. For the purposes of terminal planning, however, all three of these groups must be combined when considering enplaning facility requirements. Facility requirements for deplaning passenger activity must be split into international and domestic components but with Canadian (international) arrivals included with domestic passengers.

In order to adjust the peak hour forecasts to take these distinctions into consideration, the Official Airline Guide (OAG) schedule for Sea-Tac during the peak month of August 8-14, 1993 were calibrated to airport records for the same period which showed an average-day, peak-month activity of 36,500 enplanements. Using this schedule data, non-Canadian international arrivals were analyzed separately from U.S. and Canadian arrivals and unique peaking characteristics were determined for each. The daily peaking characteristics (as measured in arriving and departing seats) resulting from the analysis of one week's data is presented in Tables 4-2, 4-3, and 4-4.

The average ratio of peak hour to daily activity from this OAG data was then multiplied by the average daily passengers forecast in Technical Report No. 5 to revise the estimates of peak hour passenger activity in each category. These revised peak hour passenger forecasts are presented in Table 4-5. It is worth noting that the peak hour arriving *passenger levels* are somewhat higher in this analysis than in the comparable August 1993 estimates contained in Technical Report No. 5. The resulting deplaning peak hour *load factors*, however, are consistent with those of the enplaning peaks and are therefore considered reasonable estimates to be used in terminal programming.

Due to the consideration of multiple unit terminals, one final adaptation of the passenger demand forecasts is required. The planning of each unit terminal should be based upon the peak activity it will be expected to accommodate. While this can only be determined with any accuracy by analyzing the flight schedules of the airline tenants of those unit terminals, the number of gates provided at each unit terminal has been used as an indicator of future passenger activity in this program.

For the purposes of the Master Plan Update, these demands have been estimated by assuming a 30% - 70% split between the gates of the new unit terminal(s) and those of the existing terminal. This split of gates assumes the allocation of all of the new gates forecast for 2020 to the new unit terminal(s) as a worst-case scenario. Under this demand scenario, each terminal will have its own unique peak activity characteristics which will determine its facility requirements.

Because the ratio of peak hour activity to daily activity *decreases* as overall passenger activity *increases*, the sum of these separate unit terminal peaks for any given year will exceed that of a single centralized terminal. For this reason, and because of the necessary duplication of facilities, two separate facilities will require a greater amount of area than one single facility.

AIRCRAFT GATE REQUIREMENTS

The need for aircraft parking positions (gates) is a fundamental criteria in the planning of future

Table 4-2

Hourly Scheduled Departing Seats (Airport Total)

From OAG data for SEA - Sunday, August 8 to Saturday, August 14, 1993

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Average
Peak Hour	5,559	5,559	5,559	5,559	5,559	4,801	5,401	5,428
at:	07:46 AM	07:46 AM	07:46 AM	07:46 AM	07:46 AM	12:59 PM	12:59 PM	
Total Daily	52,848	53,780	52,923	53,545	53,194	38,130	40,224	49,235
Peak/Daily	10.5%	10.3%	10.5%	10.4%	10.5%	12.6%	13.4%	11.0%
12:00 AM	416	416	416	416	416	144	144	338
01:00 AM	328	328	328	328	328	144	144	275
02:00 AM	0	0	0	0	0	0	0	0
03:00 AM	0	0	0	0	0	0	0	0
04:00 AM	0	0	0	0	0	0	0	0
05:00 AM	271	0	0	0	0	0	0	39
06:00 AM	2,834	2,834	2,834	2,834	2,834	1,046	1,010	2,318
07:00 AM	4,997	4,997	4,997	4,997	4,997	1,005	819	3,830
08:00 AM	5,080	5,080	5,080	5,080	5,080	2,297	2,180	4,268
09:00 AM	2,641	2,779	2,641	2,779	2,641	1,698	1,724	2,415
10:00 AM	2,589	2,625	2,589	2,625	2,589	2,168	2,149	2,478
11:00 AM	3,101	3,477	3,101	3,477	3,101	2,873	2,488	3,088
12:00 PM	4,188	4,204	4,188	4,204	4,188	3,691	3,790	4,067
01:00 PM	5,161	5,161	5,507	5,161	5,507	4,801	5,401	5,243
02:00 PM	2,084	2,084	2,084	2,100	2,084	1,856	1,857	2,010
03:00 PM	2,960	3,221	2,960	2,960	3,221	3,227	3,225	3,108
04:00 PM	2,018	2,018	2,018	2,018	2,018	1,386	1,846	1,903
05:00 PM	1,863	2,089	2,089	2,089	2,089	1,598	1,854	1,913
06:00 PM	3,609	3,403	3,403	3,403	3,403	2,858	3,088	3,308
07:00 PM	2,921	2,921	2,921	2,921	2,921	2,439	2,921	2,852
08:00 PM	1,519	1,519	1,519	1,519	1,519	1,118	1,519	1,462
09:00 PM	1,368	1,714	1,368	1,714	1,368	1,210	1,332	1,439
10:00 PM	1,561	1,561	1,561	1,561	1,561	1,494	1,561	1,551
11:00 PM	1,369	1,369	1,369	1,369	1,369	1,064	1,369	1,346

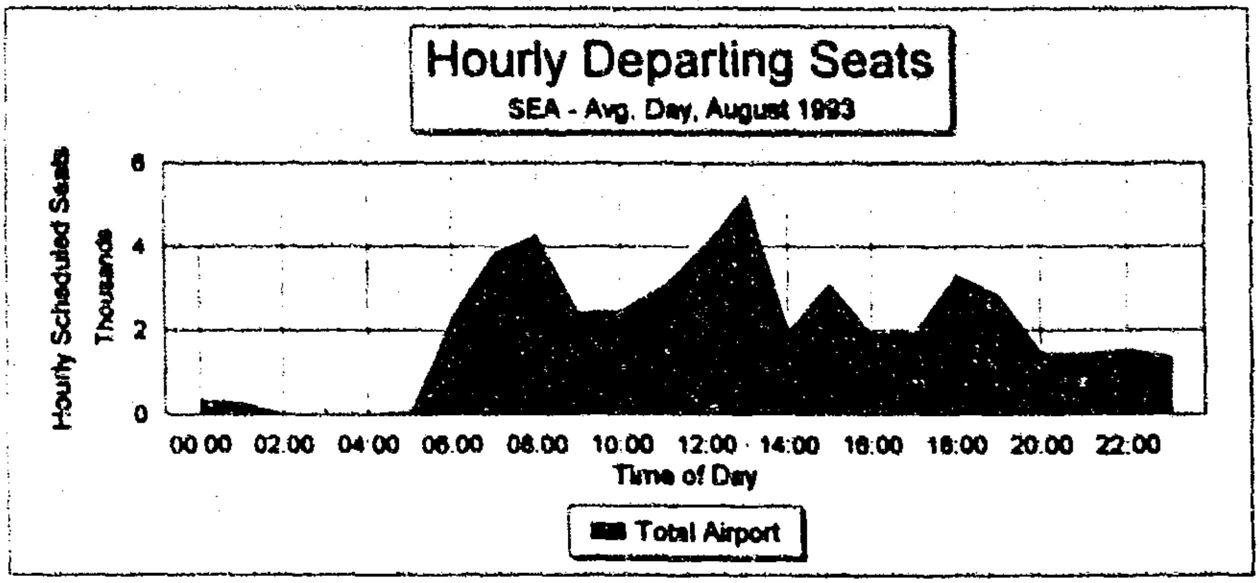


Table 4-3

Hourly Scheduled Arriving Seats - Domestic (including Canada)

From OAG data for SEA - Sunday, August 8 to Saturday, August 14, 1993

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Average
Peak Hour	5,492	5,492	4,405	5,492	5,492	5,277	5,489	5,306
at:	08:14 PM	08:14 PM	12:59 PM	08:14 PM	08:14 PM	08:19 PM	08:21 PM	
Total Daily	51,853	51,925	39,945	51,690	52,199	48,804	51,190	49,658
Peak/Daily	10.6%	10.6%	11.0%	10.6%	10.5%	10.8%	10.7%	10.7%
00:00	1,416	1,416	144	1,416	1,416	1,418	1,416	1,234
01:00	0	0	144	0	0	0	0	21
02:00	0	0	0	0	0	0	0	0
03:00	419	148	0	148	148	148	148	166
04:00	0	0	0	0	0	0	0	0
05:00	873	873	0	873	873	873	873	748
06:00	1,063	1,063	1,062	1,063	1,063	871	696	966
07:00	1,790	1,790	1,222	1,790	1,790	1,710	1,634	1,675
08:00	1,811	1,811	2,335	1,811	1,811	1,754	1,854	1,864
09:00	1,867	1,903	1,772	1,903	1,867	1,802	1,783	1,842
10:00	3,782	3,782	2,353	3,782	3,782	3,618	3,652	3,536
11:00	4,629	4,665	2,569	4,665	4,629	4,539	4,647	4,366
12:00	3,431	3,431	3,884	3,431	3,777	3,428	3,504	3,565
13:00	2,697	2,697	4,405	2,697	2,697	2,743	2,702	2,957
14:00	2,098	2,367	1,792	2,132	2,367	2,067	2,122	2,136
15:00	2,658	2,658	3,221	2,658	2,658	2,392	2,560	2,690
16:00	1,667	1,667	1,862	1,667	1,667	1,490	1,732	1,682
17:00	3,486	3,486	1,448	3,486	3,486	3,225	3,551	3,167
18:00	3,238	3,238	2,914	3,238	3,238	2,954	3,238	3,151
19:00	3,309	3,309	2,921	3,309	3,309	2,858	3,309	3,186
20:00	4,556	4,556	1,519	4,556	4,556	4,307	4,519	4,061
21:00	4,102	4,102	1,368	4,102	4,102	3,918	4,136	3,690
22:00	1,701	1,701	1,581	1,701	1,701	1,574	1,563	1,643
23:00	1,263	1,263	1,389	1,263	1,263	1,120	1,263	1,261

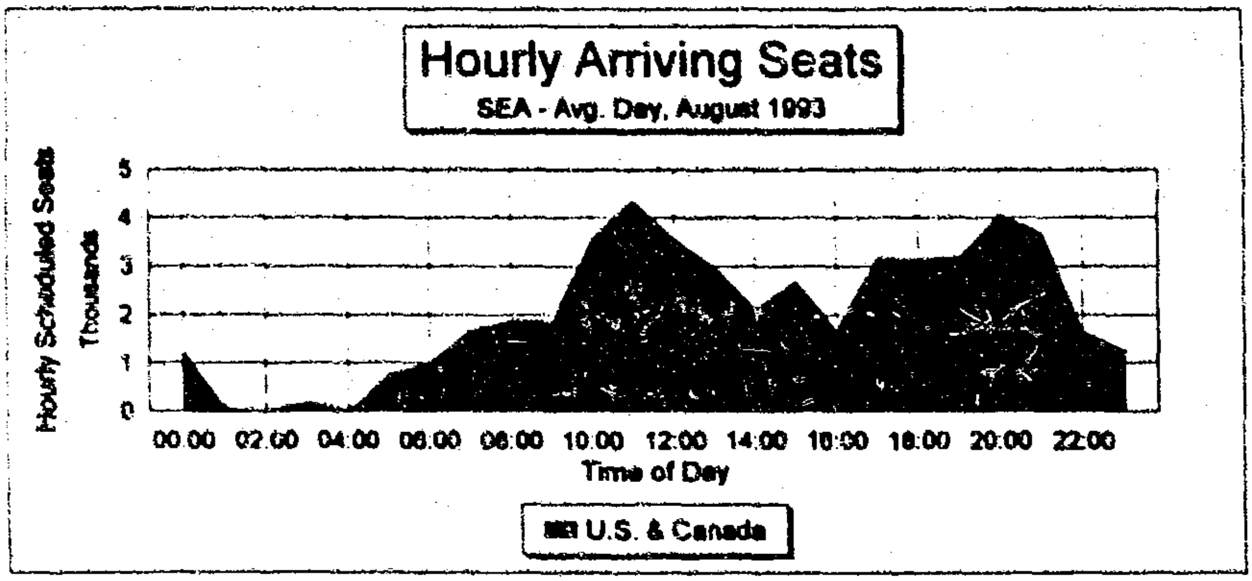


Table 4-4

Hourly Scheduled Arriving Seats - International (excluding-Canada)

From OAG data for SEA - Sunday, August 8 to Saturday, August 14, 1993

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Average
Peak Hour	376	647	376	647	416	647	687	542
at:	07:31 AM	09:01 AM	07:31 AM	09:01 AM	03:06 PM	09:01 AM	03:11 PM	
Total Daily	1,259	1,991	1,269	1,991	1,269	1,991	1,540	1,617
Peak/Daily	29.6%	32.5%	29.6%	32.5%	32.8%	32.5%	44.6%	33.5%
00:00	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0
02:00	0	0	0	0	0	0	0	0
03:00	0	0	0	0	0	0	0	0
04:00	0	0	0	0	0	0	0	0
05:00	0	0	0	0	0	0	0	0
06:00	0	0	0	0	0	0	0	0
07:00	0	0	0	0	0	0	0	0
08:00	376	376	376	376	376	376	376	376
09:00	0	376	0	376	0	376	0	161
10:00	271	271	271	271	271	271	271	271
11:00	208	208	208	208	208	208	208	208
12:00	0	0	0	0	0	0	0	0
13:00	208	208	208	0	0	0	0	88
14:00	0	0	0	0	0	0	0	0
15:00	210	210	210	210	210	210	481	249
16:00	0	0	0	208	208	208	208	118
17:00	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	0	0	0
19:00	0	348	0	348	0	348	0	148
20:00	0	0	0	0	0	0	0	0
21:00	0	0	0	0	0	0	0	0
22:00	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0

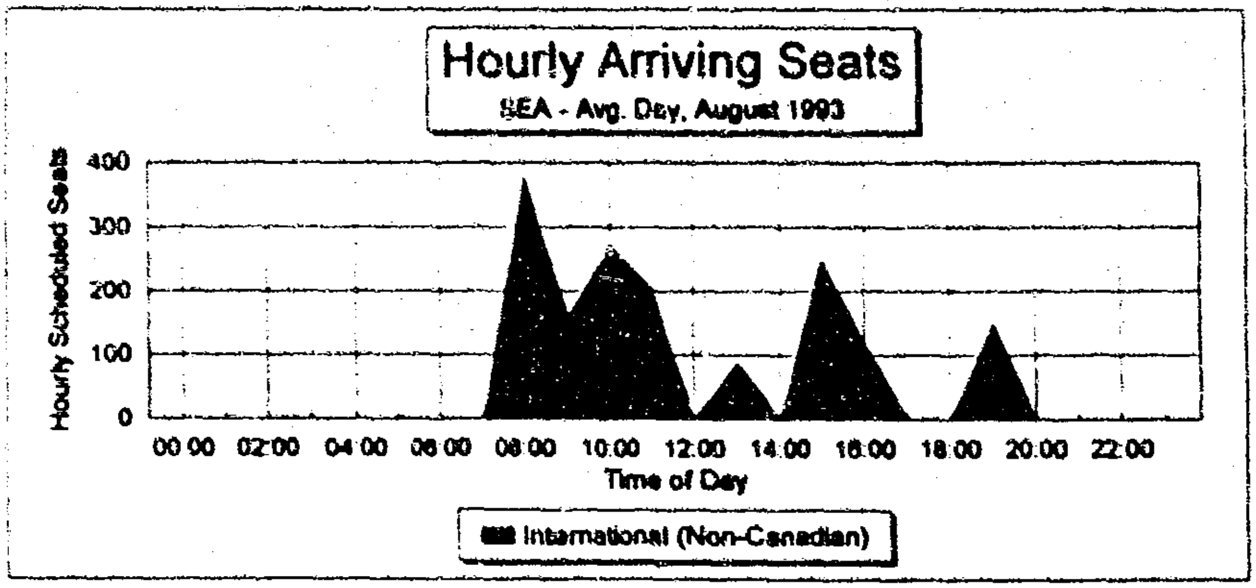


TABLE 4-5
Peak Hour Passenger Activity Forecasts

Year	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
Average Day Peak Month (ADPM) Enplanements				
Domestic	33,900	42,100	53,800	67,000
Trans-Border	1,300	2,200	3,000	3,700
'Pure' International	1,200	2,000	2,700	3,500
Total	36,500	46,200	59,400	74,200
Peak Hour ADPM Enplanements				
Total Enplanements				
- Originating	2,800	3,500	4,400	5,200
- Connecting	1,200	1,600	1,900	2,300
Total Enplaned [1] [2]	4,080	5,100	6,300	7,500
Peak Hour ADPM Deplanements				
US + Canada				
- Terminating	2,700	3,400	4,100	4,900
- Connecting	1,100	1,400	1,800	2,100
Total Deplaned [2]	3,800	4,800	5,900	7,000
Other International				
- Terminating	190	230	290	340
- Connecting	210	270	330	400
Total Deplaned [2]	400	500	620	740

[1] Note: from Technical Report #5, Table 2.1
[2] Enplaning and deplaning peaks are not additive.

terminal facilities. Aircraft gate requirements not only determine the number of aircraft which may be loading and unloading simultaneously, but in large part define the configuration of the terminal, the building area required, and the ability of the airport to accommodate changes in the types of aircraft and airlines serving the airport.

Because of the significant difference in physical requirements of an individual gate, and in order to standardize the definition of 'gate' in evaluating aircraft gate requirements, a NarrowBody Equivalent Gate (NBEG) statistic has been used in this report to normalize ramp frontage demand and capacity to that of a typical narrowbody aircraft. This index uses FAA aircraft taxiway design group criteria (AC 150-5300-13) and classifies the amount of space each aircraft requires on the aircraft parking ramp based upon the maximum wingspan of aircraft in each group. The resulting index may be used to more accurately compare Sea-Tac with other airports as well as to evaluate the relative capacity of alternative concepts without being misled by alternative parking configurations. The individual aircraft design groups and NBEG index for each group are listed along with baseline airport and international fleet mix in Tables 4-6 and 4-7.

These coefficients have been extensively used in the description and estimation of both existing and future gate requirements at Seattle. The actual count of aircraft parking positions for a given configuration are hereafter referred to as Nominal Gates, while effective ramp frontage is measured in NBEG.

A number of factors at Sea-Tac suggest a significant increase in passengers per operation in the future. These factors include (1) the continuing trend towards higher capacity aircraft to achieve lower costs per passenger and/or greater payload range, (2) the continued saturation of existing commuter markets and a shift in the accommodation of commuter passengers by larger aircraft, and (3) increased limitations on additional incremental expansion. Furthermore the airport has expressed an interest in increasing the utilization of terminal gate facilities in order to ensure maximized use of available facilities before investing in additional expansion of terminal facilities.

The aircraft gate forecast has been determined by projecting three factors - (1) the average seats per aircraft, (2) the average load factor, and (3) the turnover per gate per day. All of these factors have been estimated from the forecasts of passengers per departure and average fleet mix contained in Technical Report No 5, the OAG schedule for August 1993, and knowledge of the existing gate configuration at the airport. Commuter activities, which now account for nearly 40% of the daily passenger aircraft operations at Sea-Tac, have been included in the estimation of these factors.

From the passenger per departure data contained in Technical Report No. 5, the first of these criteria, the average number of seats per aircraft, is forecast to increase by 8% between 1993 and 2000, an additional 12% from 2000 to 2010, and an additional 12% from 2010 to 2020. The second of these criteria to be considered, average load factor, is forecast to increase by 1% from 1990 to 2000, by 1.3% from 2000 to 2010, and by 1.3% from 2010 to 2020. It is important to recognize that this load factor includes only passengers boarding aircraft in Seattle. Because some capacity is utilized by "thru" passengers, the actual load factor on departing flights during this period will usually be higher than the load factor estimated from local enplanements.

The final criteria to be considered is the average gate utilization as measured by departures per NBEG per day. From current departure statis-

TABLE 4-8

Aircraft Fleet Mix

DAILY DEPARTURES

Aircraft Type	Sun 8/8/93	Mon. 8/9/93	Tue 8/10/93	Wed 8/11/93	Thu 8/12/93	Fri 8/13/93	Sat 8/14/93	Average Daily
Group V	2	4	3	4	3	4	3	3
Group IV	39	39	38	38	39	37	39	38
Group IIIb	45	45	45	45	45	45	45	45
Group IIIa	245	246	245	246	245	225	229	240
Group II	159	161	159	162	159	125	141	152
Group I	127	127	127	127	127	90	114	120
Total	689	694	699	694	699	695	638	687
Total NBEGates								89.90
Departures/NBEGate								7.64

DAILY DEPARTING SEATS

Aircraft Type	Sun 8/8/93	Mon. 8/9/93	Tue 8/10/93	Wed 8/11/93	Thu 8/12/93	Fri 8/13/93	Sat 8/14/93	Average Daily
Group V	752	1,474	1,098	1,474	1,098	1,474	1,098	1,210
Group IV	10,115	10,115	9,844	9,844	10,115	9,573	10,115	9,960
Group IIIb	7,984	7,984	7,984	7,984	7,984	8,020	7,984	7,989
Group IIIa	30,416	30,554	30,416	30,554	30,416	28,900	29,240	30,071
Group II	5,724	5,798	5,724	5,832	5,724	4,500	5,078	5,462
Group I	2,237	2,237	2,237	2,237	2,237	1,589	1,990	2,109
Total	55,503	57,228	58,160	57,303	57,925	57,574	54,056	56,821
Average Daily Enplanements								36,500
Average Load Factor								64.2%

AVERAGE SEATS PER DEPARTURE

Aircraft Type	Sun 8/8/93	Mon. 8/9/93	Tue 8/10/93	Wed 8/11/93	Thu 8/12/93	Fri 8/13/93	Sat 8/14/93	Average Daily
Group V	376	369	366	369	366	369	366	368
Group IV	259	259	259	259	259	259	259	259
Group IIIb	177	177	177	177	177	178	177	178
Group IIIa	124	124	124	124	124	128	128	125
Group II	36	36	36	36	36	36	36	36
Group I	18	18	18	18	18	18	17	18
Total	81	82	83	83	83	83	85	83

Narrowbody Equivalent Gate (NBEG) Index

Design Group	Maximum Wingspan	Typical Aircraft	NBEG Index
I.	49 ft.	Metro	0.4
II.	79 ft.	Embraer	0.7
III.	118 ft.	MD-80	1.0
IV.	171 ft.	MD-11	1.4
V.	213 ft.	B747-400	1.8

TABLE 4-7

Aircraft Fleet Mix - International

DAILY DEPARTURES

Aircraft Type	Sun 8/8/93	Mon. 8/9/93	Tue 8/10/93	Wed 8/11/93	Thu 8/12/93	Fri 8/13/93	Sat 8/14/93	Average Daily
Group V	1	2	2	2	2	2	2	2
Group IV	5	5	4	4	5	4	4	4
Group IIIb	0	0	0	0	0	0	0	0
Group IIIa	0	0	0	0	0	0	0	0
Group II	0	0	0	0	0	0	0	0
Group I	0	0	0	0	0	0	0	0
Total	6	7	6	6	7	6	6	6
Total NBEGates								22.40
Departures/NBEGate								0.28

DAILY DEPARTING SEATS

Aircraft Type	Sun 8/8/93	Mon. 8/9/93	Tue 8/10/93	Wed 8/11/93	Thu 8/12/93	Fri 8/13/93	Sat 8/14/93	Average Daily
Group V	376	752	722	752	722	752	722	685
Group IV	1,164	1,164	893	893	1,164	893	893	1,009
Group IIIb	0	0	0	0	0	0	0	0
Group IIIa	0	0	0	0	0	0	0	0
Group II	0	0	0	0	0	0	0	0
Group I	0	0	0	0	0	0	0	0
Total	1,540	1,916	1,615	1,645	1,886	1,645	1,615	1,695
Average Daily Enplanements								1,200
Average Load Factor								70.8%

AVERAGE SEATS PER DEPARTURE

Aircraft Type	Sun 8/8/93	Mon. 8/9/93	Tue 8/10/93	Wed 8/11/93	Thu 8/12/93	Fri 8/13/93	Sat 8/14/93	Average Daily
Group V	376	376	361	376	361	376	361	369
Group IV	233	233	223	223	233	223	223	228
Group IIIb	NA	NA	NA	NA	NA	NA	NA	ERR
Group IIIa	NA	NA	NA	NA	NA	NA	NA	ERR
Group II	NA	NA	NA	NA	NA	NA	NA	ERR
Group I	NA	NA	NA	NA	NA	NA	NA	ERR
Total	257	274	269	274	269	274	269	270

Narrowbody Equivalent Gate (NBEG) Index

Design Group	Maximum Wingspan	Typical Aircraft	NBEG Index
I.	49 ft.	Metro	0.4
II.	79 ft.	Embraer	0.7
III.	118 ft.	MD-80	1.0
IV.	171 ft.	MD-11	1.4
V.	213 ft.	B747-400	1.8

tics, a gate utilization of 7.6 departures/NBEG/day occurred during an average day in August 1993 (Table 4-6). This included both air carrier and commuter departures, and also includes many commuter aircraft parked within what have been counted as jet aircraft gates. This factor is forecast to increase by 0.5 by the year 2020 in recognition of the potential increase in gate turnover attributable to industry trends and maneuvering improvements being considered as a part of this master plan.

The aircraft gate forecast therefore combines the aforementioned parameters and projects gate requirements on the basis that gate utilization will steadily increase from its current level of approximately 210,000 passengers/NBEG/ Year to achieve a target utilization of somewhat greater than 270,000 passengers/NBEG/Year by the year 2010. After this target is achieved, further increases in utilization will be more difficult to achieve and have been forecast to increase by 17% to 320,000 passengers/NBEG/year by the year 2020. These forecasts result in the need to provide a net increase of over 4,000 linear feet of usable ramp frontage by the year 2020.

The forecast aircraft gate mix is achieved by allocating the forecast of NBEG to provide a supply of gates which is consistent with the forecast fleet mix. Considered in the development of the aircraft gate mix is a provision for dedicated commuter aircraft gates, and an increase in the average wingspan and capacity of the typical aircraft serving the airport. The aircraft gate forecast is presented in Table 4-8.

An important sub-category of the gate forecast is the group of gates capable of accommodating international arrivals. These gates are defined as those which provide a segregated and direct means for the deplaning international passengers to walk from the aircraft to the (FIS) international arrivals lobby. International gates should be planned to alternatively accommodate domestic operations wherever the architectural configuration of the concourse will allow.

At Sea-Tac, all thirteen of the gates on the South Satellite (21.8 NBEG) provide access to the FIS area, although their use for international traffic is limited by the mix of aircraft currently configured at the satellite and by the exclusive long-term leases held on many of the gates. As a result, not all of these FIS-capable gates are utilized simultaneously for international arrivals, even during the peak period. Based upon the Official Airline Guide (OAG) schedule for August 1993 (Table 4-7), the peak simultaneous demand by scheduled airlines is for four international gates. The baseline 1993 international gate demand has therefore been estimated to be a total of four gates used during the deplaning peak with one additional B747 gate for use by future, non-scheduled, and charter carriers.

This baseline international gate demand, combined with the number of average daily international departures results in a gate turnover statistic of 0.73 turns per international NBEG/day. Compared to other international terminals of a similar size, these are relatively low utilization statistics. In general, a criteria of 1.5 to 3.0 turns per NBEG per day is a more typical level of utilization at international terminals. These utilization statistics are typically lower than those for domestic gates because of the long turnaround times, and scheduling necessities of inter-continental travel. The international gate utilization at Sea-Tac is therefore forecast to increase by 68% to a level of 1.23 turns per NBEG/day by the year 2020. This is a significant improvement but is still somewhat low as compared to other international airports.

By considering future changes in the fleet mix at Sea-Tac, it is possible to estimate the number of gates required at the airport in a fashion

TABLE4-8

Aircraft Gate Forecasts

	Actual	Forecast			Units
Year	1993	2000	2010	2020	
TOTAL AIRCRAFT GATES					
ESTIMATED REQUIREMENT					
Avg. Day Peak Month Enpl.	36,500	46,200	59,400	74,200	Enpl.
Seats Per Departure	82.7	89.4	99.9	111.7	Seats/Dep
Average Load Factor	64.2%	65.2%	68.5%	67.8%	Pax/Seats
Departures/NBEGate/Day	7.64	7.77	7.95	8.14	Deps/NBE
NBEGates Required	89.9	102.1	112.4	120.3	NBEGates
NOMINAL GATES					
Group V (B747)	12	14	16	18	Gates
Group IV (widebody)	14	16	18	20	Gates
Group III (narrowbody	48	52	54	56	Gates
Group II (lg. commuter)	1	4	6	6	Gates
Group I (sm. commuter)	–	–	–	–	Gates
Total Nominal Gates	75	86	94	100	Gates
Total NBEGates	89.9	102.4	112.2	120.6	NBEG
Equivalent Ramp Frontage	12,100	13,800	15,100	16,300	LF
Annual Passengers/NBEGate	209,000	232,000	273,000	317,000	Pax/NBEG
INTERNATIONAL GATES [1]					
ESTIMATED REQUIREMENT					
Avg. Day Peak Month Enpl.	1,200	2,000	2,700	3,500	Enpl.
Seats Per Departure	269.6	273.5	279.2	285.0	Seats/Dep
Average Load Factor	70.8%	71.6%	72.8%	74.0%	Pax/Seats
Departures/NBEGate/Day	0.73	0.84	1.02	1.23	Deps/NBE
NBEGates Required [2]	8.6	12.2	13.1	13.5	NBEGates
NOMINAL GATES				105.7%	
Group V (B747)	3	4	5	5	Gates
Group IV (widebody)	2	4	4	5	Gates
Group III (narrowbody	–	–	–	–	Gates
Group II (lg. commuter)	–	–	–	–	Gates
Group I (sm. commuter)	–	–	–	–	Gates
Total Nominal Gates	5	8	9	10	Gates
Total NBEGates	8.2	12.8	14.6	16.0	NBEG
Equivalent Ramp Frontage	1,100	1,700	2,000	2,200	LF
Annual Passengers/NBEGate	80,000	78,000	82,000	100,000	Pax/NBEG

[1] Requirement for gates with access to FIS areas for international arrivals. These gates are a sub-set of Total Aircraft Gates.

[2] Includes one additional gate for charter/non-scheduled operations.

similar to that used above for total airport gates. The size of the average international aircraft currently serving Sea-Tac is already relatively large, with the typical aircraft being a B767-300. While aircraft with larger capacities are being designed, a more likely scenario is for a continued increase in the use of wide-body, twin and tri-jets on the long, thin international routes from Seattle. The general impact of the introduction of this type of equipment would be an increase in frequency and a slight increase in average capacity. Aircraft representative of this group are the B767, MD11, and the future B777. It is estimated that a 5% increase in the average seating capacity will be achieved from a shift towards the larger of these twin and tri-engine aircraft. Finally, a 3% increase in the average load factor has been forecast over the next 30 years reflecting higher loads required to maintain profitability. The resulting forecast international gate requirements are also shown in Table 4-8.

TERMINAL AREA REQUIREMENTS

The criteria used in the development of individual program elements are discussed in greater detail in each individual section. Many of the passenger facilities are keyed to enplaned or deplaned peak hour activity. This ensures that facilities increase in direct proportion with the increase in peak activity rather than average daily activity. Distinctions have been drawn between facilities serving international passengers, domestic passengers, or in some cases both. Some space requirements are determined by other functional elements of the terminal. For instance, the baggage claim area is related directly to the size of the claim devices required.

Some of the sizing criteria used in the analysis are design standards which were modified to meet the needs of an airport with the activity level and characteristics of Sea-Tac. These design standards have been developed and revised over several years from a wide cross-section of U.S. and foreign airports and terminal buildings. Specifics considered in the selection of sizing criteria include passenger activity characteristics, the number of airlines, and interests expressed in additional or expanded passenger and tenant services.

It is important to note that this facilities program assumes the accommodation of forecast passenger activities under two terminal configurations. The first of these is a centralized terminal concept similar to that of the 1985 Master Plan and the Terminal Development Program (TDP). The second is the development of either a new north or south unit terminal supplemented by the continued use of the existing terminal complex. Because the centralized terminal is to be expanded from the existing terminal, the opportunities which may be available to implement the facilities forecast in the program may be somewhat constrained. Where practical, these constraints have been accounted for in developing the facility program.

Holdroom and Concourses

Holdrooms should be sized for the largest type of aircraft serving each gate. The area requirements for each type are calculated by taking the typical maximum seating configuration of this aircraft at an 80% load factor, and allowing 15 square feet (SF) per passenger. This results in an average holdroom design standard of approximately 4,800 SF for B747 holdrooms, 3,600 SF for wide-body holdrooms, 1,800 SF for narrowbody holdrooms, and 600 SF for commuter holdrooms. If any B757-specific aircraft parking positions are planned, these would require a 2,400 SF holdroom.

Holdroom areas may be combined in a contiguous area to achieve additional operating efficiencies. The ability to cross-utilize holdroom areas results in a potential space reduction of 10% to 20% of the sum of the individual area requirements. A 10% reduction may be considered a reasonable factor for a common holdroom area serving two or more gates. These holdroom areas include the provision for check-in podiums and the circulation to the loading bridge from the public concourse.

Overall concourse areas may also be estimated from the gate forecasts. The length of concourse required may be estimated from the NBEG frontage requirements using 135' per NBEG (assuming 25' wingtip clearance for a typical narrowbody). This length may be combined with a typical concourse width of 90' for double-loaded and 60' for single loaded concourses to estimate gross floor area required for each. Both passenger level and ramp level space have been included in this area estimate.

Forecasts of the incremental increase in holdroom and concourse areas required to meet the forecast gate requirements are provided in Table 4-9. These forecasts suggest a need for somewhere between 150,000 to 200,000 square feet of new concourse area between the years 2000 and 2005. By the year 2020 the existing concourses will need to expand by 380,000 to 500,000 square feet to accommodate forecast gate requirements.

Ticketing Area

Ticketing area requirements are generally based upon the number of originating peak hour enplaning passengers and a continuation of the frontal ticketing arrangement which exists today. While the peak hour statistic provides a rough measurement of the number of passengers to be accommodated, there are several other important factors which also have a bearing on the needs for ticketing in the terminal. The most important of these factors is the number of airlines serving the airport. Because each airline typically requires it own space regardless of the aggregate peak hour demand, airports with a large number of airlines typically have above average ticketing requirements relative to the peak hour activity.

Two additional assumptions were therefore used in developing the forecast ticketing requirements for Sea-Tac. The first of these is an increase in the number of airlines serving Sea-Tac in the future. While many airports today are faced with airline consolidation, of more importance at an international terminal such as Sea-Tac is the globalization of the airline industry. In this globalization, competing airlines will begin service to a broader number of markets which may include Sea-Tac. In addition, the growth of low-cost, short-haul carriers may result in new tenants at Sea-Tac as well.

Secondly, consideration has been given to estimating the ticketing required under both the baseline scenario of a single centralized terminal, and the alternative scenario of both the existing and a new unit terminal. In the case of the latter, the ticketing requirements of the two buildings have been based on the airlines and peak hour activity being divided between the two buildings according to the methodology described earlier in this report.

These two assumptions are combined with the NBEG forecast to result in the estimated ticket counter frontage forecast for Sea-Tac (Table 4-10). These results are generally consistent with those of the TDP, but show somewhat greater ticketing required in the 2020 timeframe. In the case of a single centralized terminal an additional 570 ft. of counter is required by the year 2020. With a new unit terminal, most of future requirements can be accommodated within the new unit terminal but some expansion of the existing terminal would

TABLE 4-9

Holdroom and Concourse Forecasts

	Actual	Forecast			Units
Year	1993	2000	2010	2020	
Nominal Gates					
Group V (B747)	12	14	16	18	Gates
Group IV (widebody)	14	16	18	20	Gates
Group III (narrowbody	48	52	54	56	Gates
Group II (lg. commuter)	1	4	6	6	Gates
Group I (sm. commuter)	0	0	0	0	Gates
Total Nominal Gates	75	86	94	100	Gates
Total NBEGates	89.9	102.4	112.2	120.6	NBEG
Equivalent Ramp Frontage	12,100	13,800	15,100	16,300	LF
New Holdroom Area					
Group V (B747)	NA	9,600	19,200	28,800	SF
Group IV (widebody)	NA	7,200	14,400	21,600	SF
Group III (narrowbody	NA	7,200	10,800	14,400	SF
Group II (lg. commuter)	NA	1,800	3,000	3,000	SF
Group I (sm. commuter)	NA	0	0	0	SF
Total New Area	NA	25,800	47,400	67,800	SF
Total Holdroom Area	127,270	153,070	200,470	268,270	SF
New Concourse Area [1]					
Double Loaded (90' wide)	NA	150,000	270,000	380,000	SF
Single-Loaded (60' wide)	NA	200,000	360,000	500,000	SF
Mixed Configuration	NA	180,000	320,000	440,000	SF
Total Concourse Area					
Double Loaded (90' wide)	NA	940,000	1,060,000	1,170,000	SF
Single-Loaded (60' wide)	NA	990,000	1,150,000	1,290,000	SF
Mixed Configuration	790,000	970,000	1,110,000	1,230,000	SF

[1] Concourse area assumes development of both passenger and ramp levels

TABLE 4-10

Ticket Counter Requirements

	Actual	Forecast			Units
Year	1993	2000	2010	2020	
CENTRALIZED TERMINAL ALTERNATIVES					
Existing Terminal					
PeakHour Orig. Enpl.	2,800	3,500	4,400	5,200	Pax
Number of Airlines	22	22	24	26	Airlines
Counter Frontage	1,116	1,250	1,480	1,690	LF
Additional Required		130	360	570	LF
Counter Area	11,100	13,000	15,000	17,000	SF
ATO Area	39,000	31,000	37,000	42,000	SF
Lobby Area	29,000	56,000	67,000	76,000	SF
Total Ticketing	79,100	100,000	119,000	135,000	SF
NEW UNIT TERMINAL ALTERNATIVES					
Existing Terminal					
PeakHour Orig. Enpl.	2,800	2,600	3,300	3,900	Pax
Number of Airlines	22	15	17	18	Airlines
Counter Frontage	1,116	905	1,080	1,235	LF
Additional Required	0	(210)	(40)	120	LF
Counter Area	11,100	9,000	11,000	12,000	SF
ATO Area	39,000	23,000	27,000	31,000	SF
Lobby Area	29,000	41,000	49,000	56,000	SF
Total Ticketing	79,100	73,000	87,000	99,000	SF
New Unit Terminal					
PeakHour Orig. Enpl.		1,300	1,600	1,900	Pax
Number of Airlines		7	7	8	Airlines
Counter Frontage		425	500	575	LF
Additional Required		430	500	580	LF
Counter Area		4,000	5,000	6,000	SF
ATO Area		11,000	13,000	14,000	SF
Lobby Area		19,000	23,000	28,000	SF
Total Ticketing		34,000	41,000	48,000	SF

likely still be required to meet forecast 2020 requirements.

The forecast for the ticketing counter area reflects a typical depth of 10 feet from the front of the counter to the backwall. The lobby area requirement reflects 25 feet of queuing and service space in front of the ticket counter and 20 feet for lateral circulation between the queuing area and the curbside entrances. This results in a minimum depth of 45 feet which could be increased to 60 feet or more depending on the specifics of the terminal design. Currently, the depth available for queuing at most ticket counters at Sea-Tac is 26 feet, not including the waiting areas located between the ramps and the curb.

An example of the lobby depth recommended in this facilities program is at the Northwest ticket counter which has been set back an additional 20 feet within the ticketing lobby. With the potential for increased security requirements for screening and x-raying checked baggage at the ticket counter in the future, additional demands may be placed upon the ticketing area than are experienced today. If possible, any expansion or reconfiguration of the ticketing lobby should recognize these changes and add lobby depth wherever feasible.

One alternative to providing additional queuing would be to convert the existing ticketing facilities to a flow-through arrangement similar to that used in Terminal 1 at Chicago-O'Hare. While this flow-through arrangement would make good use of the depth of the existing terminal, it would also necessitate extensive reconfiguration of the outbound baggage system and relocation of numerous concessions. In addition, the flow-through configuration typically requires over twice the frontage per agent as compared to a more conventional frontal arrangement. A flow-through configuration would therefore also require greater overall ticketing frontage than has been accounted for in the facility forecasts contained herein.

Baggage Processing Areas

Baggage areas are an increasing constraint on the continued growth of the terminal at Sea-Tac. With expansion of the terminal in the future, these baggage constraints pose a considerable problem to providing a high level of passenger service at reasonable cost. The areas considered in the baggage program include outbound sortation areas, interline transfer and re-check-areas, and the inbound drop areas to the international and domestic systems.

The existing baggage processing areas at Sea-Tac include a variety of systems, equipment, and locations. Some of these are intermixed, and some are exclusive in serving the needs of the various airlines. The forecasts of baggage handling requirements presented in Table 4-11 include assumptions regarding future changes to existing systems and are discussed in greater detail in the following text and elsewhere in this report.

Outbound Baggage Area

The outbound baggage area required at Sea-Tac may vary considerably depending on whether the airlines share a common make-up facility, or whether each airline operates its own exclusive system. In addition, the actual area requirements will be influenced by the location and type of baggage sortation equipment selected. In some terminals with large, automated sortation systems, outbound baggage areas have been located on the ramp underneath the concourses while at other terminals the sorting area is located in an area behind or beneath the ticketing lobby within the terminal building. Outbound baggage equipment available varies considerably and includes laser

TABLE 4-11

Outbound Baggage Requirements

	Actual	Forecast			Units
Year	1993	2000	2010	2020	
CENTRALIZED TERMINAL ALTERNATIVES					
Existing Terminal					
NBEGates	89.9	102.4	112.2	120.6	NBEG
Outbound	95,500	138,000	151,000	163,000	SF
Interline	14,200	17,000	19,000	20,000	SF
Domestic Input	18,000	32,000	38,000	46,000	SF
International Input	2,500	14,000	20,000	28,000	SF
Total	130,200	201,000	228,000	257,000	SF
NEW UNIT TERMINAL ALTERNATIVES					
Existing Terminal					
NBEGates	89.9	71.7	78.5	84.4	NBEG
Outbound	95,500	97,000	106,000	114,000	SF
Interline	14,200	12,000	13,000	14,000	SF
Domestic Input	18,000	24,000	30,000	35,000	SF
International Input	2,500	6,000	12,000	17,000	SF
Total	130,200	139,000	161,000	180,000	SF
New Unit Terminal					
NBEGates		30.7	33.7	36.2	NBEG
Outbound		41,000	45,000	49,000	SF
Interline		5,000	6,000	6,000	SF
Domestic Input		14,000	16,000	19,000	SF
International Input		14,000	16,000	19,000	SF
Total		74,000	83,000	93,000	SF

sortation spur systems, indexing belts, oval and sloped bed devices, automated cart delivery systems and others. Several of these are currently in use at Sea-Tac.

The current layout at Sea-Tac combines both sloped-bed and racetrack type devices in a mix of exclusive and joint use areas at the terminal, with exclusive pier-sort areas for United on the North Satellite and a similar facility for Alaska Airlines on Concourse D. Because of the potential changes required in the terminal to accommodate both baggage claim and an expanded outbound and interline system, an expanded pier-sort system has been considered as the basis for the forecasting of new additional baggage area requirements.

The forecast outbound baggage requirement is based on providing approximately 1,350 square feet of make-up space (a 90x15 foot module) for each sort-pier exclusive of any inbound baggage drop-off areas and drives. This module provides space for a drive-thru, pier-sort configuration large enough to accommodate a parked four-cart train with lateral vehicular drives on either end of the spur. This estimate does not include any additional area for cart storage, manual or automated encoding stations, or conveyor runs to and from the check-in areas. These support areas are highly dependent on the type of installation and may be located in interstitial levels or below or above the spurs. An example of the variation which can occur is the existing pier sort on the North concourse which provides approximately 2,185 square feet per sort-pier.

The outbound baggage program includes one sort-pier programmed for each NBEG. While the North Satellite, for example, has 12 piers and 17.6 NBEG, providing one pier for each NBEG provides the flexibility to provide a separate pier for each flight, as well as to designate multiple piers for aircraft with large baggage loads, or to further sort destinations on flights with large volumes of connecting baggage or separate classes of service. Although this area is identified as one large common area, it could also be broken into separate units located in proximity to gates at individual areas of the terminal.

Interline Sortation

Interline baggage is a major concern at Sea-Tac because of the significant number of connecting passengers at the airport. As mentioned previously, there are a number of different types of systems, each of which has its own space and functional requirements. The forecast presented below is based upon a pier type input arrangement at each pier-sort location. Each of these leads to a station for manual encoding and distribution into the pier-sort system.

One interline input pier has been estimated for each group of eight NBEG. Each location should be planned for at least two, if not more, of these stations to accommodate expected volumes and provide redundancy. Each input station would be tied into a manual or automated encoding station serving both interline baggage into the sort- pier system, and providing a re-coding station to catch bags which may have missed their pier in their first circuit of the system.

Inbound Baggage Drop-off

The existing inbound baggage input stations are a mixture of feed belts serving both round and oval sloped bed devices in the baggage claim area. Flat-plate recirculating devices within the bagwell area are accessed in a similar manner. Currently this function is interspersed with outbound baggage sort areas throughout the bagwell in the Sea-Tac terminal.

To accommodate peak period volumes and to provide redundancy the forecast for inbound baggage claim input requirements is based upon the provision of two input feed belts serving each 80x20 foot sloped bed claim device. This is analogous to the existing layout in which each 30 foot round device is served by one feed belt. The design module for this area includes a 60x25 foot lane for cart unloading with a bypass lane.

The future inbound baggage area may be integrated as a part of the outbound baggage area or it may be independent, depending on the configuration of the building. An independent area may require some additional area for baggage cart entry, exit, and circulation to the area. With remote fed baggage claim devices, this inbound area may be on a different level in the terminal and remote from the bag claim area, although the distance from the claim area should be minimized to reduce the cost and maintenance of the conveyor system.

Domestic Baggage Claim

The domestic baggage claim is a critical component of the efficient functioning of the terminal building. The existing claim area has not been expanded appreciably since the construction of the new terminal in the 1970's and is becoming increasingly overtaxed. The existing claim area at the terminal is a mix of several different types of claim devices. These include ten round, two oval and four flat plate devices each providing a range between 80 to 200 feet of claim device frontage. Half of the units are 80 foot round devices.

Although the terminal currently has 75 gates, its 16 domestic baggage claim devices provide only a total claim frontage of 1760 linear feet to serve these gates, for an average of over four gates per 110 claim device. As measured by ramp frontage, this supply/demand ratio further increases to over five NBEG per claim device.

While an adequate claim frontage appears to exist in aggregate, the distribution and location of these devices throughout the terminal may be insufficient to serve the peak demands within each individual claim area or sub-component. It is further recognized that as the concourses and satellites are expanded in length, the probability of bags arriving in the claim area ahead of the passenger becomes greater. This is already the case with some flights arriving at the North and South Satellites. When this occurs, unclaimed baggage accumulates on the device necessitating the off-loading and storage of the bags by airline personnel as the device begins to overload. Replacement of existing flat-plate and round devices with larger, sloped-bed claim devices would mitigate some of the need for this manual handling of bags and might eliminate it altogether due to the higher storage capacity of the sloped bed device.

The baggage claim area program, is predicated on 60% of the peak hour terminating passengers arriving with 1.4 bags each in the peak 30 minute period. These demand loads have been multiplied by a factor of 1.5 to account for the separate claim locations in the terminal which essentially function as independent claim areas during peak periods. The total claim frontage requirement is then estimated on the basis of comprehensive use of sloped bed claim devices. These criteria result in demand for total claim frontage which is slightly greater than that existing in the terminal today at current passenger loads, but with additional storage capacity provided in the larger sloped bed claim devices (as compared to the flat plate devices which exist today).

The number of claim devices required to meet the overall claim frontage requirement has been estimated throughout the forecast period using a

20x80 foot sloped-bed device which provides approximately 183 linear feet of frontage. This claim device size is typical of that used for widebody arrivals at many airports, but may also be used to serve multiple narrowbody arrivals. The baggage claim area requirement (including the device) is estimated to provide a 15 foot clear area around the perimeter of each device. Additional circulation in and around the claim area is not included in this estimate. The estimated program requirements for both continued expansion of the existing terminal, and development of new unit terminals are provided in Table 4-12.

International Arrivals Area

Because of the recent decline in international traffic to Sea-Tac, the need for additional Federal Inspection Services (FIS) areas to meet forecast requirements is virtually nil well into the twenty-first century. Peak hour enplanements in 1990 were estimated at 1,100 passengers per hour, while the current estimate falls closer to 400. At the same time, various terminal concepts suggest the relocation of international arrivals area to a more convenient landside location. In order to avoid under-designing any future facilities because of a temporary lapse in demand, international arrivals facilities have been keyed to incremental demand milestones rather than forecast demand.

The area requirements for the FIS areas are determined largely by comparing peak-hour international passenger forecasts to standards provided by the various FIS agencies. Because these agencies must approve of any facilities to be built, the use of these standards is important, even though there are sometimes concerns regarding the ability of the various agencies to adequately staff the facilities so designed. For planning purposes, the following program has been based upon the continuation of international arrivals processing at one centralized location on the airport, which appears to be the likely development scenario given FIS policies.

The most current guidelines for sizing the international facilities have been used although it is understood that customs has recently begun to revise space standards and operating procedures to reflect limited manpower availability and increased workload at most airports. The thrust of this change is aimed at the selective screening of passengers on a high- or low-risk basis, and by the use of 'rovers' in the claim area to identify suspicious passengers for further interviews or searches. As an adaptation of the 'red/green' procedure used in Europe, this technique further reduces the size of customs primary and secondary areas in the terminal.

Immigration/Naturalization Service (INS) screening requirements have been forecast by evaluating the peak hour international arrivals forecasts at an average processing rate of 50 passengers per hour per agent (72 seconds per passengers) which is an FIS standard. While higher average throughput rates may be achieved, this average rate has been demonstrated to be a reasonable design level for international terminal arrivals which occur primarily in the Pacific region. Individual station areas have been calculated on the basis of a 14 foot wide double agent tandem module, with approximately fifty feet of queuing area in front of the primary inspection station.

The international baggage claim area program has been estimated utilizing a similar criteria to that of the domestic claim area with changes in some of the input variables. For instance a higher bag/passenger ratio (1.7 bags per passenger) has been applied to the peak hour international passenger forecast to estimate the number of bags arriving in the area. Because of the potential build-up of bags during the INS

TABLE 4-12
Baggage Claim Requirements

Year	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020	Units
CENTRALIZED TERMINAL ALTERNATIVES					
Existing Terminal					
Peak Hour Terminating Depl.	2,700	3,400	4,100	4,900	NBEG
Device Frontage	1,763	2,140	2,580	3,090	LF
Number of Devices[1]	16.0	12.0	14.0	17.0	Units
Area	53,000	66,000	77,000	94,000	SF
NEW UNIT TERMINAL ALTERNATIVES					
Existing Terminal					
Peak Hour Terminating Depl.	2,025	2,600	3,100	3,700	NBEG
Device Frontage	1,763	1,640	1,950	2,330	LF
Number of Devices[1]	16.0	9.0	11.0	13.0	Units
Area	53,000	50,000	61,000	72,000	SF
New Unit Terminal					
Peak Hour Terminating Depl.		1,300	1,500	1,800	NBEG
Device Frontage		820	950	1,130	LF
Number of Devices[1]		5.0	6.0	7.0	Units
Area		28,000	33,000	39,000	SF

[1] Future Claim units assume 20x80' sloped bed units.

screening process and the variability in international arrivals schedules, it has also been assumed that the design peak for the claim area should be based upon the entire hour rather than the peak half hour. In addition, the design claim unit has been changed from a 20x80 foot sloped bed device to a 20x100 foot sloped bed device to provide a total of 220 linear feet of frontage in each claim device in recognition of the high proportion of B747 arrivals and higher baggage volumes anticipated. Customs primary screening areas are assumed to provide a similar area to that provided today. Queuing in this area has been estimated at 40 feet from the face of the primary inspection station.

FIS agency office areas are assumed to grow at a rate of approximately 250 square feet per additional INS primary agent. This additional space however would be divided among the various agencies at the terminal. A summary of the various FIS area requirements are provided in Table 4-13.

Tenant and Port Storage Areas

The inventory and plans of the terminal do not, for the most part, identify storage areas separately and requests for additional space in the terminal do not highlight any atypical high requirements for storage areas in the terminal. Each component of the terminal should be developed to accommodate some additional storage capacity as it is expanded.

Corridor and Public Services Areas

Typical corridor widths vary based upon the type of traffic flow, existing architectural considerations, and the consideration of any mechanical aids which might affect circulation in the concourse. In general, a width of 30 feet is considered adequate for two-way passenger movement in an unobstructed concourse. In situations where architectural considerations prohibit this dimension, no less than 25 feet should be provided at all points on the concourse and these areas should be free of obstructions or hindrances to passenger flow. In areas where there are a great number of lateral passenger movements, typically at the base of a long concourse or near a concentration of concessions and passenger services, a width of 35 to 40 feet or more may be desirable. Where moving sidewalks are provided within the concourses, a minimum of 16 feet clear on either side should be provided.

In ticketing and baggage claim areas, approximately 20 feet of clearance should be provided for circulation to and around the primary queuing and processing areas. The pedestrian connections from these areas to the concourses should be designed to the same dimensional criteria as the concourses wherever possible. In other, less intensively used parts of the terminal, a more relaxed standard may apply.

Concourse lengths are determined by the number of aircraft parked at the concourse. At lengths greater than 950-1,000 linear feet, moving sidewalks or some other form of people mover should be considered for passenger convenience. At lengths greater than 1,200-1,500 linear feet, some form of people mover (automated vehicle or moving sidewalk) becomes imperative. While walking distances greater than this do occur without mechanical aids at some airports, passenger acceptance is generally negative and service levels are deteriorated.

Security Screening

The requirements for the screening of passengers is an additional area of concern in the design of the near-term and long-term expansions of the terminal complex at Sea-Tac. There are currently six points at which passengers are screened in the existing terminal.

TABLE 4-13
International Arrivals Area

	Actual	Forecast			Units
Year	1993	2000	2010	2020	
Peak Hour International Depl.[1]	400	1,200	1,600	2,400	Pax
Immigration					
Primary Inspection Stations	22	24	32	48	stations
Area Required (including que	16,700	15,000	20,000	30,000	SF
Baggage Claim Area					
Frontage	575	1,080	1,440	2,160	LF
Number of devices [2]	4	5	7	10	Units
Area	24,400	42,000	59,000	84,000	SF
Customs					
Primary Inspection Stations	14	12	16	24	stations
Area Required (including que	7,300	5,000	6,000	9,000	SF
Secondary Inspection Stations	10	12	16	24	stations
Secondary Area	6,200	3,000	3,000	5,000	SF
Misc. Offices/Circulation/Other	39,800	20,000	22,000	26,000	SF
Total Area	94,400	85,000	110,000	154,000	SF

[1] Forecast requirements based on milestone activity levels rather than forecast demand.
[2] Future Claim units assume 20x100' sloped bed units

Four of these points lead to the four concourses and are located on the ticketing level of the terminal. The other two checkpoints are located on the platforms of the transit system (STS) in the lower level of the terminal.

To investigate the specific nature of how passenger peaking might affect the four stations, the August 1990 schedule of operations was analyzed in the TDP using a distribution based simulation model to estimate the number of passengers entering the terminal complex in ten minute intervals throughout the day. The schedule for the airlines on each concourse were analyzed separately to evaluate the demand at each screening point.

For the ultimate configuration of the terminal, as defined in the TDP, additional gates would be added to Concourse A, and to the North and South Satellites. The passenger demand at the screening points serving these areas has been assumed to increase in proportion to the increase in NBEG (Table 4-14).

It is apparent from the estimates above that the existing screening points in the terminal are generally capable of adapting to the pre-2000 increases in passenger peaking resulting from the increased gate utilization at Sea-Tac. In the timeframe past the year 2000 however, the expanded number of gates, particularly on the North and South Satellites, could require an increase in screening station capacities which may exceed the physical limitations of the areas in which they are currently located.

People Mover System

The requirements for supplementing or adding capacity to the people mover system is an additional area of concern in the design of the long-term expansion of the terminal complex. The segments with the greatest sensitivity to increases in demand are the two segments running from the satellites to the terminal area which serve not only passengers arriving and departing from these satellites, but are also used by passengers connecting from one part of the terminal to the other.

In order to study the specific nature of how passenger peaking affected the people mover system, the 1990 Terminal Development Plan used a distribution based simulation model to estimate the number of passengers entering the terminal system on a 10 minute interval throughout the day. The schedule for the tenants of each satellite were analyzed separately to determine the peak 10 minute demand by deplaning passengers. The resulting data was evaluated using a load factor of 90% and a meeter greeter ratio of 0.35.

Because of the uncertainty regarding how and where connecting passengers might use the system, all passenger arrivals at the satellites were assumed to require the use of the people mover system to return to the terminal, a worst case scenario. The resulting 10 minute passenger and visitor demand levels along this critical link were tested with the capacity of three different people mover system configurations. These system capacities are presented below:

Peak 10 Minute One-Way People Mover System Capacities (85 passenger cars)

2 2-Car trains 120 second headway	= 850 pax/10 minutes
3 2-Car trains 90 second headway	= 1,133 pax/10 minutes
2 3-Car trains 120 second headway	= 1,275 pax/10 minutes

Table 4-14

Security Screening Requirements [1]

Design Year	1994	2000	2020
Concourse A [2]			
NBEGates	7.8	7.8	7.8
Peak 10 min. demand	79	122	297
Units Required	1.0	1.0	3.0
Concourse B			
NBEGates	14.0	14.0	14.0
Peak 10 min. demand	127	219	219
Units Required	1.0	2.0	2.0
Concourse C			
NBEGates	17.8	17.8	17.8
Peak 10 min. demand	248	278	278
Units Required	2.0	3.0	3.0
Concourse D			
NBEGates	11.0	11.0	11.0
Peak 10 min. demand	123.2	172	172
Units Required	1.0	2.0	2.0
North Satellite [2]			
NBEGates	16.6	16.8	33.4
Peak 10 min. demand	203	260	523
Units Required	2.0	3.0	5.0
South Satellite [2]			
NBEGates	21.8	21.8	32.0
Peak 10 min. demand	278	341	501
Units Required	3.0	3.0	5.0

Notes:

[1] Based on analysis provided in the 1991 Terminal Development Plan

[2] Assumes maximized development with a centralized terminal concept (ie. Alt. A1)

In order to forecast peak ridership in the future, two additional assumptions were made in the TDP study. The first was that the peaking factor would increase by 28% on a per gate basis resulting from the increased utilization expected. In the ultimate configuration of the terminal, as defined in both the TDP and the Master Plan, additional gates would be added to the North and South Satellites. The ridership demand on the two loops has been assumed to increase proportionate to this increase in gates. The results of this analysis are provided in Table 4-15.

It is apparent from these calculations that the existing system should be capable of accommodating the projected pre-2000 increase in demand resulting from higher gate utilization, but may fall short of accommodating the ultimate expansion of the two satellites. Either of the two expansion alternatives are estimated as adequate to meet the additional ridership demand resulting from the expansion of these concourses, but the narrow margin of capacity in each of these scenarios is reason for concern. Increased dependence on the 30-year old STS system as the sole means of serving the north and south satellites, even with expansion, may therefore be undesirable and alternative means of providing access to these gates may become an important design feature. The exact configuration and capacity of this alternative system will need to be evaluated separately for each terminal layout should be considered.

Concession Spaces

The concession space requirements throughout the terminal have been described in greater detail in the Gateway 90 Study. The thrust of the study was to expand and unify the concession offerings in the terminal in an effort to enhance passenger convenience, and to increase airport revenues. The results of the Gateway 90 Study should be carefully considered in any further expansions of the size or capacity of the terminal including the satellites and concourses.

It is worth noting that some of the recommendations of the Gateway 90 Study may impact some of the potential alternatives for the long-term expansion of the ticketing lobby in the western half of the terminal. As ticketing alternatives are developed the needs for ticketing versus concessions locations should be re-examined with regard to the importance of one function over another.

Maintenance Facilities

Terminal maintenance facilities are influenced by the long-range terminal configuration and by the capacity and future life of the existing systems in the terminal. The area requirements of any future maintenance facilities will need to be related to the configuration of the terminal, and the location of the various mechanical, electrical, HVAC other terminal systems within the terminal. Both the mid- and long-range terminal expansion plans must be considered in sizing and locating maintenance facilities.

TERMINAL AREA REQUIRED

In order to judge the impact of the program requirements on the need for new facilities over the forecast timeframe, the individual program elements have been combined to estimate total building area required under both the centralized terminal scenario and the new unit terminal scenario. This estimate is provided in Table 4-16.

The major building elements included in this estimate include the forecasts of concourse, ticketing lobby, baggage claim area, baggage handling areas, and international arrivals processing areas presented in Tables 4-9 through 4-13. In the case of a centralized terminal, an additional 50% is added to any new areas

Table 4-15

Forecast Satellite Transit System Demand as % of Capacity [1]

Design Year	1994	2000	2020
North Satellite [2]			
NBEGates	16.6	16.6	33.4
Peak 10 min. demand	433	554	1114
2- 2 car trains @ 120 sec	51%	65%	insufficient
3- 2 car trains @ 90 sec	38%	49%	98%
2- 3 car trains @ 120 sec	34%	43%	87%
South Satellite [2]			
NBEGates	21.8	21.8	32.0
Peak 10 min. demand	544	727	1067
2- 2 car trains @ 120 sec	64%	86%	insufficient
3- 2 car trains @ 90 sec	48%	64%	94%
2- 3 car trains @ 120 sec	43%	57%	84%

Notes:

[1] Based on analyses provided in the 1991 Terminal Development Plan

[2] Assumes maximized development with a centralized terminal concept (ie. Alt. A1)

TABLE 4-16

Terminal Area Required

	Existing	Forecast			Units
Year	1994	2000	2010	2020	
Design Criteria					
Million Annual Passengers	18.8	23.8	30.6	38.2	MAP
NBEGates	89.9	102.1	112.4	120.3	NBEG

CENTRALIZED TERMINAL ALTERNATIVES

Existing Terminal					
Concourse	790,000	970,000	1,110,000	1,230,000	SF
Ticketing Lobby	79,100	100,000	119,000	135,000	SF
Baggage Claim Area	53,000	66,000	77,000	94,000	SF
Baggage Handling	130,200	201,000	228,000	257,000	SF
International Arrivals	94,400	85,000	110,000	154,000	SF
Total Functional Area	1,146,700	1,422,000	1,644,000	1,870,000	SF
Gross Other	753,300	890,000	1,000,000	1,110,000	SF
Total Terminal Area	1,900,000	2,312,000	2,644,000	2,980,000	SF
Increase from Existing		412,000	744,000	1,080,000	SF
PAX/SF	9.9	10.3	11.6	12.8	MAP/SF
SF/NBEG	21,000	23,000	24,000	25,000	SF/NBEG

NEW UNIT TERMINAL ALTERNATIVES

Existing + New Unit Terminal					
Concourse	790,000	970,000	1,110,000	1,230,000	SF
Ticketing Lobby	79,100	107,000	128,000	145,000	SF
Baggage Claim Area	53,000	78,000	94,000	111,000	SF
Baggage Handling	130,200	213,000	244,000	273,000	SF
International Arrivals	94,400	85,000	110,000	154,000	SF
Total Functional Area	1,146,700	1,453,000	1,686,000	1,913,000	SF
Gross Other	753,300	1,060,000	1,290,000	1,520,000	SF
Total Terminal Area	1,900,000	2,513,000	2,976,000	3,433,000	SF
Increase from Existing		613,000	1,076,000	1,533,000	SF
PAX/SF	9.9	9.5	10.3	11.1	MAP/SF
SF/NBEG	21,000	25,000	26,000	29,000	SF/NBEG

developed to account for building circulation, mechanical areas, passenger amenities, and office areas. For a new unit terminal, this additional area is estimated at double this estimate, or 100% of these major program elements.

In estimating the overall building area, it is important to recognize that the actual building areas required for a given concept may vary considerably from the estimate obtained by summing the forecast of individual major components presented in this report. The mix of tenants, the configuration of the building, the provision for non-functional areas such as offices, and the provision for connections to other terminals or satellites can only be established in coincident with selection of a specific concept and for a specific programming set of goals. While this estimate oversimplifies the sizing of an actual terminal facility, it provides a reasonable basis for comparison of alternative concepts, and the potential building area which might be required over the forecast timeframe. A more detailed design study would be required to further define the requirements specific to a unique terminal expansion concept, and would include consideration of the architecture of the concept plan itself, its tenant mix, and its functional relationship to the existing terminal.

Section 5
DEVELOPMENT AND EVALUATION OF TERMINAL OPTIONS

SECTION 5
DEVELOPMENT AND EVALUATION OF TERMINAL OPTIONS

INTRODUCTION

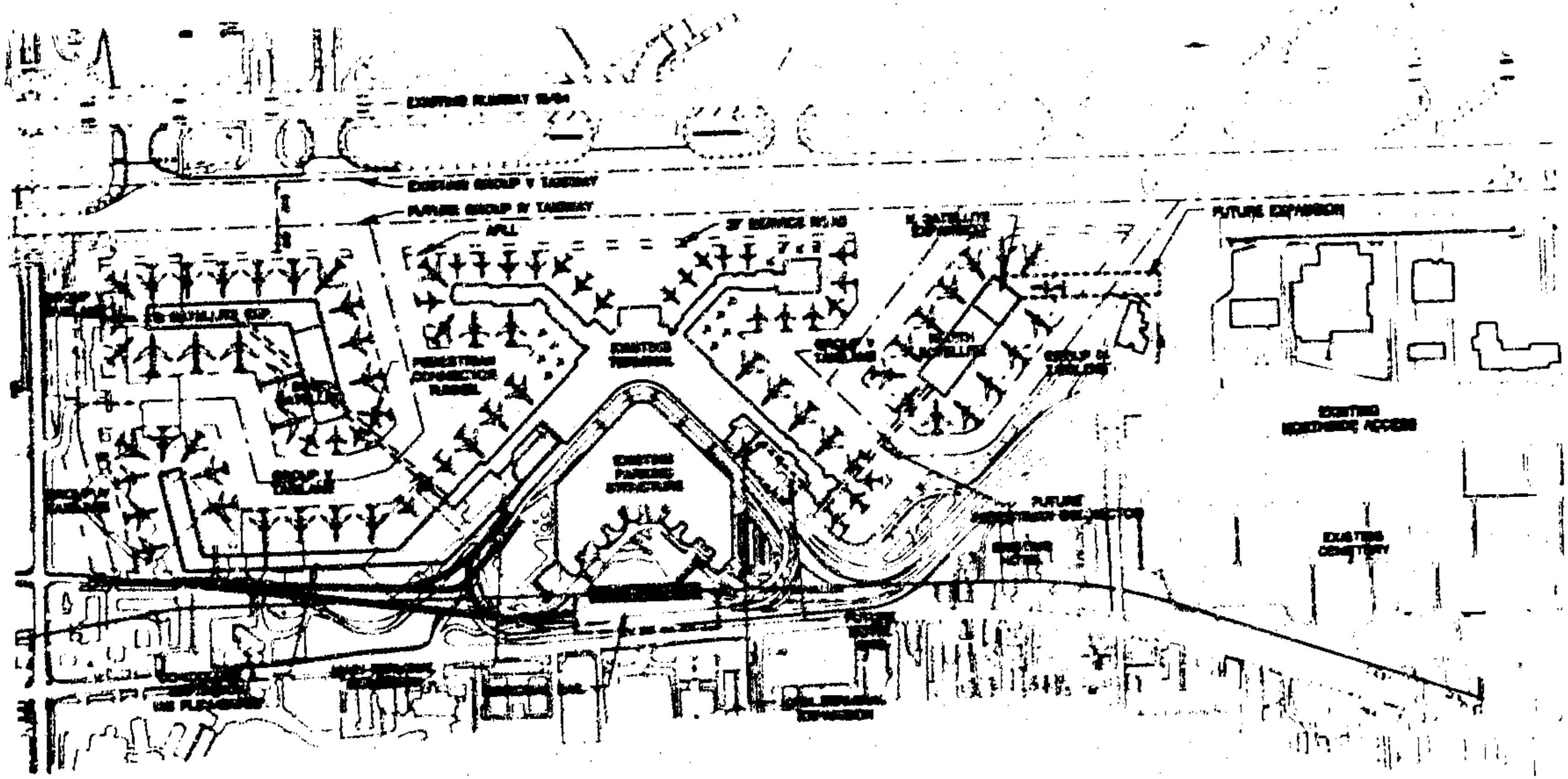
Both the landside and the airside compatibility issues impact the direction that future terminal development will take. As a starting point, a number of terminal airside concepts were developed and reviewed with POS staff. These airside options outlined the gate development opportunities (both with and without a future second parallel east taxiway) and considered the preservation, and complete or partial replacement of all existing terminal gate facilities other than Concourses A and D. The result of this review was the development of a series of planning assumptions and the organization of terminal concepts into three general development areas for subsequent evaluation and review. These planning assumptions and a description of each of the subsequent options are described below:

- Allowance for a new parallel taxiway to the east of the runways and existing parallel taxiway should be included in any long-range terminal expansion option.
- Development of terminal options must consider maximizing tenant flexibility and the potential for incremental expansion.
- Future development of the north and south apron areas need not be symmetrical.
- The main landside approach to the Airport will continue to be provided from the north to maintain the convenience of the regional roadway system. Future south access should be considered regardless.
- Any new gates should be sized to accommodate the maximum existing or planned wingspan aircraft within its design group, and should utilize the aircraft gate module previously described in Figures 3-4 and 3-5.
- Port policies will increase demand for public transit facilities in any terminal concept.
- Increased reliance on the existing Satellite Transit System (STS) should be discouraged. The need for a parallel system of some sort for back-up, flexibility, and supplemental capacity is suggested wherever practical.
- International gates should also be capable of alternatively accommodating domestic operations. Furthermore, recent reductions in the forecast for international traffic may be short term. As a result, the plan should incorporate sufficient flexibility to go beyond the forecast for international gates if necessary.
- The terminal and landside areas should be developed in proportion to the ultimate runway capacity.
- Expanded terminal facilities should be in reasonable proximity to existing facilities in order to gain airline acceptance and to help minimize connect times.

SOUTHSIDE TERMINAL DEVELOPMENT OPTIONS (Figures 5-1 through 5-5)

Of the three terminal development areas investigated, the site to the south of the main

FIGURE 5-1
OPTION A-1



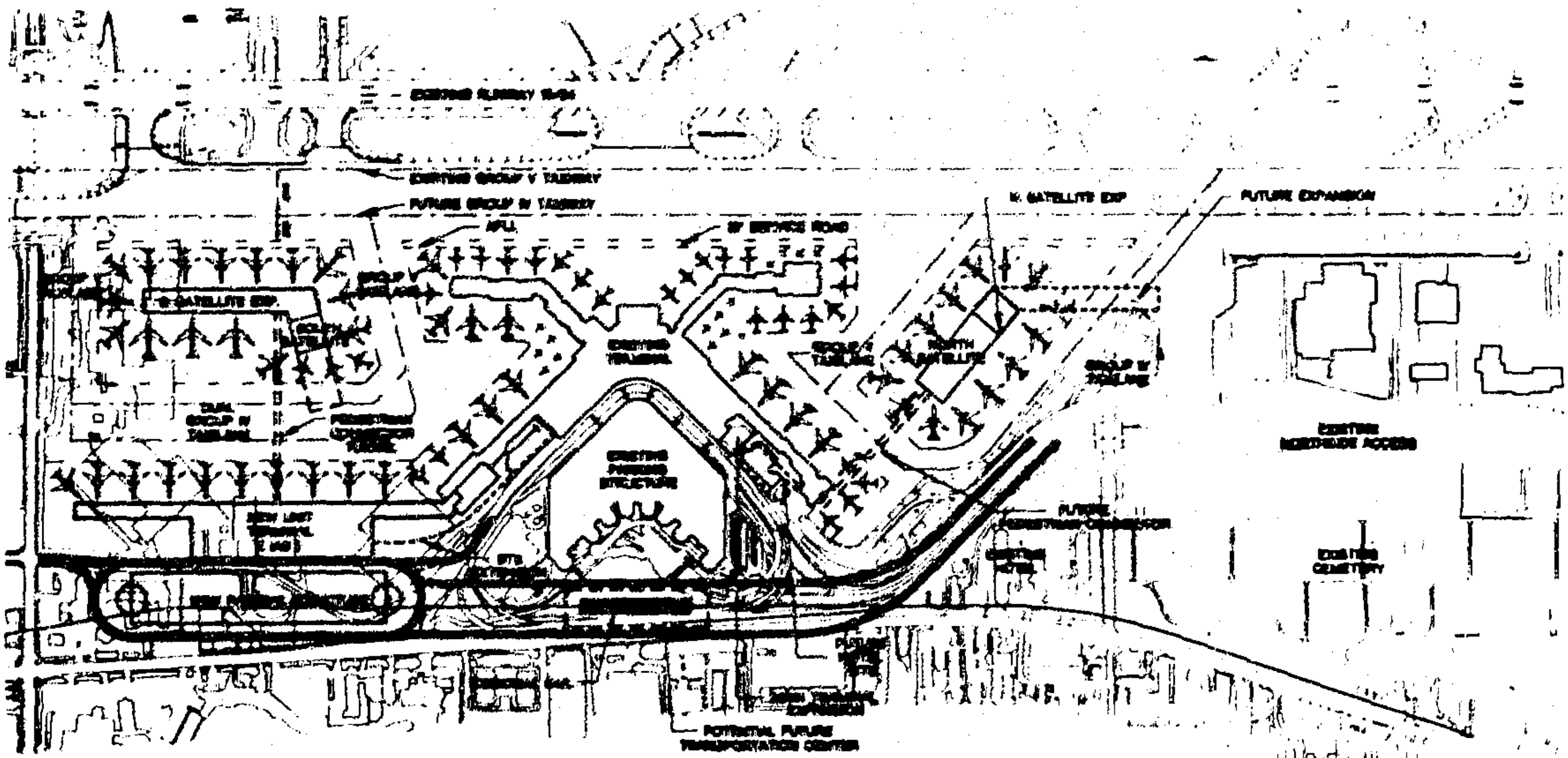
CONCEPT EXPAND MAIN TERMINAL SOUTH TO CONNECT WITH AN EXPANDED CONCOURSE A / POTENTIAL EXPANSION OF MAIN TERMINAL NORTH IF REQUIRED / NORTH AND SOUTH SATELLITES EXPANDED AS REQUIRED / NEW PEDESTRIAN CONNECTORS PROVIDED BETWEEN MAIN TERMINAL AND SATELLITES

RAMP FRONTAGE = 15,800 L.F.

ADVANTAGES ADDS CAPACITY IN CENTRAL TERMINAL AREA KEEPS TERMINAL CENTRALIZED FOR CLEAR PASSENGER ORIENTATION / UTILIZES EXISTING FACILITIES (ROADS / TERMINAL) IN A CONVENTIONAL MANNER

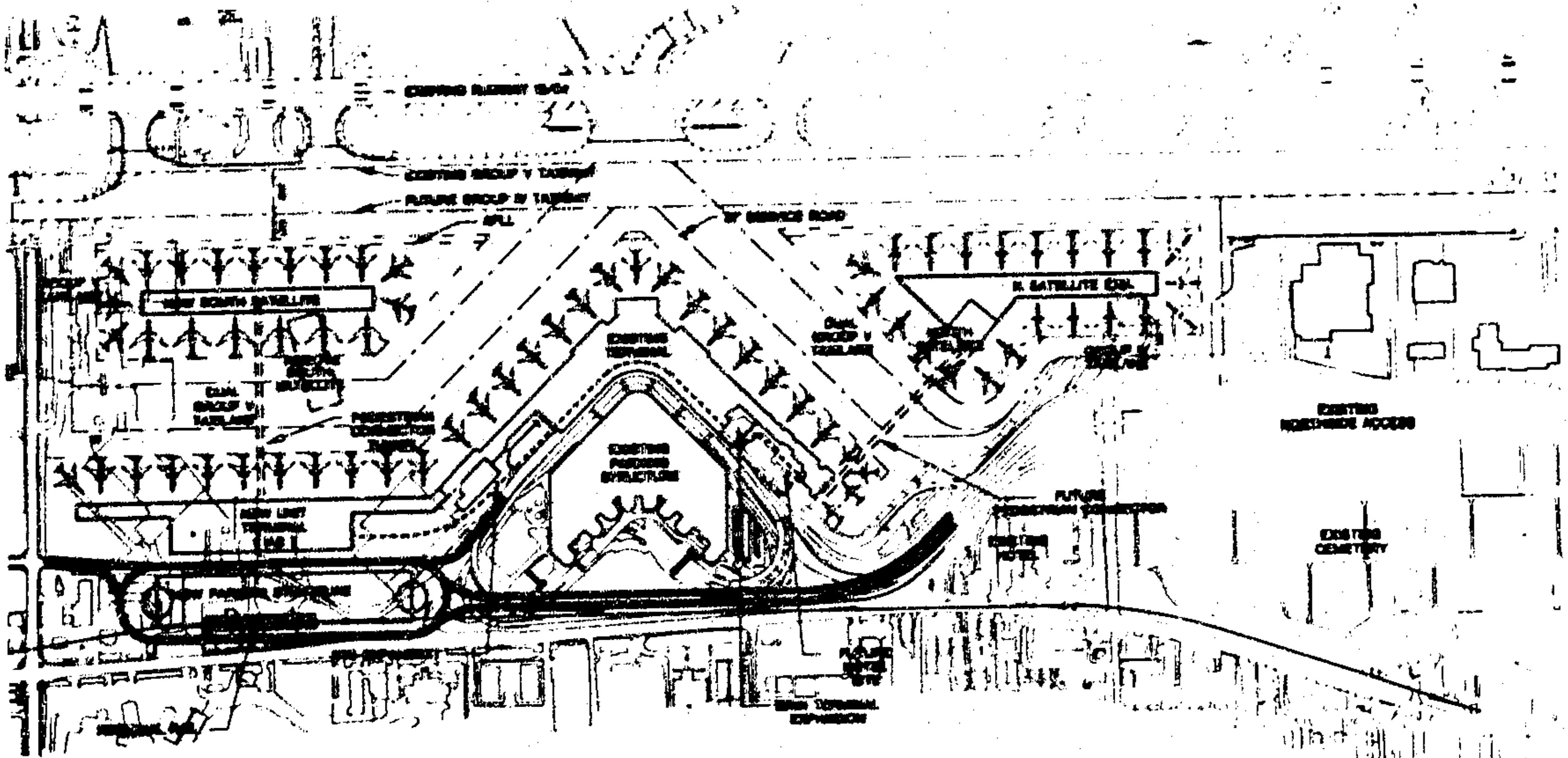
DISADVANTAGES PLACES ADDITIONAL DEMANDS UPON EXISTING TERMINAL AREA ROADWAY SYSTEM ADDITIONAL LANDSIDE CONGESTION POTENTIAL CONSTRUCTION COST AND OPERATIONAL DISRUPTION CONSIDERATIONS DUE TO LIMITED SITE AVAILABILITY

FIGURE 5-2
OPTION A-2



CONCEPT	CONSTRUCT NEW SOUTHSIDE UNIT TERMINAL (AND FUTURE IAB IF REQUIRED) / CONNECT TO MAIN TERMINAL BY REFURBISHED / EXPANDED CONCOURSE A / EXPAND SATELLITE / PROVIDE SEPARATE CURBS AND PARKING FACILITIES FOR NEW TERMINAL / BYPASS ROADWAY FOR EXISTING TERMINAL	ADVANTAGES	DECENTRALIZES LANDSIDE / RELIEVES CONGESTION AND PROVIDES ADDITIONAL CAPACITY WITHOUT OVERBURDENING EXISTING TERMINAL CURB PROVIDES FOR POTENTIAL INTERNATIONAL EXPANSION
	RAMP FRONTAGE = 16,000 LF	DISADVANTAGES	REQUIRES EXTENSIVE ROADWAY RECONSTRUCTION (COST / DISRUPTION) / REQUIRES ADDITIONAL SEPARATE PARKING AND TERMINAL FACILITIES / PASSENGER ORIENTATION MORE DIFFICULT / STS SHUTTLE REQUIRES EXPANSION

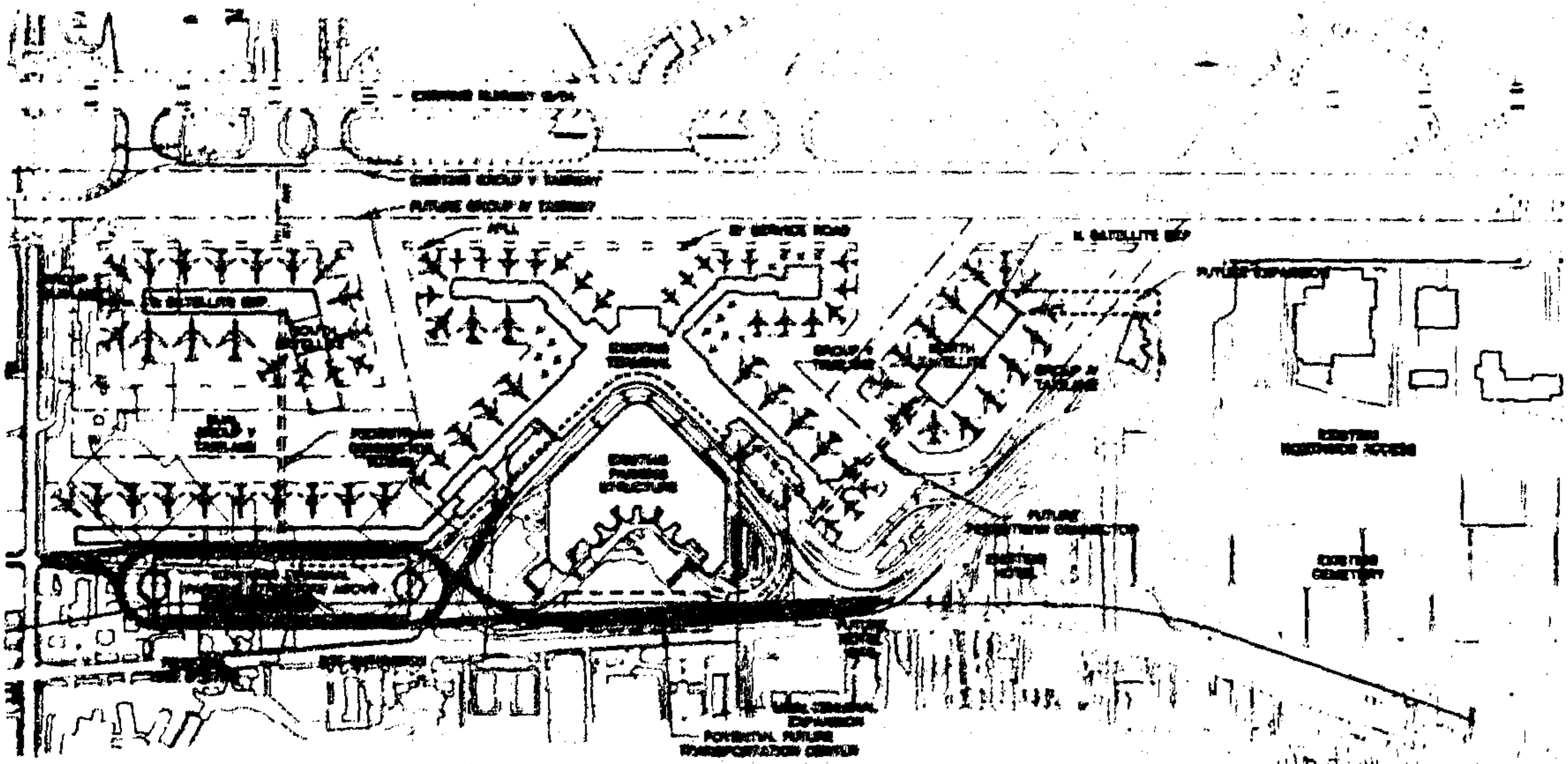
FIGURE 5-3
OPTION A-2-1



CONCEPT	CONSTRUCT NEW SOUTHSIDE UNIT TERMINAL WITH SEPARATE BYPASS ROADWAY AND PARKING FACILITIES / RECONSTRUCT NORTH AND SOUTH SATELLITES TO IMPROVE AIRCRAFT ACCESS AND CAPACITY / NEW UNIT TERMINAL TO PROVIDE EXPANDED FIS / IIB FACILITIES	ADVANTAGES	DECENTRALIZED LANDSIDE RELIEVES ROADWAY CONGESTION AND PROVIDES ADDITIONAL CAPACITY WITHOUT OVERBURDENING EXISTING TERMINAL / CURB PROVIDES FUTURE INTERNATIONAL EXPANSION
		DISADVANTAGES	REQUIRES EXTENSIVE ROADWAY RECONSTRUCTION (DISRUPTION / COST) / REQUIRES STS EXTENSION / UNIT TERMINAL MORE DIFFICULT FOR PASSENGER ORIENTATION AND CONNECTIONS / REQUIRES REMOVAL OF CONCOURSES B/C WHICH HAVE UNDERGONE RECENT RENOVATION

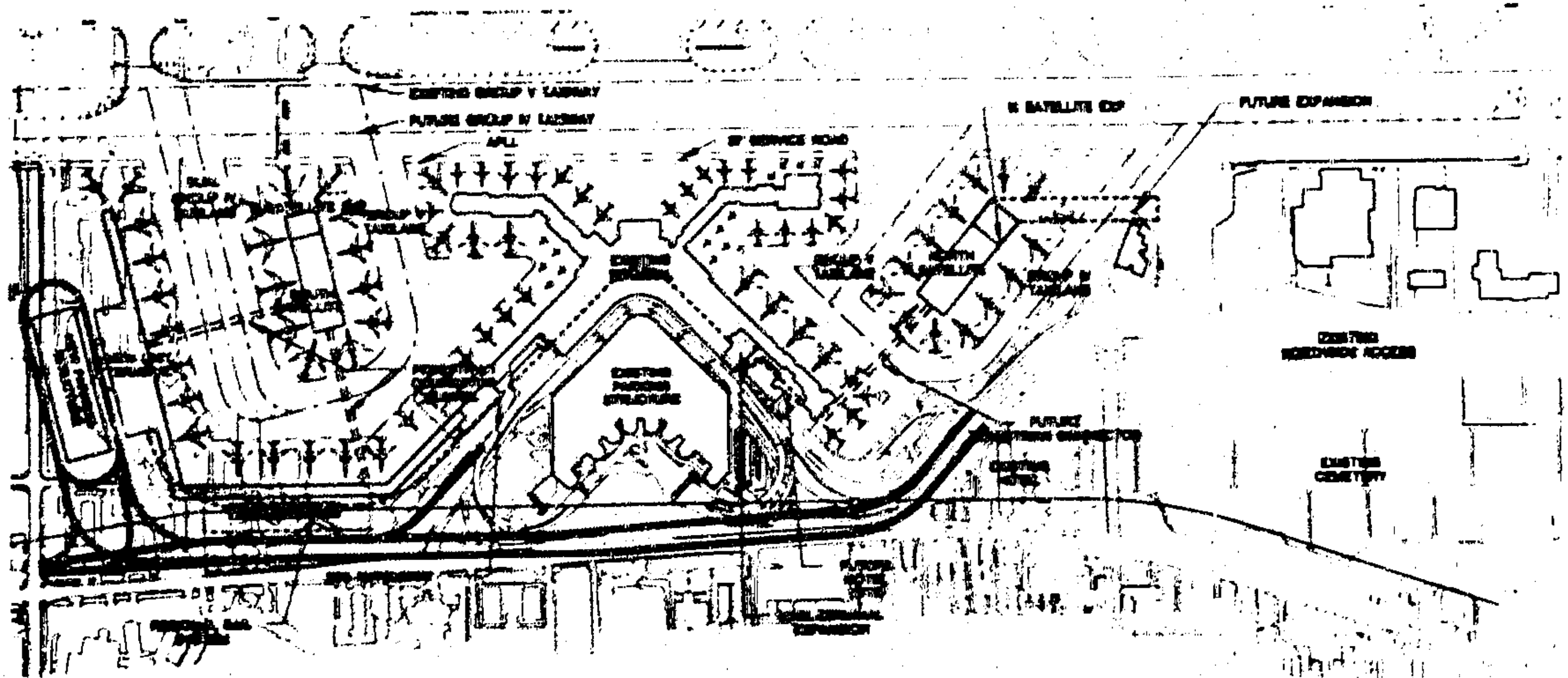
RAMP FRONTAGE = 14,400 L.F.

FIGURE 5-4
OPTION A-2-2



CONCEPT	CONSTRUCT NEW SOUTHSIDE UNIT TERMINAL WITH SEPARATE BYPASS ROADWAY AND PARKING FACILITIES / BYPASS ROAD IS REVERSE FLOW (SIMILAR TO TERMINAL 4 AT PHX) TO PERMIT A DEEPER AIRSIDE / AIRCRAFT PARKING AREA / PROVIDE EXPANDED SATELLITES AND IAB FACILITIES	ADVANTAGES	DECENTRALIZED LANDSIDE RELIEVES ROADWAY CONGESTION AND PROVIDES ADDITIONAL CAPACITY WITHOUT ADDING TO CONGESTION AT MAIN TERMINAL / CURB NEW TERMINAL HAS DOUBLE SIDED CURB / ROADWAY ACCESS
	RAMP FRONTAGE = 18,000 L.F.	DISADVANTAGES	REQUIRES EXTENSIVE ROADWAY RECONSTRUCTION (DISRUPTION / COST) AND STS SHUTTLE EXTENSION UNIT TERMINAL IS NON-STANDARD FOR PASSENGER ORIENTATION AND ROADWAY CIRCULATION

FIGURE 5-5
OPTION A-3



CONCEPT	CREATE NEW UNIT TERMINAL TO THE SOUTH OF EXISTING TERMINAL. EXPANDED CAPACITY PROVIDED THROUGH CONCOURSE A EXPANSION AND NEW UNIT TERMINAL / LINK PEDESTRIAN TUNNELS TO SOUTH SATELLITE / PROVIDE SEPARATE ROAD ACCESS AND PARKING FACILITIES
ADVANTAGES	DECENTRALIZED LANDSIDE SHOULD RELIEVE EXISTING TERMINAL CURB CONGESTION. UNIT TERMINAL PROVIDES IMPROVED AIRCRAFT ACCESS AND POTENTIAL FUTURE FIS AND IAS FACILITIES (IF REQUIRED)
DISADVANTAGES	REQUIRES EXTENSIVE ROADWAY CONSTRUCTION TO PROVIDE BYPASS FOR EXISTING TERMINAL AND ACCESS TO NEW TERMINAL - PARKING / NEW FACILITIES MAY CREATE CONNECTING PASSENGER ORIENTATION AND MOVEMENT PROBLEMS / CREATES SIGNIFICANT CONSTRAINTS UPON POTENTIAL FUTURE SOUTH ACCESS

RAMP FRONTAGE = 18,300 L.F.

terminal is the largest in terms of total area. The site itself is as deep as the entire existing terminal complex and offers the greatest expansion of any option. A number of airline maintenance hangars would likely require removal or relocation under most development options. In addition, the commercial area immediately to the southeast of Concourse A might need to be acquired to provide adequate landside area to complete the terminal landside. South access to the Airport would need to be considered in any of these options. Five terminal development options for the southside site were investigated.

Option A-1: (Figure 5-1) A South Expansion of the Main Terminal

This variation proposes to expand the main terminal to the south in an alignment with existing Concourse A. The South Satellite and Concourse A would be further extended and modified to provide additional aircraft parking capacity. A new underground pedestrian connector would be provided between Concourse A and the South Satellite to provide a supplemental means of access between these two buildings.

Option A-1 generally follows the recommended plan found in the Terminal Development Program (TDP) and requires the relocation/replacement of virtually all of the aircraft maintenance and hangar facilities now located to the south of the existing main terminal. The advantages of this arrangement are: 1) that it achieves the airside and terminal capacity requirements while 2) displacing only those facilities on the south end of the terminal area.

The primary disadvantage inherent in Option A-1 is that it does not relieve the existing curbside congestion in the main terminal area. Its proposed contiguous expansion of the main terminal would compound the vehicular congestion and circulation problems which already exist because it concentrates additional traffic in this already constrained area.

The scheme does provide direct road access to the south of the existing terminal for connection to a future SR509 or South 188 Street. Regional rail transit can be accommodated but would require an STS connection to the main terminal.

Option A-2: (Figure 5-2) A Second Unit Terminal to the South

This option differs from Option A-1 in two important aspects. First, it proposes a separate, but connected, terminal unit to the south of the main terminal. Secondly, it could have a separate access roadway system to the south which bypasses the main terminal roadways and links the new terminal to the primary terminal area access road to the north. This separate roadway access minimizes airport vehicular congestion by distributing traffic between the two separate terminal systems. The amount of traffic captured by each system would depend upon the number and operating characteristics of the airlines operating out of the new South Terminal.

Airside capacity is provided by extensions of the North and South Satellites, as well as the gates provided on the extension to Concourse A. In order to provide sufficient depth of terminal facilities at the Concourse A area, some portion of the South Satellite would require demolition. As shown, this option provides a dual Group IV (widebody) taxilane at this location, but could alternatively provide a single Group V (B747) taxilane instead.

To facilitate passenger connections, the STS shuttle would need to be extended to the new South Terminal. Furthermore, additional capacity on the North Satellite would be required.

This could take the form of an additional underground connector, or additional train capacity on the existing STS system. Most other airside aspects of Option A-2 are similar to Option A-1 in that a South Satellite expansion with separate below-grade pedestrian connector would be provided. In keeping with one of the recommendations of the TDP, Option A-2 would offer the potential for a future new international arrivals facility to replace or supplement those in the existing South Satellite.

Connection of the new terminal roadways to improve south access roads and the existing terminal roadway would require careful planning of both horizontal and vertical movements. For maximum convenience Option A-2 provide additional, separate parking facilities integrated with the roadway access system and the new terminal. A regional rail station between SR99 and the existing terminal parking garage would require an STS connection.

This option provides a good balance between the newly created airside, terminal, and landside facilities. It also minimizes alterations required to the existing terminal, with the exception of the demolition of a portion of the South Satellite. Option A-2 also maintains new terminal facilities within reasonable proximity to the existing terminal and may cross-utilize the gates of Concourse A and the South Satellite thereby facilitating flexible use among airlines.

The primary disadvantage of Option A-2 is that it does require costly, time-consuming, and disruptive site acquisition and roadway work to provide the elevated bypass access.

Option A-2-1: (Figure 5-3) A Southside Unit Terminal with Modified Expanded Satellites Airside

From the landside standpoint, this option is similar to Option A-2, with the exception of the alignment of the bypass roadway, and the location of the future regional rail station. Like Option A-2 the new unit terminal is physically linked to the existing main terminal by an expanded and refurbished Concourse A. However, the new unit terminal is served by a separate bypass access road from the north and separate curbs and parking facilities. The regional rail station would be integrated into this new terminal. Again, better south access with improved roadways are proposed.

From the airside the terminal concept is dramatically different form Option A-2 in that Concourses B and C, and most of the North and South Satellites, have been demolished and replaced by expanded satellites on the north and south sides of the existing terminal. This major modification enables the creation of dual Group V (B747) taxilanes the length of the terminal area, and conceptually provides unlimited flexibility in gate use through the terminal area.

Option A-2-1 was developed primarily to investigate the relative costs and benefits of a terminal solution which would improve aircraft maneuverability and circulation. It should be noted that this airside concept could also be incorporated on a comprehensive or partial basis into other terminal options.

Option A-2-2: (Figure 5-4) A Southside Unit Terminal with Reverse-Flow Roadway Flow

From an airside standpoint, Option A-2-2 is identical to Option A-2; existing satellites are expanded, Concourses B and C remain in place, frontal gates are provided along an expanded Concourse A with a new southside unit terminal.

From a landside standpoint, Option A-2-2 differs substantially from Option A-2 in that the unit terminal and parking area are separated by the roadway from the extension to Concourse A. This requires that vehicular traffic flow clockwise around the terminal building (operationally similar to Terminal 4 at Phoenix Sky Harbor International Airport) in order to permit vehicles to drop off passengers from the right side of the vehicle. This concept was developed as an attempt to reduce the depth of area required by separated terminal and parking facilities (as in Option A-2), maximize airside capacity, and provide improved aircraft access and maneuverability. It also provides unique opportunities to provide landside access on both sides of the terminal building, as well as incorporating the parking into the terminal itself. Improved access roadways to the south are proposed and a regional rail station is proposed to be incorporated directly into the new terminal structure.

The primary disadvantages of this option are: 1) some roadway complexity inherent in reversing the flow of the individual roadway systems, 2) the lack of direct terminal to gate access on the same building level, and 3) the passenger orientation problems associated with directing passengers to and from the aircraft gates.

Option A-3: (Figure 5-5) A Unit Terminal Along South 188th Street

This option is similar to Option A-2 in that it proposes a separate, but linked, unit terminal to be built south of the existing main terminal. Option A-3 also would include a separate roadway bypass and parking facility and an extension of the existing STS shuttle. Option A-3 differs from Option A-2 in that the new terminal is separated from the existing main terminal by a considerable distance (approximately 1,800 ft. separation for Option A-3 versus approximately 800 ft. separation for Option A-2). A regional rail station would be placed between the existing and new terminals.

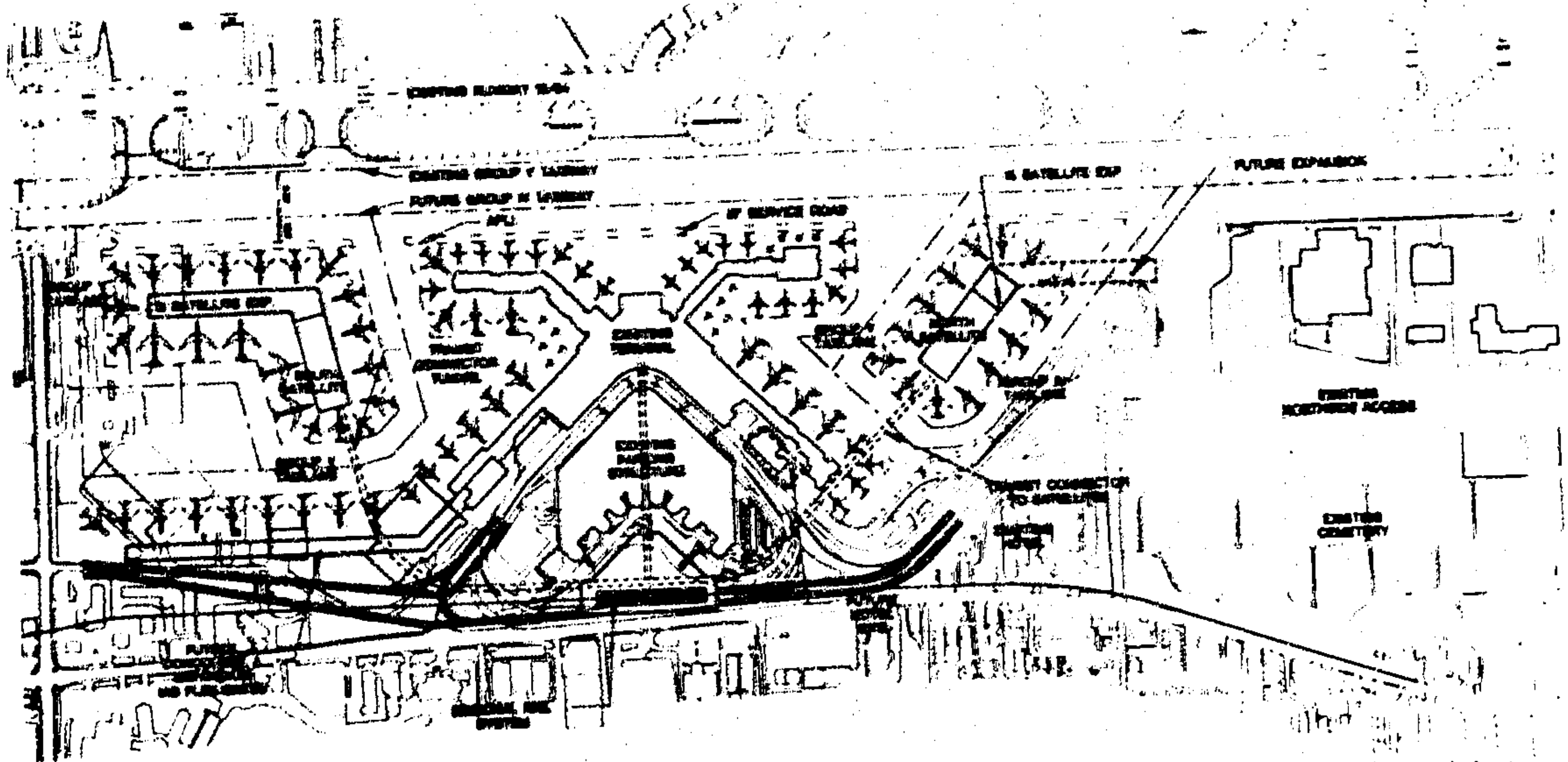
The physical orientation of the terminal also differs from Option A-2 in that its landside is oriented east-west along South 188th Street. This orientation results in a somewhat limited terminal and curb length, sub-standard roadway curves, and a constrained parking facility compared to other options. Because of its orientation at the end of the site, this option provides access to relatively few gate positions. Further expansion of the south satellite is also restricted when compared with the expansion potential in Option A-2. Access to the South Satellite from the Option A-3 terminal is provided by means of a below-grade pedestrian connector. This concept also inhibits connection to the SR509 proposed alignment.

Option A-3, while creative, does not provide an adequate airside/landside balance to warrant the necessary investments in developing the site. In addition, the isolated location at the south of the terminal area is poorly oriented to the north access for originating passengers, and poorly connected to the main terminal for connecting passengers. Finally, the cramped landside area makes access to, and from, 188th street problematic at best.

CENTRAL TERMINAL DEVELOPMENT OPTION (Figure 5-6)

The site to the East of the existing main parking structure offers the most central location for supplementary terminal and landside facilities. Because of its unique size and configuration, only one option for this site was investigated.

FIGURE 5-6
OPTION B



CONCEPT	INCREASE LANDSIDE CAPACITY BY PROVIDING A NEW LANDSIDE TERMINAL AND TRANSPORTATION CENTER EAST OF EXISTING PARKING STRUCTURE / PROVIDE TRANSIT LINKS TO EXISTING TERMINAL AND EXPANDED NORTH AND SOUTH SATELLITES / POTENTIAL EXPANSION OF CONCOURSE A FOR IAB CAPACITY
ADVANTAGES	ADDS CAPACITY IN CENTRAL TERMINAL AREA KEEPS TERMINAL CENTRALIZED / DOES NOT DEPEND UPON EXISTING STS FOR ADDITIONAL CAPACITY / UTILIZES EXISTING ROADWAY AND TERMINAL FACILITIES
DISADVANTAGES	DEPENDENCE UPON ADDITIONAL STS - TYPE TRANSIT SYSTEM FOR CONNECTIONS TO AIRSIDE / LIMITED SITE AND ROADWAY DEVELOPMENT AREA POTENTIAL COST AND OPERATIONAL DISRUPTION CONSIDERATIONS / PASSENGER ORIENTATION MORE COMPLICATED DUE TO MULTIPLE TERMINALS

RAMP FRONTAGE = 16,000 L.F.

Option B: (Figure 5-6) A Centrally Located Transportation Distribution Center

Because of the constrained landside at Sea-Tac, an important consideration in the future operational success of the terminal will likely involve provisions for option modes of transportation to the Airport. The use and development of high occupancy vehicles (HOVs), light rail, or other similar alternative means of transport could divert a proportion of landside arrivals and departures away from private automobiles, taxis, and limos. To be successful, this mode of transport must be accommodated in a manner convenient for its users, and be directly accessible to the main terminal. However, it must not add to existing vehicular activity or compete with the already congested terminal curbfront.

Option B proposes that a Transportation Distribution Center be developed on a site immediately east of the existing main parking structure. This facility could accommodate regional rail access as well as provide supplemental curb frontage for high occupancy vehicles, busses, or other types of vehicles designated by the Port of Seattle, which might otherwise congest the main terminal curbfront. Because of the distances involved, the Transportation Distribution Center would need to be connected directly to the existing main terminal and potentially to the satellites via a people mover and some form of baggage handling system. This system might require the use of one or more floor, of the existing parking structure as a right of way. With several hundred buses per hour proposed to use this facility, horizontal and vertical integration of transportation elements is very constrained due to site limitations and the existing access roadway system.

Supplementary check-in and baggage claim facilities might also be provided in the Transportation Distribution Center depending upon demand, cost, and technical feasibility. Some expanded ticketing and baggage facilities could be provided similar to Option A-1 at the main terminal providing additional curbfront congestion could be mitigated. This would depend, to a great extent, upon the amount of landside traffic successfully diverted to the Transportation Distribution Center.

In general, Option B provides insufficient area to support all of the suggested objectives for this facility. In addition, the technical challenge of moving passengers from the transportation center to the aircraft gates in a convenient manner and at reasonable cost is considerable. Orientation of arriving (multi-lingual) passengers and baggage to either the main terminal baggage claim or this alternative facility would be difficult. Finally airline support in staffing a secondary check-in area may be difficult to achieve. For these reasons, Option A-3 is unlikely to prove a viable long-range terminal solution at Sea-Tac.

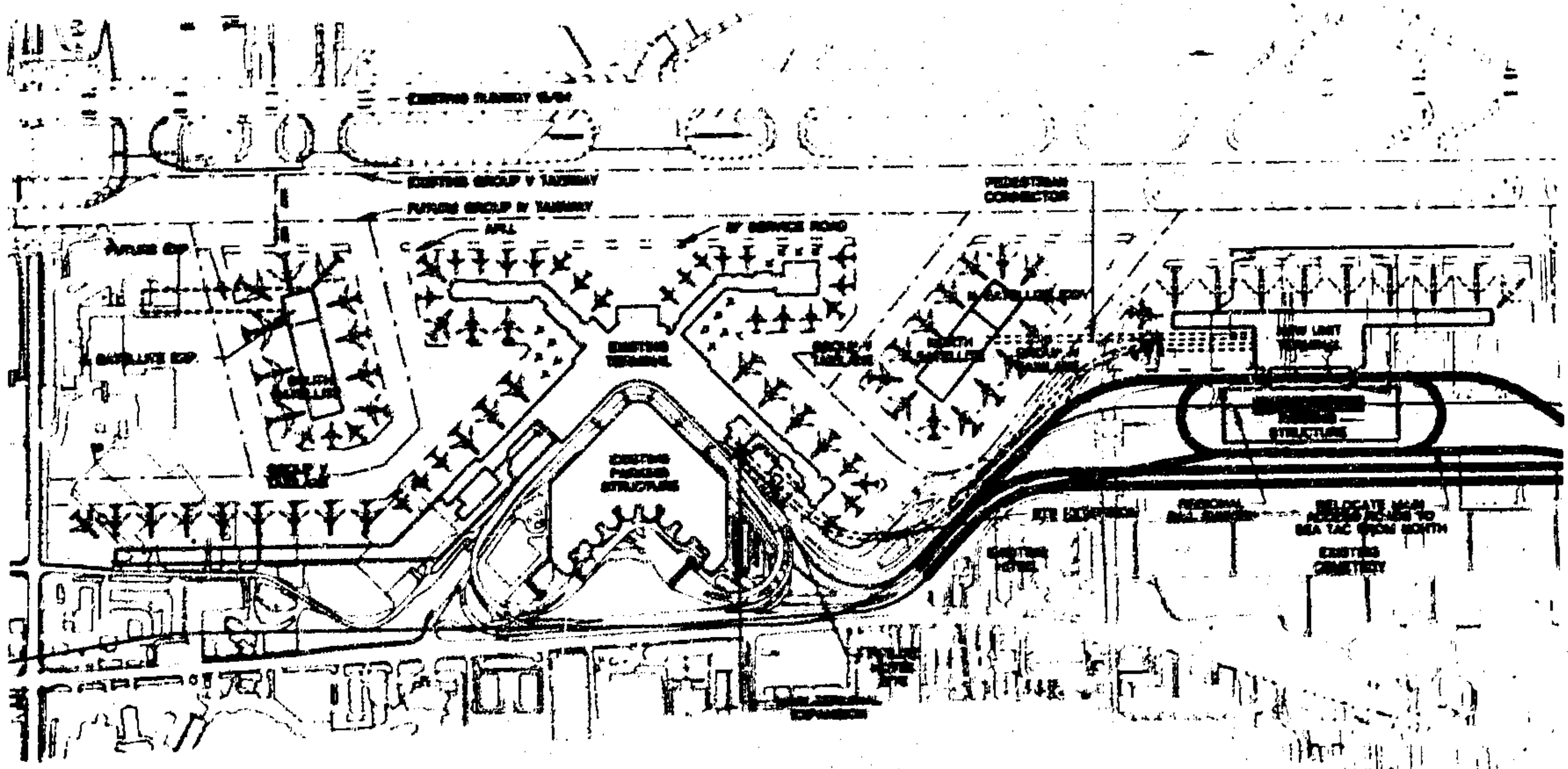
NORTHSIDE TERMINAL DEVELOPMENT OPTIONS (Figures 5-7 through 5-10)

A site to the north of the existing terminal offers a smaller, but perhaps more convenient, location than the Southside Development options for expanded terminal/landside interface. This location would be in greater proximity to the main airport entrance, and would most likely not require additional property acquisition. Development in this area would, however, require relocation of the ARFF facility, the USPS facility and a number of cargo facilities. Four terminal options were considered for this location.

Option C-1: (Figure 5-7) Unit Terminal North of the Existing Terminal

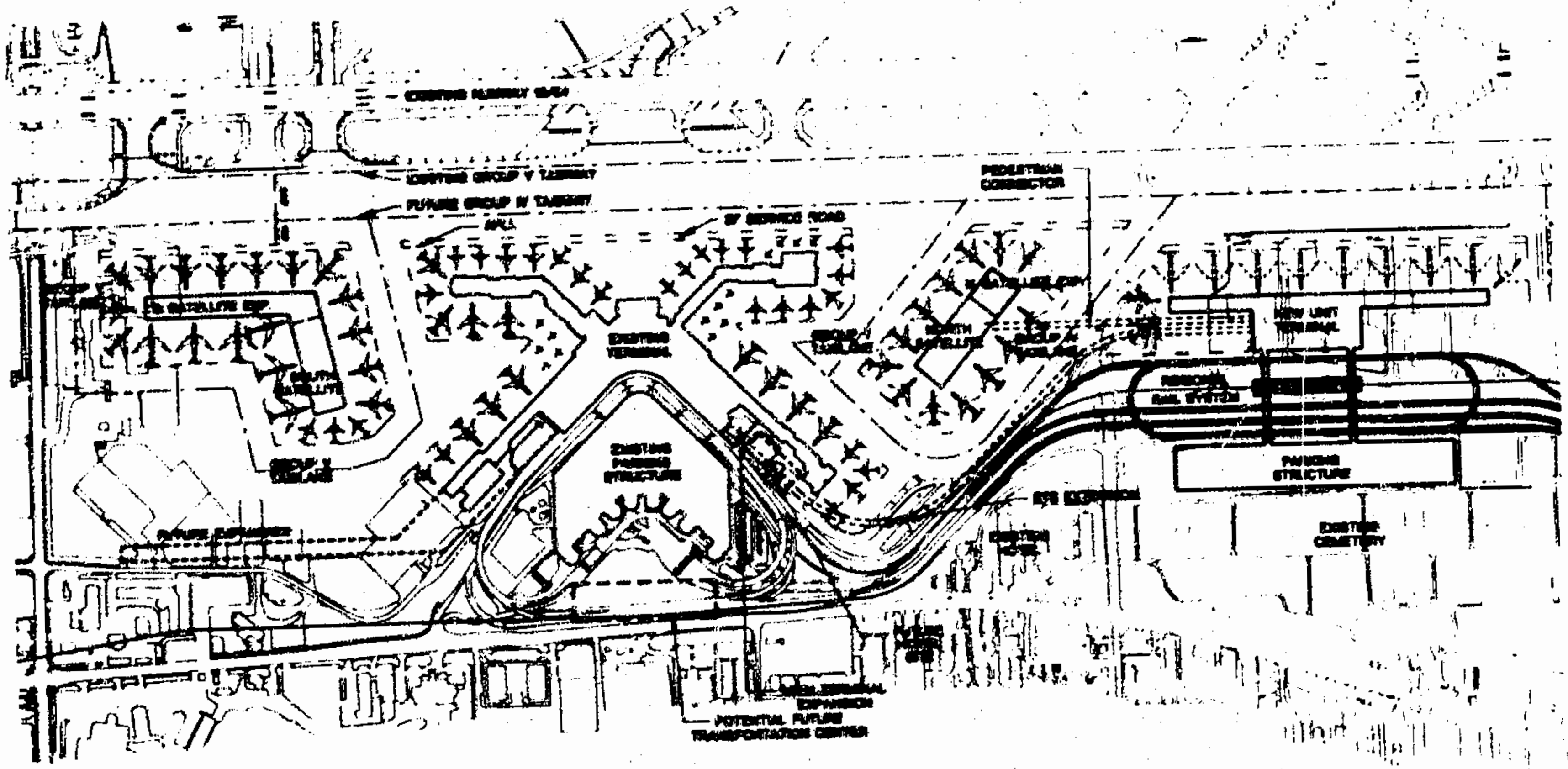
Although the TDP considered a modest expan-

FIGURE 5-7
OPTION C-1



CONCEPT	RETAIN EXISTING TERMINAL AND PARKING STRUCTURE / EXPAND SATELLITES & CONCOURSE A / ADD NEW UNIT TERMINAL TO THE NORTH AND PARKING STRUCTURE / RELOCATE EXISTING ACCESS ROADS TO THE NORTH / CONNECT TO EXISTING TERMINAL AND NORTH SATELLITE VIA STS SHUTTLE EXTENSION AND NEW TUNNEL CONNECTOR	ADVANTAGES	ADDS CAPACITY WITHOUT ADDING CONGESTION TO EXISTING TERMINAL / DECENTRALIZED LANDSIDE TO NORTH PERMITS TRAFFIC TO BE SIPHONED OFF BEFORE REACHING EXISTING TERMINAL
	RAMP FRONTAGE = 18,400 L.F.	DISADVANTAGES	RELOCATION OF MAIN ACCESS ROADS IS COSTLY AND DISRUPTIVE / SEPARATE UNIT TERMINAL MAKES PASSENGER ORIENTATION AND CONNECTIONS MORE DIFFICULT / LIMITED ADDITIONAL AIRSIDE CAPACITY DUE TO RESTRICTED SITE

FIGURE 5-8
OPTION C-2



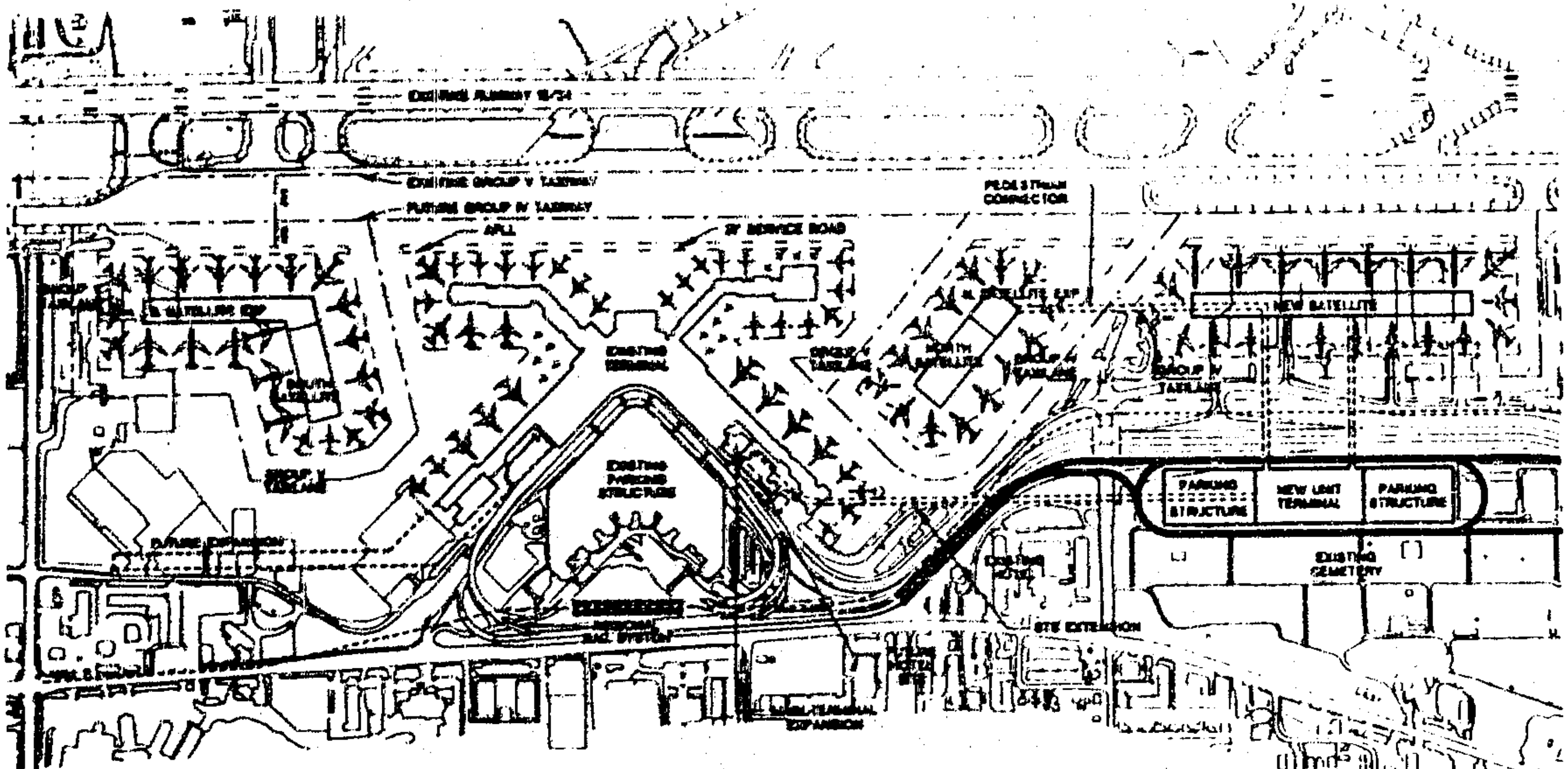
CONCEPT RETAIN EXISTING TERMINAL AND PARKING STRUCTURE / EXPAND SATELLITES ONLY / ADD NEW UNIT TERMINAL TO THE NORTH AND PARKING STRUCTURE / CONNECT TO EXISTING TERMINAL AND NORTH SATELLITE VIA STS SHUTTLE EXTENSION AND NEW TUNNEL CONNECTOR

ADVANTAGES ADDS CAPACITY WITHOUT ADDING CONGESTION TO EXISTING TERMINAL / DECENTRALIZED LANDSIDE TO NORTH PERMITS TRAFFIC TO BE SIPHONED OFF BEFORE REACHING EXISTING TERMINAL

DISADVANTAGES SEPARATE UNIT TERMINAL MAKES CONNECTIONS MORE DIFFICULT / PASSENGER ORIENTATION (ESPECIALLY BY ROAD) MAY BE MORE PROBLEMATIC PARKING STRUCTURE IS SEPARATED FROM TERMINAL BY LONG DISTANCE

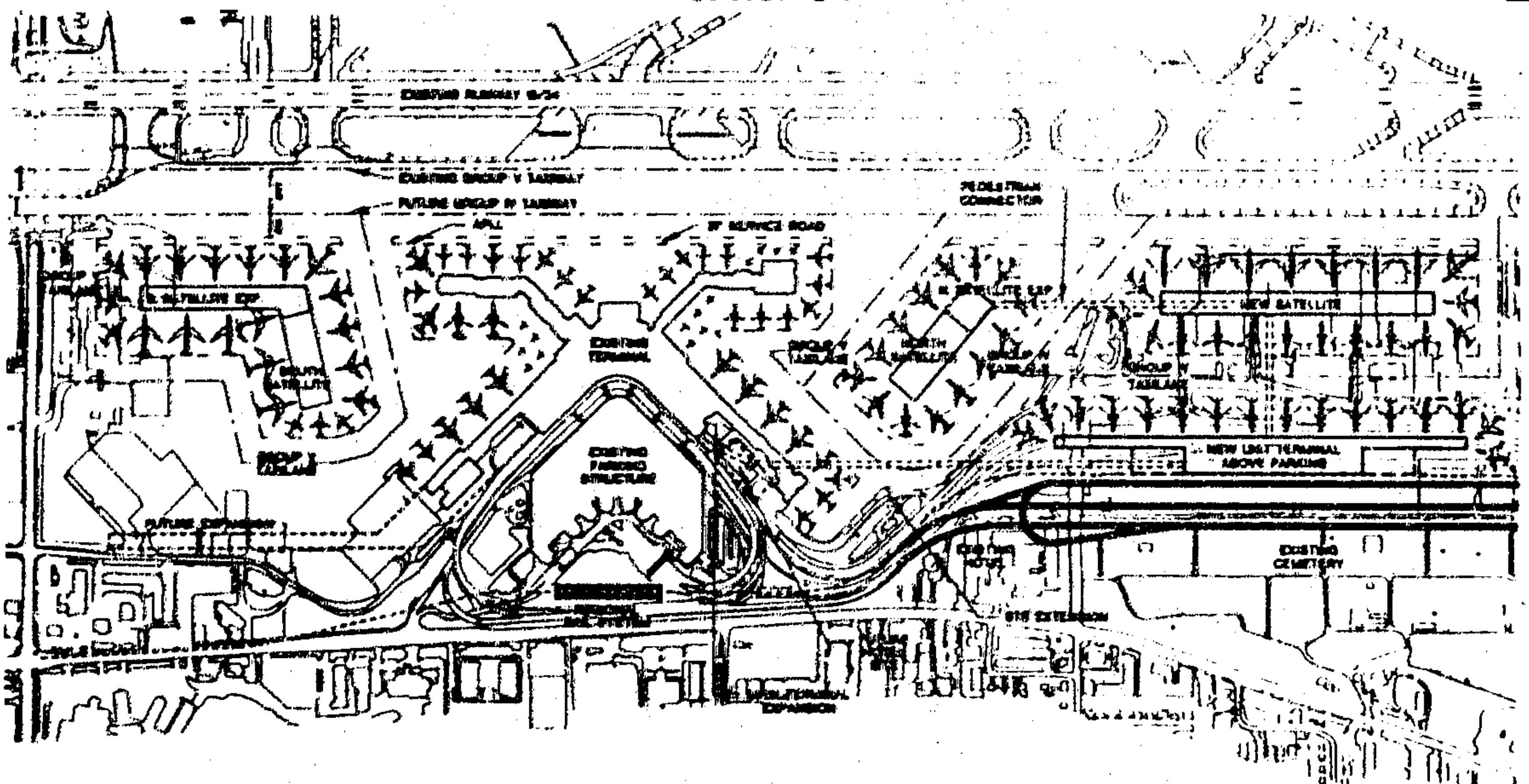
RAMP FRONTAGE = 16,300 L.F.

FIGURE 5-9
OPTION C-3



CONCEPT	RETAIN EXISTING TERMINAL AND PARKING STRUCTURE / EXPAND SATELLITES ONLY / ADD NEW UNIT TERMINAL TO THE NORTH AND PARKING STRUCTURE / CONNECT TO EXISTING TERMINAL AND NORTH SATELLITE VIA STS SHUTTLE EXTENSION AND NEW TUNNEL CONNECTOR	ADVANTAGES	ADDS CAPACITY WITHOUT ADDING CONGESTION TO EXISTING TERMINAL / DECENTRALIZED LANDSIDE TO NORTH PERMITS TRAFFIC TO BE SIPHONED OFF BEFORE REACHING EXISTING TERMINAL
	RAMP FRONTAGE = 17,800 L.F.	DISADVANTAGES	SEPARATE UNIT TERMINAL MAKES CONNECTIONS MORE DIFFICULT / PASSENGER ORIENTATION (ESPECIALLY BY ROAD) MAY BE MORE PROBLEMATIC PARKING STRUCTURE AND TERMINAL ARE SEPARATED FROM CONCOURSE BY LONG DISTANCE

FIGURE 5-10
OPTION C-4



CONCEPT	RETAIN EXISTING TERMINAL AND PARKING STRUCTURE / EXPAND SATELLITES ONLY / ADD NEW UNIT TERMINAL TO THE NORTH AND PARKING STRUCTURE / CONNECT TO EXISTING TERMINAL AND NORTH SATELLITE VIA STS SHUTTLE EXTENSION AND NEW TUNNEL CONNECTOR	ADVANTAGES	ADDS CAPACITY WITHOUT ADDING CONGESTION TO EXISTING TERMINAL / DECENTRALIZED LANDSIDE TO NORTH PERMITS TRAFFIC TO BE SIPHONED OFF BEFORE REACHING EXISTING TERMINAL
	RAMP FRONTAGE = 18,006 L.F.	DISADVANTAGES	SEPARATE UNIT TERMINAL MAKES CONNECTIONS MORE DIFFICULT / PASSENGER ORIENTATION (ESPECIALLY BY ROAD) MAY BE MORE PROBLEMATIC REQUIRES EXTENSIVE ROADWAY RELOCATION

sion of the main terminal to the north as well as an expansion of the North Satellite, it did not recognize the potential for a separate unit terminal at this location. As in Options A-2 and A-3, this option is landside-driven due to the anticipated saturation of the existing terminal curbfront.

Option C-1 defines a simple unit terminal with frontal gates north of the existing North Satellite. The site available for such a facility is relatively narrow, and in its present form would require that the main access road into Sea-Tac from the north be relocated eastward in order to provide sufficient parking facilities in proximity to the terminal.

Because its ultimate airside capacity would be limited to a fraction of that provided by a South Unit Terminal, overall airport gate requirements would need to be supplemented by the expansion of either the South Satellite or Concourse A. An airside passenger connection could be made to the North Satellite and a landside passenger connection could be made to the north end of the existing terminal.

The northside unit terminal would provide one important advantage in that it would not require construction of an expensive and potentially operationally disruptive roadway bypass as in Options A-2 and A-3. However, the additional northside terminal facilities would provide an insufficient number of gates to adequately draw landside activity away from the main terminal. In addition, its distance from the main terminal would make passenger connections between the two terminals relatively lengthy. This concept could accommodate regional rail alignments. Improved road access south of the existing terminal is still required.

Option C-2: (Figure 5-8) Unit Terminal North of the Existing Terminal

Option C-2 is similar to Option C-1 but maintains the airport access road in its current location. Because the remaining site available for such a facility is relatively narrow, it would require development of automobile parking facilities to the east of the main north terminal access road to Sea-Tac. On-grade parking facilities already occupy some of the site, although these might need to be converted to structural parking, and would be connected to the new North Unit Terminal by either bridges or tunnels several hundred feet long.

This concept also can integrate well with regional rail plans. Again, improved road access south of the existing terminal is required.

Option C-3: (Figure 5-9) Unit Terminal North of the Existing Terminal

Like Options C-1 and C-2 the main feature of Option C-3 is a northside unit terminal. This unit terminal is not physically linked to the existing main terminal except through an extension of the STS shuttle. Like Options C-1 and C-2, Option C-3 has an independent landside circulation and parking system tied into the northside airport access system which would be relocated to accommodate the modified terminal configuration. The key difference in Option C-3 is the exploration of the double-sided airside concourse and the resulting site requirements.

The airside in Option C-3 has been expanded and improved considerably over that proposed in either Options C-1 and C-2. The satellite permits an approximate doubling of aircraft parking capacity over that shown in either Options C-1 or C-2. Aircraft flow is also improved although potential maneuvering conflicts and delays are possible between the west side of the satellite and the airfield taxiway system. Some expansion of the north satellite together with a connector tunnel to the new north unit terminal would be desirable. The larger airside capacity provided in Option C-3 would mean that a smaller expansion of the South Satellite would be required with reduced relocation impacts on the airline maintenance areas.

The C-3 Terminal Plan is a simple unit terminal which is integrated with, and directly accessible to, a parking structure. The terminal is connected to the satellite via a passenger tunnel with moving sidewalks. The terminal is sufficiently deep to accommodate international arrivals facilities although these would need to be carefully planned with a separate sterile access from the satellite aircraft gates. The terminal would operate with enplaning functions on the upper level and deplaning functions on the lower level to facilitate development of a dual level roadway system. Baggage processing facilities could be located either at basement level and connected to aircraft via a baggage tunnel, or located at the satellite and accessed via below grade conveyors to and from the terminal.

Retention of the existing main access road in Option C-3 also potentially requires the terminal to be shifted east to provide for a deeper terminal site. This would likely require some additional property acquisition to the east or costly construction of the terminal over the main access roadway itself. The main drawbacks to Option C-3 are the long, deep tunnels between the satellite and the main terminal which would require moving walks and could result in a certain amount of passenger inconvenience.

The terminal area roadway system in Option C-3 would function in much the same manner as Option A-2-2 (or Terminal 4 at Phoenix). This system has a clockwise traffic flow (sometimes referred to as a "reverse" flow) which provides access to both sides of the unit terminal and creates a very large curbfront capacity with potential dual level roadways. As in Options C-1 and C-2, the primary traffic access from the north would be diverted before reaching the congested roads of the existing main terminal.

Option C-3 is higher in cost than either Options C-1 and C-2. Both the satellite construction and the main access roadway relocation are contributing factors to a relatively high cost for this option. Acquisition of some additional property is also an important factor in the relative poor cost and implementation ranking for this option.

Option C-4: (Figure 5-10) Unit Terminal North of the Existing Terminal

Option C-4 is a variation of Option C-3 as a northside unit terminal not physically linked to the existing main terminal at Sea-Tac except by an extension of the existing STS shuttle. Its landside circulation and parking system would also be completely independent of the existing main terminal. Option C-4 differs from Option C-3 in that it requires an even deeper site (requiring further property acquisition) but provides an expanded airside capacity providing additional frontal gates and lends itself to a conventional terminal arrangement similar to that which already exists at Sea-Tac.

The addition of frontal gates in Option C-4 increases the airside capacity substantially. This increased capacity is provided through a deeper site which requires even more property acquisition than Option C-3; however, the additional capacity provided to the north would mean that very little expansion south of the existing main terminal would be required to meet the forecast gate requirements of the Master Plan. As a result, most of the airline maintenance facilities on the south side would not require relocation.

The C-4 Terminal Plan also differs from Option C-3 in that a conventional two-level terminal is proposed which would serve both the satellite(s) and the frontal gates. The gradients of the existing site should permit a parking structure to be integrated physically and functionally below the unit terminal. The terminal footprint would be sufficiently deep to accommodate international facilities but these would probably need to be linked with the satellite (and B747-400 gates) via separate below grade sterile connectors. The terminal itself would function much in the same manner as the existing terminal at Sea-Tac with enplaning functions on the upper level and deplaning functions on the lower level. Frontal gates on the main terminal would provide additional capacity and convenience for terminal users.

As in Options C-1, C-2, and C-3, the most important landside feature of Option C-4 is that it utilizes existing terminal access roadways without adding demand to the existing terminal roadways or requiring complex roadway construction to the south. Traffic access from the north would be diverted to the unit terminal before reaching the congestion of the existing main terminal roadways. Option C-4 would also provide a dual level terminal roadway which would be simpler and more cost-effective to construct than Option C-3 and would function much in the same way as the existing main terminal roadways.

Option C-4 and C-3 are similar in that they are anticipated to be costlier than either Options C-1 or C-2. This is due primarily to the larger size of the facilities provided, satellite construction, tunnels, the relocated access roads, and property acquisition.

SUMMARY

The future terminal development at Sea-Tac appears to be affected by non-terminal elements of the Master Plan update in one very important respect: the terminal development options are landside-driven. This results in a probable future need to decentralize the main passenger processing facilities at Sea-Tac in order to distribute landside (curbfront and parking) demand between terminals and relieve vehicular congestion on existing terminal roadways.

It is noteworthy that decentralization of terminal and landside facilities into separate unit terminals has consistently occurred at airports having the operational characteristics and a level demand similar to Sea-Tac. The only notable exceptions are large connecting hubs (such as Atlanta) where the majority of passenger traffic connects and therefore has no impact upon the terminal, landside, or regional access infrastructure. Consideration of a new unit terminal at Sea-Tac may, therefore, be a realistic milestone in the continued development of the airport.

EVALUATION OF TERMINAL OPTIONS

The evaluation process leading to a recommended approach to future terminal development at Sea-Tac combines both subjective and objective elements. This process further reflects either direct or indirect input from a variety of sources including POS staff, Master Plan consultants, public, airlines, and other airport users and tenants.

Perhaps the single most important factor to emerge during the evaluation process was the need to incorporate flexibility and adaptability to change as operational requirements at Sea-Tac continue to evolve in the future. One such change is the continued evolution of commuter operations which tend to blur with air carrier operations as aircraft types and terminal requirements in their respective markets mature. Another changing element at Sea-Tac involves international operations which have shifted dramatically over a very short period of time and may shift again.

In addition to operational flexibility, the need to provide for incremental growth in the terminal is important and this should be designed to accommodate a range of aircraft types and sizes in the future. Finally, the respect for the established architectural character of the existing terminal as a major international and domestic gateway to the northwestern United Sates is an important point of consideration.

Evaluation Process

For each of the conceptual terminal options, sixteen criteria were evaluated and assembled in a matrix format (Table 5-1). Since many of the options share similar characteristics and advantages, a weighted numerical ranking system was used to assist in evaluating the conceptual terminal development options.

The results of the evaluation were used to select three "finalist concepts" from each development area which would be capable of adapting to a variety of future conditions and operational changes at Sea-Tac. The ranking process used in the evaluation may be defined as follows:

- **Step One:** The Terminal Evaluation Criteria were developed to represent a comprehensive listing of the essential factors to be considered in determining the best future terminal development concept for Sea-Tac International Airport. The criteria list was carefully tailored from guidelines used for the TDP as well as other similar terminal projects in the United States. Included are key issues related to airside, landside, terminal, and cost considerations.

- **Step Two:** Weighting factors were assigned to each specific evaluation criterion based upon the priorities and values established by the Master Plan Team. These factors were collected and adjusted to reflect the issues, concerns, and priorities and views of many diverse elements including POS staff, user groups, airlines, concessionaires, and others.

- **Step Three:** A suggested concept ranking was developed to reflect the consensus opinion of the planning team, and the specific experience of team members with other similar terminal projects in the planning process. For clarity and consistency in evaluation, rankings were typically categorized as being either a positive (+1), neutral (0), or negative (-1) factor as compared to the recommendations of the 1985 Master Plan and the 1992 TDP.

- **Step Four:** The comparative score for each option was computed. The Score for each criterion is the sum of all the weighted factors reflected for the sixteen evaluation criteria as defined by the collective issues, objectives, and concerns researched by the Master Plan Team.

It is noteworthy that for the purposes of this Master Plan, the terminal development plan will need to cover a number of different operational scenarios which may occur. The terminal lay-out ultimately reflected in the Master Plan should accommodate not only the recommended space program and definable changes which may be anticipated within the forecast time-frame, but be capable of further adaptation beyond the forecast periods.

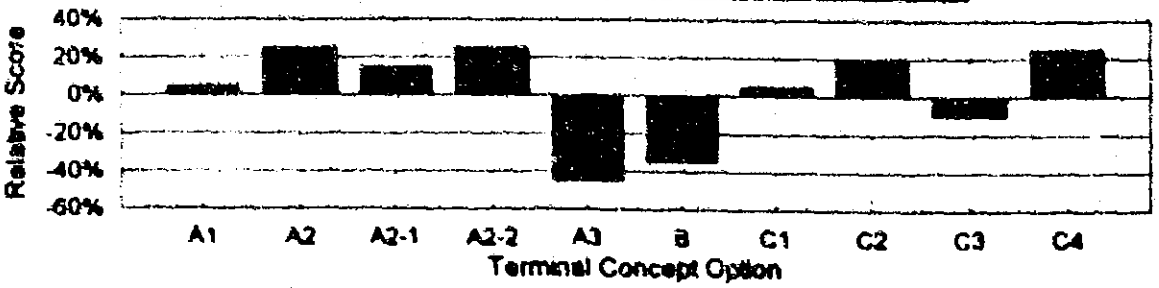
The evaluation criteria used in comparing and evaluating the terminal options are defined below and compared in Table 5-1. The description of each criteria is followed by a brief discussion of how it was applied to the

Table 5-1
Terminal Concept Evaluation Matrix

Evaluation Criteria	Weight	A1	A2	A2-1	A2-2	A3	B	C1	C2	C3	C4
		Conceptual Options									
Airside (Aircraft Gates)											
Capacity	10%	1	0	(1)	1	0	1	(1)	(1)	0	1
Flexibility	5%	0	0	1	0	0	0	0	0	1	1
Access	5%	0	0	1	0	1	0	1	1	1	1
Maneuverability	5%	0	1	1	1	(1)	(1)	1	1	1	1
Raw Sub-Total	25%	1	1	2	2	0	0	1	1	3	4
Weighted Sub-Total		10%	5%	5%	15%	0%	5%	0%	0%	15%	25%
Terminal											
Balance	5%	(1)	1	1	1	(1)	(1)	0	0	0	1
Capacity	5%	(1)	0	0	0	(1)	(1)	1	1	0	0
Convenience	5%	0	1	1	1	0	(1)	0	0	(1)	1
Constructability	5%	0	(1)	(1)	(1)	0	(1)	1	1	(1)	(1)
Flexibility	5%	(1)	1	1	1	1	(1)	0	0	(1)	0
Raw Sub-Total	25%	(3)	2	2	2	(1)	(5)	2	2	(3)	1
Weighted Sub-Total		-15%	10%	10%	10%	-5%	-25%	10%	10%	-15%	5%
Landside (Roads + Parking)											
Capacity	10%	(1)	1	1	1	0	(1)	1	1	1	1
Simplicity	5%	1	0	0	(1)	(1)	(1)	0	0	(1)	0
Constructability	5%	0	(1)	(1)	(1)	(1)	0	0	1	(1)	(1)
Compatibility	5%	0	0	0	(1)	(1)	(1)	1	1	1	1
Raw Sub-Total	25%	0	0	0	(2)	(3)	(3)	2	3	0	1
Weighted Sub-Total		-5%	5%	5%	-5%	-15%	-20%	15%	20%	5%	10%
Cost											
New Construction	10%	1	0	(1)	0	(1)	1	(1)	0	0	0
Special Systems	10%	0	1	1	1	(1)	(1)	(1)	(1)	(1)	(1)
Facility Relocations	5%	1	(1)	(1)	(1)	(1)	1	0	0	(1)	(1)
Raw Sub-Total	25%	2	0	(1)	0	(3)	1	(2)	(1)	(2)	(2)
Weighted Sub-Total		15%	5%	-5%	5%	-25%	5%	-20%	-10%	-15%	-15%
Raw Total	100%	0	3	3	2	(7)	(7)	3	5	(2)	4
Weighted Total		5%	25%	15%	25%	-45%	-35%	5%	20%	-10%	25%

Key: 1 = Positive Influence, 0 = Neutral, -1 = Negative Influence

Terminal Concept Evaluation



evaluation of the eight option terminal concepts at Sea-Tac.

Airside Criteria

- **Capacity:** *Ability to provide sufficient aircraft parking positions to meet or exceed forecast demand.*

  Airside capacity reflects the ability to meet the forecast for gate frontage within the overall terminal site defined in the TDP. Options which scored higher exceeded the forecast requirement or required a smaller overall area, while options which scored lower generally required additional area to achieve the forecast gate requirements.

- **Flexibility:** *Ability of the terminal concept to accommodate the forecast number and mix of aircraft parking positions and facilitate cross-utilization by different airlines.*

  Airside flexibility reflects the ability of the concept to provide an unlimited range of aircraft types at a greater number of gates than the TDP. Options which scored higher replaced a greater number of existing gates, while options which scored lower generally continued to re-use existing somewhat restrictive gate areas.

- **Access:** *Ability of the terminal concept to facilitate unconstrained aircraft access between the terminal area and the taxiway system.*

  Airside access measures the ability of the concept to provide airfield access from the apron area (in addition to the 2nd east parallel taxiway). Options which scored higher provided at least one additional lane of access to the parallel taxiway system, while options which scored lower reduced airfield access as measured against the TDP.

- **Maneuverability:** *Ability of the concept to facilitate aircraft maneuvering within the immediate terminal and aircraft parking areas.*

  Airside maneuverability reflects the ability of the concept to provide increased taxilane access or area in and around the aircraft gates in comparison with the TDP. Options which scored higher provided additional parallel taxilanes or direct taxiway access, while options which scored lower created increasingly constricted and congested apron areas.

Terminal Criteria

- **Balance:** *The capability of the terminal concept to conveniently combine sufficient airside and landside capacity and adapt to the functional requirements of each as defined in the Master Plan.*

  Terminal balance describes the ability of the concept to mate the airside development capacity with a corresponding level of landside development. Options which scored higher provided gates closer to the landside facilities, while options which scored lower generally provided airside and landside capacity requirements which were further apart.

- **Capacity:** *Ability of the concept to accommodate the forecast program in an economical, efficient manner with consideration of existing functional and architectural conditions.*

  This terminal capacity reflects the ability of the concept to provide sufficient area to provide for the construction of terminal facilities and connecting infrastructure. Options which scored higher had terminal facilities sited in relatively unconstrained locations to the north, while options which scored lower generally depended upon an expansion of the existing terminal.

- **Convenience:** *Ability of the concept to facilitate passenger convenience and enhance the travel experience when considering orientation, walking distances, level changes, accessibility, amenities, and minimization of connecting times.*

  As used at Sea-Tac, this terminal evaluation criterion reflects the ability of the concept to facilitate use by both originating/terminating and connecting passengers. Options which scored higher provided short curb-to-gate distances as well as contiguous terminal facilities, while options which scored lower generally increased both curb-to-gate and short terminal-to-terminal distances.

- **Constructability:** *Ability of the concept to be implemented in a cost effective, incremental fashion. Constructability includes consideration of property relocations and acquisitions which may be required, as well as staging areas and construction access. Equally important is the ability to maintain ongoing operations through construction with a minimum of disruption.*

  As used at Sea-Tac, constructability reflects the ability of the concept to be developed without more extensive relocations and/or property acquisitions than previously identified in the TDP. Options which scored higher, required no property acquisition and minimized the number of facilities relocated, while options which scored lower, required acquisition of additional property and extensive relocation or modification of facilities.

- **Flexibility:** *Ability of airport and tenants to adapt to changing marketing and operating requirements with minimal changes to the terminal.*

  This flexibility reflects the ability of the terminal concept to adapt to changes in airline and tenant demands for terminal and gate facilities. Options which scored higher provided contiguous terminal facilities and unconstrained sites which enabled future terminal modification. Options which scored lower provided physically separated terminal facilities or developed new facilities in already constrained sites.

Landside Criteria

- **Capacity:** *Ability of the landside development concept to provide sufficient landside area convenient to the terminal to accommodate forecast requirements with minimal congestion at peak periods.*

  Landside capacity reflects the ability of the terminal concept to meet or exceed present curbside and roadway level of service. Options which scored high provided ample facilities at new unit terminals, while options which scored lower continued to depend on the existing terminal roadway.

- **Simplicity:** *Ability of the landside concept to facilitate rapid driver orientation and ease of movement to and from all landside elements.*

  Simplicity reflects the overall logic of the roadway system, the ease of orientation and the generousness of the horizontal and vertical vehicular movements. Options which scored higher were those continuing to rely on a single terminal complex, while options which scored lower relied on complex or unconventional roadway geometry in confined areas.

- **Constructability:** *The ability of the landside concept to maintain ongoing operations through various construction phases with minimal disruption and the degree to which it does (or does not) rely on uncertain future easements, acquisitions, and facility relocations.*

  Constructability reflects the ease with which the proposed roadway system may be developed while maintaining existing operations and within existing airport boundaries. Options which scored higher relied on existing roadway infrastructure or developed new facilities in relatively unconstrained sites. Options which scored lower developed complex roadway facilities requiring extensive engineering and likely disruptions to ongoing operations.

- **Compatibility:** *Compatibility of the landside concept with existing regional access points and flows as well as with future anticipated regional transportation networks and terminal area interface points.*

  Landside compatibility reflects the ability of the concept to facilitate access from the north, while providing a graceful future connection to a revised south access. Options which scored higher provided unconstrained landside solutions oriented towards the primary airport access, while options which scored lower created unusual impacts on off-airport roads, or provided constraints to accessing the terminal from future south access.

Cost Criteria

- **New Construction:** *Anticipated construction cost premiums associated with terminal, landside or airside options including required temporary or interim structures.*

  Costs of new construction reflects the degree to which the existing facilities require expansion and or replacement. Options which scored higher maximized the re-use of the existing terminal and related infrastructure, while options which scored lower required wholesale demolition and replacement of the terminal and/or roadway system.

- **Special Systems:** *Implied capital and operating costs resulting from the development of mechanical systems for the intra- and inter-terminal movement of people or baggage.*

  The cost of special systems reflects the ability of the concept to accommodate increased demand without costly expansion or replacement of the existing STS system. Options which scored higher provided direct inter-terminal connections and did not rely on expansion of the existing STS system, while options which scored lower required either increased capacity on the existing STS system, or the creation of new, more complex systems in addition to the existing STS system.

- **Facility Relocations:** *Costs of relocating/replacing existing facilities, property acquisition, and other site preparation projects prior to construction.*

  The cost of facility relocations reflects the degree to which the concept requires extensive site relocations and/or acquisition of property not currently owned by the Airport. Options which scored higher were sited entirely on existing airport property and minimized the relocation of adjacent facilities. Options which scored lower required acquisition of some non-airport property or required extensive relocation of existing facilities.

The evaluation process was performed on each of the conceptual terminal options, and the highest scoring options within each of the three site groups was identified for further refinement (Table 5-1). These options include Option A-2, Option B, and Option C-4.

Section 6
IMPLEMENTATION ANALYSIS

SECTION 6
IMPLEMENTATION ANALYSIS

INTRODUCTION

Through the initial evaluation process the leading variations of the three concept areas were selected or "short listed" for further development and evaluation. These options are listed below and described in more detail in this section of the report.

- South Unit Terminal Option (Figure 6-1) - A new unit terminal to the south of the existing Main Terminal at Sea-Tac based upon refinements to terminal Option A-2.
- Central Terminal Option (Figure 6-2) - A centralized expansion of the existing Main Terminal at Sea-Tac based upon refinements to terminal Option B.
- North Unit Terminal Option (Figure 6-3) - A new unit terminal north of the existing Main Terminal at Sea-Tac based upon a hybrid of refinements to terminal Option C-4.

Each of the foregoing conceptual terminal options was developed as an expansion of the existing terminal complex. Although each terminal option was developed to reflect the anticipated maximum program requirement for the forecast period of the Master Plan, it was recognized that each option may also be capable of some expansion beyond that required of the forecast period. It was also recognized that future operational scenarios at Sea-Tac could play an important part in determining which terminal option might be best, and that certain hybrid combinations of all three options might be appropriate depending upon the type of operation and growth anticipated. An additional important consideration which emerged during the evaluation process was that of incremental expansion. These considerations and others from the evaluation matrix are briefly revisited in summarizing the three shortlisted terminal options.

TERMINAL OPTIONS SELECTED FOR FURTHER ANALYSIS

The following sections briefly outline the basis upon which each of the three terminal configurations was selected for further refinement and evaluation.

South Unit Terminal Option (Figure 6-1)

This option develops a unit terminal linked to the main existing terminal at Sea-Tac through an extension of Concourse A. Concourse A serves as frontal gates for the new unit terminal which is also connected to the south satellite via an underground pedestrian tunnel.

Airside - The South Unit Terminal Option meets the overall forecast ramp frontage for the Master Plan horizon by expanding the existing North and South Satellites and Concourse A. Access and parking is provided for Group VI aircraft along the south side of the South Satellite and Concourse A. The airside may be expanded incrementally without impacting existing airport roadways by lengthening Concourse A in two or three phases until the new unit terminal is necessary or desired. Expansion of Concourse A will require demolition/relocation of the Northwest and Delta hangar areas. The satellites may also be

2000)
2005) UNDER FURTHER STUDY
2010)

2020) UNDER FURTHER STUDY

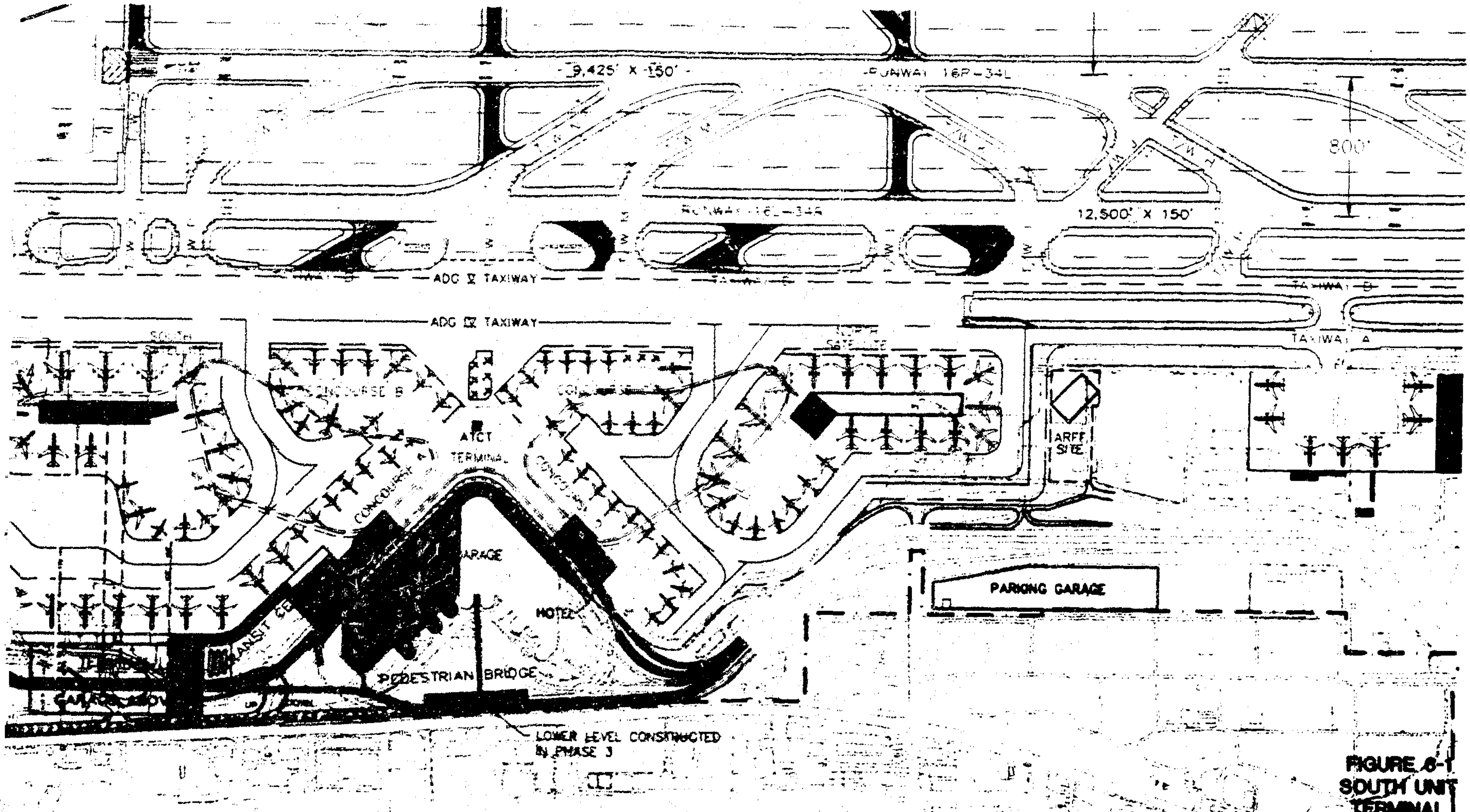
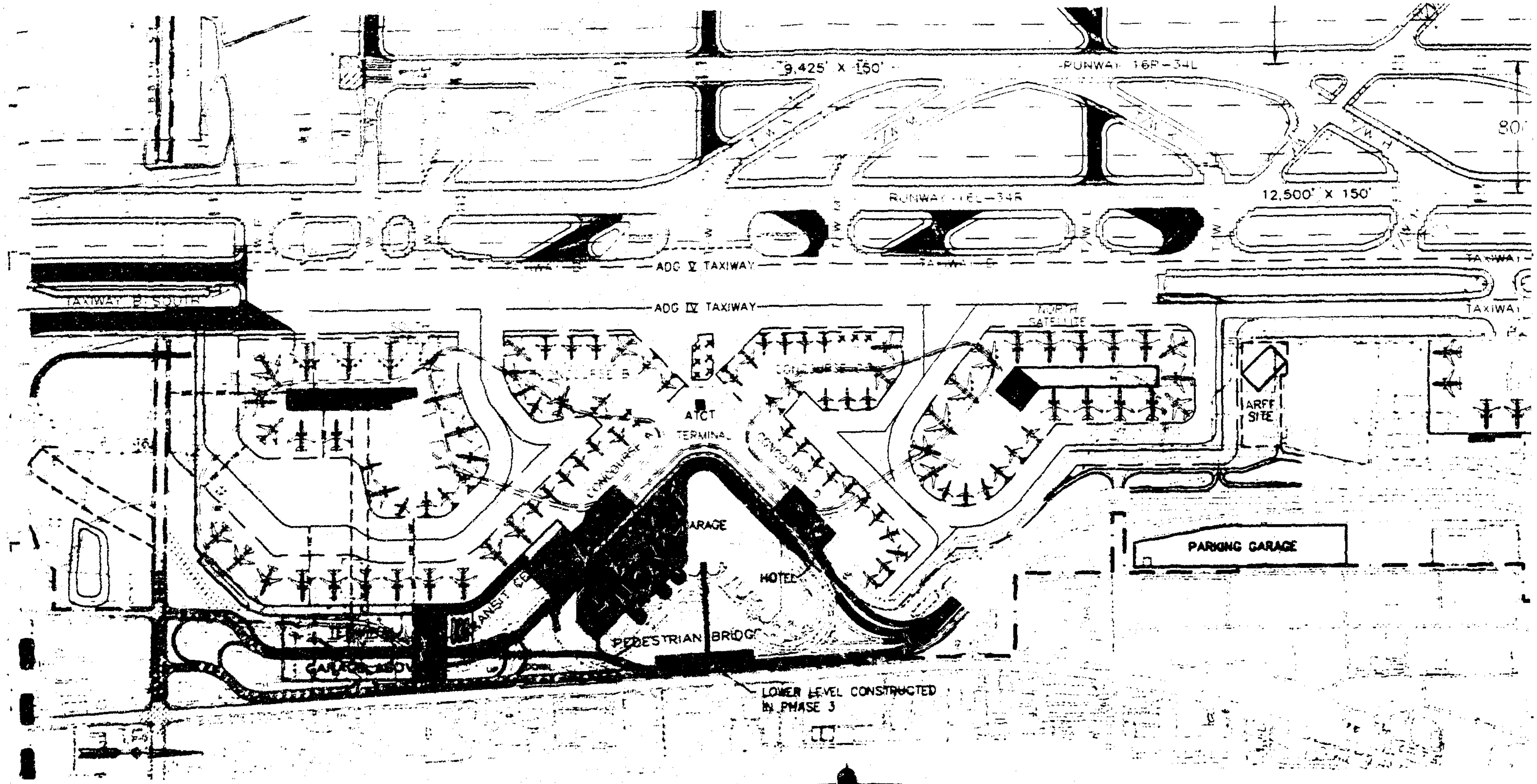


FIGURE 6-1
SOUTH UNIT TERMINAL OPTION

LEGEND:

PHASE 1 (1995-2000)
PHASE 2 (2001-2005)
PHASE 3 (2006-2010) — UNDER FURTHER STUDY
PHASE 4 (2011-2015)
PHASE 5 (2016-2020) — UNDER FURTHER STUDY



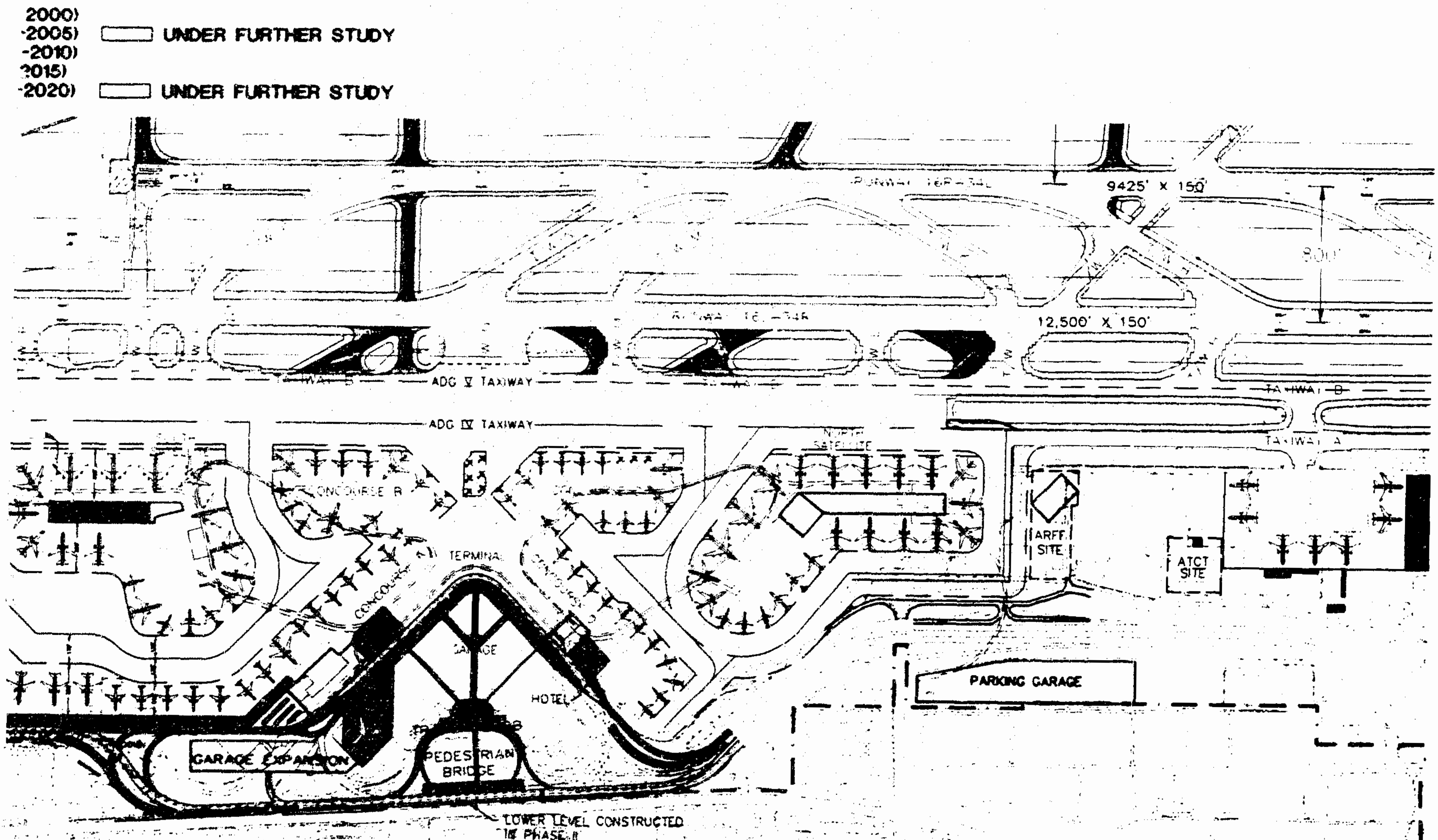
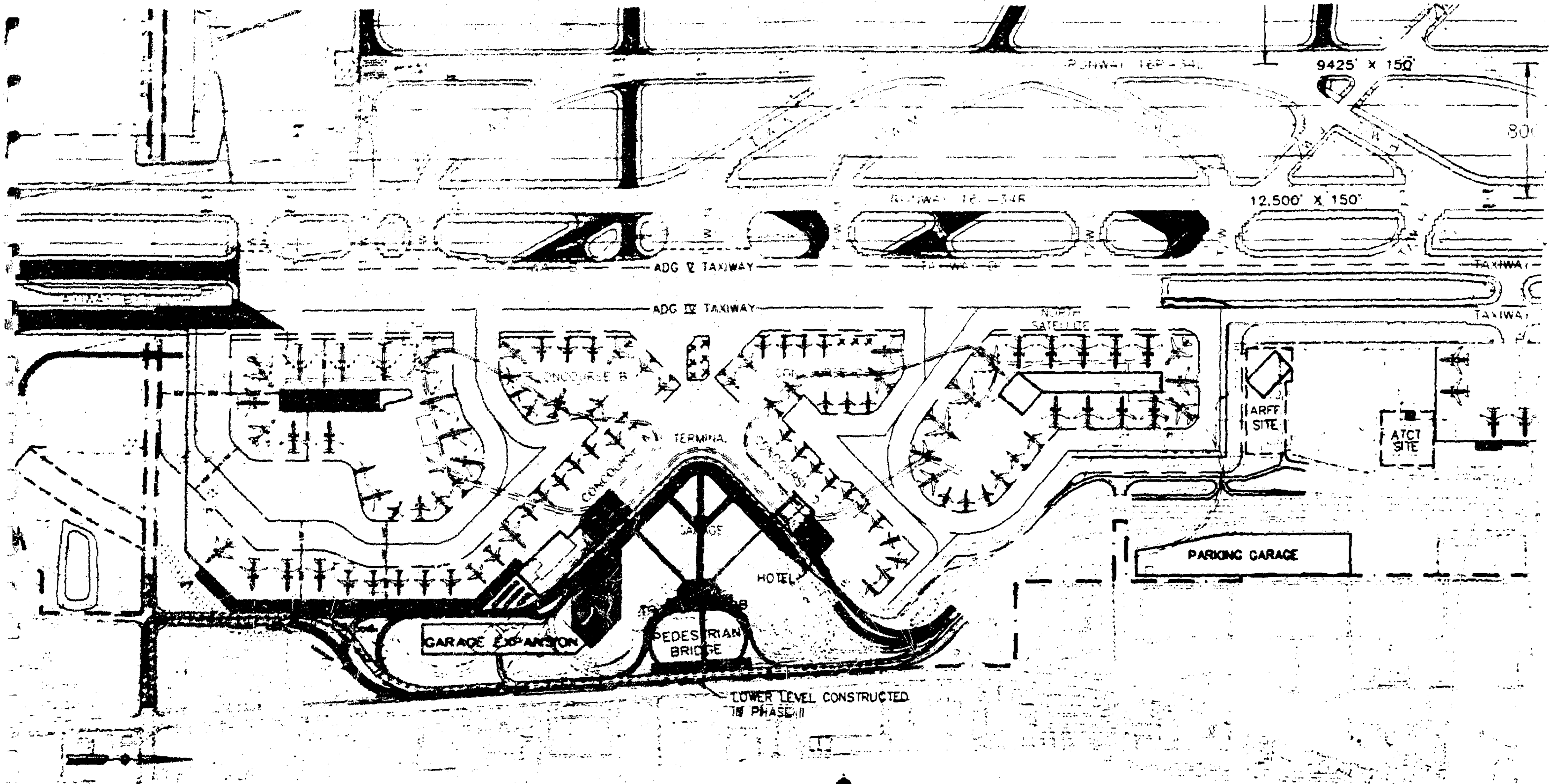


FIGURE 6-2
CENTRAL TERMINAL OPTION

LEGEND:

- PHASE 1 (1995-2000)
- PHASE 2 (2001-2005)
- PHASE 3 (2006-2010)
- PHASE 4 (2011-2015)
- PHASE 5 (2016-2020)
- UNDER FURTHER STUDY
- UNDER FURTHER STUDY



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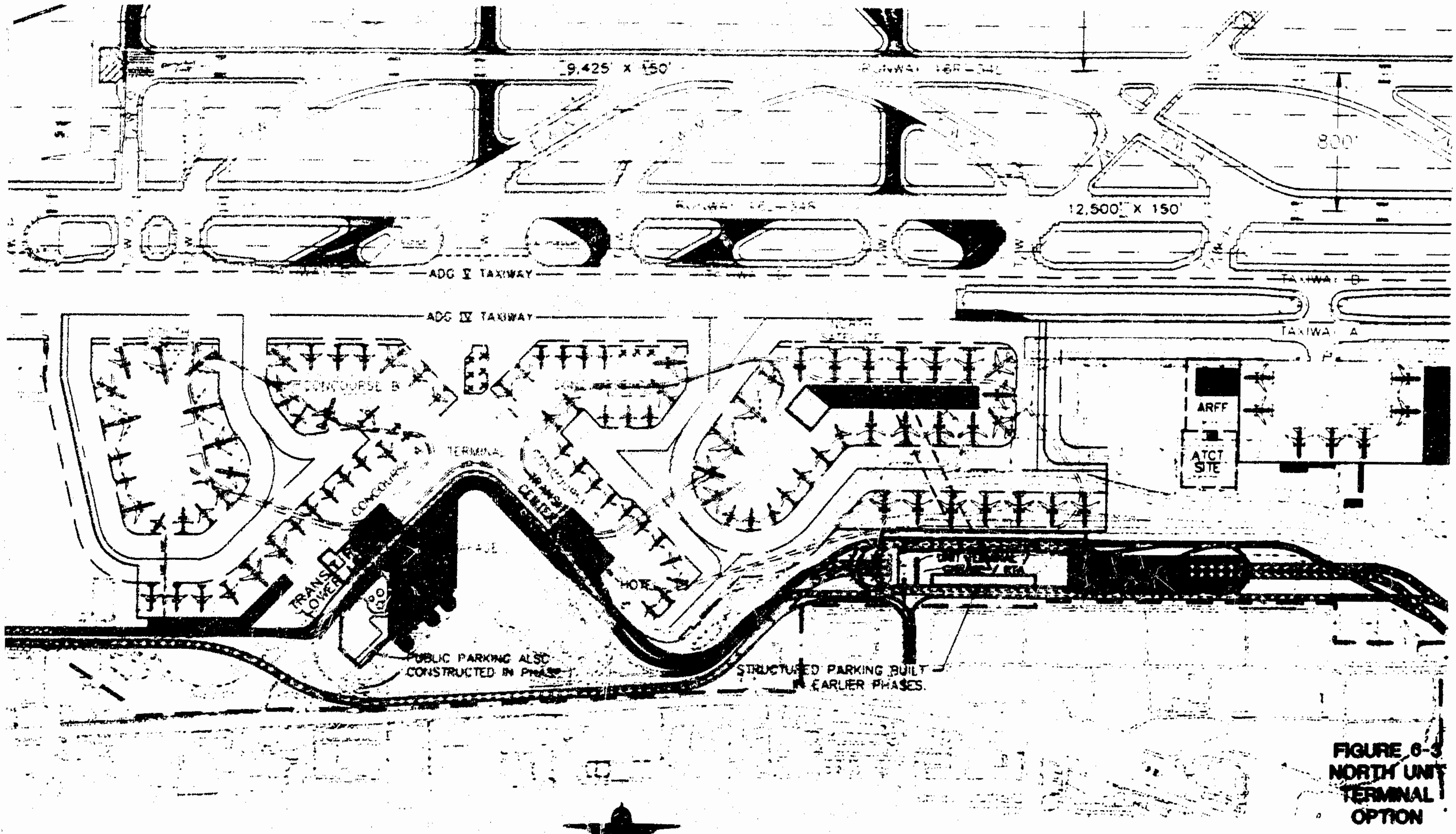
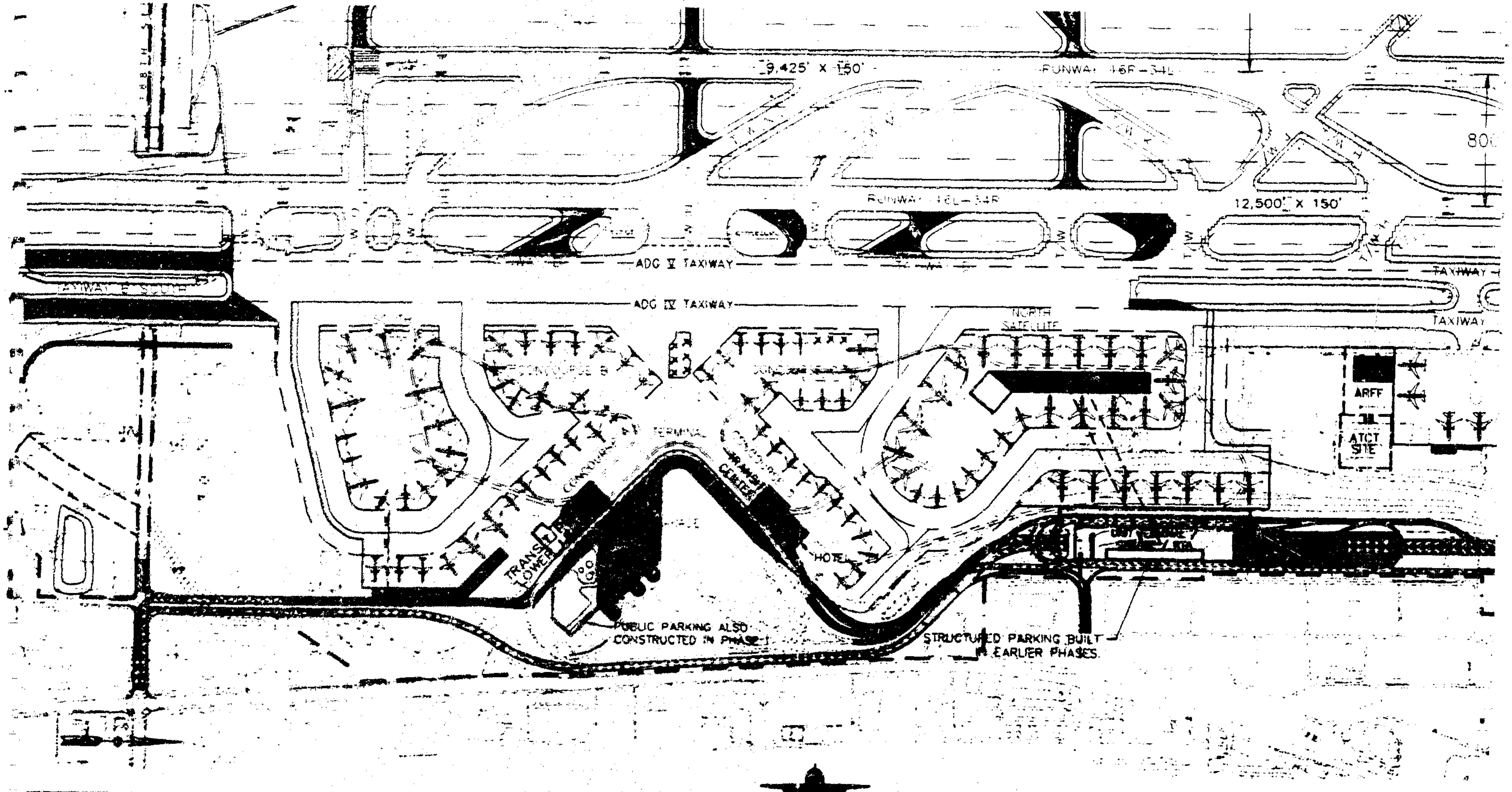


FIGURE 6-3
NORTH UNIT TERMINAL OPTION

LEGEND:

PHASE 1 (1995-2000)
PHASE 2 (2001-2005)
PHASE 3 (2006-2010) UNDER FURTHER STUDY
PHASE 4 (2011-2015)
PHASE 5 (2016-2020) UNDER FURTHER STUDY



expanded incrementally but significant improvements to the South Satellite will require demolition/relocation of the existing Alaska Airlines hangar areas. Expansion of the North Satellite will require the demolition/relocation of the existing ARFF facility.

Terminal. The South Unit Terminal Option functions in much the same manner as the existing terminal at Sea-Tac. The unit terminal is linked physically to the existing terminal through a secured passage alongside Concourse A, making passenger orientation clear and direct. Passengers may move freely between the terminals with a minimum of level changes and confusion. For improved passenger access to the South Satellite, a new pedestrian/baggage tunnel is provided between the South Satellite and the new South Unit Terminal. This will supplement the existing STS which links the existing South Satellite and main terminal. Moving walks would be provided in the pedestrian tunnel to facilitate passenger movement. The unit terminal site is sufficient in depth to accommodate an international arrivals facility if this is desired. Further expansion of the Main Terminal to the south may also be desirable to provide an expanded security screening interface for the Concourse A extension as well as to provide for interim expansion of airline and passenger facilities at the airport.

Landside. The South Unit Terminal Option provides relief to the existing terminal curbfront through a separate terminal access roadway and curbfront system. This bypass roadway system requires an elevated structure which runs from the north end of the Main Terminal, along the east side of the parking structure, and ties into the South Unit Terminal curbside to the south of the Main Terminal. A separate parking structure will be provided as a part of the new South Unit Terminal landside system which will be integral with the terminal itself. The proposed terminal area landside system will be consistent with the existing two-level terminal area roadway with enplaning traffic using the upper level and deplaning traffic using the lower level. All existing traffic movements are retained with the exception of southbound traffic exiting the Main Terminal which must use the South Unit Terminal curbside roadway system.

Cost. The unique cost features of the South Unit Terminal Option include the development of a separate terminal facility, eventual property acquisition of the commercial areas to the south, demolition/relocation of Alaska, Delta, and Northwest Hangar facilities, construction of a passenger tunnel from the South Unit Terminal to the South Satellite, and construction of the elevated bypass roadway serving the South Unit Terminal and the related modifications to other on-airport roadways. Expansion of the North Satellite will require the demolition/relocation of the existing ARFF facility.

The Central Terminal Option (Figure 6-2)

This option includes many airside elements of the South Unit Terminal Option but attempts to expand landside and terminal capacity entirely by modifications to the existing Main Terminal and supporting roadway system.

Airside - The Central Terminal Option meets the overall forecast ramp frontage for the Master Plan horizon by expanding the existing North and South Satellites and by expanding Concourse A. Access and parking is provided for Group VI aircraft along the south side of the South Satellite and Concourse A. The airside may be expanded incrementally without impacting existing airport roadways by lengthening Concourse A in two or three phases. Expansion of Concourse A will require demolition/relocation of the Northwest and Delta hangar areas. The satellites may also be expanded incrementally but significant improvements to the South Satellite will require demolition/relocation of the existing Alaska Airlines hangar areas.

Terminal - The Central Terminal Option relies on the continued expansion of the existing Main Terminal to provide passenger facilities through the forecast period. Expansion is provided on the south end of the main terminal for a replacement FIS facility, expanded passenger facilities, as well as an improved security screening interface to Concourse A. A limited amount of terminal expansion is also planned for the north end of the existing main terminal. A separate check-in facility is also provided to the east of the parking garage to serve the transit curb created there. This would be a check-in facility only - no baggage claim would be provided at this location. This transit curb and associated check-in facility would be connected to the main terminal via a series of moving sidewalks and baggage conveyors which would help facilitate passenger and checked baggage movement across the 4th floor of the parking garage to the main terminal.

Landside - Forecast roadway deficiencies are addressed in the Central Terminal Option through a combination of measures, all centered on the existing curbside, roadways, and parking. The first of these is the widening of the existing terminal roadway. This provides some additional through capacity in addition to the potential for an island curb, but may negatively impact existing curbside capacity due to added pedestrian crossing of the inner roadway from the island curb. In addition, an elevated transit curb is proposed above the parking lot exit on the east of the parking structure. This transit curb would require development of moving sidewalks within the existing parking structure and would, therefore, reduce parking available within the existing structure. Additional parking in support of the expanded terminal facilities would be provided to the south of the existing parking structure. In addition, the transit curb requires a separate elevated roadway running east of the existing parking garage. This elevated roadway would not only serve the transit curb, but could provide an alternative entrance to the parking structure.

Cost - The unique cost features of the Central Terminal Option include demolition/relocation of Alaska, Delta, and Northwest Hangar facilities, widening of the existing terminal curb, construction of the elevated bypass roadway serving the South Unit Terminal and the related modifications to other on-airport roadways. The terminal expansion itself would likely be less expensive than concepts requiring development of a separate unit terminal. Expansion of the North Satellite will require the demolition/relocation of the existing ARFF facility.

The North Unit Terminal Option (Figure 6-3)

A northside unit terminal with frontal gates is the main feature of the North Unit Terminal Option together with significant expansion of the North Satellite and Concourse A. Unlike the South and Central Options the unit terminal in the North Unit Terminal is not physically linked to the main existing terminal at Sea-Tac, except through a potential extension of the STS shuttle and a passenger tunnel linking it to the North Satellite.

Airside - The airside in the North Unit Terminal Option provides frontal gates at the new unit terminal which are connected to the new unit terminal via pedestrian bridges. Additional gates are provided in extensions to the North Satellite and Concourse A. The North Satellite gates are connected to the new unit terminal via an underground connector with moving sidewalks. It has been assumed that the North Satellite will serve as the transfer point for passenger connections between both the Existing and North Unit Terminals.

Terminal - The terminal in the North Unit Terminal Option is located directly above the north entrance roadway and is connected to the flightline via a pedestrian bridge. Additional gates on the North Satellite are accessed via an underground connector with moving sidewalks. The terminal itself is oriented to take advantage of a two-level curb on both the east and west sides with integral parking located above. In addition, some expansion of the main terminal would be provided to the south to provide for replacement FIS facilities alongside Concourse A. (While FIS facilities could be provided at the North Unit Terminal, restrictive airside parking clearances at the North Satellite would limit the usefulness of an FIS facility at this location.)

Landside. Perhaps the most important landside feature of the North Unit Terminal Option is that its location eliminates the need for, and cost of, an elevated main terminal bypass roadway system. Traffic access from the north (the primary airport access route) would be diverted to the new unit terminal before reaching the congested roads of the existing main terminal. The terminal itself would be served with a reverse-flow (Phoenix-style) roadway on two levels with the main access road beneath. Vehicular parking would be provided in a structure above the North Unit Terminal as well as in expanded parking at the Main Terminal.

Cost. The North Option could also be constructed entirely on land now owned or controlled by the Port of Seattle. In addition, it would not require the relocation of the Alaska, Delta, and Northwest hangar facilities to the south. Relocations to the north, however, would be extensive and would include the ARFF, the USPS facility, Doug Fox parking, and various cargo and catering kitchens. Relocation and construction over of the existing north access road would also be a significant cost and construction scheduling impact.

APPROACHES FOR INCREMENTAL EXPANSION

The process of evaluation which led to the shortlisted terminal concepts for the Sea-Tac Master Plan reflects input from a variety of sources. One of the most important elements to emerge during the evaluation process was the need to provide flexibility and adaptability to change in an incremental fashion as operational requirements for the airport continue to shift in the future. For instance, the size and evolution of the commuter operation at Sea-Tac is an emerging factor, and there have been important shifts in the international market as well.

The ability to facilitate incremental growth is a major consideration. The successful terminal option must satisfy not only a long range requirement, but must be easily and incrementally expandable to satisfy short term demand. Because the expansion of terminal facilities at Sea-Tac is tied directly to the prudent and effective utilization of existing aircraft gates, improved gate utilization has been factored into the overall terminal program for the Master Plan.

Each of the shortlisted terminal options reflects the need for significant improvements in landside infrastructure and, in some cases, new unit terminals. As a result, the incremental expansion is more challenging than would be the case if the existing terminal and roadway system were expanded by itself. For example, the development of terminal facilities in the North Option could be undertaken in an earlier phase by relying exclusively on access to the North Satellite if needed to meet pressing demands for expanded terminal and landside facilities.

The need for improved landside access is an important departure from the TDP and its impact upon incremental expansion should, therefore, be re-examined.

A suggested approach to incrementally expanding each of the three shortlisted terminal concepts follows. It should be noted that these suggested expansion approaches are conceptual only and are subject to refinement as costs, construction phasing, and changes in demand are further defined.

Expansion in each phase would be triggered by the need for the following key elements of the terminal area. A suggested phasing approach for each is as follows.

South Unit Terminal Option Incremental Expansion

Phase 1 - Expansion of Concourse A, development of commercial/hotel property to north of main terminal.

Phase 2 - Initial expansion of main terminal to south, initial expansion of North and South Satellites.

Phase 3 - Development of the new south unit terminal including: completion of Concourse A, integral parking structure, extensions to existing terminal roadways, development of southern bypass road east of main terminal parking, and other related improvements. A parking structure at the Doug Fox lot is developed in this phase.

Phase 4 - Extension of South Satellite

Phase 5 - Extension of North Satellite

Central Terminal Option Incremental Expansion Concept

Phase 1 - Expansion of Concourse A, development of commercial/hotel property to north of main terminal.

Phase 2 - Initial expansion of main terminal to south, completion of Concourse A.

Phase 3 - Expansion of the main terminal including: initial expansion of North and South Satellites, integral parking structure, extensions to existing terminal roadways, development of southern bypass road east of main terminal parking, development of parking structure at Doug Fox lot, and other related improvements.

Phase 4 - Extension of South Satellite

Phase 5 - Extension of North Satellite

North Unit Terminal Option Incremental Expansion Concept

Phase 1 - Expansion of Concourse A, development of commercial/hotel property to north of main terminal.

Phase 2 - Initial expansion of main terminal to south, additional expansion of Concourse A.

Phase 3 - Initial Extension of North Satellite and extension of South Satellite.

Phase 4 - Completion of North Satellite

Phase 5 - Development of the new north unit terminal including: roadways, development of access roads for the new unit terminal, and other related improvements.

SUMMARY

The North, Central, and South Terminal Options for the Sea-Tac Master Plan Update reflect a number of options, each of which may be appropriate to meet differing operational scenarios which could develop in the future. These options are not necessarily mutually exclusive of one another and may be combined to meet functional requirements in the future as deemed necessary. For instance, a development of terminal facilities to the south may not necessarily preclude the development of terminal facilities to the north, and elements of the centralized terminal expansion concept might be combined with either the north or the south unit terminals. A summary of the program elements of each option appears in Table 6-1.

The next steps in the terminal evaluation process will be the inclusion of these three options in an environmental review, further narrowing of regional access recommendations, and the refinement of other forecast airport infrastructure and tenant requirements. These other non-terminal airport requirements include but are not limited to cargo, aircraft maintenance, fire and rescue, police, air traffic control, and general aviation. Once these non-terminal factors have been defined, and their impact on the terminal plan identified, the most appropriate terminal concept will be refined in greater detail.

TABLE 6-1

Terminal Concept Summary

	Existing 1994	Program 2020	Terminal Option South	Terminal Option Central	Terminal Option North	Units
AIRSIDE						
Gates	90.6	120.6	121.0	121.4	120.1	NBEGate
% widebody	42%	50%	56%	49%	49%	
Flexibility			best	better	good	
TERMINAL						
Terminal Area [1]						
centralized	1,900,000	2,980,000		3,400,000		SF
new unit terminal		3,433,000	3,900,000		3,700,000	SF
Balance			best	good	better	
LANDSIDE						
Curb Frontage	6,446	13,000	11,000	8,000	13,100	LF
Public Parking [2]	9,400	14,850	14,850	14,850	14,850	Spaces
Level of Service	C	C	C	D/E	C	L.O.S.
OVERALL RANK			1	3	2	

[1] Terminal options include extensive tunnels, mezzanines, and transit facilities unique to each concept and which were not included in the terminal program estimates.

[2] From 'Airport Parking System - Long Range Analysis' P&D Aviation, January 1995

Section 7
TERMINAL GROUND ACCESS AND SURFACE TRANSPORTATION ELEMENT

SECTION 7
TERMINAL GROUND ACCESS AND SURFACE TRANSPORTATION ELEMENT

INTRODUCTION

This section examines the issues involved in upgrading the ground access and surface transportation facilities at Sea-Tac International Airport to meet the projected demand of 38 Million Annual Passengers (MAP) by about the year 2020. Airport ground access is of major concern because of the physical requirements needed to support the passenger terminal with its daily activity level and the impact these facilities can create on the off-site area surrounding the terminal. With a projected doubling of the passenger population using the Sea-Tac terminal in twenty-five years, access to the terminal complex for passengers, employees, and visitors is an important issue and vital element of a successful master plan.

EXISTING CONDITIONS

Daily Travel Activity

Currently, the terminal complex serves about 50,000 daily air travelers on an average day. Of these passengers approximately 30% are connecting and do not use ground access to the terminal. It is estimated that the remaining 35,000 passengers are joined by about 15,000 daily visitors and another 10,000 employees on the typical day. In August, the busiest travel season, passenger and visitor traffic is about 30% above the annual average. For planning purposes the peak period is based on a typical day in August with 46,000 daily air passengers using ground access to the terminal joined by another 18,000 visitors, with employee trips constant.

Regional Roadways

From the north the terminal is accessed by a six-lane limited access roadway connection to the SR 518 Freeway, with an interchange at South 170 Street. From the east, the terminal complex has an entrance at South 180 Street and International Boulevard (US99). International Boulevard is a four-lane major arterial with a fifth central turning lane in the section adjacent to the airport. South 188 Street, a 4-6 lane major arterial, connects the terminal area to the Interstate 5 Freeway east of the airfield and SR 509 Freeway west of the airfield.

Restricted commercial traffic and employees can access the terminal from South 188th and 28th Avenue South to the commercial roadway under the terminal complex. This road becomes the cargo road north of the complex with a connection at South 170 Street to International Boulevard. Except for the North Access road, all other road access is from major arterials with mixed traffic.

On-Site Roadways and Parking

The regional access roads converge north of the existing terminal complex into a southbound one-way system with a four-lane upper (ticketing level) and five-lane lower (baggage claim) roadway system. The inner two lanes of both levels are for passenger curb service, and the other lanes for traffic merge and through traffic. The roadways are connected by a single 4-lane north-bound roadway to the eastern edge of the terminal site, which allows traffic on either level to flow northward, and provides access to the International Boulevard portal only from the lower level roadway.

The upper level roadway has access from the North access road, but no exit to the south, requiring that traffic destined for the International Boulevard exit recirculate on the connecting roadway past the lower terminal curb to exit the terminal.

Both the upper and lower roadways have about 1,600 feet of curb at the building face, with the second lane providing an equivalent of 960 feet of additional curb frontage. Thus, each level has about 2560 feet of effective curb frontage. There are transit terminals to the immediate north and south of the terminal building, with access only from the lower roadway. The north transit center can hold about 15 vehicles and the south transit center about 25 vehicles depending on vehicle size.

The central parking garage has access from both the North access road and the International Boulevard portal. There is a single toll plaza, with all vehicles exiting north or to the lower roadway. The garage is connected to the terminal by five elevated pedestrian crossings at the fourth floor of the garage.

The garage has 9,400 spaces (or equivalents), divided as follows: 1) Short-term metered parking - 1,000 spaces; 2) Long-term parking 7,000 spaces; 3) Car Rental facilities - 1,000 space equivalent; and, 4) Employee parking - 400 spaces. The garage was most recently expanded in 1992. In 1993, the third floor of the garage was converted to short-term metered parking which can avoid the toll plaza and has a separate third level entrance. This improvement was combined with a two-lane, third level transit roadway on the edge of the garage with 5 stops at each pedestrian crossing connecting to the transit stops one floor below.

In August 1994, an estimated 12,000 vehicles used the upper roadway on a typical day; about the same number used the lower roadway; and about 3,000 vehicles used the transit roadway in the parking garage. The short-term parking level accommodated about 5,000 vehicles daily, while approximately 8,000 vehicles daily used the long-term parking area, with an estimated 2,900 vehicles remaining over-night. There are three on-site auto rental firms with rental, return and servicing inside the garage. Other rental companies have agents in the terminal but vehicle rentals and returns are off-site from the terminal.

Travel-Behavior, Transit and Off-Site Services

The vast majority (70%) of air passengers and visitors arriving at or departing from the terminal complex come by private auto. Courtesy buses connecting to the surrounding airport area carry about 12% of passengers; for-hire shuttles and buses carry about 8.5% of passengers; rental cars account for 5% of passengers; taxis about 2.5% of passengers; and Metrobuses carry about 1% of passengers.

Existing information on parking behavior is imprecise due to conflicting definitions used in collecting data. However, of passenger vehicle trips, on-site short term-parking is believed to account for 35% of passenger and visitor trips; 20% of travelers use off-site lots; 12% either pick-up or drop-off at the curb without parking; and 5% use on-site long-term parking. About 9,500 parking spaces are operated by private concerns along International Boulevard in the airport vicinity.

Many different transit operations provide service to the terminal. In addition, vans connect the terminal to the numerous hotels, off-site parking areas and off-site car rental agencies along International Boulevard. For-hire vans and buses connect to the greater Seattle area and Eastern Washington state communities. Taxis are regulated by the Port of Seattle and those with airport access are restricted in number.

2020 MASTER PLAN NEEDS

Daily Travel Activity

Passenger forecasts suggest that by the year 2020 demand will to grow to nearly 90,000 passengers and 36,000 visitors on a typical August weekday. On-site employee trips are estimated to be about 17,000 daily by the Puget Sound Regional Council (PSRC).

On-Site Facility Needs

As shown in Table 7-1 below there will be a substantial need for additional curb space, access roads, parking spaces and related on-site ground access facilities, assuming a continuation of existing policies.

Regional Access

While some of the data requires further examination, in general the North access road can accommodate projected growth. However, International Boulevard access especially at South 188th Street and South 180 Street will be very constrained. Regional rail access via the RTA light-rail system is assumed. Use of the High Occupancy Vehicle (HOV) lanes in Interstate 5 will continue to be encouraged.

At present there are initiatives underway led by Washington State D.O.T. to extend SR 509 and allow for connecting access from the south end of the airport. Such a connection would provide considerable relief from the congestion in that area anticipated in the master plan. The Port of Seattle fully supports and will continue to pursue those initiatives. In the event that the SR 509 project is canceled or delayed, alternatives for alleviating vehicular congestion in the south end were investigated.

ALTERNATIVE GROUND ACCESS CONCEPTS

The development of surface transportation policies for the entire Puget Sound region is currently being reviewed by the Puget Sound Regional Council (PSRC) as part of its 2020 long-range planning program. The development of the Federal Intermodal Surface Transportation Efficiency Act (ISTEA) encourages alternatives to expansion of highways for single occupant vehicles, as does Washington State's comprehensive planning and congestion management programs. Therefore, regional transportation policy is searching for ways to improve surface transportation through implementation of Transportation Demand Management (TDM) and Transportation System Management (TSM) policies. The 2020 PSRC plan encourages the use of High Occupancy Vehicles (HOV), increased use of transit, non-motorized vehicles, congestion pricing strategies, and more efficient land use systems.

The Sea-Tac 2020 Master plan update is aware of these policies and will try to incorporate them into the ultimate plan. The assessment of the three alternative ground access systems for the Master Plan Update, however, is based on a continuation of existing travel habits, patterns and trends and represents a worst-case scenario since travel data from the peak month of August is used as well. The plans do allow for expansion of transit and rail facilities to serve any option. Planning for a number of facilities such as parking supply, and regional access will be dependent on policies eventually adopted for the region in the future, as well as on Port of Seattle actions to complement regional transportation plans. These trends will increase the need for infrastructure improvements to correct

TABLE 7-1

SEA-TAC INTERNATIONAL AIRPORT
LANDSIDE - FACILITY REQUIREMENTS

FACILITY	1993	PROGRAM 2020	MASTER PLAN CONCEPTS: Central Expansion	South Unit Terminal	North Unit Terminal
CURB LENGTH					
Ticketing Levels (1)	2560'	5230'	4160'	5120'	6080'
Baggage Levels	3136'	6272'	3136'	4740'	5056'
Small Transit Vans	750'	1500'	750'	1150'	1950'
VEHICLE PARKING*					
Garage: Short-Term	1000	2000	Distribution To Be Based on Policies		
Garage: Long-Term	7000	10,750			
Garage: Car Rental	1000	2000			
Garage: Employees	400	100			
Subtotal	9400	14,850	14,850	14,850	18,450
Large Transit	40	80	60	80	80
Cargo Area	1173	2460	1600	1460	2460
Employee Lot	4500	8000	8000	8000	8000
Private Off-Site	9500	N/A	N/A	N/A	N/A

(1) South and Central Terminal Options have new island curb at terminal ticketing level
* Garage parking needs for 2020 are subject to policy decisions
N/A Not Applicable

transportation deficiencies that can be addressed best at the regional and policy levels.

CENTRAL TERMINAL EXPANSION (Figure 6-2)

Major Roadways - This ground access and landside development system would provide a southbound access road to be decked over the existing northbound road east of the parking structure, directly connecting to the North access road's southbound lanes. The upper and lower level terminal ticketing and baggage claim roadways could be extended south to South 188th Street near 28th Avenue. A new northbound roadway could start at South 188th Street and South 28th Avenue parallel to the added area south of the existing terminal and connect to a two-way roadway system that would permit direct access and egress to the terminal from South 188th Street. This system eliminates congestion from International Blvd. and allows a southern exit from the existing ticketing level roadway.

Curbside - To gain added curb space, the ticketing level terminal roadway would be widened, with a pedestrian island set in the roadway. There would be six moving lanes, three each on either side of the pedestrian island.

Transit - An elevated RTA rail station and a transit center are placed to the east of the existing parking structure. Vehicular access and egress would be from the decked north/south roadways at the eastern edge of the terminal area. About 400' of added transit curb space would be provided, with access from south and north bound roadways. A pedestrian connection from the RTA and transit center would be made through the 4th floor of the parking structure. At the south edge of the terminal building a large transit plaza would be built for airport users to replace the existing plaza which would be taken by terminal expansion.

Minor Roadways - Ramps to the upper ticketing levels and lower baggage level curb area would be doubled in size.

Access/Egress Points - South 188th Street/28th Avenue could become a new entry/exit point. A southbound flyover from the southbound exit road over South 188th Street could eliminate left-hand turns onto South 180th Street. This entry will reduce the need for turns from Northbound International Boulevard into the existing South 180th Street entrance. The existing portal at South 188th Street/International Boulevard would only be a northbound entrance to terminal. South 188th Street would require widening, channelization, and other traffic improvements between the terminal and International Boulevard.

A South Access road connection could connect to SR509 in addition providing improved connections between South 188th Street and the new terminal complex roadways. Both improvements are not needed to meet forecast requirements however. Any resulting plan should continue to be coordinated with other local and regional roadway improvements being considered outside of the terminal area.

Parking - Added spaces are provided by expanding the existing garage to the south and by building a structure at the existing Doug Fox off-site parking area. The expansion of the main garage would add about 4,800 spaces and the Doug Fox site about 4,500 spaces.

SOUTH UNIT TERMINAL (Figure 6-1)

Major Roadways - This ground access and landside development system would provide a southbound access road to be decked over the existing northbound road east of the parking structure, directly connecting to the North access road's northbound lanes. The upper and lower level terminal southbound roadways will be extended to South 188th Street and South 28th Avenue parallel to the new south unit terminal. A new northbound roadway beginning at South 188th Street could permit direct access and egress to both the existing and new unit terminal from South 188th Street. This system would eliminate congestion on International Boulevard and allow a southern exit from the existing ticketing level roadway.

Curbside - Additional curb space would be gained from the new ticketing and baggage levels at the unit terminal.

Transit - An elevated RTA rail station would be sited to the east of the existing terminal parking garage, with pedestrian access through the parking garage. Transit centers would be provided just north of the new unit terminal and next to the existing terminal for airport patrons.

Minor Roadways - Ramps to the upper ticketing levels and lower baggage level curb area would be doubled in size to handle projected growth. Connections would be made between the new south and north roadways at the unit terminal to allow recirculation. Ramps would be built into the existing parking garage from the new main northbound roadway.

Access Points - South 188th Street/28th Avenue could become a new entry/exit point. A southbound flyover from the southbound exit road over South 188th Street could eliminate left-hand turns onto South 188th Street. This entry would reduce the need for turns from North-bound International Boulevard into the existing South 180th Street entrance. The existing portal at South 180th Street/ International Boulevard would only be a northbound entrance to terminal. South 188th Street would require widening, channelization, and other traffic improvements between the terminal and International Boulevard.

The South Access road connection to an extended SR509, would connect to the terminal just south of the south unit terminal, in addition to the improved connection between South 188 Street and other new terminal complex roadways. However, both full improvements are not needed and must be coordinated with local and regional roadway improvements away from the terminal area.

Parking - Added spaces are provided by expanding the existing garage to the south and by building a structure at the new south unit terminal. The expanded main garage would add about 2,000 spaces and the south unit terminal garage about 4,000 spaces. A garage at the Doug Fox site could hold about 4,500 cars.

NORTH UNIT TERMINAL (Figure 6-3)

Major Roadways - To accommodate the north unit terminal about 2,000' of the existing six-lane divided North access road would require relocation eastward and would be depressed to allow the unit terminal to be built over the roadway. Connections from the relocated North roadway would be made to/from the unit terminal from all directions. The Doug Fox parking lot would be eliminated with this alignment.

The lower level terminal southbound roadway could be extended to South 188th Street near 28th Avenue. In addition, a new northbound roadway could extend from South 188th Street and South 28th Avenue to the existing terminal roadway that would permit direct access and egress to the terminal from South 188th Street. This system eliminates congestion from International Boulevard and allows a southern exit from the existing ticketing level roadway, with full northbound access from South 188th Street. Southbound traffic from the North Unit terminal, going toward South 188th Street would use the main terminal southbound roadway system.

This scheme shows southbound traffic from the north unit terminal using the curbside roadways of the main terminal to reach South 188th Street. This concept is consistent with the south unit terminal concept. However, due to existing constraints at the main terminal, a separate bypass road may be desirable for southbound traffic.

Curb Space - The new unit terminal would have both ticketing and baggage claim curb levels. Since this system allows access to the "backside" of the terminal, there are curb fronts on both the east and west sides of the terminal. The ticketing level roadway of the main terminal would be widened to six lanes with a central pedestrian island to add curb space.

Transit - An elevated RTA rail station would be located over the north unit terminal (an alternative location would be east of the main terminal parking garage as shown in Figure 6-2). Small transit vans would use space over the terminal building for airport patrons. A transit plaza for large buses using the main terminal would be located to the south of the main terminal complex. The unit terminal would be linked to the main terminal by shuttle buses or a STS extension.

Minor Roadways - South 170 Street will be able to access the north unit terminal complex, but not the North access road. Roadways would link the different levels of the unit terminal with each other and the parking ga ·ge on top of the unit terminal. Expansion of ac ss ramps to the ticketing and baggage claim levels of the main terminal are required to handle projected growth.

The location of this facility would eliminate access to the cargo road and support roads that now service that area. A new connection to the main complex tunnel roadway would be developed from SR 518 north of the runway area.

Access Points - South 188th Street/28th Avenue could become a new entry/exit point. A southbound flyover from the southbound exit road over South 188th Street could eliminate left-hand turns onto South 188th Street. This entry would reduce the need for turns from north-bound International Boulevard into the existing South 180th Street entrance. The existing portal at South 180th Street International Boulevard would only be a north-bound entrance to the terminal area. South 188th Street would require widening, channelization, and other traffic improvements between the terminal and International Boulevard.

The north unit terminal could be accessed from a rebuilt North access road, the new roadway system at the existing main terminal, or from South 170 Street and International Boulevard. This reconstruction would be extensive. A SR 518 partial interchange would be located near 20th Avenue South to service the cargo area and ·mployee parking, replacing the existing S ·h 24th Avenue partial interchange. This interchange would connect with the relocated 156 South alignment north of the runways.

The South Access road connection to an extended SR509, would connect to the terminal area near 188th Street. An improved connection between South 188th Street and the new terminal complex roadways is also shown. However, both full improvements are not needed, and must be coordinated with local and regional roadway improvements away from the terminal area.

Parking - Parking will be placed in levels over the new unit terminal, adding about 4,000 spaces to the unit terminal. An expansion of the main terminal garage can add another 4,000 cars.

PHASING AND PROJECT PRIORITIZATION

During the course of the Master Plan Update, several scenarios of future traffic conditions at the existing terminal and immediate access roads were simulated. These scenarios examined how well the terminal curb roads, parking garage, and access roads could accommodate the projected increase in passenger traffic in phased increments from the 1993 level of about 18 MAP to the projected 38 MAP. This analysis is based on retaining the level of service now experienced by Sea-Tac patrons, so the future traffic conditions are not worse than current levels, even though airport use will more than double.

Several roadway and parking segments of the terminal, based on August weekday conditions, reach saturation. Based on analysis of the existing system assuming uniform growth in passenger traffic and no improvements in ground access capacity at the terminal, the following problems are likely to occur at the times cited below.

CURRENT PROBLEM AREAS

- Short-term parking inadequate.
- Congested ramps to ticketing and baggage claim levels from recirculation roads.
- Ticketing level roadway congestion.
- Lack of ticketing level south access causing congestion on recirculation roads east of the parking structure.

2000 - 2010 PROBLEMS

- Inadequate baggage claim level exit roadway
- Inadequate rental car level access roadway
- South entry access on to recirculation roadway and access roads to both Ticketing and baggage claim levels.
- South entrance/exit functions at Level of Service (LOS) F.

2010 - 2020 PROBLEMS

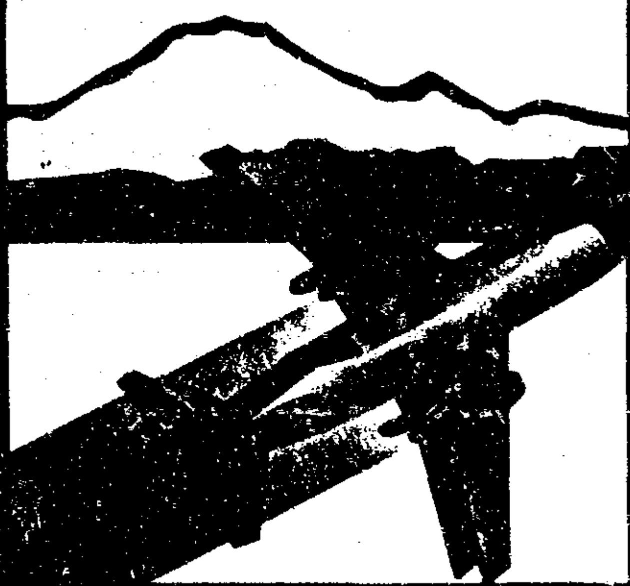
- Rental-car parking inadequate
- Ticketing and baggage claim level roadway space inadequate in front of terminal
- Ramps from North Access Road to ticketing and baggage claim levels overly congested.

2020+ PROBLEMS

- Roads from south entrance to all Terminal levels inadequate
- Outbound ramps from Ticketing and Baggage Claim level inadequate
- All roads on the east side of the parking structure leading to terminal and outbound north access road are congested.

Attachment B
to Port Resolution 3245

TECHNICAL REPORT NO. 7B
OTHER FACILITIES REQUIREMENTS AND OPTIONS



AIRPORT MASTER PLAN UPDATE

F O R

SEATTLE-TACOMA INTERNATIONAL AIRPORT

P&D Aviation

TECHNICAL REPORT NO. 7B
OTHER FACILITIES REQUIREMENTS AND OPTIONS

AIRPORT MASTER PLAN UPDATE FOR SEATTLE - TACOMA INTERNATIONAL AIRPORT

Prepared by:

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Prepared for:

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FEBRUARY 24, 1995

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LANDSIDE OPTIONS EVALUATION

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INTRODUCTION

BACKGROUND

Technical Report 7B documents the facility requirements of those airport elements contained in Tasks 5.5 and 5.6 of the Airport Master Plan Update Work Program and presents an analysis of feasible options to implement facility improvements.

Task 5.5 covers the air cargo facilities needed to satisfy demand through to the year 2020 in terms of cargo terminal floor areas, all-cargo aircraft parking positions adjacent to the terminals, truck docks and employee/customer parking spaces on the landside of terminals. Task 5.5 also includes cargo terminal floor areas for belly-hold cargo carried on passenger aircraft as well as freight forwarder facilities. It does not include the U.S. Postal Service Air Mail Facility (AMF).

Task 5.6, Other Airport Elements, documents facility requirements for the following airport elements:

- General and Corporate Aviation Facilities
- Air Traffic Control Tower
- Airport Rescue and Fire Fighting Facilities (ARFF)
- Aircraft Maintenance Facilities
- Flight Kitchens
- Aviation Fuel Storage Facilities
- Airport Operations, Maintenance and Administration
- Other Airport Tenants
- Drainage and Stormwater Control and Treatment Facilities
- Pollutant and Hazardous Material Control Facilities

The general approach taken to determine facility requirements in the forecast years 2000, 2010 and 2020, involved the comparison of existing facilities with projected facility needs based upon the forecast of traffic growth in the future planning periods or based upon interviews with the users of the facilities.

The following subsections contain discussions of each of the aforementioned airport elements and facility requirements and the options for satisfying these facilities.

The existing building land use arrangement at the airport is not highly organized. The northeast airport quadrant contains air cargo terminals, AMF, flight kitchens, a ground handling equipment storage facility, ARFF, United Aircraft Maintenance and airport maintenance facility. The southeast quadrant contains airline maintenance hangars, Northwest Airlines cargo terminal and flight kitchen, bulk fuel storage facilities and general aviation servicing (FBO) facilities. The westerly quadrant contains only the Weyerhaeuser aviation facility together with certain navaids (ASR, ASDE, VHF transmitter/receiver and weather station).

PROJECT OBJECTIVES

The overall objective of this project is to "prepare a comprehensive Airport Master Plan

[Update] for the airside, terminal, and landside facilities needed at Sea-Tac to meet air travel demand to the year 2020 and beyond." Specifically, the master plan update study must fulfill each of the relevant objectives stated in Port Resolution 3125. These are as follows:

- Design a mechanism and process to promote [land use and community] compatibility through improved coordination, communication and involvement.
- In addition to the third runway studies, include a reconsideration of a fast rail system together with diversion of all cargo carriers.
- Fully explore the impacts of peak period pricing and other demand management techniques.
- Explore land acquisition and redevelopment to compatible uses.
- Attenuate airport noise through the use of berms and barriers.
- Promote aggressive on-airport emission reductions.
- Promote regional transit and reduction in use of automobiles.
- Improve the aesthetic appearance of the airport boundary.
- Develop a comprehensive stormwater management plan.

SCOPE OF STUDY

The first assignment of the Airport Master Plan Update study was the development of a detailed scope of work designed to fulfill the project objectives. The final scope of work, prepared on December 2, 1993, contains forty-five work tasks. The detailed scope of work is contained in Technical Report No. 1, Scope of Work.

The primary issues addressed in the scope of work include:

- ***Forecasts.*** The master plan update and related Environmental Impact Statement and FAA Part 150 Study must be based on a reliable and generally accepted set of forecasts.
- ***Airside Evaluations.*** An important component of the study is the analysis of a new dependent parallel (minimum runway separation of 2,500 feet) runway. The Airspace Update Study and the FAA Airport Capacity Enhancement Task Force both determined that a substantial capacity improvement can be achieved by constructing a new parallel dependent runway.
- ***Terminal Evaluations.*** A key issue in the terminal development is to achieve a balance between added terminal capacity and additions to airside and landside capacity. Curb frontage, roadway and automobile parking are critical components.
- ***Multi-Modal Evaluations.*** There is considerable interest at the federal, State and local levels of government to development inter-modal transportation systems that are economically efficient and improve air quality and reduce airport congestion.
- ***Financial Planning.*** A comprehensive financial plan and implementation strategy must be developed to maximize the Port's ability to fund needed capital improvement projects.

- ***Part 150 Issues.*** The Noise Mediation Agreement resulted in substantial noise reduction programs, now being implemented. This agreement plays a vital role in existing and future planning efforts at the airport and has been incorporated into the recently completed FAR Part 150 Study 1993 Amendments. However, those amendments did not consider the implementation of a third runway, and thus the Noise Exposure Maps that were generated in the study will be updated to consider the third runway option.

- ***Process.*** Public involvement in the planning process is an important element of the Airport Master Plan Update. The public involvement program developed for the study allows for better understanding of the sentiments in the surrounding communities and constructively involves the public in focused workshops for the project. Elements of the public involvement program include workshops, public opinion surveys, and dissemination of project information through newsletters and technical reports prepared during the study.

STUDY SCHEDULE AND DOCUMENTATION

The Airport Master Plan Update is scheduled to be completed in December 1995. During 1994, forecasts will be prepared, facility requirements will be developed and individual options for accommodating projected needs will be evaluated. In 1995, option "packages" will be developed and evaluated and concurrently an Environmental Impact Statement will be prepared.

The following documents are scheduled to be delivered to the Port during the course of the project:

- Technical Report No. 1, Final Work Scope
- Technical Report No. 2A, Market Research Results
- Project Brochure
- Technical Report No. 2B, Program Development Report
- Technical Report No. 3, Planning History and Study Relationships
- Technical Report No. 4, Facilities Inventory
- Technical Report No. 5A, Preliminary Forecast Report
- Technical Report No. 5, Final Forecast Report
- Technical Report No. 6, Preliminary Airside Report
- Technical Report No. 7A, Terminal Options Evaluation
- Technical Report No. 7B, Other Facilities Requirements and Options
- Demand Management Report
- Technical Report No. 8, "Package" Evaluations Report
- Technical Report No. 9, Draft of Master Plan Update Final Report
- Airport Layout Plan Set
- Final Report

PLANNING TEAM COMPOSITION

The Master Planning Team led by P&D Aviation consists of ten firms which are listed below with their key responsibilities:

- ***P&D Aviation*** - Project Management, Forecasts and Facility Requirements, Airside Planning, Ground Access Planning, Overall Airport Master Planning and Coordination
- ***O'Neill & Company*** - Public Involvement
- ***Parsons Brinckerhoff*** - Multi-Modal Evaluations
- ***Thompson Consultants International*** - Terminal Planning
- ***Barnard Dunkelberg & Company*** - Part 150 Integration
- ***Berk & Associates*** - Financial Planning
- ***Murase Associates*** - Airport Beautification, Landscape Architecture
- ***Mestre Greve Associates*** - Aircraft Noise Impacts
- ***Landrum & Brown*** - Passenger Terminal Concepts
- ***Claire Barrett & Associates*** - Demand Management

CONTENTS OF THIS REPORT

This report documents the facility requirements of specific airside facilities other than runways and taxiways and options for satisfying needed facilities. It also documents circumstances related to drainage and stormwater control and treatment facilities as well as pollutant and hazardous material control facilities. The planning period extends to the year 2020 and where applicable development phases are identified for the intervening years of 2000 and 2010.

The report is organized into nine sections. Following this Section 1 Introduction, are the following sections:

- Section 2 Executive Summary
- Section 3 Cargo Facilities
- Section 4 Other Airport Facilities
- Section 5 Stormwater and Hazardous Material Control Facilities
- Section 6 Cargo Terminal Options
- Section 7 Aircraft Maintenance Options
- Section 8 Other Facilities Options
- Section 9 Options Evaluation Process

Section 2
EXECUTIVE SUMMARY

SECTION 2
EXECUTIVE SUMMARY

INTRODUCTION

This executive summary section presents the highlights of the other airport facilities requirements and the evaluation of options for accommodating new or expanded other facilities.

Previous technical reports document the requirements for expanded airside and passenger terminal/ground access facilities. This Technical Report No. 7B documents what is referred to as other Airport facilities which include the following:

- Cargo Terminals, Truck Docks, Auto Parking and Aircraft Hardstands
- General and Corporate Aviation Facilities
- Air Traffic Control Tower and Terminal Radar Approach Control (TRACON) facility
- Airport Rescue and Fire Fighting (ARFF) Facility
- Aircraft Maintenance Facilities
- Flight Kitchens
- Aviation Fuel Storage Facilities
- Airport Operations, Maintenance and Administration
- Air Mail Facility (AMF)
- Port of Seattle Police Department
- Drainage and Stormwater Control and Treatment Facilities
- Pollutant and Hazardous Material Control Facilities

This report is organized into two major subjects. Sections 3, 4 and 5 contain analysis dealing with the capacities of the above referenced facilities to accommodate the forecast traffic through to the year 2020. Sections 6, 7, 8 and 9 document the evaluation process and the analyses undertaken to identify the preferred option for implementing the facility expansions.

This executive summary briefly narrates the essence of each report section, presenting only the key points and leaving the reader to study the individual sections for a more in-depth discussion of the subject matter.

SECTION 3 CARGO FACILITY REQUIREMENTS

Cargo facility requirements are determined from a capacity analysis of projected cargo volumes to be processed through to the year 2020. The cargo forecast was presented for the years 2000, 2010 and 2020 and cargo facilities were identified for each of the three forecast periods.

From Technical Report No. 5B Final Forecast, the following cargo forecast in metric tonnes was used to project needed cargo facilities. Table 2-1 summarizes the cargo forecast used in the analysis.

The methodology utilized to project cargo facilities for each of the forecast periods was to establish productivity indices based upon 1993 circumstances and then amend the indices over the 26 year forecast period based upon expected increase in all-cargo aircraft sizes and increased

TABLE 2-1
AIRPORT MASTER PLAN CARGO FORECAST (TONNES)

Description	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
Inbound/Outbound Domestic	246	310	420	550
Inbound/Outbound International	51	100	140	190
Total Inbound/Outbound Cargo	297	410	560	740
Total Cargo by All-Cargo Carriers	160	220	300	400
Total Cargo by Passenger Flights	137	190	260	340
Total Inbound/Outbound Cargo	297	410	560	740

Note: Does not include air mail, since mail handling and processing is by the U.S. Postal Service at a dedicated facility at the Airport. Cargo facility requirements will be determined from the above forecast.

use of automated materials handling equipment in the cargo terminals.

Projection of Cargo Warehouse Floor Areas

Table 2-2 presents the warehouse productivity factors used to project future warehouse floor areas.

TABLE 2-2
WAREHOUSE PRODUCTIVITY FACTORS

Year	Factor (Tonnes/SF)
1993	0.59
2000	0.64
2010	0.67
2020	0.70

Table 2-3 summarizes the projection of warehouse floor areas using the factors of Table 2-2 and the cargo forecast shown in Table 2-1.

TABLE 2-3
WAREHOUSE FLOOR AREAS

Year	Floor Area [1]
2000	641,000
2010	836,000
2020	1,060,000

[1] Rounded to nearest 1,000 SF.

Projection of Cargo Office Floor Areas

Currently, office floor areas equal 24 percent of warehouse floor areas. This relationship was held throughout the forecast period to produce the office floor areas shown in Table 2-4.

TABLE 2-4
OFFICE FLOOR AREAS

Year	Floor Area (SF) [1]
2000	154,000
2010	201,000
2020	254,000

[1] Rounded to nearest 1,000 S.F.

Projection of Truck Docks

The current relationship between the number of truck docks and warehouse floor area is one truck dock per 1,950 SF of warehouse. Holding this relationship throughout the forecast period produced the projection of truck docks shown in Table 2-5.

TABLE 2-5
CARGO TERMINAL TRUCK DOCKS

Year	Number of Docks
2000	329
2010	429
2020	544

Projection of Automobile Parking

The current relationship between employees/customer auto parking spaces and total building floor area is one parking space per 534 SF of total cargo terminal floor area (warehouse plus office). Holding this relationship throughout the forecast period produced the projection of parking spaces shown in Table 2-6.

TABLE 2-6
AUTOMOBILE PARKING SPACES

Year	No. of Spaces [1]
2000	1,490
2010	1,940
2020	2,460

[1] Rounded to nearest 10 spaces.

Projection of All-Cargo Aircraft Hardstands

The methodology used to project the number of aircraft hardstands is to establish the current productivity of hardstands in terms of total annual cargo tonnage processed by all-cargo aircraft at each hardstand. Productivity increases during the forecast period were assumed based on the belief that the all-cargo aircraft would increase in size and that all-cargo aircraft would gain a larger share of total cargo.

Only DC-10 equivalent hardstands were considered in the projection because it was assumed during the 26 year forecast period, all-cargo aircraft would increase in size to explain the increase in hardstand productivity.

Table 2-7 contains the productivity factors used to project the number of hardstands. Table 2-8 shows the projected number of hardstands.

TABLE 2-7
ALL-CARGO HARDSTAND PRODUCTIVITY FACTORS

Year	Factor (Tonnes/Hardstand)
1993	8,900
2000	9,800
2010	10,400
2020	11,400

TABLE 2-8
PROJECTION OF ALL-CARGO AIRCRAFT HARDSTANDS

Year	Number of Hardstands
1993	18
2000	23
2010	29
2020	35

SECTION 4 OTHER AIRPORT FACILITY REQUIREMENTS

The projection of other airport facilities, as documented in Section 4, unlike the cargo terminal projections contained in Section 3, is not based upon the forecast of traffic. These facilities would be relocated because of the passenger terminal expansion. The main thrust of Section 4 is to identify which facilities require relocation and whether the present capacities are satisfactory. This knowledge was gained from interviews with representatives of the effected facilities. Some consideration was given to a feasible airport location for the relocations since the facilities covered are not major land absorbers, except for the aircraft maintenance facilities.

General and Corporate Aviation Facilities

There are two facilities that accommodate non-commercial aircraft at Sea-Tac. Signature Flight Support functions as the fixed base operator (FBO) and handles all privately owned itinerant aircraft. Parking and fueling are the only services offered.

The other facility is the Weyerhaeuser Flight Department that maintains aircraft storage and servicing for the corporately owned aircraft.

Both of these facilities will require relocation from their present sites. The FBO relocation will be occasioned by expansion of the passenger terminal, while the Weyerhaeuser facility conflicts with the proposed third runway.

The FBO has requested the same apron area for parked aircraft and a slightly larger building for pilot lounge, flight briefing and administrative offices. Weyerhaeuser would desire a slightly larger hangar (30,000 SF vs. 26,900 SF). There is an operational advantage of having both non-commercial aviation facilities on adjacent parcels with easy access to the third runway to share a common fuel storage facility and to operate from the third runway. This effectively separates small aircraft operations from the air carrier aircraft.

Possible locations for relocated GA facilities are a north field or SASA site. A north field site would encourage use of the third runway.

Air Traffic Control Tower and TRACON Facility

The air traffic control tower (ATCT) is presently located on the roof of the passenger terminal. The Terminal Radar Approach Control (TRACON) facility is located on the floor below the tower. Although the controller's line of sight from the tower meets criteria for the third runway, the cab floor area is too small for the current number of controller positions and requirements for additional positions in the future will compound the space problem.

The FAA has expressed interest in constructing a new tower. A parcel of land about 1 to 4 acres, is estimated by FAA to be necessary depending on the site requirements and layout. The FAA has suggested that the new tower be about 10 feet higher than the present tower.

Two locations for the ATCT have been identified. The first is the existing cargo area on the site of the Airborne cargo building. The second is the existing location atop the passenger terminal. The latter would present certain cost and operational concerns which must be addressed before the location is adopted.

Two other optional sites may be considered. These are in the Doug Fox parking area and a west side location.

Airport Rescue and Fire Fighting (ARFF) Facility

The present ARFF located just north of the north satellite terminal will eventually have to be relocated because of passenger terminal expansion.

Currently, an eleven stall fire station is located on the east side of the airfield for suppression of structural fires and to assist with airside incidents. The current ARFF site occupies about 2-1/2 acres. FAA minimum requirements for an Index E classification airport such as Sea-Tac specify 3 vehicles must be provided.

Two locations for ARFF sites have been recommended. Both would displace existing cargo buildings. One would be located on the site of the Delta Airlines cargo building and the other would be located at the present site of United's cargo building. Development of new ARFF facilities would not be required until later phases of the Master Plan Implementation Program, with the timing dictated by the need to extend the North Satellite.

Aircraft Maintenance Facilities

Second only to the cargo terminals, aircraft maintenance facilities are the next largest land absorbers. The present maintenance facilities will require relocation to make room for passenger terminal expansion.

An EIS was prepared for establishment of aircraft maintenance facilities in the South Aviation Support Area (SASA) and an FAA Record of Decision was issued. The preferred alternative would occupy 84 acres with a total paved area of 270,000 SY and assumes all airlines would choose to replace their current facilities if required to vacate. The new SASA would accommodate relocated line maintenance hangars of Alaska, Delta and Northwest Airlines and would provide land area for the establishment of base maintenance facilities should inquiries be made by airlines in the future. Provisions for a "hush house" and ground service equipment (GSE) also were included in the plan.

Flight Kitchens

There are five on airport and one off-airport flight kitchens. The on-airport kitchens total 203,000 SF and are operated by Northwest and United Airlines, Flying Food Fare and Caterair International which operates two kitchens.

The Northwest Airlines kitchen, located in the southeast quadrant will require relocation for the passenger terminal expansion. United Airlines may require relocation if the North Unit Terminal is selected for implementation.

All of the on-airport kitchens appear to have sufficient land for expansion at their present locations.

Aviation Fuel Storage Facilities

Aviation fuel is presently stored in a series of above-ground and underground fuel storage tanks. The above storage tanks with a combined capacity of 24.1 million gallons of Jet A fuel supply fuel to four underground storage tanks systems owned by United, Northwest, Delta and Continental Airlines which in turn supply fuel to their respective passenger gate fuel hydrants. The main above-ground storage tanks owned by Olympic Pipeline Company, also supply fuel to a truck fill stand facility which in turn supplies fuel to the all-cargo aircraft and passenger aircraft at gates not presently equipped with a fuel hydrant system.

The main above ground fuel storage tanks will not be effected by any of the passenger terminal expansion options. The underground fuel storage systems will be impacted by the proposed terminal expansion plans and most likely will require relocation.

However the Port is considering an expansion of the fuel hydrant system to supply fuel to all of the expanded passenger terminal gates. This revamp of the fuel hydrant system will require extensive extension and modification of the present system.

Aircraft Service International (ASI) provides fuel truck service to those carriers not presently served by the fuel hydrant system and also the commuter carriers and all-cargo carriers that are not serviced by a fuel hydrant system. ASI's operation will be drastically reduced if the extended fuel hydrant system is implemented.

Airport Maintenance Facility

The main airport maintenance base is located in the cargo area adjacent to Air Cargo Apron 4 in the northeast quadrant of the Airport.

Should it be necessary to relocate this facility, according to an internal needs study performed in 1991, a building of 100,000 SF, 80 parking spaces, a vehicle wash rack and vehicle fueling facilities will be needed at a new location.

Furthermore, additional space is required for the storage of snow removal equipment. A 50,000 SF building could house existing vehicles plus provide space for materials storage, office and support areas.

Air Mail Facility (AMF)

The present AMF is located north of Delta Airlines air cargo terminal in the northeast quadrant of the Airport.

Should it be necessary to relocate the AMF, a building equal to the existing 182,500 SF would be required with 239 parking spaces and access to the airfield. The U.S. Postal Service operates one aircraft daily and contracts with Evergreen for the balance of mail transport.

Port of Seattle Police Department

The Police Department has jurisdiction over both the airport and waterfront facilities operated by the POS. Police facilities are scattered around the Airport and total 40,000 SF.

If a new Police Department facility can be sited, a 60,000 SF building would be preferred. A 1,500 SF office would be required in the passenger terminal for report preparation and interviewing.

SECTION 5 STORMWATER AND HAZARDOUS MATERIAL CONTROLS

This section presents a brief description of the stormwater and hazardous material controls that exist at Sea-Tac and must be considered in the design of the other airport facilities covered in this report.

The natural drainage streams serving the airport include Des Moines Creek, Miller Creek and Lake Reba and they must continue to accept run-off from expanded airport facilities according to Washington State Department of Ecology "1992 Stormwater Management Manual for the Puget Sound Basin" (SMMPSB).

Sea-Tac has operated since 1952, an industrial wastewater system (IWS) which consists of a series of indoor and outdoor drains and catch-basins that receive wash water and stormwater in areas where contamination from airport operations is common. There are three IWS treatment ponds on airport property where pollutants are removed through primary treatment by a settling of solids and skimming of light oil fractions. The capacity of the IWS is limited to an 18 inch diameter pipe that discharges the wastewater at 10 cubic feet per second.

Hazardous material controls consist of a more intensive treatment of wastewaters entering the Runoff Treatment Facility than the run-off directed to the stormwater detention site. Operations that have the potential to produce hazardous wastes should have on-site storage facilities until arrangements are made for transportation to off-site disposal at a licensed RCRA facility.

SECTION 6 CARGO TERMINAL OPTIONS

The planning of cargo terminal options was an iterative process in which generalized concepts were first developed and refined in a series of meetings and workshops. The recommended option is a decentralized concept in which the existing cargo area is modified and expanded to meet program requirements through 2010. After 2010, the projected demand can be met with supplemental cargo facilities in SASA, and in some cases, with warehouses at remote north locations as well.

SECTION 7 AIRCRAFT MAINTENANCE OPTIONS

The planning process concluded that the south site (SASA) was preferred for aircraft maintenance facilities.

SECTION 8 OTHER FACILITIES OPTIONS

This section covers those other airport facilities that require a relocation because of the expansion and relocation of the passenger terminal, cargo terminals or aircraft maintenance facilities. The facilities covered by this section include:

- Airport Rescue and Fire Fighting (ARFF) Facilities
- General and Corporate Aviation Facilities
- Air Traffic Control Tower and TRACON
- Flight Kitchens
- Aviation Fuel Storage Facility
- Airport Maintenance Facility
- Port of Seattle Police Department

Two ARFF sites located on the east side were identified for future fire fighting facilities. The existing ARFF will require relocation in the later Master Plan development phases due to ultimate expansion of the North Satellite.

General aviation operations to be relocated are the Signature FBO and Weyerhaeuser Flight Department facilities. Two possible locations for these relocated facilities were identified. These are a north field or SASA site. Both of these GA operations can share a common fuel storage facility, and the type of aircraft to operate from these facilities can be accommodated on the third runway as adequate runway length is provided.

Relocation of the air traffic control tower and TRACON, now housed in the passenger terminal, to a new eastside location would provide adequate land area and would provide controllers a good line of sight to all runway approaches as well as the passenger terminal apron. As an alternative, further consideration of the existing location has been recommended.

At least one flight kitchen will require relocation and if the North Unit Terminal Option is selected, one additional flight kitchen may be relocated. Suitable sites are available in the northeast quadrant to accommodate the relocated flight kitchens, or if needed, replacement facilities may be developed in SASA.

Planned eastside terminal expansion will not effect the main above ground fuel storage tanks, but the underground tanks operated by four airlines will be impacted by terminal plans. Since the POS is considering extension of the existing fuel hydrant system to serve the new passenger terminal gates, the underground tanks most likely will have to be supplemented. Commuter aircraft and all-cargo aircraft will continue to be fueled by trucks operated by ASI. The fuel truck fill stand will need improvements particularly with respect to the road geometrics to facilitate access to the fill stand by the large fuel tender trucks.

The airport maintenance base should be relocated with the current site being converted to cargo use.

The Port of Seattle Police Department is in need of new facilities when the passenger terminal expansion program is implemented. According to police representatives a 60,000 SF building located adjacent to the ARFF would be preferred. About 1,500 SF of space in the passenger terminal would be needed for report preparation and interviewing.

SECTION 9 OPTIONS EVALUATION PROCESS

This section presents three airport development options that have been formulated to match each of the three passenger terminal options. The south unit terminal, the north unit terminal, and central terminal expansion options are combined with the 7,000', 7,500' and 8,500' third runway options, respectively. Each runway option is compatible with each terminal expansion option and thus the runway and terminal options are interchangeable.

Section 3
CARGO FACILITIES

SECTION 3
CARGO FACILITIES

An Air Cargo Study was completed by HNTB in June 1993. The objective of this study was to update the existing air cargo master plan to provide guidance for the development of air cargo facilities through the year 2020.

According to the HNTB inventory and data collection analysis, the major U.S. airlines carried the greatest proportion of cargo in 1991, although their share had dropped from 43 percent in 1990 to 40 percent in 1991. The integrated carriers -- Federal Express, Burlington, Emery, Airborne and DHL carried about 27 percent of total cargo in 1991. Alaska Services, International Cargo Carriers, Foreign Flag Carriers and other services accounted for the balance of air cargo traffic.

The cargo facilities requirements identified in the HNTB study were based upon an earlier cargo forecast which is lower than the current Airport Master Plan Update forecast.

BASELINE CONDITIONS

The cargo facilities requirements set out in this report are based upon the Airport Master Plan Update forecast which is shown in Table 3-1, expressed in thousands of metric tonnes. The cargo values do not include metric tonnes of air mail as mail is handled at the Air Mail Facility operated by the U.S. Postal Service. Air mail requirements are therefore separate from cargo requirements.

The existing air cargo facilities are located in the northeast quadrant with the exception of the Northwest Airlines cargo facility which is located in the southeast quadrant adjacent to their maintenance hangar. Existing cargo facilities are summarized by tenant in Table 3-2. The tabulation does not include the Air Mail Facility (AMF).

Supplementing the tabulation of cargo facilities by tenant is Table 3-3 containing the existing all-cargo aircraft parking positions by tenant.

PROJECTION OF FUTURE CARGO WAREHOUSE FLOOR AREA

The methodology used to project future cargo facility requirements is to identify historical relationships of cargo volume processed with existing facilities. It can be shown that a relationship exists between cargo warehouse floor area and tonnes of cargo processed. This productivity factor can be effected by the degree of mechanization employed in the cargo terminals. It is reasonable to assume that the cargo operators at Sea-Tac will eventually utilize more mechanization in their terminals in view of the scarce land availability on-airport for terminal expansion. Another form of relief from land absorption for cargo terminal development is for operators, such as freight forwarders, that do not require direct access to the airside, to relocate their facilities to an off-airport site.

The warehouse productivity factor at Sea-Tac in 1993 was found to be 0.59 metric tonnes per square foot of warehouse floor area. This was determined from the following relationship:

WPF = Tonnes ÷ Warehouse Floor Area (SF)
= 297,00 ÷ 504,849 = 0.59 Tonnes/SF

The HNTB cargo study reviewed warehouse productivity of eight of the busiest cargo airports and found that the average warehouse productivity factor was 0.99 Tonnes/SF. The

TABLE 3-1
AIRPORT MASTER PLAN CARGO FORECAST (TONNES)
(Excluding Air Mail)

Description	Actual 1993	Forecast 2000	Forecast 2010	Forecast 2020
Inbound/Outbound Domestic Cargo	246	310	420	550
Inbound/Outbound International Cargo	51	100	140	190
Total Inbound/Outbound Cargo	297	410	560	740
Total Cargo by All-Cargo Carriers	160	220	300	400
Total Cargo by Passenger Flights	137	190	260	340
Total Inbound/Outbound Cargo	297	410	560	740

TABLE 3-2
EXISTING CARGO FACILITIES BY TENANT

Tenant	Land Area (Acres)	Warehouse (SF)	Office (SF)	Total SF	Truck Docks	Auto Parking
NW Airlines	1.6	48,000	10,000	58,000	16	350
Delta Airlines	5.0	29,046	2,514	31,560	16	53
Airborne Express	2.3	17,500	5,000	22,500	8	48
United Airlines	5.9	41,004	20,000	61,004	12	78
Alaska Airlines	4.7	63,734	5,000	68,734	16	67
Airfreight Distribution Center	2.1	15,190	10,512	25,702	9	38
Emery	3.8	9,799	5,159	14,958	12	44
SEKO Air Freight	2.1	25,350	9,750	35,100	14	49
Federal Express	10.1	45,000	3,000	48,000	28	108
Transplex Building A	12.8	61,500	22,515	84,015	30	51
Transplex Building E	--	22,000	3,000	25,000	14	40
Transplex Building F	--	22,000	3,000	25,000	14	40
Transplex Building G	--	19,500	5,500	25,000	12	65
AVIA Air Cargo No. 1	11.1	42,151	8,442	50,593	28	63
AVIA Air Cargo No. 2	--	43,075	8,125	51,200	30	79
Total	61.50	504,849	121,517	626,366	259	1,173

Source: HNTB Air Cargo Study, June 1993.

TABLE 3-3
ALL-CARGO AIRCRAFT PARKING POSITIONS BY TENANT

Tenant	DC-10 Parking Positions		B727 Parking Positions	Apron Area (SY)
AVIA 1	3	or	4	22,222
AVIA 2	3	or	4	19,683
Transplex	1	or	1	2,756
Federal Express	3	or	4	22,800
POS Cargo 3	2	or	3	22,800
POS Cargo 4	2	or	3	10,500
Alaska Airlines	1	or	1	5,100
South Hardstand	2	or	3	8,944
Northwest Airlines	1	or	1	7,031
Total	18	or	24	121,836

Source: HNTB Air Cargo Study, June 1993.

average productivity factor for the top 50 airports was 0.58 Tonnes/SF.

The range of factors at the eight busiest airports varied from a low of 0.63 (Boston) to a high of 1.59 (Atlanta). During the 26 year forecast period, it is reasonable to assume that the current warehouse productivity factor will increase by reason of the introduction of more mechanization in Sea-Tac's cargo terminals. The assumed productivity factors used to project future warehouse floor areas are set out in Table 3-4.

TABLE 3-4
WAREHOUSE PRODUCTIVITY FACTORS

Year	Factor (Tonnes/SF)
1993	0.59
2000	0.64
2010	0.67
2020	0.70

Using the above factors and the forecast of cargo produced the warehouse floor areas (SF) in Table 3-5.

TABLE 3-5
WAREHOUSE FLOOR AREAS

Year	Floor Area [1]
2000	641,000
2010	836,000
2020	1,060,000

[1] Rounded to nearest 1,000 SF.

PROJECTION OF FUTURE CARGO OFFICE FLOOR AREA

The current relationship between warehouse and office floor areas in the cargo terminals is 120,807 SF ÷ 504,849 SF. This equation shows that office floor areas are 24 percent of warehouse floor areas. Holding this relationship throughout the forecast period produced the office floor areas as shown in Table 3-6.

TABLE 3-6
OFFICE FLOOR AREAS

Year	Floor Area [1]
2000	154,000
2010	201,000
2020	254,000

[1] Rounded to nearest 1,000 SF.

PROJECTION OF TRUCK DOCKS

The current relationship between the number of truck docks and warehouse floor area is 504,849 ÷ 259 docks. This equates to one truck dock per 1,950 SF of warehouse. Holding this relationship throughout the forecast period produced the truck dock requirements set out in Table 3-7.

TABLE 3-7
CARGO TERMINAL TRUCK DOCKS

Year	Number of Docks
2000	329
2010	429
2020	544

PROJECTION OF AUTOMOBILE PARKING

The current relationship between employees/customer auto parking spaces and total building floor area is 625,656 ÷ 1,173 parking spaces. This equates to one parking space per 534 SF of building floor area. Holding this relationship throughout the forecast period produced the projection of auto parking spaces at the cargo terminals shown in Table 3-8.

TABLE 3-8
AUTOMOBILE PARKING SPACES

Year	No. of Spaces [1]
2000	1,490
2010	1,940
2020	2,460

[1] Rounded to nearest 10 spaces.

PROJECTION OF AIRCRAFT HARDSTANDS

The methodology used to project the number of aircraft hardstands is to establish the current productivity of hardstands in terms of total annual cargo tonnage processed at each hardstand. This methodology is similar to assessing the productivity of gates at a passenger terminal.

According to a recent Airbus Industries Forecast, *Airbus Industry; Market Perspectives for Civil Jet Aircraft, June 1991*, it was estimated that the ratio of revenue ton kilometers per all-cargo aircraft will increase at an average rate of 1.49 percent per year through the year 2000. This conclusion considered changes in average aircraft size and shifts in cargo tonnage between all-cargo aircraft and belly-hold cargo carried on passenger aircraft. The projection was valid through the year 2000. Extrapolating the growth at a decreasing rate to the year 2020 produced a hardstand productivity factor based upon the present factor (1993) of 8,900 tonnes/all-cargo hardstand. These are shown in Table 3-9.

Only DC-10 equivalent hardstands were considered in the projection because it was assumed during the 26 year forecast period, all-cargo aircraft would increase in size to explain the increase in hardstand productivity.

TABLE 3-9
ALL-CARGO HARDSTAND PRODUCTIVITY FACTORS

Year	Factor (Tonnes/Hardstand)
1993	8,900
2000	9,800
2010	10,400
2020	11,400

Applying the productivity factors to the forecast of cargo tonnage produces the projection of equivalent DC-10 all-cargo aircraft hardstands as summarized in Table 3-10.

TABLE 3-10
PROJECTION OF ALL-CARGO AIRCRAFT HARDSTANDS

Year	Number of Hardstands
1993	18
2000	23
2010	29
2020	35

CARGO TERMINAL FACILITY REQUIREMENTS SUMMARY

The Table 3-11 summarizes the projected cargo terminal facilities that were determined in the previous subsections. The total land area requirement was calculated by applying planning standards to the individual facility elements. The land area occupied by the buildings assumed a depth of 150 feet and an overall length of 1,200 feet. DC-10 hardstands were estimated to be 200' diameter nose-in parking spaces. Automobile parking was estimated at 375 SF per space, truck docks at 720 SF per dock, and landside roadways at 24 foot widths. In view of the total number of DC-10 hardstands, a dual parallel taxiway connecting the cargo terminal complex with the airside was included in the estimated land area requirement. Airplane Design Group V was used for airside separation criteria.

TABLE 3-11
TOTAL CARGO TERMINAL FACILITY REQUIREMENTS

Terminal Element	2000	2010	2020
Warehouse (SF)	641,000	836,000	1,060,000
Office (SF)	154,000	201,000	254,000
Total Terminal (SF)	795,000	1,037,000	1,314,000
Number of Truck Docks	329	429	544
Auto Parking Spaces	1,490	1,940	2,460
Aircraft Hardstands	23	29	35
Land Area (ACS)	115	158	176

Section 4
OTHER AIRPORT FACILITIES

SECTION 4
OTHER AIRPORT FACILITIES

GENERAL AND CORPORATE AVIATION FACILITIES

General aviation and corporate operations at Sea-Tac occupy a very minor share of total operations at the Airport. According to the Airport Master Plan Update forecast, these activities will only represent 2.3 percent of total operations during the forecast period.

General aviation aircraft servicing is currently performed by Signature Flight Support, doing business as the sole fixed base operator (FBO) from a facility located in the southeast quadrant of the Airport, adjacent to Alaska Airlines maintenance base. A tie-down apron of 67,400 SF serves as an itinerant aircraft parking facility and according to the FBO, it can accommodate about 10 aircraft of the type that normally visit the Airport. The apron size is adequate for their level of business.

The FBO does not perform any aircraft servicing except for fueling. A small building provides a pilots lounge (which is judged by the FBO to be too small) and a flight briefing room.

The final alternative passenger terminal expansion concepts call for an extension of the existing south satellite in various degrees of penetration. The central and south unit terminal alternatives will require relocation of the FBO to another site on the Airport. The FBO has requested a larger building for its pilot lounge and briefing room.

The corporate aviation facility is owned by the Weyerhaeuser Corporation and consists of a storage/maintenance hangar, apron, fuel storage tanks and auto parking. The facility is located in the west quadrant of the Airport and it will require relocation if the third runway is constructed. The facility presently occupies about 2.5 acres of land. It consists of a storage/maintenance hangar for three aircraft and a helicopter, an apron on the airside of the hangar, auto parking and fuel storage tanks on the landside of the hangar. The present size of the hangar (26,900 SF) is adequate.

In an interview with Weyerhaeuser's Flight Department Manager, P&D Aviation was advised that the size of the present facility is currently satisfactory, but when relocated, a slightly larger hangar (30,000 SF) would be preferred. Aircraft are only parked on the apron during fueling, otherwise aircraft are stored in the hangar.

AIR TRAFFIC CONTROL TOWER AND TRACON FACILITY

The current Level IV control tower is mounted on the roof of the passenger terminal. The Tracon room is situated on the terminal building floor beneath the tower. In an interview with the FAA Area Manager, we were advised that the present control tower cab is too small for the number of positions currently in use with the expectation that more positions will be needed in the future.

The existing ATCT cab is approximately 625 square feet in size. The FAA has determined that a cab of approximately 850 square feet would be needed to handle the increased requirements.

Although the HNTB Preliminary Engineering report for a third dependent runway contained a line-of-sight analysis from the present control tower cab and concluded that the controllers eye level elevation met line-of-sight criteria, the FAA would like to have the new tower about 10 feet higher.

An east side location for the new tower would be desirable. This avoids having controllers look into the morning sun. A non-functional tower shaft could be situated on a 1 to 4 acre parcel depending on specific facility and site requirements. An additional 10 feet of height is believed to be preferable for better line-of-sight should be considered in the ATCT design. ATCT eye level should be at about elevation 508.00.

AIRPORT RESCUE AND FIRE FIGHTING FACILITY (ARFF)

The existing ARFF is located on the east side of the Airport, north of the passenger terminal north satellite building. It contains a 28,000 SF fire station building housing 10 vehicles and other function rooms. Sea-Tac is an Index E Airport and the present equipment exceeds the minimum standards for Index E as set out in FAR Part 139. In addition to aircraft incidents, the ARFF is also responsible for structural fires on the Airport.

Associated with the ARFF is a burn pit and bomb bunker for training located in the southwest quadrant of the Airport. The burn pit will not be needed in the future facilities for the Fire Department since an offsite regional fire training facility is being proposed.

FAA requirements stated in Part 139 of the Federal Aviation Regulations specify at least 3 vehicles must be provided for Index E airports. The present equipment needs exceed these standards and will be accommodated if possible in siting relocated ARFF facilities.

AIRCRAFT MAINTENANCE FACILITIES

Northwest, Alaska, Delta and United Airlines presently operate maintenance bases at Sea-Tac. All of the maintenance facilities are located in the southeast quadrant except for the United base which is located among the cargo terminals in the northeast quadrant.

In March 1994, the FAA published the South Aviation Support Area (SASA) Final Environmental Impact Statement (EIS) which had the following objectives:

- To accommodate the existing line maintenance facilities that must be relocated prior to the expansion of the passenger terminal facilities.
- To accommodate future line maintenance expansion.
- To accommodate major base maintenance facilities in response to existing and/or future market demands.

The SASA EIS evaluated three alternative concepts. The preferred Alternative No. 2 consisted of the following provisions:

- Relocation of Northwest, Delta and Alaska Airlines line maintenance facilities.
- Construction of a base maintenance facility similar to the one previously planned but deferred by Alaska Airlines.
- An area for the future expansion of base maintenance facilities.
- A "hush" facility for engine runups.
- Additional developable land of 21.2 acres for possible future commercial development.

- A ground service equipment (GSE) facility.

Alternative No. 2 would occupy 84 acres with a total paved area of 270,000 SY. The estimated cost for site development is $99.3 million. This cost does not include leasehold improvements such as hangars and maintenance equipment.

Alternative No. 2 did not include facilities for United Airlines maintenance facility which is located in the northeast quadrant.

SASA investigated alternative locations on the airport as well as at other airports in the region as follows:

- Northeast
- North
- West
- Southwest
- Southeast
- Other Airports

SASA concluded that the site in the southeast Airport quadrant was the preferred location and best met the following evaluation factors:

- Capacity for direct aircraft access to taxiway/runway/terminal system.
- Efficiency with respect to airport operations.
- Minimization/mitigation of adverse environmental impacts.
- Sufficient area to accommodate anticipated facilities.
- Compatibility with FAA regulations and guidelines.
- Compatibility with other Airport planning and land use.
- Feasible construction cost.

Although the northeast location also met or bettered the evaluation criteria, SASA assumed this site was already developed as a cargo terminal facility and the site did not have sufficient spare area to accommodate the maintenance facilities.

The future airport expansion options described in later sections of this report will attempt to meet these requirements. The ability to meet their needs depends on the terminal and cargo expansion options being considered.

FLIGHT KITCHENS

There are five flight kitchens located on Airport and another kitchen located just beyond Airport property. Caterair International Corp. operates two on-airport kitchens and the off-airport kitchen. Flying Food Fare, Inc., Northwest Airlines and United Airlines (now Dobbs) operate the remaining on-airport facilities. The following tabulation summarizes the sizes of the on-airport kitchens.

Northwest Airlines	34,000 SF
United Airlines (Dobbs)	65,000 SF
Flying Food Fare	33,000 SF
Caterair International - (2 kitchens)	71,000 SF
Total	203,000 SF

All of the on-Airport kitchens are located in the northeast quadrant of the Airport except the Northwest Airlines kitchen which is located in the southeast quadrant adjacent to their maintenance hangar and cargo terminal. The off-Airport kitchen is also located southeast of the passenger terminal near the intersection of 188 Avenue and 28 Avenue South.

Except for the Northwest Airlines kitchen, which most likely will require relocation for terminal expansion, all of the on-Airport kitchens appear to have sufficient land for expansion at their present locations. In the case of Flying Food Fare kitchen, they are only operating at about 30 percent of capacity at the present.

AVIATION FUEL STORAGE FACILITIES

Aviation fuel is stored in a series of above and below ground storage tanks. Fuel is delivered to the main above ground storage tanks via Olympic Pipeline from the refinery. The above ground tanks in turn, furnish fuel to four underground storage tank systems and a truck fill stand located near the FBO facility.

The main above ground storage facility consists of eight tanks with a combined capacity of 24.1 million gallons. These tanks are owned by Olympic Pipeline Company. Underground storage tanks are owned by United, Northwest Continental and Delta Airlines, which in turn supply fuel to their respective hydrant fuel systems.

The United Airline underground fuel storage system consists of 11 tanks with a combined capacity of 460,000 gallons. Their hydrant system was recently tested and was found to be without leaks. The underground tanks are located northeast of Concourse 'D' between the edge of apron and the North Entry Drive. These tanks serve eight gates used by United at the North Satellite Terminal. All other aircraft using the North Satellite Terminal are fueled by tanker truck.

Northwest Airlines underground fuel storage system consists of 14 tanks with a combined capacity of 308,000 gallons. These tanks serve the hydrant system on eight of the ten gates used by Northwest at the South Satellite Terminal. All of the remaining gates on the South Satellite Terminal are served by tanker trucks. The underground storage tanks are located on Air Cargo Road South near the Northwest Airlines maintenance hangar.

Delta Airlines underground fuel storage system is also located on Air Cargo Road South near the Northwest Airlines maintenance hangar. It consists of three tanks with a combined capacity of 100,000 gallons. These tanks serve four of the six gates on Concourse B used by Delta. The other two Delta gates are fueled by tanker trucks.

Continental Airlines underground fuel storage system is located northeast of Concourse D on Air Cargo Road North adjacent to the United Airlines underground tanks. There are four tanks with a combined capacity of 160,000 gallons. These tanks serve eight Continental Airlines gates on Concourse C, however because of gate configuration changes, only two of the existing hydrants are currently usable.

A fifth underground fuel storage system formerly operated by Pan American Airlines was abandoned about 1980 and is no longer in service.

The south refueler loading facility is located at the southeast quadrant on Fill Stand Row. It consists of four refueler positions and is used by all refueler trucks at the Airport. The fill stand is operated by Olympic Pipeline Company. Road geometrics at the fill stand are sub-standard for the 10,000 gallon refuelers now in common use at the airport. Demand for fuel at gates without hydrants has caused delays in excess of one hour at the fill stand during peak demand periods.

The underground piping to the fuel hydrants, except for the Delta Airlines system, is not cathodically protected.

In 1990, Robert and Company prepared a Fuel System Feasibility Study for nine of the airlines serving Sea-Tac. The objectives of the study were several-fold as follows:

- Upgrade existing Olympic Pipeline Company fuel storage facility with a hydrant pumping and filtration system in order to provide fuel to all existing and new hydrants and truck loading system on the Airport. At least four of the Olympic storage tanks are to be considered as hydrant system operating tanks.
- Provide fuel transmission pipelines to the passenger gates at the four concourses, two satellite terminals and truck loading facilities, stressing maximum possible re-use of existing piping and pits.
- Provision of a refueler truck loading, facility at the north end of the airport and an upgrading of the existing refueling loading facility.
- Development of conceptual plans for: integrating the Existing Emergency Fuel Shut-Off System (EFSO), addition of an automated inventory control system, provision of a leak detection system which satisfies all current and anticipated environmental protection requirements, and emergency electrical power backup capability.

The Fuel System Feasibility Study assumed that all-cargo aircraft as well as commuter aircraft would be fueled by tanker trucks. The study recommended that a second truck fill stand be located at the north end of the airport to serve the all-cargo aircraft. Since alternate locations for the establishment of a cargo complex are under study in this Master Plan Update, the location of a truck fill stand should be deferred until the cargo complex location is determined.

Another underground fuel storage system is maintained by Weyerhaeuser located adjacent to their hangar on the west side of the airport. Olympic Pipeline does not supply fuel to Weyerhaeuser.

Aircraft Service International (ASI) provides fuel service to the carriers not fueled by the terminal hydrant system. They also fuel the all-cargo aircraft in the cargo complex. ASI presently leases a plot of about 0.7 ac which houses a small office building and parking for their fueling tenders. ASI operates 16 fuel tenders with a combined capacity of 146,000 gallons. Their present plot is too small for present operations and to maintain separation distances between parked fuel tenders (10 feet between vehicles, 25 feet from lease boundary). Should the Port of Seattle proceed with a new expanded fuel hydrant system, ASI's operation would be drastically reduced. A location near a relocated truck fill stand would be preferred by ASI.

AIRPORT MAINTENANCE FACILITY

The present main airport maintenance facility is located in the cargo complex adjacent to Air Cargo Apron 4. In addition to this main maintenance facility, the Airport Maintenance Department operates satellite maintenance facilities at other locations on the airport including the passenger terminal building.

Depending on the conclusions arrived at in the alternatives analysis, it may be necessary to relocate the main maintenance facility to another location on the airport.

According to a Maintenance Department representative, an internal needs study was conducted by the department at the end of 1991. The study concluded that the following functions and building areas will be needed.

	Square Feet
Administrative Offices	7,670
Maintenance Control	700
Carpentry Shop	5,020
Electrical Shop	14,400
Automobile Shop	11,170
Field Maintenance Shop	38,050
Paint Shop	7,170
Supply and Receiving	10,000
Common Areas	5,400
Total Building Area	100,000

In addition to the building, the facility should provide 80 employee parking stalls, a wash rack for vehicles and fueling facilities (gas, diesel, propane). The facility should have easy access to the ramp. The needs study suggested that the new maintenance facility be located at apron level on an expanded passenger terminal concourse extension.

OTHER TENANTS

This section deals with other major airport tenants that may require new facilities by reason of a need to relocate their present facilities or because of the inadequacy and widely dispersed existing facilities.

Port of Seattle Police Department

The police department has jurisdiction over both the airport and water front facilities operated by the Port. Although minor police facilities are located at the water front, both divisions have their principal facilities at the Airport.

Currently police facilities are decentralized in various locations within the passenger terminal as well as the old Pan American hangar at the end of Concourse 'A'. Two recent studies (1989 and 1993) were prepared concerning needed police facilities. The 1993 study was prepared by a consultant retained by the Port while the 1988 study was prepared by the police staff.

The current police staff level is 90, composed of both male and female officers and non-officers. Vehicles number between 35 and 40, with some vehicles being specially equipped for the SWAT team and the K-9 force.

The principal functional areas of the police department include the following with existing floor areas:

	Square Feet
■ Training Room	4,000
■ Administrative Offices	1,000
■ Locker Rooms (Male and Female)	2,300
■ Patrol Sergeants Room	600
■ Communications Room	3,200
■ Investigators Room	1,450
■ Retention Cells (2)	120
■ Weapons Storage Closets	Unknown
■ Gun Cleaning and Maintenance	Unknown

The total floor area of all police facilities is 40,000 SF.

Employee parking is located in the parking garage while police vehicles are parked at various locations within the terminal area.

Future facility requirements include larger locker rooms, investigator rooms, sergeants patrol room, additional retention cells, a day/eating room, a roll call room and an exercise/work-out room.

Dog kennels would not be needed since the patrolman partners take the dogs home at the end of a shift, and their K-9 cars are specially fitted for housing dogs.

Air Mail Facility (AMF)

The present AMF is located north of Delta's air cargo terminal in the northeast quadrant of the airport. The building was opened in 1978. The Postal Service contracts with Evergreen for the transport of mail and one Postal Service aircraft cperates daily.

There are currently 350 employees working in three shifts in the 182,500 SF building. There are 20 truck docks and 239 parking spaces for employees. The building is a one story structure, situated on 9.7 acres.

In the event of relocation, the AMF should have airside access with an aircraft hardstand adjacent to the building. Employee parking and truck docks would be required.

The capacity of the AMF is adequate except at Christmas when the mail volume exceeds the building's capacity. The new site should provide some expansion capacity.

Section 5
STORMWATER AND HAZARDOUS MATERIALS CONTROLS

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STORMWATER AND HAZARDOUS MATERIALS CONTROLS

DRAINAGE AND STORMWATER CONTROL AND TREATMENT FACILITIES

Most of Sea-Tac is within the Des Moines Creek watershed. Des Moines Creek is a Class AA stream as defined in the Water Quality Standards for the State of Washington. Over the past 20 years, many studies have analyzed the water quality of Des Moines Creek and several of the studies concluded that the Creek often does not meet Class AA water quality.

Criteria and requirements contained in the Washington State Department of Ecology "1992 Stormwater Management Manual for the Puget Sound Basin" (SMMPSB) establishes design storm criteria for drainage conveyance and detention systems.

A major requirement under SMMPSB is the preservation of natural drainage patterns and discharge locations. Natural drainage patterns shall be maintained, and discharges from the site shall occur at the natural location, to the maximum extent practicable. The design significance to the relocated and expanded projects in this report is that areas which currently flow to Des Moines Creek, Miller Creek and Lake Reba, must continue to flow to these receiving streams after construction of the facilities.

The required facilities to satisfy the year 2020 traffic demands will have an impact on the existing drainage and stormwater control and treatment facilities. There will be an extensive increase in paved areas to accommodate expansion of the passenger terminal, cargo, and maintenance facilities.

Since fueling and other maintenance activities will be performed on these expanded paved areas, provisions must be made in the stormwater systems serving the new pavements to remove any pollutants washed from the pavement surfaces before entering the natural drainage systems.

Sea-Tac has operated and maintained an industrial wastewater system (IWS) since 1952. The IWS consists of a series of indoor and outdoor drains and catchbasins that receive wash water and storm water in areas where contamination from airport operations is common.

This water is piped to three IWS treatment ponds on airport property having a combined capacity of 4.6 million cubic feet. The ponds were designed to treat runoff and wash water from a 225 acre area up to the 100 year, 7 day rainfall event (about 10 inches of rain over a 7 day period). The existing runoff area is almost 262 acres, which makes the systems runoff capacity somewhat lower.

The IWS removes pollutants through primary treatment (settling of solids and skimming of light oil fractions). After treatment, the water is pumped into an 18 inch diameter pipe that connects with the Des Moines Sewage Treatment Plant outfall pipe and then discharges offshore into Puget Sound. The IWS is operated under a National Pollutant Discharge Elimination System (NPDES) permit which requires that discharges not exceed an average oil and grease concentration of 10 mg/l and never exceed 15 mg/l of oil and grease. Operating records indicate that the IWS is usually discharging water with a concentration of about 5 mg/l of oil and grease and the system has never exceeded the permit limits.

The discharge rate must be below 9.3 cubic feet per second (cfs) which is near the maximum capacity of 10 cfs available with the 18 inch diameter discharge pipe. The capacity of the pipe is the major factor limiting the capacity of the IWS.

POLLUTANT AND HAZARDOUS MATERIAL CONTROL FACILITIES

The major airport contributors to hazardous materials are underground full storage tanks, de-icing aircraft and the aircraft maintenance bases.

Operations at the maintenance bases involving hazardous materials include aircraft washing, de-icing, paint stripping and repainting and metal plating. There have been four substantial fuel spells at the Airport during the past 20 years. The largest spill occurred in 1985, when 30,000 gallons of jet fuel bypassed the spill containment system at the main bulk fuel storage facility and contaminated Des Moines Creek as far downstream as the Des Moines Sewage Treatment Plant.

Wastewater produced from operations at the aircraft maintenance facilities most likely contains process materials such as metals, solvents, oils and grease.

A stormwater management facility should consist of a system using natural settling and filtration principles to remove particles and chemical constituents which most likely are contained in run-off originating within the maintenance facility. Operations that have the potential to produce hazardous wastes should have onsite storage facilities until arrangements are made for transportation to off-site disposal at a licensed RCRA facility.

Stormwater run-off and process waste waters directed to the Runoff Treatment Facility will have the greatest potential for containing hazardous wastes. These waste waters will need more intensive treatment than those directed to the stormwater detention site.

Section 6
CARGO TERMINAL OPTIONS

SECTION 6
CARGO TERMINAL OPTIONS

INTRODUCTION

The development of a plan to accommodate future cargo demand was an iterative process in which concepts were developed and refined based on coordination and review with the Port. General cargo options were first developed and focused on centralized and decentralized cargo area concepts. The centralized concepts assumed abandoning existing cargo facilities and redeveloping at other locations on-airport, while the decentralized concepts were based on supplementing existing cargo terminal facilities with additional terminals, truck docks, auto parking and aircraft hardstands at new sites on-airport.

After review of the general concepts it was decided that the continued use of existing cargo facilities was preferred which suggested adoption of a decentralized concept. A decentralized concept is needed since the year 2020 program requirements cannot be met within the confines of the existing cargo area. This necessitated the identification of other sites to provide the supplemental cargo facilities.

At this point in the cargo planning process two cargo development options were considered. The first was based on minimum disruption of existing cargo buildings with a minimal amount of development of new facilities within the cargo area. The second option considered a radical reconfiguration of the existing cargo area to maximize aircraft parking but at the expense of extensive replacement of existing cargo buildings.

After consideration of all work and input to date, a final option was identified which can be adapted for use with each passenger terminal option.

GENERAL CARGO OPTIONS

Two possible options for accommodating the 2020 cargo complex requirements are developing a centralized complex at one location, or a decentralized complex by siting facilities at various locations on or off the Airport.

Centralized Concept

A land area of 176 acres was identified as needed to satisfy a centralized cargo complex. In order to appreciate the magnitude of the projected cargo complex requirements, Figure 6-1 offers a schematic layout of a centralized development concept. For comparison, this area is shown superimposed over the existing cargo area in Figure 6-2. The development is shown in stages for year 2000, 2010, and 2020 requirements. The centralized scheme assumes that all existing cargo terminals, including those not requiring relocation, would be developed at a new site. It is for this reason that the initial development phase absorbs the largest land area (115 acres).

Two locations for centralized concepts were initially identified - SASA and a north site. These were predicated upon two unnegotiable characteristics of a cargo complex site that must be met, namely direct access to the airport's airside and direct access to an airport or public road.

Both sites met the two primary characteristics, plus provided advantages of promoting an efficient use of space, separating cargo and

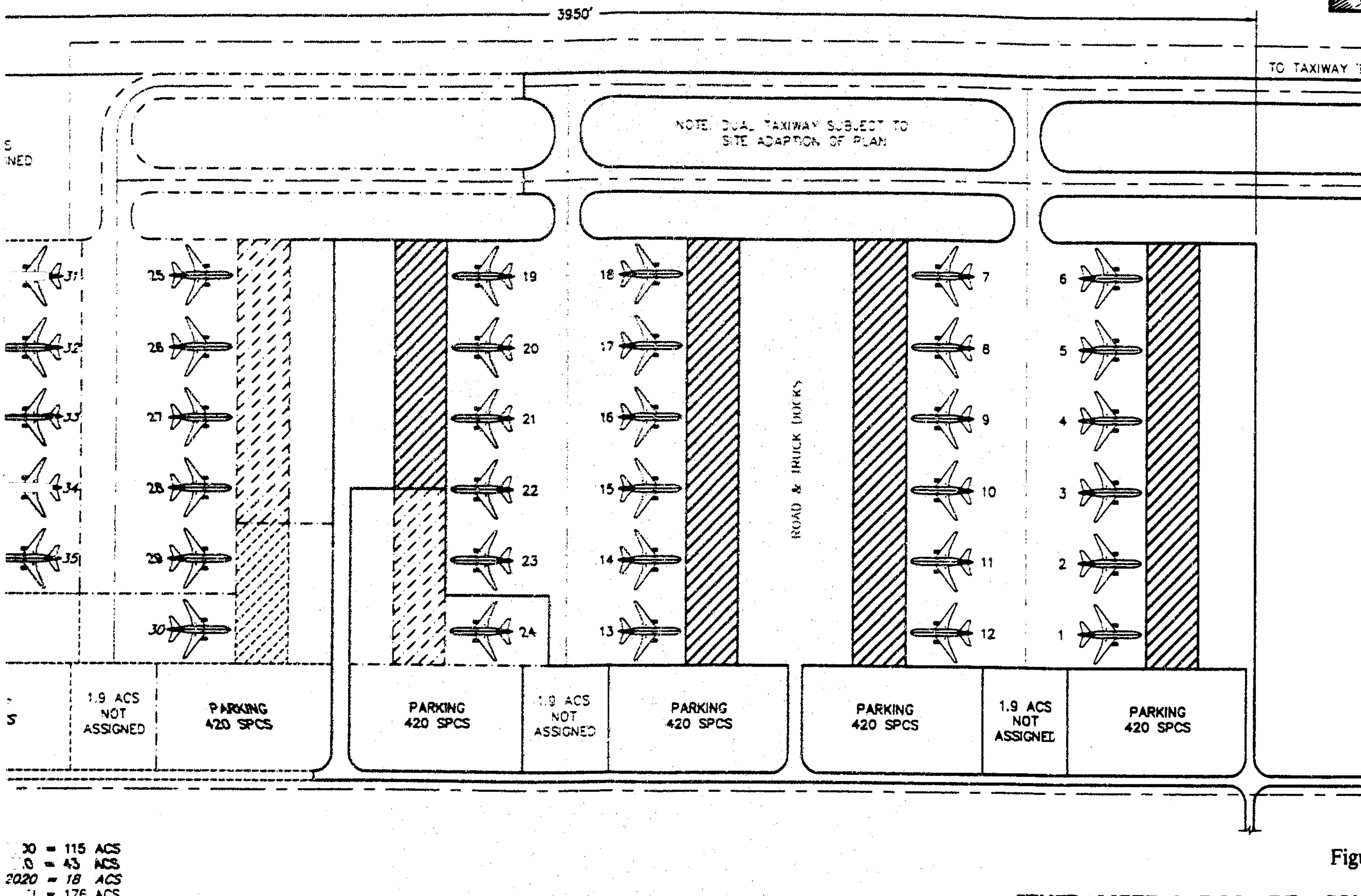
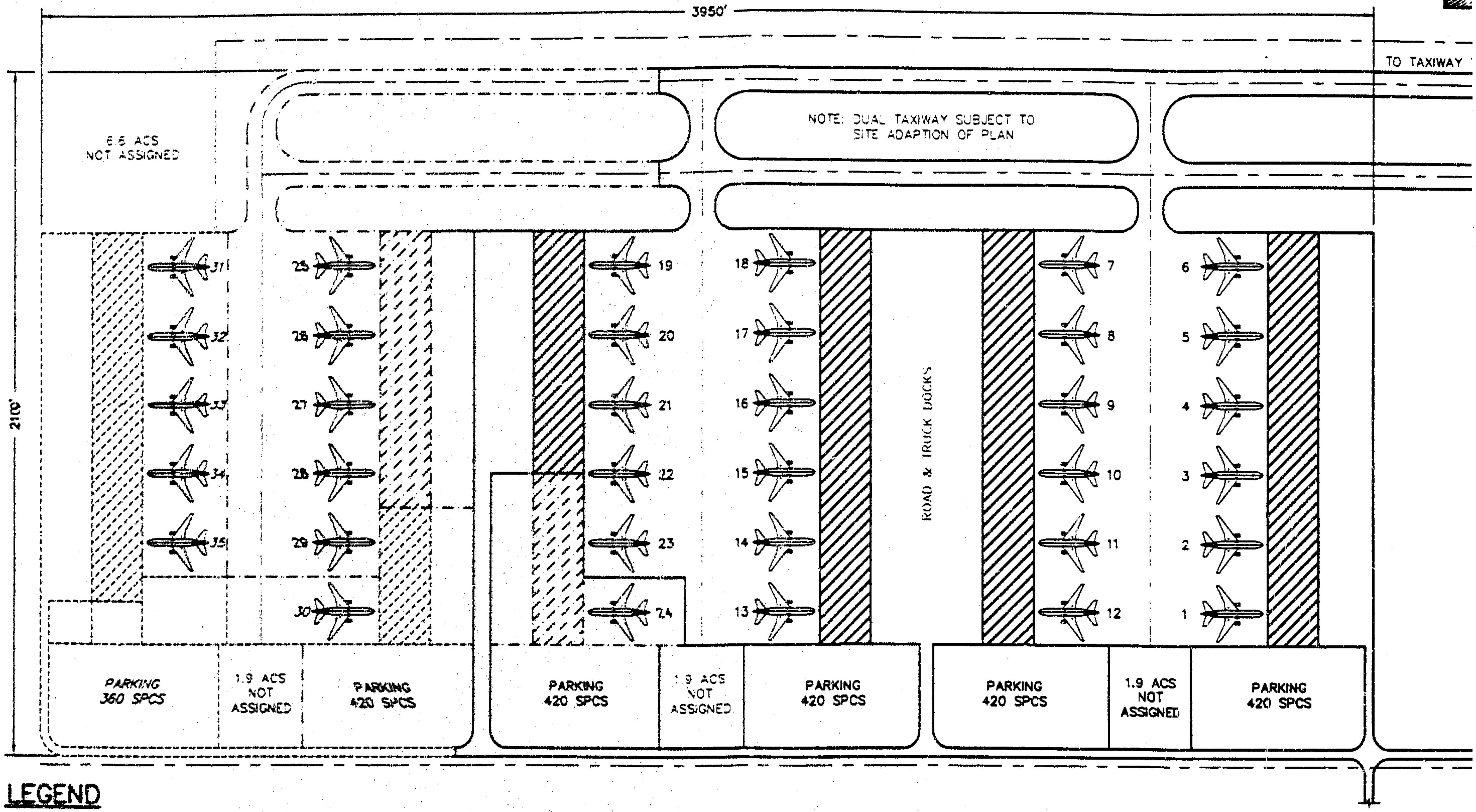


Figure 6-1

CENTRALIZED CARGO AREA CONCEPT

Scale : 1" = 300'



LEGEND

1993 - 2000 = 115 ACS
2000 - 2010 = 43 ACS
2010 - 2020 = 18 ACS
TOTAL = 176 ACS

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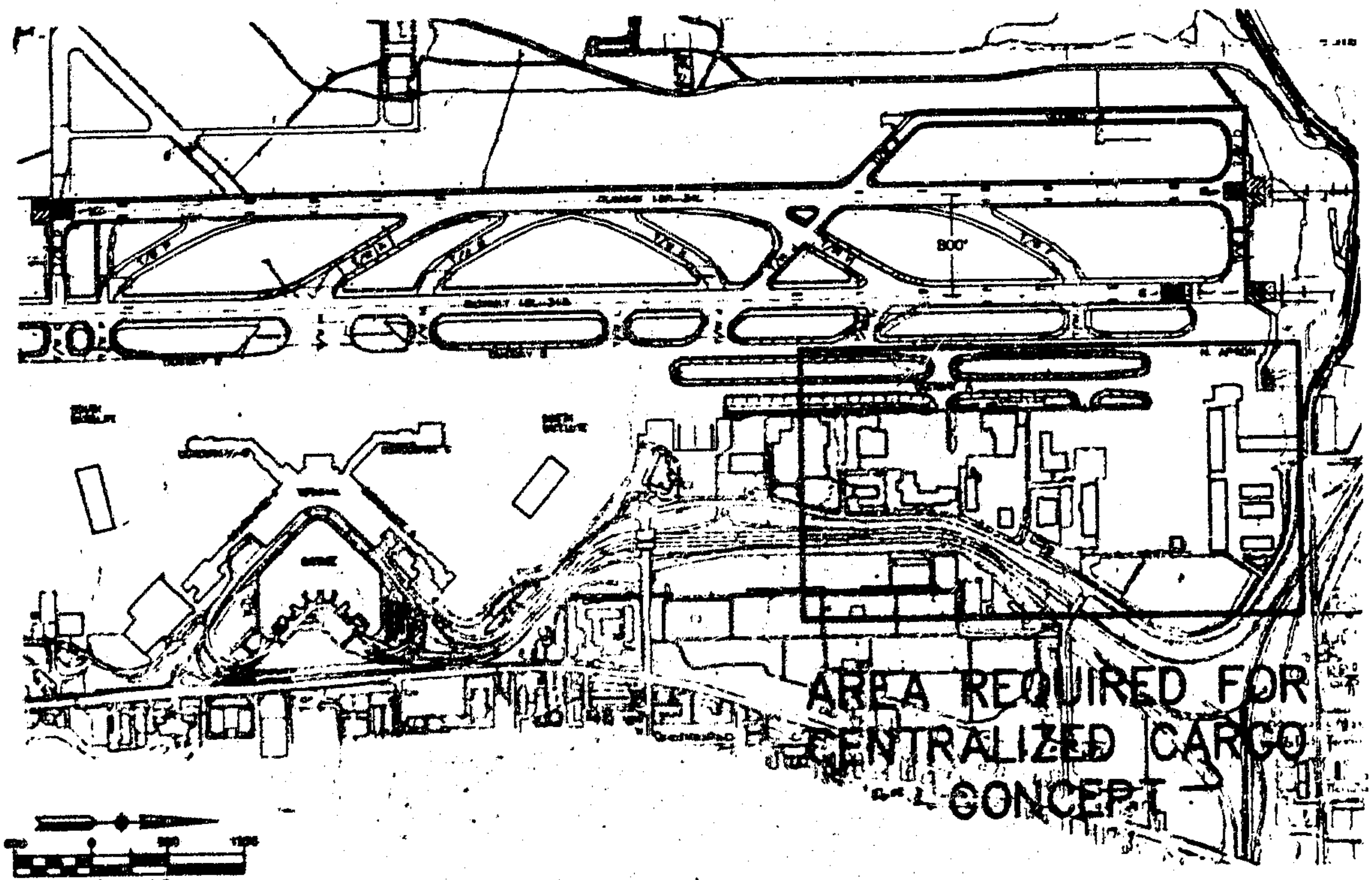
CENTRALIZED CARGO AREA CO

Scale : 1

FIGURE 6-2
CENTRALIZED CONCEPT LAND REQUIREMENTS



passenger traffic, and permitting phased development without interrupting existing cargo operations. However, each concept required overcoming major disadvantages in order to be implemented and it was concluded that accommodation of a centralized cargo option in the master plan was not practical and was dropped from further consideration.

Decentralized Concept

The initial cargo analysis also considered the two sites as described for the centralized concepts with the difference being the extent of new development at the supplemental sites. At the SASA site the future cargo development originally considered utilized most of the SASA area and did not lend itself to accommodating other facilities such as aircraft maintenance, general aviation, etc. The north location presented a major conflict with existing development. However, in spite of these major disadvantages, the concepts did encourage consideration of development of supplemental cargo facilities at both north and south locations, but with less development than originally prescribed.

REFINEMENT OF CARGO OPTIONS

Having gained consensus on the adoption of a decentralized cargo option, it was suggested that two decentralized options be considered. The first would minimize disruption of existing cargo facilities and included relatively modest construction of new facilities within the present cargo area. The second was based on a major reconfiguration of the cargo area in order to maximize the number of cargo aircraft hardstands.

Minimum Development Option

This option contained the following key features.

- Construction of a large (approximately 240,000 SF) cargo building on the south side of the main cargo apron. This would displace the existing Federal Express building.
- Extension of Transiplex A to the east.
- Construction of a 25,000 SF warehouse in the Transiplex complex.
- Renovation and conversion of a portion of the existing United Airlines maintenance building to cargo use.
- Construction of a warehouse encompassing approximately 100,000 SF. This would require the demolition of the existing POS maintenance facility.

The key capacities of this option were:

- Warehouse/office space - 882,000 SF
- Hardstands (DC-10) - 21

It should be noted that the building area shown above does not include the existing Delta cargo building which is ultimately displaced by passenger terminal options. Existing Northwest cargo facilities are also not included in this area and would also be relocated due to expansion of the passenger terminal.

This option would satisfy only 67 percent of the 2020 program for cargo buildings and only 57 percent of the requirement for hardstands, providing 21 of the required 35. In order to meet the program requirements it is necessary to supplement these facilities at either SASA or at north remote locations.

Major Development Option

An option was suggested for consideration which was predicated on a linear cargo building configured within the confines of the north access road. The rationale for this concept was that it would provide more aircraft parking and provide area for expansion of passenger facilities to the north, or redevelopment of cargo facilities to the south. Both expansions would impact the existing United Airlines, Alaska Airlines and Airborne cargo buildings. This concept was based on construction of 700,000 SF of a new cargo building which permitted 24 hardstands. When combined with the present United, Alaska and Airborne buildings, the capacity of this concept was:

- Warehouse/office space - 855,000 SF
- Hardstands (DC-10) - 27

This option would satisfy 65 percent of the 2020 program for cargo buildings and 77 percent of the requirement for hardstands. In order to meet the program requirements it is still necessary to supplement these facilities at either SASA or at north remote locations.

While an improvement in aircraft parking is achieved by this concept, it is done so at the expense of radical reconfiguration of the present cargo area and replacement of nearly 385,000 SF of existing cargo buildings. This represents over 60 percent of existing cargo buildings, or almost 30 percent of the program requirement for the year 2020. Furthermore, the major portion of facilities to be relocated would involve fairly new buildings of the Avia and Transiplex complexes (260,800 SF). These buildings were constructed in the early to late 1980s.

RECOMMENDED CARGO OPTION

Having considered the various options it was concluded that the Minimum Development Option offered a practical solution and should serve as the basis of the expansion of cargo facilities at the Airport. This was based on two main factors. First, is that all options studied required the construction of supplemental cargo facilities at other sites on-airport, and secondly, there is minimal disruption of existing cargo facilities, and contrary to the Major Development Option there is not an extensive taking and replacement of present cargo buildings. Thus, the costs associated with this option serve to expand the existing cargo area capacities instead of replacement of existing capacities.

However, the Minimum Development Option was less than ideal in terms of aircraft parking and it was evaluated further to determine if additional parking could be provided. It was determined that the area between the present United cargo building and POS maintenance building offered the greatest opportunity for expanding parking for cargo aircraft. In order to accomplish this it would be necessary to demolish the POS maintenance building. Since the building is one of the oldest in the cargo area and its use is inconsistent with the cargo function it was judged to be expendable and recommended for replacement elsewhere on-airport. By redeveloping the apron in this area an additional two aircraft parking positions can be created. Figure 6-3 presents the recommended configuration of the existing cargo area and the following paragraphs highlight a phasing plan for expansion of cargo facilities at the Airport.

Phase 1 (1996-2000)

1. Construct a cargo building on the south side of the main cargo apron. The building shown in Figure 6-2 totals 240,000 SF and when considering the existing Federal Express building would result in a net gain of 192,000 SF of cargo building area.

The buildings provided in this phase would meet 96% of the Phase 1 requirement including the loss of the Northwest cargo terminal due to passenger terminal expansion. This slight deficiency in meeting the interim program is not deemed critical in that development of the next

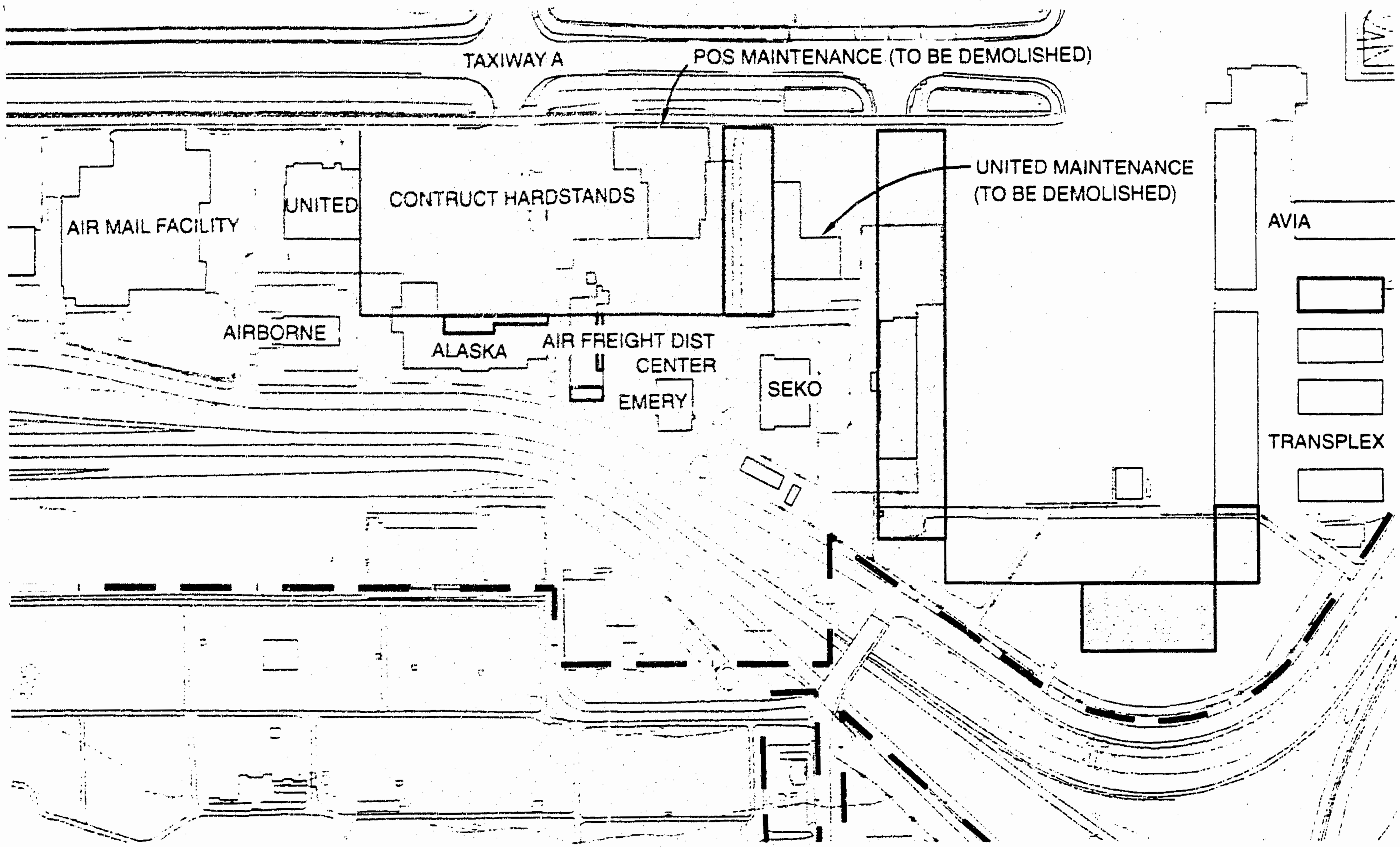
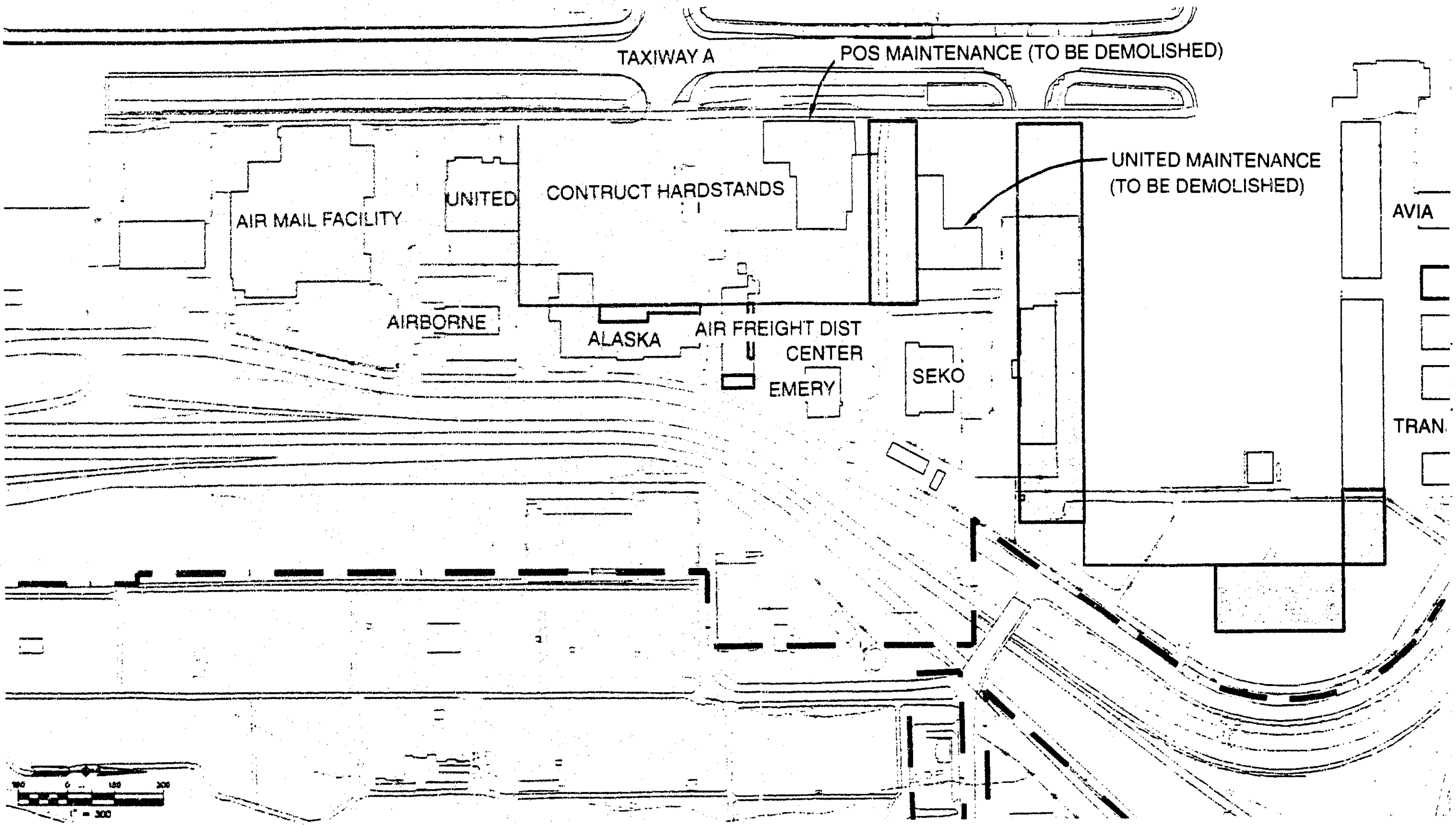


FIGURE 6-3
RECOMMENDED CARGO AREA DEVELOPMENT



FIGUR
RECOMMENDED CARGO AREA DEVELOPM

phase can be accelerated if the future demand warrants.

Phase 2 (2001-2005)

1. Demolish the POS Maintenance Building.

2. Demolish United Airlines Maintenance Building. (It is noted that part of this building was abandoned in other plans).

3. Modify Alaska Air Cargo and Air Freight Distribution Center buildings to allow construction of hardstand area for seven DC-10 aircraft.

4. Construct hardstand.

5. Construct cargo building (81,000 SF) on the north side of the newly constructed hardstand area.

6. Expand Transiplex A to the south (25,125 SF).

7. Construct new Transiplex warehouse (25,000 SF).

At the completion of the Phase 2 development, 97% of the cargo building requirement would be met and 23 out of a required 26 hardstands would be provided.

Phase 3 (2006-2010)

1. Construct a cargo building (80,000 SF) east of the main hardstand area. It is noted that a larger building can be constructed by extending the building to the south.

This development meets 94% of the cargo building requirement for the year 2010 and it is possible to meet 98% of the requirement by constructing a 120,000 SF building which is possible on the site. In terms of aircraft parking, 23 out of 29 hardstands are provided. The shortfall may not be as significant in the mid-term period as the need for all DC-10 parking may not be required in this interim planning period.

Phase 4 (2011-2015)

At this point the buildout of the existing cargo area will have occurred and it will be necessary to develop supplemental cargo facilities at other sites. Two locations have been considered -- SASA and a north site for remote warehouses. The latter is not favored since it does not provide a means of increasing cargo aircraft parking. Therefore, it is recommended that supplemental cargo facilities be developed first in SASA. If long term cargo demands prove to exceed the additional capacity available at SASA, then north remote warehouses can ultimately be developed.

1. Begin development of cargo buildings in SASA.

The Phase 4 requirement calls for a need of 1,175,500 SF of building and 32 hardstands. There is sufficient area in SASA to meet the building requirements, and overall parking capacity (existing cargo area plus new facilities in SASA) would be 30. It is noted that the existing Delta cargo terminal would be relocated because of ultimate passenger terminal expansion in this phase.

Phase 5 (2016-2020)

1. Expand SASA cargo buildings.

With the exception of a north unit passenger terminal option, it is possible to meet the 2020 requirement within SASA. A total of 33 out of a required 35 hardstands are provided, but there would be additional area within SASA to meet the hardstand requirement.

Features of the Plan

- The recommended plan minimizes disruption of existing cargo facilities and is compatible with plans pending for the expansion of existing facilities.

- The recommended plan accommodates program requirements through the year 2010 by utilizing the existing cargo area. Development of SASA for cargo can be deferred until then.

- Demolition of new buildings on the north (Avia and Transiplex) constructed in the early and late 1980s is avoided.

- The only buildings demolished are old buildings, both of which are not presently used for cargo purposes (POS Maintenance and United Airlines Maintenance).

It should be noted that while development of SASA for cargo use can be deferred until 2010, construction of cargo facilities earlier should be considered under certain circumstances. An example would be if a cargo carrier desires to significantly expand operations at the Airport.

Section 7
AIRCRAFT MAINTENANCE OPTIONS

SECTION 7
AIRCRAFT MAINTENANCE OPTIONS

INTRODUCTION

The Final Environmental Impact Statement (FEIS) for the South Aviation Support Area (SASA) was published in March 1994. The FEIS covered the development of an aircraft maintenance base at the SASA site in anticipation of the need for new and expanded existing maintenance facilities.

The proposed action covered by the FEIS had three principal objectives which were:

- To accommodate the existing line maintenance facilities that must be relocated prior to the expansion of the terminal facilities.
- To accommodate future line maintenance expansion.
- To accommodate major base maintenance facilities in response to existing and/or future market demands.

Although the SASA study considered other locations on and off airport for establishment of relocated maintenance facilities, other sites were rejected in preference to the SASA site.

In this alternatives analysis, other sites will be considered since the maintenance facilities and cargo facilities analyzed in Section 7 are major land absorbers and their interrelationships cannot be ignored.

The alternatives analysis will rely on the projection of aircraft maintenance facilities contained in the SASA FEIS. The SASA study explored in much greater depth the need for maintenance facilities, and it is logical to accept this previous work.

SASA Maintenance Site

The SASA study investigated alternative sites for the establishment of maintenance facilities and concluded that the South Aviation Support Area was the preferred site.

The SASA study identified three alternative concepts and selected Alternative 2 as the preferred layout concept. The concept provided facilities for the three existing line maintenance facilities located south of the passenger terminal as well as the construction of a base maintenance facility that was envisioned by Alaska Airlines. Land also was provided for future expansion of base maintenance facilities, in the event the POS received inquiries from other airlines. Included in the concept is a "hush facility" for engine runups and a ground service equipment (GSE) maintenance facility.

Alternative 2 would provide 922,600 square feet of developable land for possible commercial development within the area bounded by South 192nd Street 28th Avenue South, South 200th Street and Tyee Valley Golf Course.

The finished area of Alternative 2 would be about 84 acres with a total paved area of 270,000 square yards. Extensive fill would be required to bring the site up to grade so that direct access to the airfield could be achieved.

Provisions were made to accommodate the alignment of the proposed South Access Freeway on the West side of the site, and a corridor for the 28/24 arterial on the east side of the site. Figure 7-1 is a concept layout of the maintenance facility envisioned for this site.

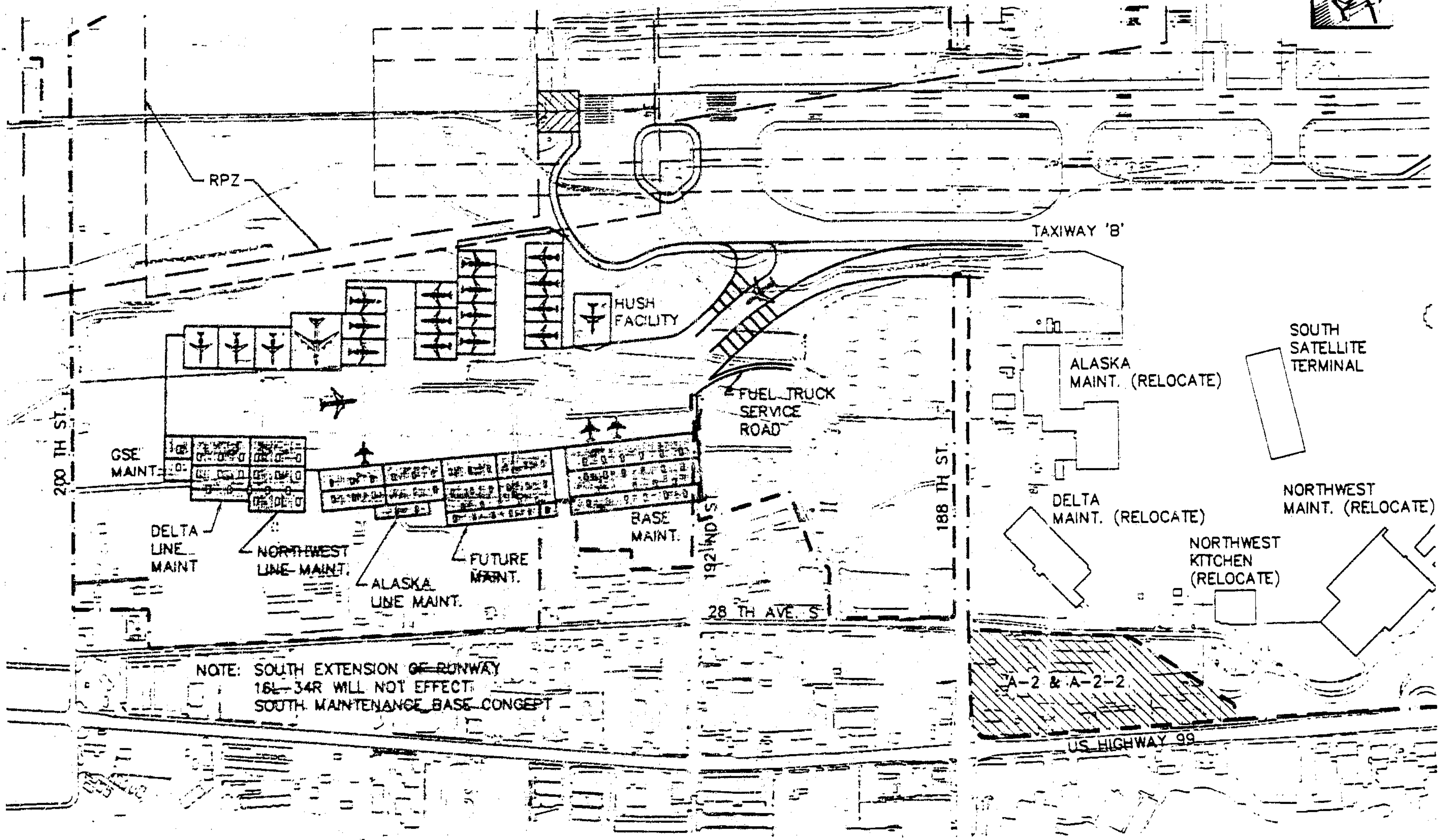
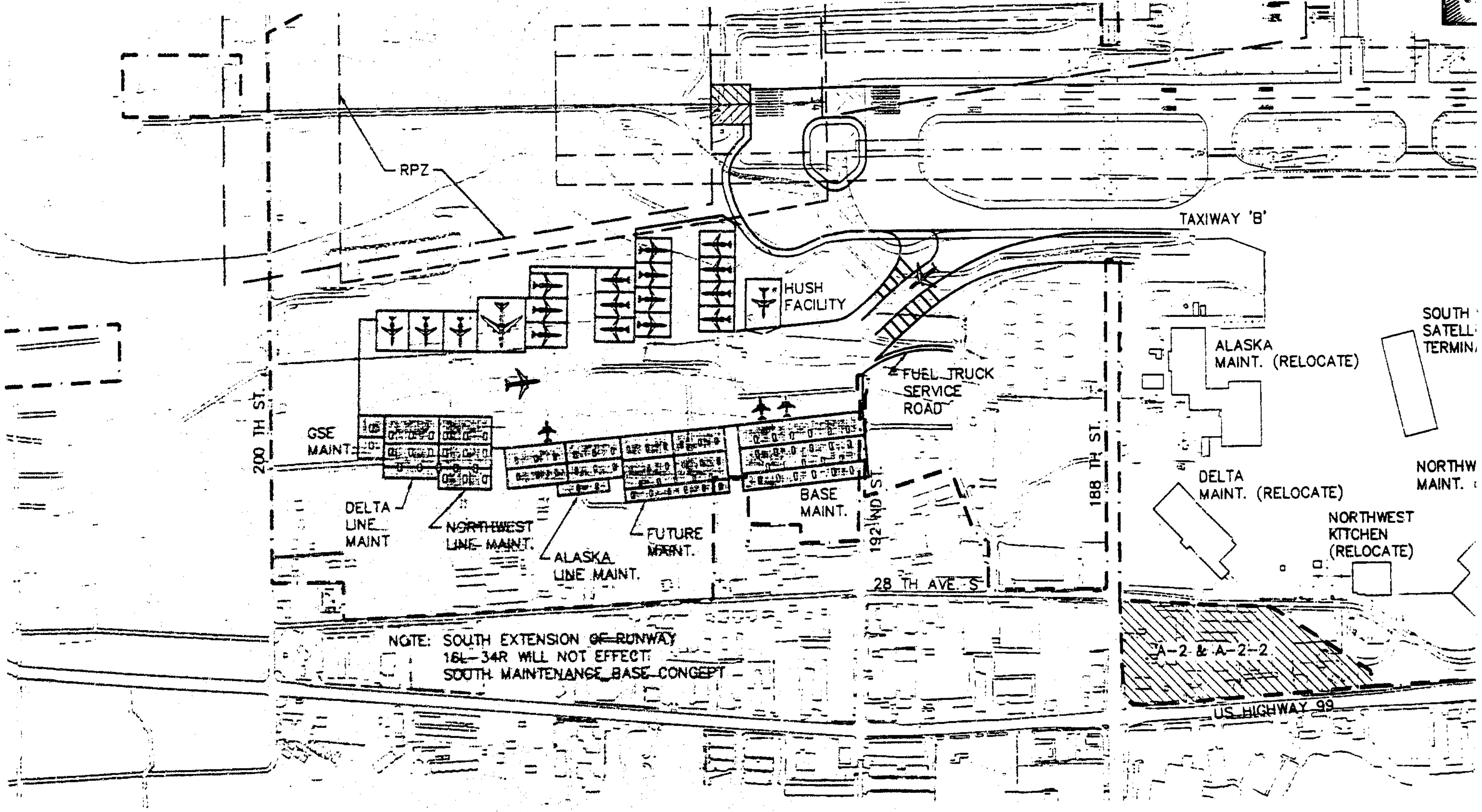


Figure 7-1

SASA SITE MAINTENANCE BASE

Scale : 1" =500'



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SASA SITE MAINTENANC

Scale :

The planned extension of Runway 16L-34R will not effect the maintenance facility concept at the SASA site.

Advantages of SASA Site

- Environmental analysis completed
- Direct access to airfield
- Sufficient land area to meet objectives
- No violation of FAR Part 77 criteria
- No interruption of airport operations during construction
- Good local road access to site
- Compatible with zoning and area plans
- No land acquisition required
- Provisions for future freeway and arterial

Disadvantages of SASA Site

- Expensive construction
- Des Moines Creek relocation
- Reduce golf course to nine holes
- Sea-Tac's IWS would require expansion
- Does not accommodate other uses such as cargo

Northeast Maintenance Site

This site was considered in the SASA study but was rejected because of limited space to develop the required maintenance facilities. This site presently houses the air cargo terminals, hardstands, truck docks and parking for all operators except Northwest Airlines, whose cargo terminal is located in the southeast quadrant adjacent to their maintenance hangar.

Since the recommended cargo option proposes continued use of the area for cargo operations, the site is not viable for an aircraft maintenance complex.

Far North Maintenance Site

This site is the POS owned property located north of State Highway 518 and west of 24th Avenue South. This site was considered in the SASA and was rejected because of the need to construct a taxiway bridge over State Highway 518.

Use of the site is further complicated by existing development, proposed use of part of the area for airport employee parking, plus the need for extensive fill.

CONCLUSIONS

Of the three locations discussed for possible airline maintenance, only one site is deemed feasible for consideration--the SASA site. It provides sufficient area for development of maintenance facilities and does not conflict with the recommended cargo facilities option.

Because of the need to also utilize portions of the SASA site for other uses such as supplemental cargo facilities, general aviation, GSE, etc., the dedication of land for maintenance purposes should be less than that shown in Figure 7-1.

The extent of aircraft maintenance development in the SASA should primarily be dictated by the replacement requirements of those facilities that are relocated by passenger terminal expansion. Development of maintenance facilities in addition to those which are relocated should be reconciled with demands for other uses of the area such as cargo.

Section 8
OTHER FACILITIES OPTIONS

SECTION 8
OTHER FACILITIES OPTIONS

INTRODUCTION

Having addressed the cargo and maintenance facilities, attention can be focused on the remainder of other airside and landside facilities options. This report section deals with the following other facilities:

- Airport Rescue and Fire Fighting Facilities (ARFF)
- General and Corporate Aviation Facilities
- Air Traffic Control Tower
- Flight Kitchens
- Aviation Fuel Storage Facilities
- Airport Operations, Maintenance and Administration
- Police Department
- Air Mail Facility (AMF)

AIRPORT RESCUE AND FIRE FIGHTING FACILITIES (ARFF)

The present ARFF located just north of the north satellite terminal will eventually have to be relocated because of passenger terminal expansion.

Currently the eleven-stall fire station is located on the east side for suppression of structural fires and to assist with airside incidents. The current ARFF site occupies about 2.5 acres. FAA minimum requirements for the airport as stipulated in FAR Part 139, classify the airport as Index E and specifies that three vehicles be provided.

During the development of alternatives, three sites for an ARFF were considered: an east side site; a west side site; and, a north airport site with a south field satellite station. The west side site was not deemed feasible because of development costs largely driven by earthwork. A split operation as suggested by the north airport site presented additional cost and operational burdens than a centralized facility and was also judged not to be practical. Thus, an east side location was determined as best.

Two east side locations have been identified as candidates for ARFF use. The first is located immediately south of the U.S. Post Office facility. This location may require a slight taking of the Post Office leasehold (estimated at approximately one-tenth acre). This location could be used with Central and South Unit Passenger Terminal options. It should be noted that the development of a new ARFF building would be required only as extension of the north satellite demanded taking of the existing fire station area.

A second ARFF location identified is immediately north of the Post Office facility, on a site presently occupied by United Airlines cargo. This site would be used if a North Unit Passenger Terminal was developed.

GENERAL AND CORPORATE AVIATION FACILITIES

Two separate facilities are grouped under this general category. General aviation aircraft servicing is performed by Signature Flight Support, the only fixed base operator (FBO) doing business at Sea-Tac. The principal services are aircraft fueling and parking of itinerant aircraft since there are no individual privately owned aircraft based at the airport.

The other facility covered under this subsection is the Weyerhaeuser corporate flight department that maintains a hangar and fueling facilities for its own aircraft and rotorcraft.

The requirements of both of these general aviation aircraft services are similar, in that direct access to the airfield and public roads is required. The FBO does not require a hangar but does need a building for pilot lounge weather briefing and administrative offices. A tie-down apron, approximately equal to the present 67,400 SF apron is required in addition to auto parking and access to a fuel supply.

Two sites are shown on the alternatives as possible GA areas--SASA and a north field location. Additionally, a west side location was initially considered but was ruled out due to prohibitive development costs.

SASA Site

Advantages

- Potential lower development costs for GA if included as part of wider development in the area (i.e., maintenance, cargo, etc.).

Disadvantages

- Development of GA facilities would be contingent on the timing of larger projects in SASA.
- Encourages a mixing of GA and commercial aircraft on the ground.
- GA airport would be subject to long taxi routes, departure queues and crossing active runways if landing on the third runway.
- Does not encourage use of third runway.

North Field Site

Advantages

- General aviation will be relocated in early phases with the development of a third runway. Initial development of SASA for GA is not required.
- General aviation uses can be segregated from other uses on the airport and the north site can accommodate GA and utilize an area that otherwise is unsuitable for many other functions.
- In predominant south traffic flows, GA aircraft would face long taxi routes and would mix with commercial traffic in the terminal area if a SASA site was selected. A north site would avoid this situation.
- A north site would encourage greater use of a third runway as GA aircraft would be removed from the main departure queue in south flows. The third runway could also accommodate all GA departures.
- GA aircraft landing on a third runway would not be required to cross active runways to taxi back to the GA area.
- With the greater possible use of a third runway, a north field site promotes segregating GA and commercial aircraft which could provide operational advantages.

Disadvantages

- Potentially high developments cost due to fill.

It is proposed to locate the FBO and Weyerhaeuser facilities adjacent to each other. Weyerhaeuser has indicated a desire to share a fuel storage facility with the FBO. Total land area including a fuel storage facility is estimated to be 5.0 acres for both facilities.

AIR TRAFFIC CONTROL TOWER

As noted in the facilities requirement section of this report, a new control tower and TRACON facility is being considered by the FAA. It is proposed that these air traffic control facilities be located on the east side of the Airport. A ground lease of from 1 to 4 acres will permit the construction of a Level 4 tower and base building with sufficient land for parking and expansion in the future. A land area has been identified north of and adjacent to the Post Office facility and would require relocation of the Airborne Freight building.

This location would give the controllers a clear line of sight to all runway thresholds, departure queues and holding aprons. The location would also accommodate a tower cab ten feet higher than the existing cab. The tower has been located to remain clear of obstacle clearance surfaces specified in TERPS for Category II/III runways (specifically the missed approach surface for Runway 16L). The siting analysis assumed the elimination of the displaced threshold of Runway 16L.

Other sites considered in the vicinity included the Doug Fox area. However, due to the need for a cab elevation on the order of 150 feet greater than the existing tower, the site was not deemed feasible. The higher cab elevation required would be dictated by line-of-sight over the existing control tower which will remain for ramp control. A tower elevation of approximately 662 feet MSL at this location would penetrate the FAR Part 77 horizontal surface by 80-85 feet. This site may still be considered but would require lowering or removal of the existing tower.

During the assessment of tower sites the advantages of the existing location were noted. These included clear lines of sight, a location near the mid-point of Runway 16L-34R, and good view of the passenger terminal aprons. While upgrading of the existing tower poses certain cost and operational concerns during construction, it is recommended that it be carried forward for further consideration as the ultimate tower location.

Additionally, a west side tower location may be considered but would require a creative solution to reduce site preparation costs.

FLIGHT KITCHENS

The Northwest Airlines Flight Kitchen is the only definite facility to be relocated. The United Airlines flight kitchen would be impacted by terminal roadway development for a North Unit Terminal. The facility presently totals 65,000 SF and was constructed in 1990. Only a small portion of the building would be required for roadway development. It also appears possible that a roadway alignment that avoids the flight kitchen is possible. It should also be noted that the above described roadway development would be implemented in later phases consistent with the timing of the North Unit Terminal.

Space would be available for relocated flight kitchens in the area north of State Highway 518 and east of 24th Avenue South. These parcels are east of the area identified for future employee parking on Figures 6-1 to 6-3. Uses shown for the site are airport maintenance and remote cargo warehouses. Sufficient area would be available to accommodate relocated flight kitchens and the other uses considered.

AVIATION FUEL STORAGE FACILITY

Planned future eastside airport facilities will not effect the location of the main full storage tanks. New underground fuel storage tanks to supply the new hydrant system at the expanded terminal will have to be integrated into the hydrant system design.

The truck fill stand will require expansion to improve the road geometry for the large refueler trucks. Most likely an increase in the present capacity will not be needed when the expanded hydrant system is installed. Only commuter aircraft and all-cargo aircraft will be fueled by trucks. The number of refueler trucks most likely will be decreased when the hydrant system is fully operational, and the ASI ground lease can remain at about one acre.

AIRPORT MAINTENANCE FACILITY

It is recommended that the existing airport maintenance facility be relocated in favor of cargo aircraft apron expansion. There are several opportunities on airport to develop a new main base. The building plus parking, fueling and vehicle wash rack could easily be developed on a 4 to 5 acre plot, having direct access to the airfield. Possible sites would include the area north of State Highway 518 and east of 24th Avenue South, and a north field location.

Additional space will be required for storage of snow removal equipment. FAA AC 150/5220-18, Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials, suggests an area of approximately 1,000 SF per vehicle. Based on the 26 present vehicles a building totalling 50,000 SF would be adequate for vehicle and material storage. A south field location near the threshold of Runway 34L has been identified as the snow equipment storage facility.

Section 9
OPTIONS EVALUATION PROCESS

SECTION 9
OPTIONS EVALUATION PROCESS

INTRODUCTION

Section 9 of this report documents the process employed to identify the optional concepts for the development of landside and airside facilities described in Tasks 5.5 and 5.6 of the Airport Master Plan work program. Specifically, these other airport facilities include the following:

- Cargo Terminal Complex
- General and Corporate Aviation Facilities
- Airport Rescue and Fire Fighting Facilities (ARFF)
- Aircraft Maintenance Facilities
- Flight Kitchens
- Aviation Fuel Storage Facilities
- Airport Operations, Maintenance and Administration
- Other Airport Tenants
  - Air Mail Facility (AMF)
  - Port of Seattle Police Department
  - Aircraft Service International (ASI)

Associated with the development of the above mentioned airport facilities is consideration of drainage and stormwater control and treatment facilities as well as pollutant and hazardous material control facilities.

In Technical Report No. 7A, several passenger terminal options were identified and evaluated on the basis of 16 factors. This process resulted in the identification of three terminal options selected for further refinement.

At this stage of the planning process, there remains three passenger terminal options which will influence the selection of alternative options for the other airport facilities covered in this report.

It is apparent from a review of the Terminal Options report that a full buildout of these options will require the relocation of a varying number of existing facilities. The 9 existing facilities tabulated below will require relocation regardless of which terminal option is recommended for implementation.

- Airport Rescue and Fire Fighting Facility (ARFF)
- Ground Handling Storage Area
- Northwest Airlines Maintenance Hangar
- Delta Airlines Air Cargo Hangar
- Northwest Airlines Cargo Terminal
- Northwest Airlines Flight Kitchen
- Northwest Airlines Underground Fuel Storage Tanks
- Delta Airlines Underground Fuel Storage Tanks
- Police Building (Pan Am Hangar)

In addition to the above listed definite relocations, five other existing facilities will be relocated if the south unit or central terminal expansion concepts are selected. These are:

- Delta Airlines Maintenance Hangar
- Alaska Airlines Maintenance Hangars
- Signature Flight Support (FBO) Facilities
- Aircraft Service International Facilities
- Olympic Pipeline Fuel Truck Fill Stand

If the north unit terminal is selected, four other existing facilities will require relocation.

- Airborne Cargo Terminal
- United Airlines Cargo Terminal
- Delta Airlines Cargo Terminal
- United Airlines Flight Kitchen

These relocation considerations do not include any off-airport facilities that may need relocation because of additional land acquisition for terminal expansion.

DEVELOPMENT OF ALTERNATIVES

Due to the strong influence of the terminal expansion options on the replacement and expansion opportunities for other airport facilities, three comprehensive airport development alternatives have been formulated to match each of the three terminal options. These form three different approaches to expanding the east side of the airport.

The three east side expansion alternatives are formed around the south unit terminal, the north unit terminal, and the central terminal expansion options. These are combined with the 7,000', 7,500' and 8,500' third runway options respectively to create three complete airport development alternatives to be evaluated in the EIS. It is important to note that each of the runway options being considered is compatible with each of the terminal expansion options. Therefore, any combination of runway options with east side development options would be possible. For purposes of this discussion however, the combinations described above have been depicted in Figures 9-1, 9-2, and 9-3.

EVALUATION METHODOLOGY

The evaluation process leading to the formulation of the three alternatives shown for other facility improvements combines both subjective and objective elements. The definition of alternatives is guided by the need to meet the master plan update forecast requirements for the 25-year planning period. The alternatives also reflect either direct or indirect input from a variety of sources including POS staff and users of the Airport. Input was obtained through individual interviews and meetings, several workshops with Port staff and through review and comments offered by the Master Plan Technical Advisory Committee.

Perhaps the single most important factor to emerge during the alternative formulation process was the need to incorporate flexibility and adaptability to change as operational requirements at Sea-Tac continue to evolve in the future. In addition to operational flexibility, the need to provide for incremental growth in the other facilities is important and this should be designed to accommodate a range of aircraft types and sizes in the future.

The three alternatives are described in the following subsections.

SOUTH UNIT TERMINAL ALTERNATIVE

Figure 9-1 presents this alternative which combines a south unit passenger terminal with a new 7,000 foot long third parallel runway. With the eventual use of SASA and other airport properties, it is possible to accommodate the requirements for passenger, cargo and support facilities for the year 2020. Key components of the alternative are discussed below.

Airfield

The airfield improvements proposed in this alternative and the phasing are as follows:

- Construct 7,000 foot long runway, associated parallel and exit taxiways and connecting taxiways to existing airfield (Phase 1).
- Construct midfield remain overnight (RON) apron and a midfield connecting taxiway to the existing airfield (Phase 2).
- Construct dual parallel taxiway to the end of Runway 34L. (Phase 3). This will require

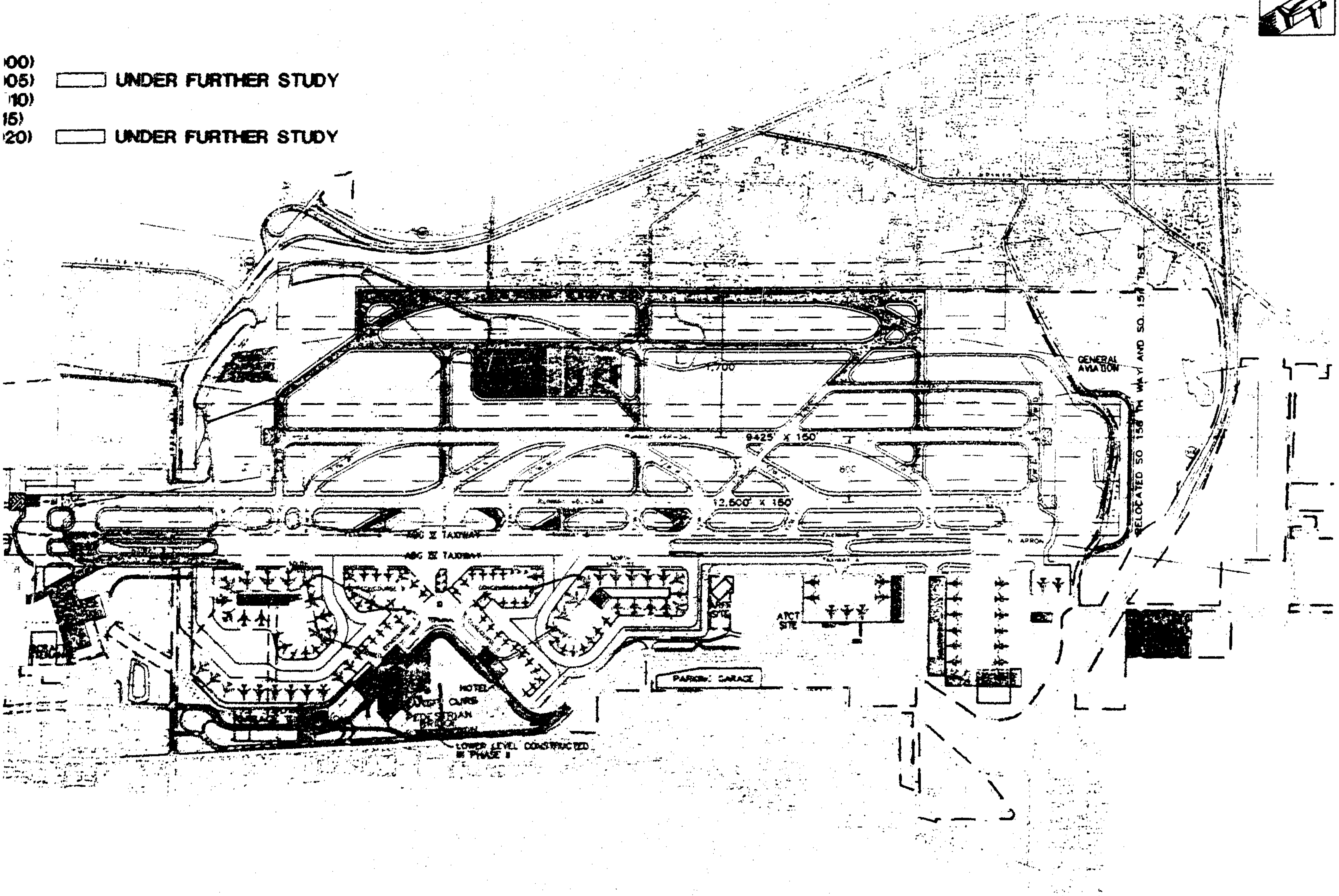

FIGURE 9-1
SOUTH UNIT TERMINAL ALTERNATIVE

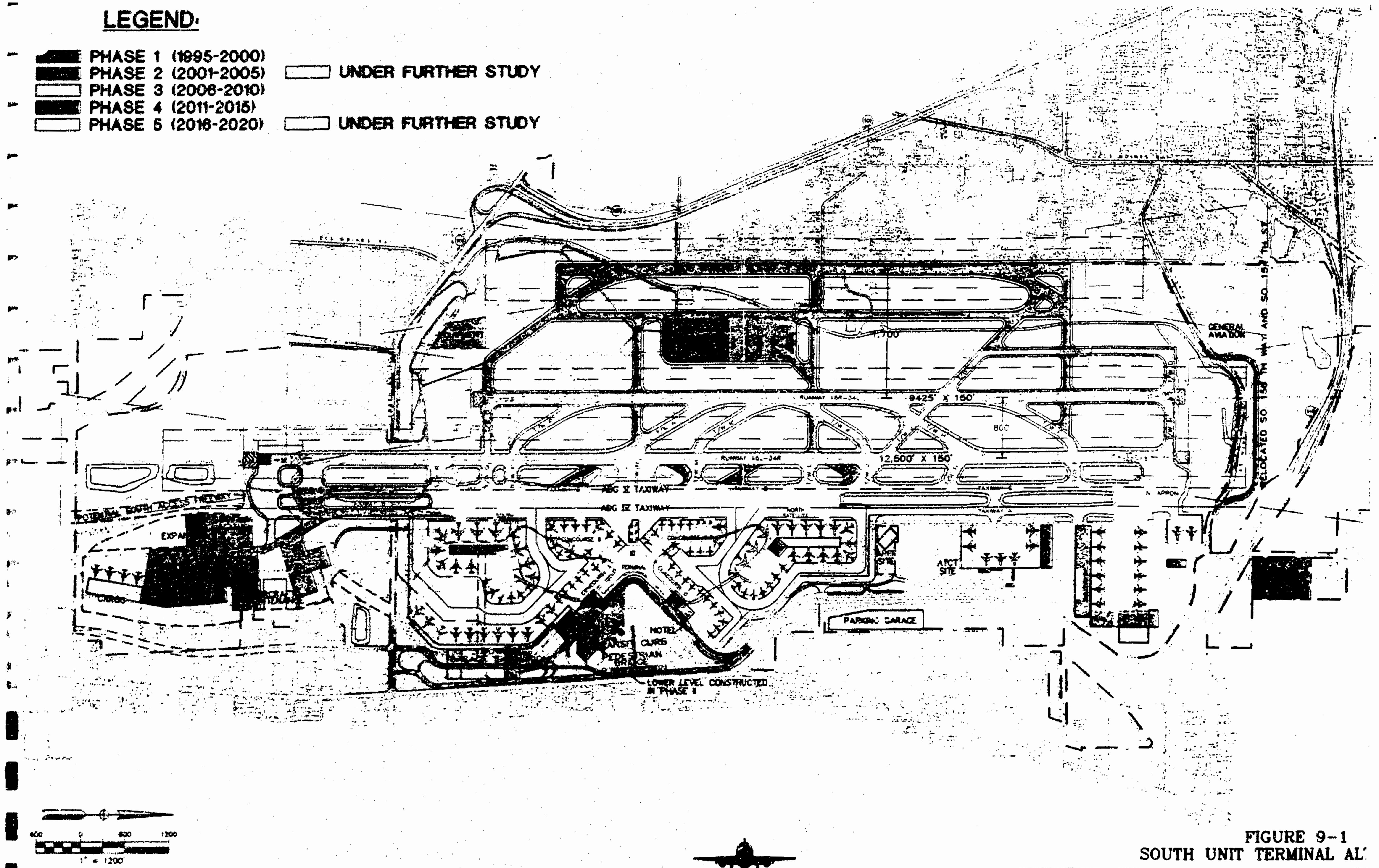

FIGURE 9-1
SOUTH UNIT TERMINAL AL'

-2000)
-2005) UNDER FURTHER STUDY
-2010)
-2015)
-2020) UNDER FURTHER STUDY

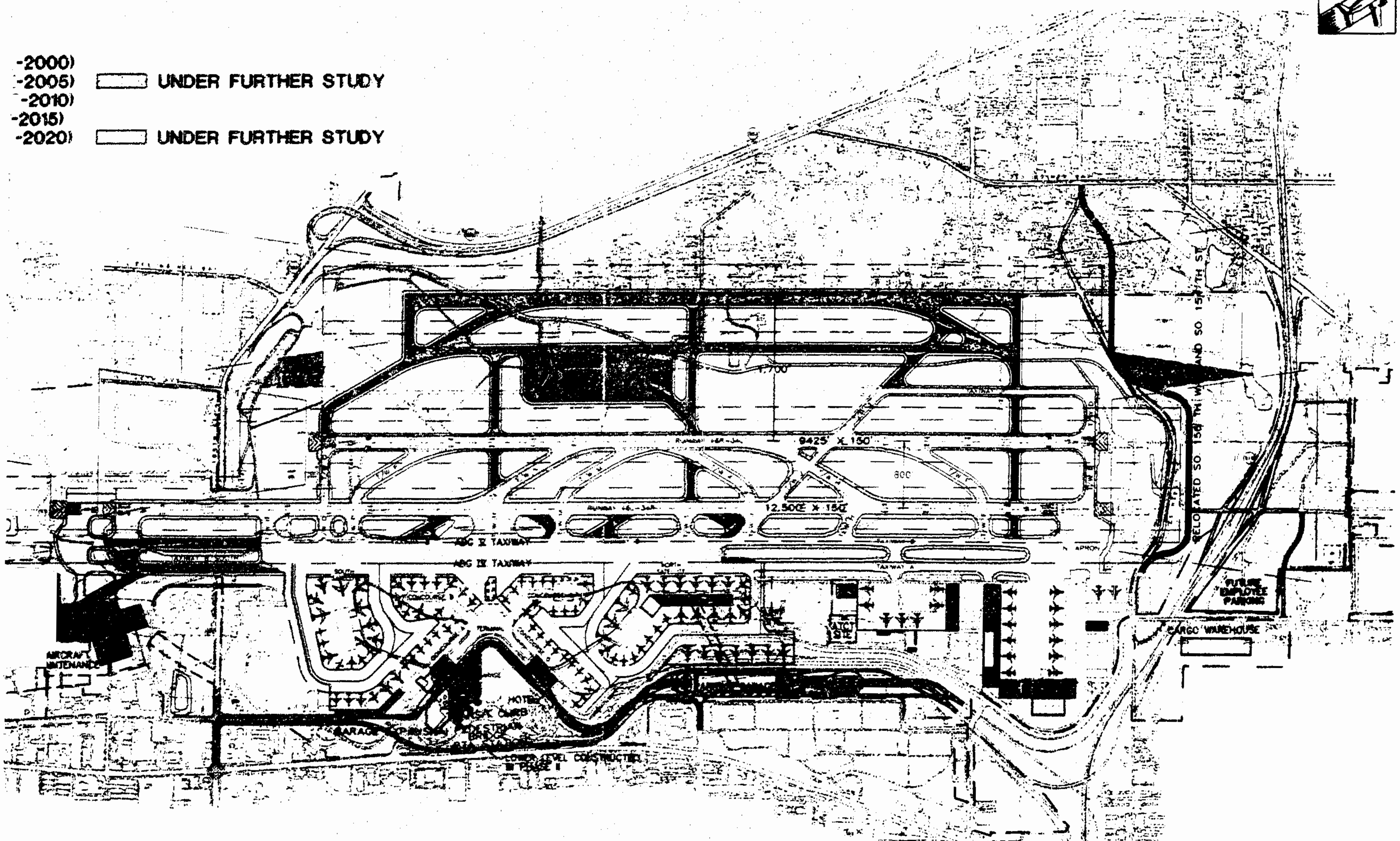

FIGURE 9-2
NORTH UNIT TERMINAL ALTERNATIVE

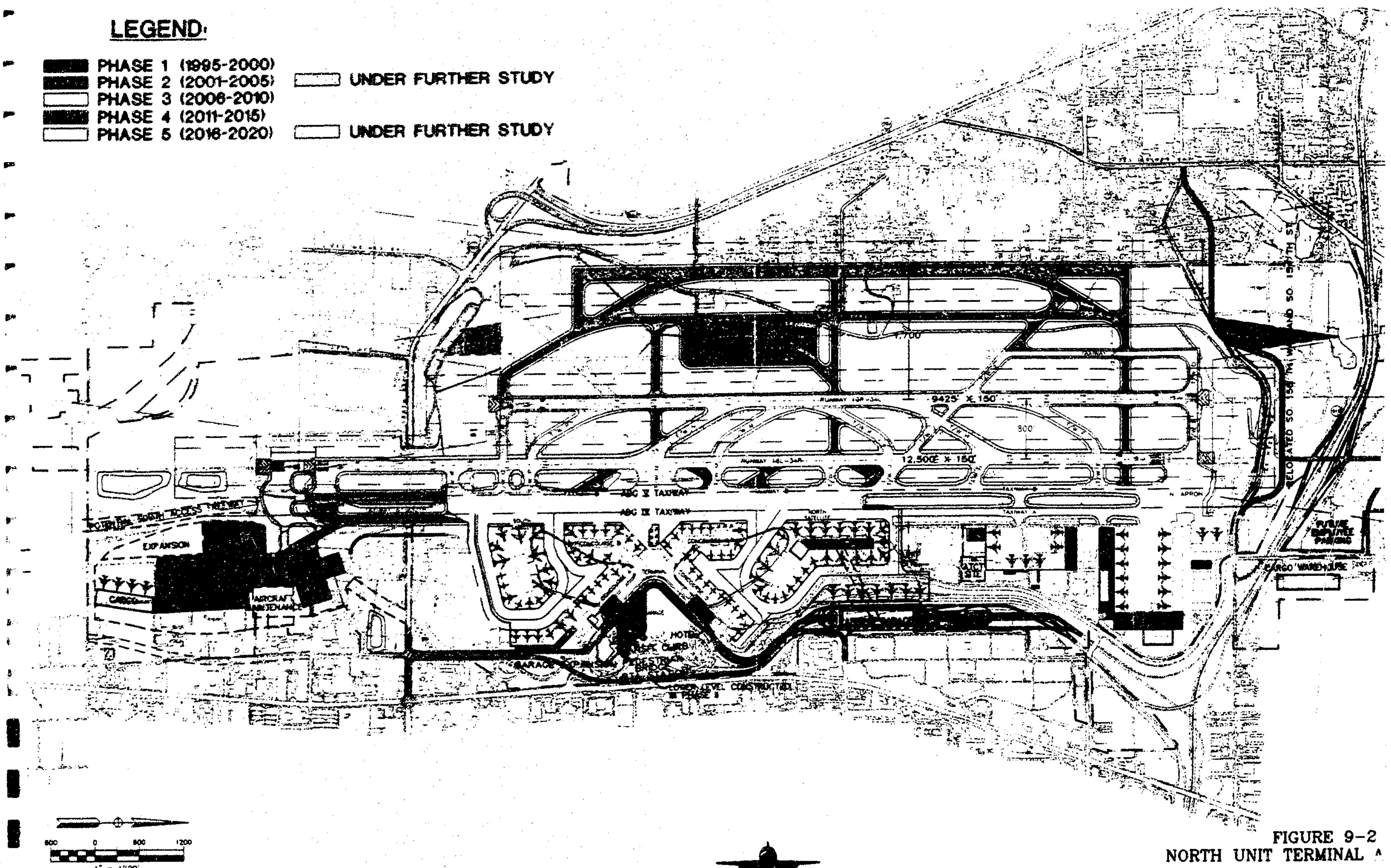

FIGURE 9-2
NORTH UNIT TERMINAL

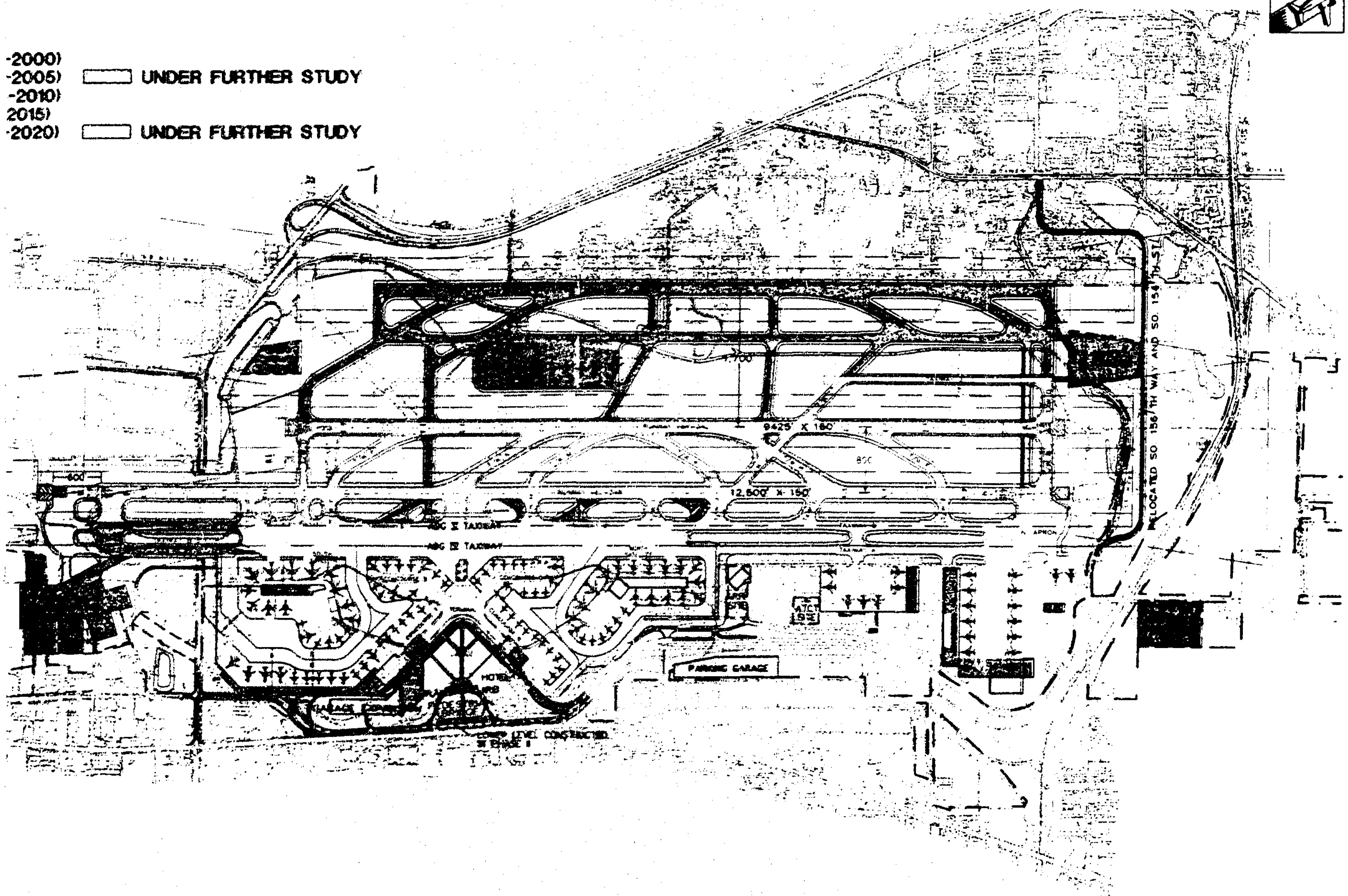

FIGURE 9-3
CENTRAL TERMINAL ALTERNATIVE

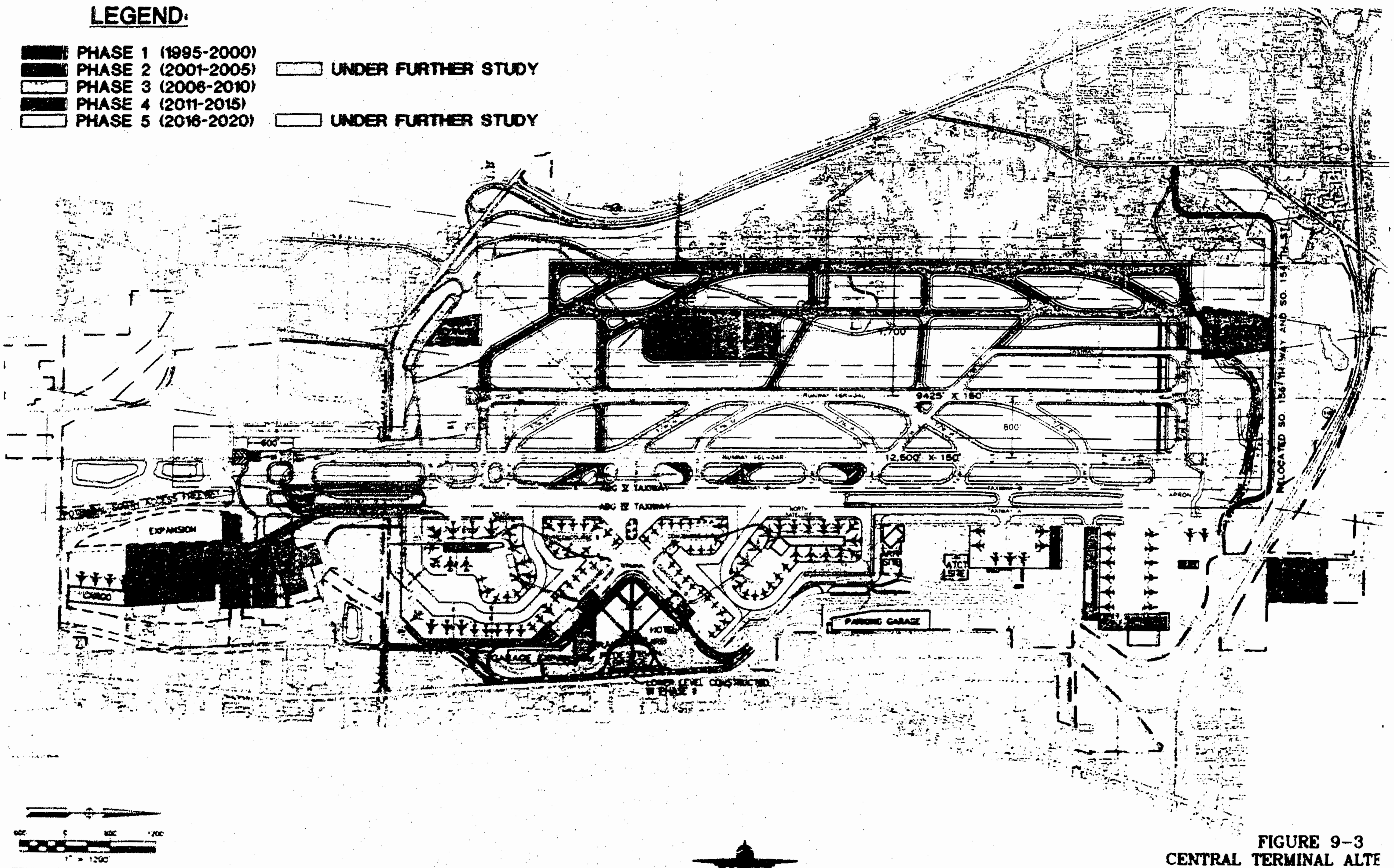

FIGURE 9-3
CENTRAL TERMINAL ALTE

construction of a bridge across 188th Street to accommodate a service road which must be realigned to be kept outside the future taxiway object free area (TOFA).

- Construct exit taxiways for Runway 16R-34L (Phase 4).
- Construct a 600 foot extension on the south end of Runway 16L-34R and widen existing Taxiway A North (Phase 5). The modification of Taxiway A is required in order to maintain TOFA standards near the north satellite expansion depicted for this phase.

The displaced threshold of Runway 16L is abandoned and runway safety areas complying with FAA standards are also constructed for Runways 16L and 16R in Phase 1. The latter will require relocation of South 156th Way and 154th Street.

Passenger Terminal

The passenger terminal and associated roadways are addressed in much greater depth in Technical Report 7A. However, for a complete description of the airport alternatives, the phasing of terminal improvements is briefly described herein. In this alternative, modest expansions of Concourse A and both the north and south satellites occur in the first ten years (Concourse A in Phase 1 and satellite expansion in Phase 2). Major terminal development occurs in Phase 3 with the construction of the south unit terminal. The balance of terminal expansion involves major extension of the south and north satellites which occurs in Phases 4 and 5 respectively.

Cargo Terminal Development

Section 7 addresses in detail the phasing of cargo facility improvements. All development of cargo facilities is confined to the existing cargo area through the year 2010. In this alternative it is possible to retain the United Airlines and Airborne cargo buildings for cargo use, or ultimate redevelopment/enhancement for continued cargo use, since these facility sites are not required for other uses (i.e., ARFF and ATCT). It is thus possible to meet the 2020 requirements for cargo terminals within the existing cargo area and with supplemental facilities at SASA. This also accounts for those cargo facilities relocated for other development (i.e., Northwest, Delta). Development of north remote warehouses would not be required in this alternative and these areas would be available for other support facilities.

Aircraft Maintenance

Airline aircraft maintenance hangars located south of the passenger terminal must be relocated in order to accommodate terminal expansion in this alternative. The timing of relocations is tied to the phasing of terminal improvements. The Northwest hangar would be impacted by the Phase 1 extension of Concourse A. Delta Airlines' hangar would require relocation with the development of the unit terminal in Phase 3 and the Alaska Airlines hangar would have to be relocated to permit the south extension of the south satellite in Phase 4. These facilities are relocated to SASA as seen in Figure 9-1.

Other Airport Facilities

The Airport Rescue and Fire Fighting (ARFF) building will ultimately be relocated in the very long term (Phase 5). This is required in order to accommodate northerly extension of the north satellite. This development would occur on the current leasehold area of the Delta Airlines cargo building.

General aviation facilities are shown in Figure 9-1 as located in SASA. As discussed later in this report, a north field site is also possible. Development of GA facilities at a north field site would be possible for this alternative. Since one of the two GA tenants (Weyerhaeuser) would be impacted by runway development in Phase 1, the immediate need to develop a general aviation area in the first phase is required.

Development of air traffic control facilities in this alternative is shown in the present location of existing facilities atop the passenger terminal. This location has been recommended for further consideration as the ultimate control tower site.

The Northwest flight kitchen would need to be relocated due to the development of the unit terminal in Phase 3. Space would be available to accommodate this displacement north of the airport near the area designated on Figure 9-1 for airport maintenance.

The future airport maintenance facility would be located north of State Highway 518 and east of 24th Avenue South. The present POS Maintenance building in the cargo area would be demolished in Phase 2 in order to develop additional cargo aircraft hardstands, and thus development of replacement airport maintenance facilities would occur in Phase 2. A separate location for the storage of snow equipment is shown in the alternatives near the threshold of Runway 34L. This site was selected to utilize an area that would otherwise not be used. This location offers sufficient area to develop an storage building for the existing 26 vehicles and other equipment in close proximity to the airfield and with employee access. Development of this area could be as early as Phase 1.

An area for ground handling equipment storage and servicing has been identified in SASA. Additional area would be available in SASA for development of additional support or cargo facilities.

Future airport employee parking has been identified for a triangular shaped parcel north of State Highway 518 and west of 24th Avenue South.

NORTH UNIT TERMINAL ALTERNATIVE

Figure 9-2 presents this alternative which combines a north unit passenger terminal with a new 7,500 foot long third parallel runway. With the eventual use of SASA and other airport properties, it is possible to accommodate the requirements for passenger, cargo and support facilities for the year 2020. Key components of the alternative are discussed below.

Airfield

The airfield improvements proposed in this alternative and the phasing are the same as described for the previous alternative except for the following:

- The third runway is 7,500 feet long (versus 7,000 feet in the previous alternative).
- Modifications of Taxiway A would occur in Phase 4 to accommodate expansion planned in this phase for the north satellite.

The displaced threshold of Runway 16L is abandoned and runway safety areas complying with FAA standards are also constructed for Runways 16L and 16R in Phase 1. The latter will require relocation of South 156th Way and 154th Street.

Passenger Terminal

In this alternative, modest expansions of Concourse A and both the north and south satellites occur in the first three phases (Concourse A in Phase 1 and satellite expansion in Phase 2). Major extension of the north satellite occurs in Phase 4 and the ultimate development is reached with the construction of a new north unit terminal in Phase 5. Development of the passenger terminal in a northerly direction minimizes the taking of existing airline maintenance hangars south of the terminal building.

Cargo Terminal Development

While northerly passenger terminal development minimizes impacts on maintenance hangars, it also requires the taking of more existing cargo facilities than the other alternatives. Therefore, the year 2020 cargo terminal requirement is met through buildout of the existing area, development of facilities at SASA, plus construction of a north remote warehouse as shown in Figure 9-2. Development of SASA cargo facilities would occur in Phases 4 and 5, and a remote warehouse would not be required until the end of the planning period in Phase 5.

Aircraft Maintenance

The Northwest hangar would require relocation to SASA in Phase 1 due to the extension of Concourse A. Figure 9-2 indicates additional area set aside for expanded maintenance facilities. Alternatively, this area could be developed for cargo terminal which would obviate the need for a north remote cargo warehouse. The maintenance hangars of Delta and Alaska Airlines are not relocated in this alternative.

Other Airport Facilities

The Airport Rescue and Fire Fighting (ARFF) building will ultimately be relocated in Phase 4 in order to accommodate northerly extension of the north satellite. This development would occur on the current leasehold area of the United Airlines Cargo building.

General aviation facilities are shown in Figure 9-2 as located in SASA as in the previous alternative. A north field site is also possible for this alternative but would require locating airport maintenance near the remote warehouse shown in Figure 9-2.

Development of air traffic control facilities in this alternative is shown north of the Post Office facility and utilizes the site of the existing Airborne cargo building. This development would occur in Phase 1.

The Northwest flight kitchen would need to be relocated due to the ultimate extension of Concourse A in Phase 2. Space would be available to accommodate this displacement north of the State Highway 518 or in SASA. The United flight kitchen may be impacted by road construction associated with the development of the North Unit Terminal in Phase 5, however, it appears that a road alignment that avoids the kitchen is possible.

The future airport maintenance facility is shown for this alternative as a north field location, in between the runway protection zones of the new runway and Runway 16R. The present POS Maintenance building in the cargo area would be demolished in Phase 2 in order to develop additional cargo aircraft hardstands, and thus development of replacement airport maintenance facilities would occur in Phase 2. A separate location for the storage of snow equipment is shown in the alternatives near the threshold of

Runway 34L. Development of this area could be as early as Phase 1.

An area for ground handling equipment storage and servicing has been identified in SASA. Additional area would be available in SASA for development of additional support or cargo facilities.

Future airport employee parking has been identified for a triangular shaped parcel north of State Highway 518 and west of 24th Avenue South.

CENTRAL TERMINAL ALTERNATIVE

Figure 9-3 presents this alternative which combines a central passenger terminal with a new 8,500 foot long third parallel runway. With the eventual use of SASA and other airport properties, it is possible to accommodate the requirements for passenger, cargo and support facilities for the year 2020. Key components of the alternative are discussed below.

Airfield

The airfield improvements proposed in this alternative and the phasing are the same as previously described alternatives except for the following:

- The third runway is 8,500 feet long.
- Modifications of Taxiway A would occur in Phase 5 to accommodate expansion planned in this phase for the North Satellite.
- A dual cross taxiway on the north end providing by-pass capability would be constructed in Phase 5.

The displaced threshold of Runway 16L is abandoned and runway safety areas complying with FAA standards are also constructed for Runways 16L and 16R in Phase 1. The latter will require relocation of South 156th Way and 154th Street.

Passenger Terminal

This alternative would involve significant and ultimate extension Concourse A in Phases 1 and 2. A phased expansion of the main building would occur in Phases 2 and 3, while the satellites would be expanded in Phases 3, 4 and 5.

Cargo Terminal Development

Development of the cargo area would be similar as in other alternatives. The present United Airlines cargo building could be retained for cargo use, however, the Airborne building is utilized for the control tower site. SASA facilities are developed in Phases 4 and 5 and there is no need for remote north warehouses in this alternative.

Aircraft Maintenance

Aircraft maintenance development would be the same as for the South Unit Terminal as relocations of Northwest, Delta and Alaska facilities to SASA would be required. Phasing, however, would be slightly different as Northwest would be relocated in Phase 1, Delta in Phase 2, and Alaska in Phase 4.

Other Airport Facilities

The Airport Rescue and Fire Fighting (ARFF) building will ultimately be relocated in the Phase 5 in order to accommodate northerly extension of the north satellite. This development would occur on the current leasehold area of the Delta Airlines cargo building.

General aviation facilities are shown in Figure 9-3 in a north field location. This development would be required in Phase 1 since Weyerhaeuser would be displaced by construction of the third runway.

Development of air traffic control facilities in this alternative is the same as previously shown for the North Unit Terminal, north of the Post Office facility and utilizes the site of the existing Airborne cargo building. This development would occur in Phase 1. Development of a tower location on the existing terminal building may also be considered for all alternatives.

The Northwest flight kitchen would need to be relocated due to the ultimate extension of Concourse A in Phase 2. Space would be available to accommodate this displacement north of State Highway 518.

The future airport maintenance facility would be located north of State Highway 518 and east of 24th Avenue South. The present POS Maintenance building in the cargo area would be demolished in Phase 2 in order to develop additional cargo aircraft hardstands, and thus development of replacement airport maintenance facilities would occur in Phase 2. A separate location for the storage of snow equipment is shown in the alternatives near the threshold of Runway 34L.

An area for ground handling equipment storage and servicing has been identified in SASA. Additional area would be available in SASA for development of additional support or cargo facilities.

Future airport employee parking has been identified for a triangular shaped parcel north of State Highway 518 and west of 24th Avenue South.

COMPARISON OF ALTERNATIVES

Table 9-1 presents a summary comparison of each of the alternatives with the program requirements for the year 2020.

TABLE 9-1
COMPARISON OF PRELIMINARY MASTER PLAN ALTERNATIVES

FACILITY	1993	PROGRAM 2020	ACTUAL YEAR 2020 CENTRAL	SOUTH	NORTH	REMARKS
Passenger Terminal						
Building Area (SF) Central	2,000,000	2,980,000	3,400,000	N/A	N/A	2,980,000 SF = 2020 req. for Central Alt.
Building Area (SF) So. & No.	2,000,000	3,433,000	N/A	3,900,000	3,700,000	3,433,000 SF = 2020 req. for South. & North Alts.
NBE Gates	89.9	120.6	121.4	121	120.1	
Cargo Area						
Warehouse + Office (SF)	626,366	1,314,000	1,314,000	1,314,000	1,314,000	Off-site = 390,000 SF for Cen. & North Alts.
DC-10 Parking	18	35	33	33	34	
Air Mail Facility						
Site (acres)	9.7	9.7	9.6	9.6	9.7	
General Aviation						
Signature (acres)	2	2	2	2	2	
Weyerhaeuser (acres)	3	3	3	3	3	
Air Traffic Control Tower						
Tower Site (acres)		3	2.4	N/A	2.4	
TRACON Site (acres)		5		Assumed Off-site		
Airport Rescue and Firefighting						
ARFF Site (acres)	2.5	16	3.5	3.5	3.0	Program as requested by POS Fire Dept.
Airline Maintenance						
Alaska Hangar (SF)	144,000	144,000	150,000	150,000	144,000	
Delta Hangar (SF)	82,000	82,000	90,000	90,000	82,000	
Northwest Hangar (SF)	114,000	114,000	120,000	120,000	120,000	
Curb Lengths						
Ticketing Level(LF)	2,560	5,230	4,160	5,120	6,080	
Baggage Level (LF)	3,136	6,272	3,136	4,740	5,056	
Small Transit Vans (LF)	750	1,500	750	1,150	1,950	
Subtotal (LF)	6,446	13,002	8,046	11,010	13,086	
Parking Spaces						
Garage - Short Term	1,000	2,000				
Garage - General Use	7,000	10,750		Distribution to be		2020 Program assumes no policy changes
Garage - Rental Cars	1,000	2,000		Based on Policies		
Garage - Other/Employees	400	100				
Garage - Subtotal	9,400	14,850	14,850	14,850	14,850	Cen. & No. Alts. include 4,500 @ D. Fox
Large Transit	40	80	60	80	80	
Cargo Area	1,173	2,460	1,600	1,460	2,460	
Employee Lot - (North side)	4,500	8,000	8,000	8,000	8,000	Future req'ts. met at new North Remote site.
Off-site parking (Private)	9,500	N/A	N/A	N/A	N/A	

Attachment B
to Port Resolution 3245

TECHNICAL REPORT NO. 8
MASTER PLAN UPDATE FINAL REPORT

AIRPORT MASTER PLAN UPDATE
FOR
SEATTLE - TACOMA INTERNATIONAL AIRPORT

Prepared by:

P&D AVIATION

Prepared for:

The Port of Seattle

JANUARY 1996

The P&D Aviation Team

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Section 1
EXECUTIVE SUMMARY

SECTION 1
EXECUTIVE SUMMARY

This section summarizes the approach and principal findings of the evaluation of Airport Master Plan alternatives and the Master Plan recommendations through the year 2020. This summary is organized according to the remaining technical sections of this report. The following topics are addressed:

- Initial concepts considered for airside, terminal and other facility improvements.
- Selection and evaluation of final Master Plan alternatives.
- Airport development recommendations and policy issues.
- Financial analysis of recommended Master Plan improvements.

CONCEPTS CONSIDERED AND SELECTION OF OPTIONS FOR FINAL EVALUATION (SECTION 3 OF THIS REPORT)

Approach

Under each of the three primary airport functional areas (airside, terminal/access and other functional areas), a number of concepts were initially examined and narrowed to several airside and terminal/access options. These options were evaluated by the consultants and Port of Seattle staff. From these evaluations, the improvement options were refined and "packaged" into three airport development alternatives for further analysis.

Initial Concepts

Airside Concepts. Eight initial airfield concepts were developed and evaluated (a "no airfield improvements" concept and seven improvement concepts). The improvement concepts all contained a new parallel runway with lengths varying from 5,200 feet to 8,500 feet and with separations from the existing Runway 16L-34R of 1,500 feet, 2,500 feet and 3,300 feet. Evaluation criteria for the airfield concepts consisted of aircraft delay measures, development costs, and preliminary environmental screening measures.

When comparing the concepts for a new runway separated 2,500 feet from Runway 16L-34R, delay savings and the percent of operations accommodated were found to increase as runway length increases. The greatest delay savings occur for Airside Concept 5 (a new 8,500 foot runway). When compared to the next best concept (a 7,500 foot runway), it was found that Concept 5 provides additional savings ranging from $1.2 million to $1.5 million. Estimates of delay savings are based upon airfield simulation studies conducted as part of the FAA Capacity Enhancement Task Force. These additional savings coincide with activity levels ranging from 345,000 operations up to a level of 425,000 annual operations. Beyond a level of 425,000 operations, the additional annual savings escalates at a much more rapid rate to over $12 million at an activity level of 525,000 annual aircraft operations. It is important to note that these projections of delay savings calculated by the FAA Task Force reflected a constant aircraft fleet mix. The master plan has assumed a mix containing more and more heavy aircraft over time, as contained in the aviation demand forecasts (Technical Report No. 5). Though the Task Force delay estimates may be somewhat conservative, should additional heavy aircraft enter the fleet mix as forecast, the savings in annual delay would be even greater. For these reasons, Airside Concept 5 was recommended as the preferred airside alternative for ultimate development. However, runway lengths of 7,000 and 7,500 feet were also evaluated in the final alternatives analysis.

Terminal/Access Concepts. Terminal/access development concepts were organized into three general development areas: to the north, south and center of the existing terminal area. Five terminal development concepts for the south site, one for the central location, and four for the north site were investigated. Several derivatives were examined to test slight modifications.

A preliminary evaluation was performed on each of the terminal concepts and the highest scoring option from each group was identified for further refinement and evaluation. These three options were a South Unit Terminal option, in which a new terminal would be constructed south of the existing terminal connected by Concourse A and the Satellite Terminals would be expanded, Central Terminal option in which the main terminal and Satellite Terminals would be expanded, and a North Unit Terminal option in which a new terminal would be constructed north of the existing terminal with extension of the North Satellite. Subsequent analysis recommended the North Unit Terminal concept include two concourses extending perpendicular from the new North Terminal and no Satellite extensions. This effectively reduced costs to be comparable with the Central Terminal option.

Concepts for Other Facilities. The two primary components of other facilities are air cargo and aircraft maintenance facilities. Concepts considered for accommodating future cargo requirements were developing a centralized complex at one location (the South Aviation Support Area or a north site) or a decentralized complex by siting facilities at various locations. It was concluded that accommodating a centralized cargo complex was not feasible given space constraints and a decentralized concept is recommended in which the existing cargo area would be modified and expanded through 2010. After 2010, the cargo facilities can be developed in the South Aviation Support Area (SASA).

Three potential sites were investigated for new airlines facilities and airline aircraft maintenance facilities that would be relocated due to terminal expansion. Of the three locations evaluated, only the SASA site was determined to be feasible. The ultimate redevelopment of certain displaced facilities will depend upon the need as determined by the respective carrier.

Selection of Options for Final Evaluation

A "Do Nothing" and three development options were carried forward for a more detailed assessment in the Airport Master Plan Update and the Draft Environment Impact Statement (EIS) for the Airport Master Plan Update.

- ***Alternative 1, Do Nothing/No Build.*** The Airport Master Plan Update requirements would not be addressed in the Do Nothing alternative.

- ***Alternative 2, Central Terminal (Figure 3-5).*** This alternative would include a new dependent (2,500-foot separation from Runway 16L-34R) parallel runway with a length of up to 8,500 feet; a 600-foot extension to Runway 34R; fill, clearing and grading of the 1,000-foot Runway Safety Areas for all runway ends; and completion of the landside and terminal development for centralized terminal facilities; and completion of the SASA.

- ***Alternative 3, North Unit Terminal (Figure 3-6).*** This alternative would include a new dependent (2,500-foot separation from Runway 16L-34R) parallel runway with a length of up to 8,500 feet; a 600-foot extension to Runway 34R; fill, clearing and grading of the 1,000-foot Runway Safety Areas for all runway ends; and completion of the landside and terminal development in a north unit terminal configuration and completion of the SASA.
- ***Alternative 4, South Unit Terminal (Figure 3-7).*** This alternative would include a new dependent (2,500-foot separation from Runway 16L-34R) parallel runway with a length of up to 8,500 feet; a 600-foot extension to Runway 34R, fill, clearing and grading of the 1,000-foot Runway Safety Areas for all runway ends; and completion of the landside and terminal development in a south unit terminal configuration; and completion of the SASA.

EVALUATION OF FINAL ALTERNATIVES (SECTION 4 OF THIS REPORT)

Section 4 presents the evaluation of alternatives including criteria, methodologies and conclusions. The three final airport development options were evaluated extensively in the Airport Master Plan Update as well as the Draft Environment Impact Statement. The terminal and runway components of the three airport development alternatives were addressed separately because runway options were not tied to terminal options.

Terminal Options Summary

Terminal options were evaluated on 18 factors which covered airline/aircraft operations, passenger and terminal services, ground access, environmental, acquisition and construction costs, and constructability considerations. The North Unit Terminal Option clearly ranked above the South Unit Terminal and Central Terminal Options, particularly with regard to phasing. Although the Central Terminal Option ranked best under three criteria, the North Unit Terminal Option ranked equal or better than the Central Terminal Option in all of the remaining 15 evaluation criteria.

Runway Options Summary

An 8,500 foot runway would be sufficiently long to accommodate 99 percent of all arrivals by the types of aircraft projected for Sea-Tac, and 90 percent of all departures by aircraft types projected for Sea-Tac. These will account for approximately 12 percent of total operations. Furthermore, the pilot rejection rate is expected to be negligible. For these reasons an 8,500-foot runway would provide maximum efficiency in aircraft flow and therefore allow the greatest benefit in minimizing aircraft delays and flexibility in runway use.

Although the 8,500-foot option would be more expensive and have slightly greater environmental impacts than the shorter runway options, the added expense of the 8,500 foot runway could be financially feasible and could offset potentially higher construction costs of an extension at a later date should a shorter runway be initially built. Further, the incremental increase in environmental impacts could be more than offset by aeronautical benefits. A runway length of up to 8,500 feet pending final design is preferred as the ultimate runway development option. It is feasible however to construct a new runway in stages with the first stage being 7,500 feet in length.

AIRPORT DEVELOPMENT RECOMMENDATIONS AND POLICY ISSUES (SECTION 5 OF THIS REPORT)

The North Unit Terminal offers the following advantages over other terminal options:

- Lowest overall cost per new aircraft gate.
- Shorter walking distances from parking areas and curbs to the aircraft gates.
- Adequate curb frontage to meet future traveler demands.
- Relief of vehicle congestion on the existing terminal drives.
- Minimum traffic impacts in the City of Sea-Tac.
- Greater flexibility for aircraft gate and terminal expansion beyond the year 2020.
- Less aircraft taxiing congestion around the terminals.
- Preservation of the Alaska and Delta Airlines maintenance hangars and postponement of the need for full build out of the South Aviation Support Area (SASA) site.
- No impact to City of Sea-Tac tax base by virtue of no additional property acquisition. Impacts on the commercial corner of International Blvd. and South 188th Street.
- Less passenger disruption and inconvenience during construction.

Runway Length Recommendation

An 8,500-foot runway would maximize the operational benefit of having a second poor-weather arrival stream provided by adding a new runway. A runway length of 8,500 feet offers several benefits when compared with the 7,000-foot and 7,500-foot options.

- Sufficient landing length for 99 percent of the types of aircraft anticipated to use Sea-Tac in the future (compared to 96 percent for a 7,500-foot runway and 91 percent for a 7,000-foot runway). This becomes increasingly important because more larger size aircraft will be using Sea-Tac.
- Lesser rejection by pilots opting to use the existing long runway. The Air Transport Association and extensive discussion with airline pilots support an 8,500-foot runway.
- Increased aircraft delay savings potential by accommodating more aircraft types and by reducing air traffic controller work loads associated with pilot rejection and cross over "sorting" associated with different aircraft operational requirements.
- Sufficient departure length for 90 percent of the types of aircraft anticipated to use Sea-Tac in the future (compared to 85 percent for a 7,500-foot runway and 77 percent for a 7,000-foot runway) which provides increased operational flexibility for the overall airfield.
- Provides the highest safety margin during poor weather landings (which is when the runway would be used the most).
- Greater flexibility in aircraft operations if one of the other runways is closed for maintenance or an emergency. Maintenance costs on the existing runways could be reduced by reducing the need for expensive nighttime work as is currently done.
- The additional environmental impacts of an 8,500-foot runway are minimal and can be sufficiently mitigated, as described in the Environmental Impact Statement.

Facility Improvements

The Master Plan Update proposes the following facility improvements:

- A new Runway 16X-34X with an ultimate length up to 8,500 feet pending final design. The runway would be equipped to enable Category IIIb precision approaches on 16X with Cat I capability on 34X. Instrumentation would include a glide slope, localizer, RVRs, PAPI, ALSF-II/ALSF-I, and inner/middle,outer approach markers:
  - Relocation of the Airport Surveillance Radar (ASR) and Airport Surface Detection Equipment (ASDE)
  - Relocation of South 156th Way and 154th Street South
- A midfield overnight aircraft parking apron between the new runway and Runway 16R-34L
- Construction of a new Air Traffic Control Tower and TRACON
- Installation of a Cat III ILS on Runway 16L (localizer, glideslope, middle marker, and ALSF-II)
- Extension of dual parallel Taxiways A and B the full length of Runway 16L-34R and taxiway bridge over 188th Avenue South
- Additional taxiway exits on existing runways
- Extension of Runway 34R by 600 feet and relocation of the glideslope
- Remove displaced threshold from Runway 16L.
- Clearance, grading and development of expanded Runway Safety Areas at each runway end
- Limited expansion of 4-6 gates on Concourse A and the Main Terminal
  - Relocation of Northwest flight kitchen
  - Possible development of displaced Northwest aircraft maintenance facilities in the SASA
  - Development of the by-pass roadway connecting the New North Unit Terminal with 188th Street South at 24th Street
  - Expansion of the Central Parking Garage
  - Development of an On-Airport hotel on Concourse D adjacent to the terminal
- Development of the North Unit Terminal
  - Development of the North Unit Terminal access system
  - Development of access ramps from SR 518 at 20th Avenue for access to the existing cargo area and new cargo facilities
  - Potential overhaul of the Satellite Transit System (currently under separate study)
  - Displacement of the Doug Fox Parking facility
  - Relocation of the U.S. Post Office Air Mail Facility to SASA
  - Relocation of the ARFF to the existing UAL air cargo area

- Potential relocation of Airborne cargo for an alternate site for the construction of the Air Traffic Control facility
- Development of a cargo warehouse north of SR 518 east of 24th Avenue South
- Development of the SASA:
  - If required, relocate Northwest hangar
  - Expansion capacity for cargo/maintenance (as dictated by demand)
  - Cargo facility for 11 hardstand positions
  - Ground support equipment area
  - Replacement Air Mail Facility (as dictated by demand)
- Development of additional airport employee parking north of SR 518 west of 24th Avenue South
- Development of a new airport maintenance facility at Cater Air, or other possible locations in the terminal area
- Development of a new snow equipment storage site between the RPZs of Runways 34L and 34X (subject to a separate study of the feasibility of this site)
- Development of new general and corporate aviation facilities in SASA or alternatively between the RPZs of Runways 16R and 16X (subject to further study)

It is important to note that the ultimate relocation of certain facilities indicated above are somewhat uncertain, and will depend upon the need for the facility as decided by a private company or other agencies.

In addition to the Airport Master Plan improvements, some infrastructure renewal and replacement projects will be needed over the planning period, such as electrical, industrial waste systems and fueling systems. These programs would include maintenance and replacement of existing facilities and would be required regardless of the Master Plan improvements. Both the Master Plan and infrastructure renewal/replacement projects will be subject to the Business Planning and budgeting process in terms of priorities and available dollars. The financial analysis described in this report accounts for the infrastructure renewal/replacement projects which are currently budgeted but these projects are not discussed further in this report.

It is also noteworthy to mention the potential for incorporating commercial development above certain airport facilities recommended in the master plan. There may be potential on top of existing or proposed facilities to develop non-aviation commercial uses. The potential is especially attractive for new facilities where provision for these uses can be incorporated during the design stage. Possible uses would include, but not be limited to, hotels, restaurants, specialty shops, office space, etc. When incorporating such vertical development on the airport obstruction standards contained in FAR Part 77, Objects Affecting Navigable Airspace, must be addressed, as well as TERPS.

Phasing

The development of facility improvements identified in the master plan are expected to be implemented in phases over the planning period. The phasing suggested in the master plan is based on projected traffic levels contained in the forecasts of aviation demand, and attainment of these levels. It cannot be overemphasized that where development is recommended based upon demand or traffic levels, it is ***actual***, not forecast, demand that dictates the timing of construction. However, for planning purposes, a schedule must be provided and this schedule is based upon the forecasts of traffic contained in Technical Report No. 5.

It is also important to point out that the schedule of improvements proposed in this plan is contingent upon the availability of Federal, State, and local funds and private investment. While improvements are scheduled for specific phases in this report, it should be remembered that they must be reconciled with budgetary considerations of various public and private entities. Thus, the implementation will depend upon funding and business planning considerations, as well as the attainment of the projected traffic levels.

The timing of the above described improvements suggested in the master plan is set forth below. As described in the Introduction, the phasing of specific facility improvements is contingent upon further planning by the Port, and the following phasing is presented as a guideline to assist in the financial feasibility analysis. The traffic levels (in million annual passengers) associated with each development phase are indicated in parenthesis.

<u>Phase 1 22 - 24 MAP (1996-2000)</u>

- Airfield
  - Begin construction new 8,500 foot Runway 16X-34X
  - Construct expanded Runway Safety Areas for Runways 16L, 16R, and 34R
  - Construct first phase of RON apron between new runway and Runway 16R-34L
  - Develop dual parallel Taxiways A and B on south end (includes taxiway bridge over 188th Avenue South)
- Buildings and Access
  - Construct new Air Traffic Control Tower and TRACON. (Depending on the site this may require relocation of Airborne Air Freight facilities)
  - Expand Concourse A and Main Terminal
  - Construct additional cargo facilities in existing cargo area
  - Construct new snow equipment storage facility between RPZs of Runways 34L and 34X
  - Construct new general aviation facilities impacted by new runway construction
  - Construct GSE facility
  - Expand existing parking garage
  - Construct access and circulation improvements at the Main Terminal
  - Construct airport employee parking north of SR 518 (to be expanded as required in each subsequent phase)

<u>Phase 2 24 - 27 MAP (2001-2005)</u>

- Airfield
  - Complete construction of Runway 16X-34X
  - Expand RON apron between new runway and Runway 16R-34L

- Buildings and Access
  - Expand Main Terminal at Concourse A
  - Construct site improvements in cargo area
  - Construct new airport maintenance facility
  - Expand existing parking garage
  - Construct access and circulation improvements at Main Terminal

<u>Phase 3 27 - 31 MAP (2006-2010)</u>

- Buildings and Access
  - Construct first phase of North Unit Terminal (terminal and concourse) and parking structure
  - Construct site improvements in cargo area
  - Construct new ARFF facility
  - Construct access and circulation improvements for North Unit Terminal

<u>Phase 4 31 - 34 MAP (2011-2015)</u>

- Airfield
  - Construct exit taxiways on Runway 16L-34R
- Buildings and Access
  - Expand North Unit Terminal (gates on south side of north concourse)
  - Develop cargo apron and other site improvements for cargo in SASA
  - Expand North Unit Terminal parking structure

<u>Phase 5 34 - 38 MAP (2016-2020)</u>

- Airfield
  - Extend Runway 34R and dual parallel taxiway 600 feet
- Buildings and Access
  - Expand North Unit Terminal (gates on north side of north concourse)
  - Expand cargo facilities in SASA
  - Expand North Unit Terminal parking structure

Section 6 of this report describes the 5 lines of business (LOB) that the POS Aviation Division has organized as a result of a recent business planning process conducted by the Port. Each LOB has responsibility over a key operating area, which are identified as Airfield, Terminal, Concessions, Ground Access, and Commercial Properties. It should be noted that the decision to implement recommendations of the master plan will ultimately rest with one of the five LOB. A primary objective of the master planning process is to identify when facilities are required in response to demand levels, and to protect for such development by identifying suitable locations on the airport. The LOB decisions to implement master plan recommendations will consider actual demand as it materializes, and within the context of the policies and goals established for a particular LOB.

FINANCIAL ANALYSES OF RECOMMENDED MASTER PLAN IMPROVEMENTS (SECTION 6 OF THIS REPORT)

Baseline (Demand-Driven) Scenario

A financial analyses was initially prepared for the baseline Airport Master Plan program, in which capital projects are scheduled according to projected activity demand levels developed from the master plan forecast. Funding the baseline program would result in an increase in the airlines' Cost Per Enplanement (CPE). Measured in current dollars the CPE for the baseline program in the year 2000 would reach $11.53, compared with the current Port of Seattle policy of $7.35.

Financially Constrained Scenario

Although there is adequate financial capacity to fund the Master Plan improvements, much of the capacity is in the later years of the planning horizon. The implication of this analyses is that mechanisms are available that could reduce the costs of the program and the CPE for the airlines. A number of strategies were suggested and analyzed to reduce the CPE to the target level of $7.35. These included program cost reductions, changes in program phasing, non-airline revenue enhancements, and non-traditional financing mechanisms such as private sector investment.

Combining some of these strategies could provide a scenario that fits within the Port's general financial objectives. One such financially constrained scenario was evaluated, reflecting the following changes: deferring half of the Phase 1 (through the year 2000) airline capital costs into the second phase, providing parking facilities based on an accelerated development schedule, and assuming the maximum use of outside financing. The financially constrained scenario reduces the CPE in the year 2000 to $7.50, higher than the Port policy target by fifteen cents. The analyses shows that the Master Plan program can be developed within the financial constraints of the Port of Seattle by adopting policies to further defer costs or reduce costs.

In actuality, the Port recently adopted a Business Plan which has already made many of the adjustments discussed above. With those adjustments, the Port's target of a $7.35 CPE has been met.

In addition, airline (passenger and cargo) requirements are driven by forecast levels of demand measured against general planning parameters and levels of service. The degree and timing of physical development will ultimately depend on actual demand levels, the nature of a particular airline's operation, the ability and/or willingness of an airline(s) to financially support the development and actual levels of service.

CONTENTS OF THIS REPORT

This report documents the evaluation of airport master plan alternatives and presents recommendations for facility improvements to the year 2020.

- Section 1 Executive Summary
- Section 2 Introduction
- Section 3 Concepts Considered and Selection of Options for Final Evaluation
- Section 4 Evaluation of Final Alternatives
- Section 5 Airport Development Recommendations and Policy Issues
- Section 6 Financial Analysis of Recommended Master Plan Improvements

Section 2
INTRODUCTION

SECTION 2
INTRODUCTION

BACKGROUND

The population of the Puget Sound region is growing at twice the U.S. average. Governments through the region are anticipating that growth, and plans for new highway construction, rail transportation, and urban boundaries are just a few of the programs that have demanded their attention over the past several years.

Seattle-Tacoma International Airport, which is owned and operated by the Port of Seattle, is no exception. Since 1989, local governments from throughout the region have been involved in evaluating Sea-Tac's ability to accommodate regional growth.

In 1993, elected officials from the four counties surrounding Puget Sound, an organization called the Puget Sound Regional Council (PSRC), completed an extensive assessment of the region's airports. This work resulted in two major conclusions:

- The Port of Seattle should plan for, and evaluate the environmental effects of, adding a third runway and other improvements to serve regional transportation needs at Sea-Tac Airport.
- At the same time, the regional governments should continue to look for an area where a major supplemental airport could be built.

In accordance with the regional decision, the Port of Seattle began two major planning efforts in late 1993: a Master Plan Update, and in conjunction with the FAA, an Environmental Impact Statement. Final decisions resulting from these studies will be made by Port of Seattle Commissioners and the FAA. This report documents the principal findings of the Airport Master Plan Update.

Airport Master Plan Update

The Sea-Tac Airport Master Plan Update is a comprehensive planning study that will determine how Sea-Tac can best accommodate the growing number of passengers and air cargo volumes. The Master Plan has been designed to answer the following kinds of questions:

- What is the projected passenger growth at Sea-Tac? How much has traffic grown, and what changes can we anticipate for the future?
- What can be done to alleviate the aircraft delays that occur now during bad weather?
- How can the airport remain user friendly? What needs to be done to keep it as easy as possible for passengers to get in, park and get to their airline gate?
- Is there a need for a new runway? If so, how long should it be and where should it be located?
- As the number of passengers increases, what needs to be done to handle roadway congestion? What terminal expansion is needed?
- Would high-speed trains make a difference in airline travel?
- How can the aircraft using the airport be managed in a way that reduces the need for new construction? Will regulating the time

of day during which planes can take off and land--"demand management"--work?

Master Planning Approach and Concepts

There were a number of important concepts that were fundamental to the master planning approach:

- The proposed Master Plan makes maximum use of existing facilities.
- Facility improvements are designed to be consistent with the Airport Business Plan and provide for the enhancement of airport revenues.
- Future airport facility improvements will be timed and sized according to aviation demand based on future demographics and economics of the Region.
- Consistency with other Local and Regional plans will be pursued, such as plans by the City of SeaTac, King County and the Puget Sound Regional Council.
- The Airport Master Plan contains a layout plan of all recommended new facilities. This layout, especially with respect to the North Unit Terminal improvements and the South Airport Support Area (SASA), is conceptual and subject to further refinement in subsequent planning and design efforts.
- The phasing of future improvements described in the Master Plan is subject to further refinement and modification. For example, the phasing of new terminal facilities could be revised upon further study to begin with a new North Unit Terminal, rather than deferring that development until after the existing terminal is expanded. Any new airport development will be triggered by need (such as passenger or aircraft operations growth) rather than fixed time periods.

Planning Process

This report, Technical Report No. 8, one of a series of reports prepared as part of the Master Plan Update, discusses this evaluation procedure and describes the recommended Master Plan improvements. A listing of all technical reports prepared during the Master Plan Update Study appears later in this section. Technical Report No. 8 documents the final planning analyses including refinements to recommendations of previous technical reports.

The process by which various development alternatives at Sea-Tac were evaluated consisted of examining concepts for improvements to each functional area of the airport, combining the best features of the concepts to form several options for the development of the entire airport, then evaluating these airport-wide alternatives as a whole. Three airport functional areas were considered in the initial concept analysis:

- Airside, including the evaluation of a third runway, other runway improvements, taxiway improvements, safety area improvements, and navigational aids (described in Technical Report No. 6, <u>Airside Options Evaluation</u>, September 19, 1994).
- Terminal and access, including improvements to the existing terminal, terminal expansion and new terminals, expansion of aircraft parking apron, vehicle circulation, airport access improvements, and vehicle parking (described in Technical Report No. 7A, <u>Terminal Options Evaluation</u>, February 17, 1995).
- Other airport facilities, including air cargo, aircraft maintenance facilities, airport

rescue and fire fighting, general aviation, air traffic control tower, airport maintenance and administration, and other airport tenant areas (described in Technical Report No. 7B, Other Facilities Requirements and Options, February 24, 1995).

Requirements for the three airport functional areas were developed. Options for each element which would satisfy the established requirements to varying degrees were prepared and evaluated. From these evaluations, three composite Master Plan alternatives were developed and evaluated according to a range of aviation, environmental and economic criteria. From this evaluation, a recommended master plan of development was prepared. A financial analysis of the Master Plan considered development priorities and a recommended phasing of projects resulted.

PROJECT OBJECTIVES

The overall objective of the Master Plan Update Study is to "prepare a comprehensive Airport Master Plan [Update] for the airside, terminal, and landside facilities needed at Sea-Tac to meet air travel demand to the year 2020 and beyond." Specifically, the Airport Master Plan Update and related studies have fulfilled the relevant objectives stated in Port Resolution 3125. Citations of objectives from this resolution with an explanation of how each has been addressed in the Airport Master Plan Update are as follows:

- *Design a mechanism and process to promote [land use and community] compatibility through improved coordination, communication and involvement.* An extensive public involvement program was developed for the Airport Master Plan Update to allow participation of the public in the planning process. Elements of the public involvement program included 11 public workshops and meetings, public opinion surveys, telephone hotline, E-mail service and dissemination of project findings through newsletters and technical reports. Also included were meetings with technical committees, the Planners Forum, and various airline committees and briefings of elected officials and local community groups. A separate, but similar public process was conducted as part of the EIS in accordance with NEPA and SEPA requirements.

- *In addition to the third runway studies, include a reconsideration of a fast rail system together with diversion of all cargo carriers.* The potential diversion of Sea-Tac passengers to high-speed rail service was studied and documented in the following Airport Master Plan Update report: Potential diversion of Sea-Tac Airport Passengers to High Speed Ground Transportation, November 4, 1994. The study concluded that, at most, 4.3 percent of Sea-Tac aircraft operations in 2020 could be eliminated due to passengers using a high-speed rail system if it were available connecting Sea-Tac with Vancouver, B.C., Portland, Oregon and Spokane, Washington. Diversion of cargo carriers to another airport was determined to be infeasible because much of the air cargo at Sea-Tac is shipped by carriers (Alaska Airlines and Northwest Airlines) which ship their cargo on passenger and combi flights as well as all-cargo flights. Furthermore, eliminating cargo flights would have little effect on airfield delays at Sea-Tac because cargo flights operate less frequently during the peak hours.

- *Fully explore the impacts of peak period pricing and other demand management techniques.* Peak period pricing and other passenger demand management approaches available to the Port of Seattle were thoroughly investigated and documented in two Airport Master Plan Update reports: Preliminary Report on Demand Management to the Puget Sound Regional Council Expert Arbitration Panel, November 30, 1994 and Information on Demand/System Management Issues Requested by the Puget Sound Regional Council Expert Panel, April 13, 1995. These studies concluded that peak period pricing or other demand management techniques would not significantly redistribute or reduce passenger demand to effectively reduce the airfield capacity shortfall and aircraft operating delays. These conclusions were discussed in two public hearings convened by the Puget Sound Regional Council's Expert Panel and were accepted by the Expert Panel.

- *Explore land acquisition and redevelopment to compatible uses.* The Port of Seattle currently owns about 800 acres of land around the Airport which does not have direct access to the airfield. Much of this property can be redeveloped and the Port is actively pursuing development in compatible uses. For example, the Port and the City of Des Moines are currently pursuing development of the Des Moines Creek Technology Campus, a business park, on 90 acres of Port property in the City of Des Moines.

- *Attenuate airport noise through the use of berms and barriers.* Pending the final outcomes of the Master Plan Update and the Environmental Impact Statement on the update, the Draft Ground Noise Study (February 1994) conducted by the Port recommends further evaluation of the noise reduction benefits by installing berms on the western boundary of the airport. In addition, the Airport Master Plan EIS found that future noise exposure with the recommended Master Plan improvements will be less than the current noise exposure. This decline is expected due to the Port's noise reduction program and the federal mandate to phase out Stage 2 aircraft no later than the year 2003.

  Nevertheless, measures now in effect to reduce aircraft noise within the community will be continued in an effort to assure the minimization, to the extent practical, of existing and future noise levels. The measures in effect to the year 2000 include:

  - Noise Budget - limiting the total noise energy carriers may generate at the airport until the fleet is substantially at Stage 3.

  - Nighttime Limitations Program - limiting the hours of operation for Stage 2 aircraft.

  Ongoing programs include:

  - Pilot Program for Schools - soundproofing school buildings.

  - Ground Noise Control - reducing the noise of ground events such as powerback operations and run-ups.

  - Flight Corridorization - maintenance of runway heading flight tracks by departing jets until reaching specified altitudes.

  - Flight Track and Noise Monitoring - maintenance of records of noise levels and flight track location information for identification of deviations and communication with public and users.

- *Promote aggressive on-airport emission reductions.* The Port of Seattle is committed to reducing air pollutant levels by reducing emissions from various sources at the Airport. A number of on-going considerations have focused on reducing the number of vehicles accessing the airport by providing alternatives to single-occupancy vehicles. Other actions have addressed motor vehicle idling along the terminal curbfront. Airport staff rigorously monitor access by taxis, limousines and buses and idling within the terminal area.

The Port of Seattle supports a commuter trip reduction strategy which has several components: employee shuttle bus service to remote public and employee parking to reduce vehicle trips in the terminal area; support for the regional light-rail transit system; and limiting passenger drop-off and pickup and vehicle idling at the terminal through vigorous enforcement and by successfully providing short-term parking alternatives (i.e., metered short-term public parking within the terminal area).

- *Promote regional transit and reduction in use of automobiles.* The proposed Airport Master Plan improvements promote regional transit by providing additional transit plazas (for buses) at the terminals and allowing for a new regional transportation terminal (for rail transit station) adjacent to the Central Parking Structure. Transportation demand management strategies could reduce both employee and private passenger vehicular traffic by up to 20 percent. Employee trips can be reduced by peak pricing, car pooling programs, and ridesharing incentives. Vehicular traffic can be reduced by park-and-fly lots, congestion pricing, and improved transit services. Travel demand management was investigated in detail as part of the study and was documented in a report titled, Seattle-Tacoma International Airport Master Plan International Boulevard Access Study and Travel Demand Management Mitigation Policies.

- *Improve the aesthetic appearance of the airport boundary.* The Airport Master Plan Update includes an analysis of ways to improve the aesthetic appearance of the airport boundary. The plan, provides various landscape environments around the airport which reflect the variety of settings in the Region and State and assesses aesthetic improvements to the airport perimeter. These improvements are discussed in Assessment and Development of Aesthetic Improvements to the Airport Perimeter.

- *Develop a comprehensive stormwater management plan.* A comprehensive stormwater management plan is currently being prepared by the Port. A draft stormwater master plan report is under preparation. The sizing of facilities took into account facility requirements of the Master Plan Update. Implementation of the plan will follow.

SCOPE OF STUDY, SCHEDULE AND DOCUMENTATION

The Airport Master Plan Update began in December 1993 and is scheduled to be completed in January 1996.

The primary issues addressed in the scope of work include:

- ***Forecasts.*** The master plan update and related Environmental Impact Statement and FAA Part 150 Study must be based on a reliable and generally accepted set of forecasts.

- ***Airside Evaluations.*** An important component of the study is the analysis of a new dependent parallel (minimum runway separation of 2,500 feet) runway. The Airspace Update Study and the FAA

Airport Capacity Enhancement Task Force both determined that a substantial capacity improvement can be achieved by constructing a new parallel dependent runway.

- ***Terminal Evaluations.*** A key issue in the terminal development is to achieve a balance between added terminal capacity and additions to airside and landside capacity. Curb frontage, roadway and automobile parking are critical components.

- ***Multi-Modal Evaluations.*** There is considerable interest at the federal, State and local levels of government to develop inter-modal transportation systems that are economically efficient and improve air quality.

- ***Financial Planning.*** A comprehensive financial plan and implementation strategy must be developed to maximize the Port's ability to fund needed capital improvement projects.

- ***Part 150 Issues.*** The Sea-Tac Airport Noise Mediation Agreement resulted in substantial noise reduction programs, now being implemented. This agreement plays a vital role in existing and future planning efforts at the airport and has been incorporated into the recently completed FAR Part 150 Study 1993 Amendments. However, those amendments did not consider the implementation of a third runway, and thus the Noise Exposure Maps that were generated in the study will be updated to consider the third runway option.

- ***Public Involvement Process.*** Public involvement in the planning process is an important element of the Airport Master Plan Update. The public involvement program developed for the study allows for better understanding of the sentiments in the surrounding communities and constructively involves the public in focused workshops for the project. Elements of the public involvement program include workshops, public opinion surveys, and dissemination of project information through newsletters and technical reports prepared during the study.

The following documents have been produced during the course of the project:

- Technical Report No. 1, Final Work Scope

- Technical Report No. 2A, Market Research Results which presented results of research conducted to help determine issues, define key publics and clarify citizens opinions.

- Technical Report No. 2B, Public Involvement Program Development Report, which set out a community involvement program for the master plan program.

- Technical Report No. 3, Planning History and Study Relationships which summarized recent planning studies related to Sea-Tac Airport and surrounding communities.

- Technical Report No. 4, Facilities Inventory, which documented the extent of existing airport facilities.

- Technical Report 4A, Ground Access Update integrated the previous traffic and parking studies using updated data on ground transportation. It also described the recalibration effort of simulation modelling and the resulting simulation of future traffic conditions under the different terminal development options.

- Technical Report No. 5A, Preliminary Forecast Report, which presented the final projections of aviation demand as accepted by the FAA.

- Technical Report No. 5, Final Forecast Report, which presented final aviation and ground traffic forecasts.

- Technical Report No. 6, Airside Options Evaluation, which addressed various runway configurations for increasing airfield capacity along with other airside improvements to maximize airfield efficiency.

- Technical Report No. 7A, Terminal Options Evaluation, which documented an analysis of future passenger terminal configurations to meet program requirements as determined by projected demand.

- Technical Report No. 7B, Other Facilities Requirements and Options, which addressed the needs for other facilities such as cargo, airline maintenance, general aviation, etc.

- Demand Management Report which provided responses to issues raised by an Expert Panel on Noise and Demand/System Management Issues.

- Airport Parking Systems - Long-Range Analysis which assessed existing parking facilities and long-range auto parking requirements.

- International Boulevard Access Study and Travel Demand Management Mitigation Policies examined ways to minimize future traffic deficiencies along International Boulevard (State Route 99) including traffic control measures and travel demand management measures.

- Preliminary Traffic Study compared future terminal development options against the do-nothing alternative in terms of levels of service on airport roads.

- Technical Report 8, Master Plan Update Final Report (this report).

The following documents remain to be completed at the time of printing this report.

- Airport Layout Plan Set
- Aesthetics Paper
- Summary Brochure

PLANNING TEAM COMPOSITION

The Master Planning Team led by P&D Aviation consists of ten firms which are listed below with their key responsibilities:

- ***P&D Aviation*** - Project Management, Forecasts and Facility Requirements, Airside Planning, Ground Access Planning, Overall Airport Master Planning and Coordination

- ***O'Neill & Company*** - Public Involvement

- ***Parsons Brinckerhoff*** - Multi-Modal Evaluations

- ***Thompson Consultants International*** - Terminal Planning

- ***Barnard Dunkelberg & Company*** - Part 150 Integration and Community Planning

- ***Berk & Associates*** - Financial Planning

- ***Murase Associates*** - Airport Beautification, Landscape Architecture

- ***Mestre Greve Associates*** - Aircraft Noise Impacts

- ***Landrum & Brown*** - Passenger Terminal Concepts

- ***Claire Barrett & Associates*** - Demand Management

Section 3
CONCEPTS CONSIDERED AND SELECTION OF OPTIONS FOR FINAL EVALUATION

SECTION 3
CONCEPTS CONSIDERED AND SELECTION OF ALTERNATIVES FOR FINAL EVALUATION

APPROACH

Under each of the three primary airport elements (airside, terminal/access and other functional areas), a number of alternative concepts were examined. These were evaluated by the consultants and Port staff with input from both the public involvement process and the Technical Advisory Committee. From these evaluations three airport development options were developed for further analysis. This approach is described below.

Airport Elements Addressed

Potential Airport Master Plan improvement concepts were considered in three functional areas:

- Airside concepts, including the evaluation of a third runway, other existing runway improvements, taxiway improvements, safety area improvements, and navigational aids.
- Terminal/access concepts, including improvements to the existing terminal, terminal expansion and new terminals, expansion of aircraft parking apron, vehicle circulation, airport access improvements, and vehicle parking.
- Concepts for the development of other functional elements, including air cargo, aircraft maintenance facilities, airport rescue and fire fighting, general and corporate aviation, air traffic control tower, airport maintenance and administration, and other airport tenant areas.

A large number of concepts were initially examined for each of these elements. Passenger terminal requirements drove the development of plans for other facilities such as cargo and maintenance. Concepts were chosen to address the range of feasible expansion possibilities. Although the concepts were structured to satisfy the projected airport demand to 2020, they did so with varying degrees of effectiveness.

Methodology for Analyzing Concepts

Concepts for each element were evaluated according to applicable criteria. Airside concepts considered such factors as percent of aircraft operations accommodated by runway length, pilot preference, airfield operations delays, construction costs, aircraft noise impacts, wetlands impacts, earthwork impacts and displacement of homes and other properties. The terminal/access concept evaluation addressed such issues as capacity, flexibility, accessibility, maneuverability, balance, convenience and construction cost. The evaluation of other facility concepts considered functional relationships, access, availability of aircraft parking, impact on other facilities and phasing.

The concept evaluations included technical analysis by the consultant team as well as evaluation by Port staff. An Airport Master Plan Technical Work Group facilitated the Port staff evaluations. Furthermore, meetings were held to discuss the concepts with the FAA, surrounding cities, Puget Sound Regional Council, Washington State Department of Transportation, the Airline Technical Committee and the public. Technical reports were prepared at each stage of the planning process, as described in Section 1. Coordination with various concerns included the following:

- Technical Advisory Committee with over 40 representatives including FAA, WSDOT, PSRC, PSAPCA, local jurisdictions, ACC, and RCAA.
- Various airline committees including Airfield Advisory Subcommittee, Airline Airport Affairs Committee, Airline Technical Committee and a Special Master Plan Subcommittee designated by AAAC.
- Local jurisdictions through the Planners Forum.
- Series of public involvement workshops (Sea-Tac University).
- Also reports, available through local libraries with E-Mail and hotline for comments.

The best features of each concept were chosen and combined to form three airport-wide development options for final evaluation: North Unit Terminal Alternative, Central Terminal Alternative and South Unit Terminal Alternative.

INITIAL CONCEPTS

Airside Concepts

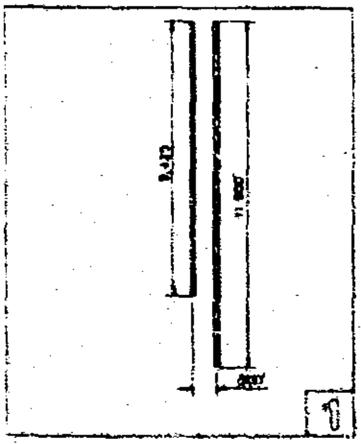
A detailed discussion of airside concepts is contained in Technical Report No. 6, Airside Options Evaluation, September 19, 1994. The description and evaluation of these concepts are summarized below.

Description of Initial Airside Concepts. Eight initial airfield concepts were developed and evaluated (a no-airfield-improvement concept and seven improvement concepts). All seven improvement concepts include an extension of Runway 34R from 11,900 to 12,500 feet (takeoff length), additional taxiway exits, dual parallel Taxiways A and B along the full length of Runway 16L-34R, and extensions of the Runway Safety Areas for Runway 16L, 16R and 34R. Seven options for a new runway were evaluated. These options are illustrated schematically in Figure 3-1 and summarized below:

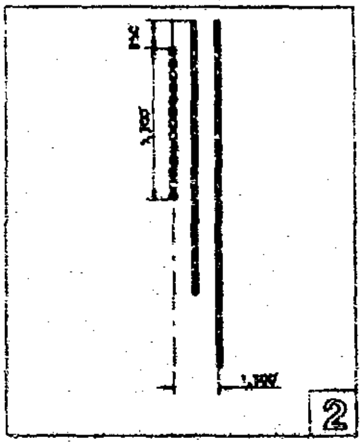
- ***Airside Concept 1: Existing Airfield.*** Under this concept, no improvements would be made to the airfield beyond those already underway (new taxiways). This "do nothing" concept is included in the analysis of alternatives to estimate the likely effects (for example, additional aircraft delays) of not providing additional airfield capacity. It provides a benchmark by which the other options are measured.

- ***Airside Concept 2: Commuter-Close.*** Under Airside Concept 2, a new 5,200 foot long by 100 foot wide commuter runway would be constructed 1,500 feet west of Runway 16L-34R. The new runway would serve primarily commuter and general aviation operations. However, it would be capable of accommodating landings and some departures by Airplane Design Group III Aircraft which include small air carrier jets such as the B737 and MD80. The north threshold of the new runway would be 950 feet south of the existing north runway ends.

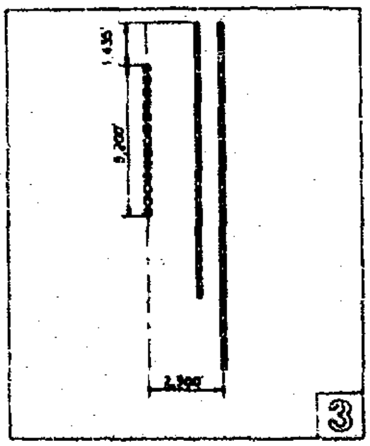
  Airside Concept 2 represents the lowest cost approach of all concepts considered. There would be no relocation of adjacent roadways (other than airport service roads) and safety area standards at the north ends of the runways would be met by relocating the north thresholds of Runway 16L-34R 300 feet to



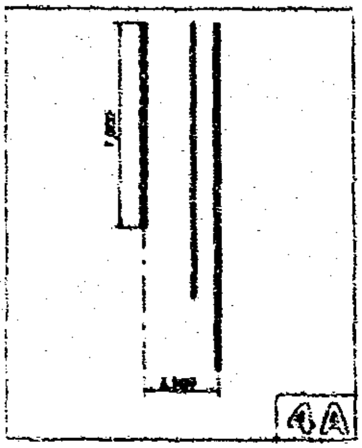
Option1 Existing Conditions



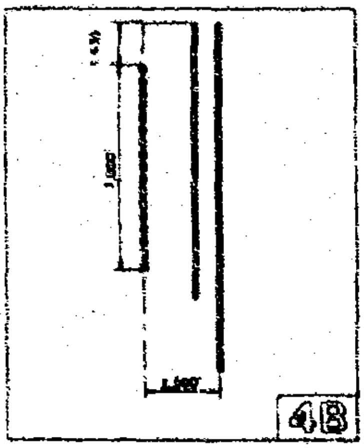
Option 2 Commuter -- Close



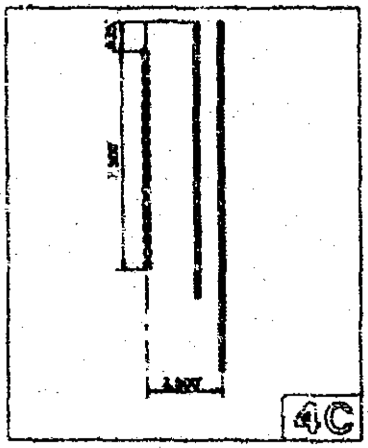
Option 3 Commuter -- Dependent



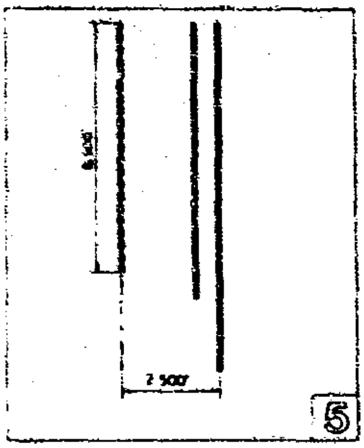
Option 4A Programatic Baseline



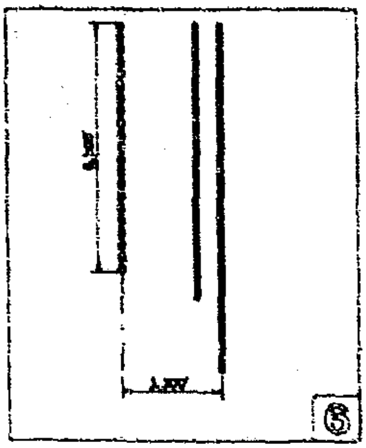
Option 4B Programatic Baseline -- Staggered



Option 4C Staggered 7,500 - Foot Runway



Option 5 Dependent -- Maximum Length



Option 6 Independent -- Maximum Length

Existing Runway

Proposed Runway (to be revised)

Figure 3-1

THIRD RUNWAY OPTIONS

the south and Runway 16R-34L 325 feet to the south. This would result in the shortening of Runway 16R-34L to 9,100 feet. Under this concept, Runway 16L-34R would be lengthened to the south to obtain a runway length of 12,500 feet.

Under Airside Concept 2 the separation between the runways would not permit an additional IFR arrival stream. The new runway would be used primarily for VFR traffic conditions.

- ***Airside Concept 3: Commuter Dependant.*** Airfield improvements under Airside Concept 3 would be similar to Airside Concept 2, with the exception that the new commuter runway would be 2,500 feet west of Runway 16L-34R. This greater separation would allow for two arrival streams under IFR conditions. The greater runway separation would also allow for an aircraft parking area to be located between Runway 16R-34L and the new runway. This area would be used to park aircraft which remain overnight at the airport or which must be temporarily parked for maintenance reasons. The north threshold of the new runway would be located 1,435 feet south of the north ends of the existing runways.

  The runway configuration permits the use of two IFR arrival streams and therefore the new runway would function in an IFR capacity. It is assumed for purposes of this comparison that a Category I ILS system would be installed on both ends of the new runway under this option.

- ***Airside Concept 4A: Programmatic Baseline.*** With Airside Concept 4A, a new 7,000 foot by 150 foot runway would be constructed 2,500 feet west of Runway 16L-34R (this is the baseline runway length and alignment considered for air carrier operations in the Programmatic EIS for the Sea-Tac Flight Plan Project in the early 1990s). The north end of the new runway would be aligned with the north ends of the existing runways. South 154th Street and South 150th Way would be relocated to the north around the new and existing runways. Because the roads would be relocated, the north thresholds of the existing runways would not need to be relocated to provide Runway Safety Areas meeting FAA criteria as with Airside Concept 4B. Therefore, Runway 16R-34L could be maintained at its present 9,425 foot length. Runway 16L-34R would be extended 600 feet to the south to achieve an overall length of 12,500 feet.

  The runway configuration permits parallel (staggered) ILS approaches. To provide maximum IFR benefits, each end of the new runway would be equipped for precision instrument approaches. If a third runway is added it is proposed to ultimately equip Runway 16L for Category IIIb approaches. As adequate separation will exist between it and the new runway to permit dual arrival streams, it is recommended that the new runway also be equipped for Category IIIb approaches from the north. This will permit parallel Category IIIb ILS approaches and thus enhance capacity during periods of extremely low visibility. In the interim, use of Runway 16R as the Category IIIb runway can continue until such time that demand indicates the need for dual, low visibility arrival streams.

- ***Airside Concept 4B: Programmatic Baseline Staggered.*** Airside Concept 4B is similar to Airside Concept 4A, except the north threshold of the new runway would be staggered approximately 1,435 feet to the south to eliminate the need to relocate South

156th Way and to reduce the fill requirements at the north end of the runway. The terrain at the north end of the new runway drops steeply to the north and offsetting the new runway to the south would substantially reduce the amount of fill material required and the construction cost. Under this option, the relocation of South 154th Street as well as South 156th Way would not be necessary to accommodate the new runway.

Accordingly, the north thresholds of the existing runways would be relocated to provide Runway Safety Areas (RSAs) and Runway Object Free Areas (ROFAs) which meet FAA standards. Note that a 7,000 foot runway is approximately the longest runway which can be accommodated at this separation without relocating existing public roadways to achieve RSA and ROFA standards. The new runway would be equipped with a Category IIIb precision instrument landing system at the north end, as in Airside Concept 4A.

- ***Airside Concept 4C: Staggered 7,500-foot Runway.*** Under this option, the new runway would be 7,500 feet long. This length was chosen to provide an option in which the runway length would be between that of Airside Concepts 4A/4B and Airside Concept 5 and accommodate at least 95 percent of the aircraft types projected to be using the airport in 2020. To allow the necessary RSA and ROFA at the south end of the new runway, it could be staggered at most about 935 feet to the south of the existing runway thresholds. For this reason, South 156th Way would need to be relocated to the north to accommodate the RSA and ROFA at the north end of the new runway. In other respects, this concept is similar to Airside Concept 4B.

- ***Airside Concept 5: Dependent-Maximum Length.*** Airside Concept 5 includes the construction of a new 8,500 foot by 150 foot runway, 2,500 feet west of Runway 16L-34R. The north end of this runway would be in alignment with the north ends of the existing runways. South 154th Street and South 156th Way would be relocated to the north as in Airside Concept 4A. With the north threshold of the new runway located as described above, 8,500 feet is the maximum length obtainable to comply with RSA and ROFA standards without major highway relocations.

  Because dual arrival streams are possible, the navaids described for Airside Concepts 4A and 4B are applicable to this concept. Therefore, the north end of the new runway would be capable of Category IIIb approaches.

- ***Airside Concept 6: Independent-Maximum Length.*** In Airside Concept 6, a new 8,500 foot by 150 foot runway would be constructed 3,300 feet west of Runway 16L-34R. Due to the greater separation of the new runway from the existing runways under this option, extensive road relocations would be necessary. In addition to the relocation of South 156th Way and South 154th Street, approximately one mile of State Route 509 and one mile of Des Moines Way would have to be relocated. The relocations would include the 2-level interchange between State Route 509 and Des Moines Way.

  In addition, this option would require greater property acquisition and the relocation of many more homes and businesses than under the other options.

The advantage of Airside Concept 6 is that the two outboard runways would be separated by 3,300 feet, which in the future will presumably permit simultaneously independent ILS approaches. Furthermore, it would provide for dual dependent IFR arrival streams on the two westerly runways, leaving the long runway, Runway 16L-34R, available for departures. Thus, this concept has the greatest capacity for handling air traffic under IFR conditions and would result in fewer aircraft operational delays than the other options. Navaids for Airside Concept 6 would be the same as those for Airside Concepts 3 through 5, Category IIIb approaches for south flow operating conditions.

Effects of Runway Stagger. In some options, certain types of operations on a runway may be limited by the fact that the runway thresholds are staggered. This pertains to parallel runways separated by 2,500 feet. In these cases the following should be noted.

Simultaneous radar controlled approaches and departures on parallel runways require 2,500 foot runway separation when the runways are not staggered. When thresholds are staggered, the separation may increase or decrease depending on the threshold locations and amount of stagger.

- When thresholds are staggered and the approach is to the near threshold, the 2,500 foot separation may be reduced by 100 feet for each 500 feet of stagger.
- When thresholds are staggered and the approach is to the far threshold, the minimum 2,500 foot separation requires an increase of 100 feet for each 500 feet of stagger.

This should not be confused with parallel ILS approaches which requires a minimum of 2,500 feet separation regardless of stagger. However, parallel ILS approaches are not simultaneous, but are termed "staggered approach" since the aircraft are separated diagonally while on the ILS localizer centerline.

Evaluation of Initial Airside Concepts. Evaluation criteria for the airfield concepts consisted of aircraft delay measures, development costs and environmental screening measures. A summary of the evaluation of airside concepts appears in Table 3-1.

Measurement of aircraft delays was accomplished using the Federal Aviation Administration's Airport and Airspace Simulation Model (SIMMOD). This model is a sophisticated computer simulation which realistically simulates the movement of every aircraft for a given runway option. The model produces quantitative measures of aircraft air arrival delays, departure delays, and ground taxi delays.

Development cost estimates were prepared based on information contained in the first draft of the <u>Preliminary Engineering Report</u> prepared by HNTB and dated March 31, 1994 and on land acquisition costs described by Landrum and Brown in a memorandum dated September 1994. To the extent possible, the same assumptions and unit cost data have been used as described in the <u>Preliminary Engineering Report</u>.

A preliminary evaluation (screening) of the environmental impacts of each of the airside options was conducted by the EIS consultant team. The purpose of this analysis was to allow environmental impacts to be considered early in the airside evaluation process and prior to the formulation of the EIS alternatives.

TABLE 3-1
EVALUATION SUMMARY
OF MASTER PLAN UPDATE AIRSIDE CONCEPTS

	Master Plan Update Airside Concepts [a]							
	1	2	3	4A	4B	4C	5	6
Percentage of Aircraft Operations Accommodated and Aircraft Operations Delays								
Percentage of Aircraft Operations Capable of Using this Runway Length, Year 2020								
Takeoffs	--	32	32	77	77	85	90	90
Landings	--	31	31	91	91	96	99	99
Annual Delay Savings, Year 2015 [b]								
Hours (Thousands)	0	10	55	118	118	123	130	130
Dollars (Millions)	0	21	116	246	246	258	270	270
Average Delay, 2015 (Minutes per Operation)	22	20.6	14.2	5.4	5.4	4.6	3.8	3.8
Preliminary Development Cost Estimates (Millions of 1994 Dollars) [c]								
Construction	--	79	255	347	279	294	364	596
Property Acquisition and Relocation	--	0	42	64	69	75	91	177
Total (Including 15% Contingency)	--	91	341	473	401	425	524	889
Environmental Effects (d)								
Noise: Impacted Area in Year 2020 (sq. mi.)								
65 DNL and Greater	7.45	[e]	7.51	7.67	[e]	7.65	7.84	8.13
60-65 DNL	10.12	[e]	10.05	10.06	[e]	10.09	10.08	10.17
Noise: Population Impacts in Year 2020								
65 DNL and Greater	12,800	[e]	13,050	13,450	[e]	13,380	14,030	15,040
60-65 DNL	40,820	[e]	40,440	40,700	[e]	40,770	40,760	41,030
Noise: Housing Impacts in Year 2020								
65 DNL and Greater	5,390	[e]	5,480	5,650	[e]	5,630	5,870	6,360
60-65 DNL	17,910	[e]	17,690	17,870	[e]	17,900	17,920	17,980
Air Inventory (Tons per Day in Year 2020)								
Carbon Monoxide	13.86	[e]	10.18	6.82	[e]	6.82	5.86	4.86
Nitrogen Oxides	6.82	[e]	6.49	6.19	[e]	6.19	6.11	6.07
Particulate Matter (PM10)	0.00	[e]	0.00	0.00	[e]	0.00	0.00	0.00
Sulfur Oxides	0.33	[e]	0.28	0.23	[e]	0.23	0.22	0.20
Wetland Impacts (acres)	0	[e]	4.2	5.4	[e]	5.0	5.4	27.7
100-Year Floodplain Impacts (acres)	0	[e]	1	7	[e]	2	7	30
Stream Relocation (linear feet)	0	[e]	2,760	2,970	[e]	2,760	2,970	12,240
Earth Impacts (million cubic yards)	0	[e]	12	17	[e]	13	17	28
Construction Impact (Units Displaced)								
Properties	0	[e]	330	410	[e]	400	420	700
Homes	0	[e]	260	330	[e]	300	320	500
Parks	0	[e]	0	0	[e]	0	0	1
Historic/Cultural sites	0	[e]	1	1	[e]	1	1	3
Schools	0	[e]	0	0	[e]	0	0	1

TABLE 3-1
EVALUATION SUMMARY
OF MASTER PLAN UPDATE AIRSIDE CONCEPTS

	Master Plan Update Airside Concepts [a]							
	1	2	3	4A	4B	4C	5	6
Noise Impacted (65+ DNL) in Year 2020 [f]								
Parks	6	[e]	6	6	[e]	6	6	6
Historic/Cultural sites	3	[e]	3	4	[e]	4	4	5
Churches	13	[e]	13	13	[e]	13	13	15
Hospitals/Nursing homes	0	[e]	0	0	[e]	0	0	0
Libraries	1	[e]	1	1	[e]	1	1	1
Schools	8	[e]	9	8	[e]	8	8	8

[a] Airside Concept 1 - Do-Nothing (assumes existing distribution of traffic)
Airside Concept 2 - Commuter-Close (New 5,200 foot long new runway located 1,500 feet west of Runway 16L/34R)
Airside Concept 3 - Commuter Dependent (New 5,200 foot long new runway located 2,500 feet west of Runway 16L/34R)
Airside Concept 4A - Programmatic Baseline (New 7,000 ft long runway located 2,500 feet west of Runway 16L/34R)
Airside Concept 4B - Programmatic Baseline Staggered (New 7,000 ft long runway located 2,500 feet west of Runway 16L/34R, north end of new runway south of existing)
Airside Concept 4C - 7,500 ft Staggered (New 7,500 ft long runway located 2,500 feet west of Runway 16L/34R, north end of new runway south of existing)
Airside Concept 5 - Dependent Maximum Length (New 8,500 ft long runway located 2,500 feet west of Runway 16L/34R)
Airside Concept 6 - Independent Maximum Length (New 8,500 ft long runway located 3,300 feet west of Runway 16L/34R)

[b] Annual delay savings compared with "do-nothing" delays in the year 2015. Source: Technical Report No. 6, Airside Options Evaluation, September 19, 1994.

[c] Source: Technical Report No. 6, Airside Options Evaluation, September 19, 1994.

[d] Sources: Landrum & Brown, Shapiro & Associates, and Gambrell Urban, as reported in Technical Report No. 6, Airside Options Evaluation, September 19, 1994. Population and dwelling based on 1990 census. Impacts presented for the preliminary airside options were updated in the Draft Environmental Impact Statement for the Airport Master Plan. Table 4-2 provides updated information for the three final runway options. Based on the Draft EIS by Landrum and Brown released in April, 1995.

[e] Data not available.

[f] Noise impacted noise sensitive facilities noted above do not include the units displaced by construction.

Selection of Airside Concepts for Further Consideration. As can be seen in Table 3-1, the increases in delay savings are not necessarily proportional with the increases in construction and acquisition costs. For example a two thirds increase in construction and acquisition costs in Airside Concept 6 when compared to Concept 5 yields no delay improvement until demand exceeds 425,000 operations (about the year 2015).

Current research and advancements in technology suggest separation requirements for independent approaches will continue to be reduced. It is conceivable that, at some time in the future, independent approaches will be possible to runways separated by 2,500 feet (Airside Concepts 3, 4A, 4B, 4C and 5). Selection of Airside Concept 6 with its greater costs and environmental impacts was therefore not recommended.

Although Airside Concepts 2 and 3 are the least costly of the new runway alternatives and create the least impacts, these options provide a much lower amount of delay reduction when compared to the options with at least 7,000 feet of runway length. The lower benefits of these options is caused by the limited usage of the 5,200-foot long runway. Currently only about one third of the aircraft in the Sea-Tac fleet could use this shorter runway length for landings and departures. In the future this segment of the Sea-Tac aircraft fleet is projected to decrease. Therefore, due to the limited ability to reduce future delays, Airside Concepts 2 and 3 were not recommended.

When comparing the concepts for a new runway separated 2,500 feet from Runway 16L-34R, delay savings and the percent of operations accommodated were found to increase as runway length increases. The greatest delay savings occur for Airside Concept 5 (a new 8,500 foot runway). When compared to the next best concept (a 7,500 foot runway), it was found that Concept 5 provides additional savings ranging from $1.2 million to $1.5 million. Estimates of delay savings are based upon airfield simulation studies calculated as part of the FAA Capacity Enhancement Task Force. These additional savings coincide with activity levels ranging from 345,000 operations up to a level of 425,000 annual operations. Beyond a level of 425,000 operations, the additional annual savings escalates at a much more rapid rate to over $12 million at an activity level of 525,000 annual aircraft operations. It is important to note that these projections of delay savings calculated by the FAA Task Force reflected a constant aircraft fleet mix. The master plan has assumed a mix containing more and more heavy aircraft over time, as contained in the aviation demand forecasts (Technical Report No. 5). Though the Task Force delay estimates may be somewhat conservative, should additional heavy aircraft enter the fleet mix as forecast, the savings in annual delay would be even greater. For these reasons, Airside Concept 5 was recommended as the preferred operational alternative for ultimate development.

Specific benefits resulting from the selection of Airside Concept 5 would be as follows:

Aircraft delays would be reduced to the lowest levels for demand expected through the year 2015.

Fewer aircraft would be restricted from using the runway due to landing and takeoff length limitations.

All aircraft using a longer new runway would have greater takeoff/stopping distance available.

An 8,500-foot runway length would provide a greater measure of usefulness in that it could accommodate heavy jet aircraft when one of the existing runways is closed for maintenance or emergency.

Although Airside Concept 5 is preferred, it was concluded that the Master Plan analysis should continue to consider the options of runway lengths of 7,000 feet (Airside Concept 4B) and 7,500 feet (Airside Concept 4C) into the final phase of alternatives analysis.

Terminal/Access Concepts

Terminal/access concepts were discussed in Technical Report No. 7A, Terminal Options Evaluation, February 17, 1995. The description and evaluation of these concepts is described below.

Description of Initial Terminal/Access Concepts. By the year 2020 the existing terminal facilities will need to be expanded by up to 1.9 million square feet of new terminal area to support the forecast level of activity. Ten terminal concepts for providing this degree of expansion were developed for initial evaluation.

Both the landside and the terminal airside (i.e., apron area) compatibility issues have a material impact upon the direction that future terminal development could take. As a starting point, a number of terminal apron-area concepts were developed and reviewed. These apron-area concepts outlined the gate development opportunities of a future parallel east taxiway and considered the preservation, partial, and complete replacement of some existing terminal gate facilities. The result of this review was the development of a series of planning assumptions and the organization of terminal concepts into three general development areas to the north, south and center of the existing terminal area.

The site to the south of the main terminal is the largest in terms of total area of the three terminal development areas investigated. The site itself is as deep as the entire existing terminal complex and offers the greatest expansion potential of any option. A number of airline maintenance areas would likely require removal or relocation under most of these development concepts. In addition, the commercial area immediately to the southeast of Concourse A would need to be acquired to provide sufficient area to complete the terminal landside development. South access to the airport needs to be considered in any of these concepts. Five terminal development concepts for the south side site were investigated.

The site to the east of the existing main parking structure offers the most central location for supplementary landside facilities. Because of its limited size and configuration, only one option for this site was investigated.

A site to the north of existing terminal offers a smaller, but in some ways less constrained location than the south for the development of an expanded terminal/landside interface. This location would provide greater proximity to the main airport entrance, and could be developed without additional property acquisition. Complete development in this area would, however, require the relocation of a significant number of facilities including the main airport entrance road, the airport fire-fighting and rescue (ARFF) facility, the U.S. Postal Service (USPS) facility and a number of cargo and flight kitchen facilities prior to construction of the north unit terminal. Four concepts were investigated for this location.

A brief description of each of the terminal/access concepts follows:

- ***Terminal Concept A-1: A South Expansion of the Main Terminal.*** This concept proposes to expand the main terminal to the south in an alignment with existing Concourse A. The South Satellite and Concourse A would be further extended and modified to provide additional aircraft parking capacity. A new underground pedestrian connector would be provided between Concourse A and the South Satellite to provide a supplemental means of access between these two buildings.

The scheme provides direct road access to the south of the existing terminal for connection to a future SR509 or South 188th Street. Regional rail transit can be accommodated but would require a connection to the main terminal.

- ***Terminal Concept A-2: A Second Unit Terminal to the South.*** This concept differs from Terminal Concept A-1 in two important aspects. First, it proposes a separate, but connected, terminal unit to the south of the main terminal. Secondly, it could have a separate access roadway system to the south which bypasses the main terminal roadways and links the new terminal to the primary terminal area access road to the north. This separate roadway access minimizes airport vehicular congestion by distributing traffic between the two separate terminal systems.

- ***Terminal Concept A-2-1: A Southside Unit Terminal with Modified Expanded Satellites Airside.*** From the landside standpoint, this concept is similar to Terminal Concept A-2, with the exception of the alignment of the bypass roadway, and the location of the future regional rail station. Like Terminal Concept A-2 the new unit terminal is physically linked to the existing main terminal by an expanded and refurbished Concourse A. However, the new unit terminal is served by a separate bypass access road from the north and separate curbs and parking facilities. The regional rail station would be integrated into this new terminal. Again, better south access with improved roadways are proposed.

  From the airside the terminal concept would be dramatically different from Terminal Concept A-2 in that Concourses B and C, and most of the North and South Satellites, would be demolished and replaced by expanded satellites on the north and south sides of the existing terminal. This major modification enables the creation of dual Group V (B747) taxilanes the length of the terminal area, and conceptually provides unlimited flexibility in gate use through the terminal area.

- ***Terminal Concept A-2-2: A Southside Unit Terminal with Reverse Roadway Flow.*** From an airside standpoint, Terminal Concept A-2-2 is identical to Terminal Concept A-2; existing satellites are expanded, Concourses B and C remain in place, frontal gates are provided along an expanded Concourse A with a new southside unit terminal.

  From a landside standpoint, Terminal Concept A-2-2 differs substantially from Terminal Concept A-2 in that the unit terminal and parking area would be separated by the roadway from the extension to Concourse A. This requires that vehicular traffic flow clockwise around the terminal building (operationally similar to Terminal 4 at Phoenix Sky Harbor International Airport) in order to permit vehicles to drop off passengers from the right side of the vehicle.

- ***Terminal Concept A-3: A Unit Terminal Along South 188th Street.*** This concept is similar to Terminal Concept A-2 in that it proposes a separate, but linked, unit terminal to be built south of the existing main terminal. Terminal Concept A-3 also would include a separate roadway bypass and parking facility and an extension of the existing STS shuttle. Terminal Concept A-3 differs from Terminal Concept A-2 in that the new terminal would be separated from the existing main terminal by a considerable distance (approximately 1,800 ft. separation for Terminal Concept A-3 versus approximately 800 ft. separation for Terminal Concept A-2). A regional rail station would be placed between the existing and new terminals.

The physical orientation of the terminal also differs from Terminal Concept A-2 in that its landside would be oriented east-west along South 188th Street. This orientation results in a somewhat limited terminal and curb length, sub-standard roadway curves, and a constrained parking facility compared to other concepts.

- ***Terminal Concept B: A Centrally Located Transportation Distribution Center.*** Concept B proposes that a Transportation Distribution Center be developed on a site immediately east of the existing main parking structure. This facility could accommodate regional rail access as well as provide supplemental curb frontage for high occupancy vehicles, busses, or other types of vehicles designated by the Port of Seattle, which might otherwise congest the main terminal curbfront. Because of the distances involved, the Transportation Distribution Center would need to be connected directly to the existing main terminal and potentially to the satellites via a people mover and some form of baggage handling system. This system might require the use of portions of one or more floors of the existing parking structure as a right of way.

- ***Terminal Concept C-1: Unit Terminal North of the Existing Terminal.*** Terminal Concept C-1 defines a simple unit terminal with frontal gates north of the existing North Satellite. The site available for such a facility is relatively narrow, and in its present form could require that the main access road into Sea-Tac from the north be relocated eastward in order to provide sufficient parking facilities in proximity to the terminal.

  Because its ultimate airside capacity would be limited to a fraction of that provided by a South Unit Terminal, overall airport gate requirements would need to be supplemented by the expansion of either the South Satellite or Concourse A.

- ***Terminal Concept C-2: Unit Terminal North of the Existing Terminal.*** Terminal Concept C-2 is similar to Terminal Concept C-1 but maintains the airport access road in its current location. Because the remaining site available for such a facility is relatively narrow, it would require development of automobile parking facilities to the east of the main north terminal access road to Sea-Tac. On-grade parking facilities already occupy some of the site, although these might need to be converted to structural parking, and would be connected to the new North Unit Terminal by either bridges or tunnels several hundred feet long.

- ***Terminal Concept C-3: Unit Terminal North of the Existing Terminal.*** Like Terminal Concepts C-1 and C-2 the main feature of Terminal Concept C-3 is a north-side unit terminal. This unit terminal is not physically linked to the existing main terminal except through an extension of the existing STS shuttle. Like Terminal Concepts C-1 and C-2, Terminal

Concept C-3 has an independent landside circulation and parking system tied into the northside airport access system which would be relocated to accommodate the modified terminal configuration. The key difference in Terminal Concept C-3 is the exploration of the double-sided airside concourse and the resulting site requirements.

- ***Terminal Concept C-4: Unit Terminal North of the Existing Terminal.*** Terminal Concept C-4 is a variation of Terminal Concept C-3 as a northside unit terminal not physically linked to the existing main terminal at Sea-Tac except by an extension of the existing STS shuttle. Its landside circulation and parking system would also be completely independent of the existing main terminal. Terminal Concept C-4 differs from Terminal Concept C-3 in that it requires an even deeper site (requiring further property acquisition) but provides an expanded airside capacity providing additional frontal gates and lends itself to a conventional terminal arrangement similar to that which already exists at Sea-Tac.

Evaluation of Initial Terminal/Access Concepts. To narrow the terminal development concepts to a manageable and reasonable number, sixteen evaluation criteria were established. These criteria were separated into landside, terminal, airside, and cost categories. The evaluation criteria used in comparing and evaluating the terminal concepts are shown in Table 3-2.

Perhaps the single most important factor to emerge during the evaluation process was the need to incorporate flexibility and adaptability to change as operational requirements at Sea-Tac continue to evolve in the future. In addition to operational flexibility, the need to provide for incremental growth in the terminal is important and to accomplish this the terminal should be designed to accommodate a wide range of aircraft types and sizes in the future. Finally, the potential for future enhancement of the architectural character of the airport as the major international and domestic gateway to the northwestern United States was an important point of consideration.

Selection of Terminal/Access Concepts for Further Consideration. The preliminary evaluation process was performed on each of the terminal concepts, and the three highest scoring development scenarios from each group were identified for further refinement and evaluation. In this refinement process, the North Unit Terminal concept was modified to include two concourses from the new north terminal rather than northerly extension of the North Satellite. These revisions were made to provide additional gate positions at the North Unit Terminal and relieve potential apron congestion resulting from long taxilanes. Selected conceptual terminal development scenarios are presented as Figures 3-2 to 3-4.

The three shortlisted concepts for the Sea-Tac Master Plan Update reflect a number of options which may be appropriate to meet differing operational scenarios which develop in the future. These options are not necessarily mutually exclusive of one another, and may be combined as functional requirements continue to evolve. For example, development of terminal facilities to the north should not necessarily preclude the development of terminal facilities to the south should this prove practical or desirable for additional capacity or functional improvement.

Concepts for Other Facilities

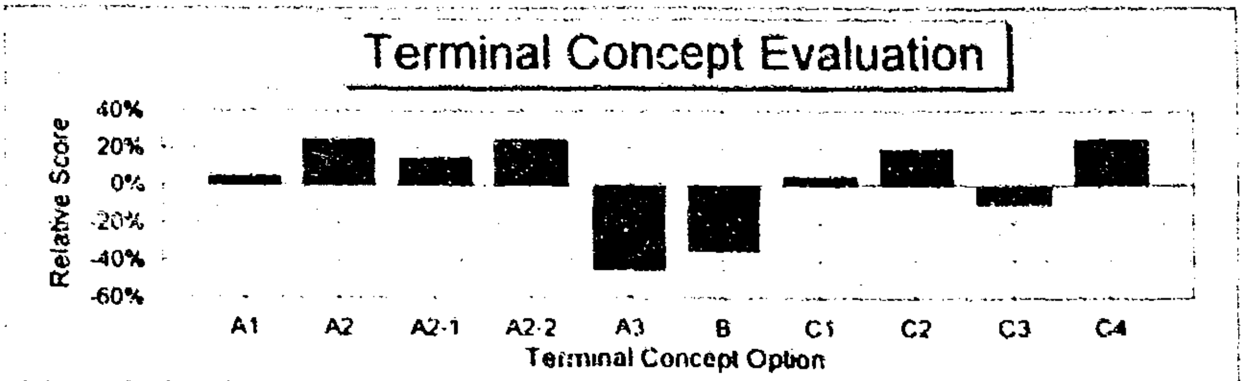
Concepts for other facilities were discussed in Technical Report No. 7B, Other Facilities

Table 3-2

Terminal Concept Evaluation Matrix

Evaluation Criteria	Weight	A1	A2	A2-1	A2-2	A3	B	C1	C2	C3	C4
		Conceptual Options									
Airside (Aircraft Gates)											
Capacity	10%	1	0	(1)	1	0	1	(1)	(1)	0	1
Flexibility	5%	0	0	1	0	0	0	0	0	1	1
Access	5%	0	0	1	0	1	0	1	1	1	1
Maneuverability	5%	0	1	1	1	(1)	(1)	1	1	1	1
Raw Sub-Total	**25%**	1	1	2	2	0	0	1	1	3	4
Weighted Sub-Total		10%	5%	5%	15%	0%	5%	0%	0%	15%	25%
Terminal											
Balance	5%	(1)	1	1	1	(1)	(1)	0	0	0	1
Capacity	5%	(1)	0	0	0	(1)	(1)	1	1	0	0
Convenience	5%	0	1	1	1	0	(1)	0	0	(1)	1
Constructability	5%	0	(1)	(1)	(1)	0	(1)	1	1	(1)	(1)
Flexibility	5%	(1)	1	1	1	1	(1)	0	0	(1)	0
Raw Sub-Total	**25%**	(3)	2	2	2	(1)	(5)	2	2	(3)	1
Weighted Sub-Total		-15%	10%	10%	10%	-5%	-25%	10%	10%	-15%	5%
Landside (Roads + Parking)											
Capacity	10%	(1)	1	1	1	0	(1)	1	1	1	1
Simplicity	5%	1	0	0	(1)	(1)	(1)	0	0	(1)	0
Constructability	5%	0	(1)	(1)	(1)	(1)	0	0	1	(1)	(1)
Compatibility	5%	0	0	0	(1)	(1)	(1)	1	1	1	1
Raw Sub-Total	**25%**	0	0	0	(2)	(3)	(3)	2	3	0	1
Weighted Sub-Total		-5%	5%	5%	-5%	-15%	-20%	15%	20%	5%	10%
Cost											
New Construction	10%	1	0	(1)	0	(1)	1	(1)	0	0	0
Special Systems	10%	0	1	1	1	(1)	(1)	(1)	(1)	(1)	(1)
Facility Relocations	5%	1	(1)	(1)	(1)	(1)	1	0	0	(1)	(1)
Raw Sub-Total	**25%**	2	0	(1)	0	(3)	1	(2)	(1)	(2)	(2)
Weighted Sub-Total		15%	5%	-5%	5%	-25%	5%	-20%	-10%	-15%	-15%
Raw Total	**100%**	0	3	3	2	(7)	(7)	3	5	(2)	4
Weighted Total		5%	25%	15%	25%	-45%	-35%	5%	20%	-10%	25%

Key: 1 = Positive Influence, 0 = Neutral, -1 = Negative Influence



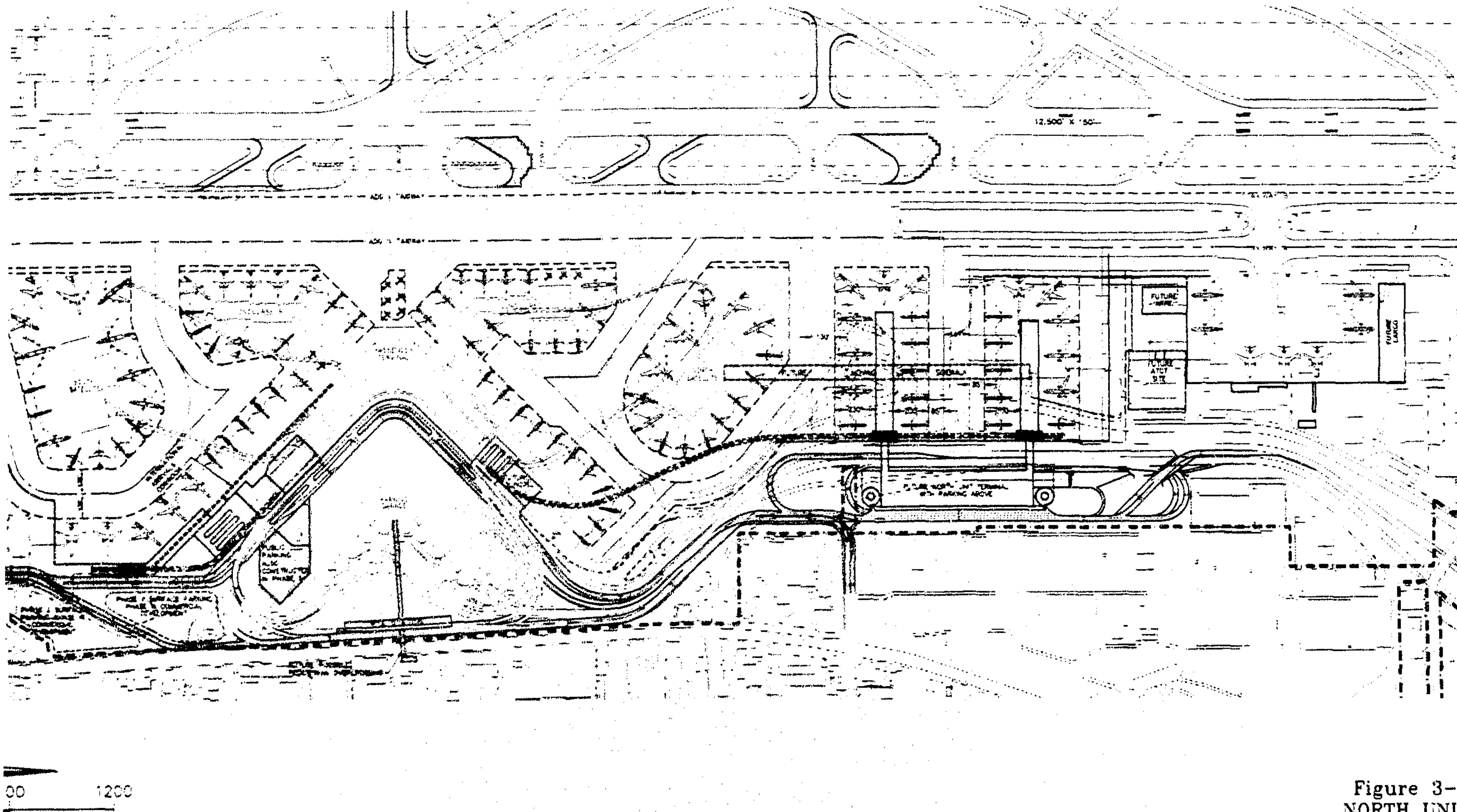
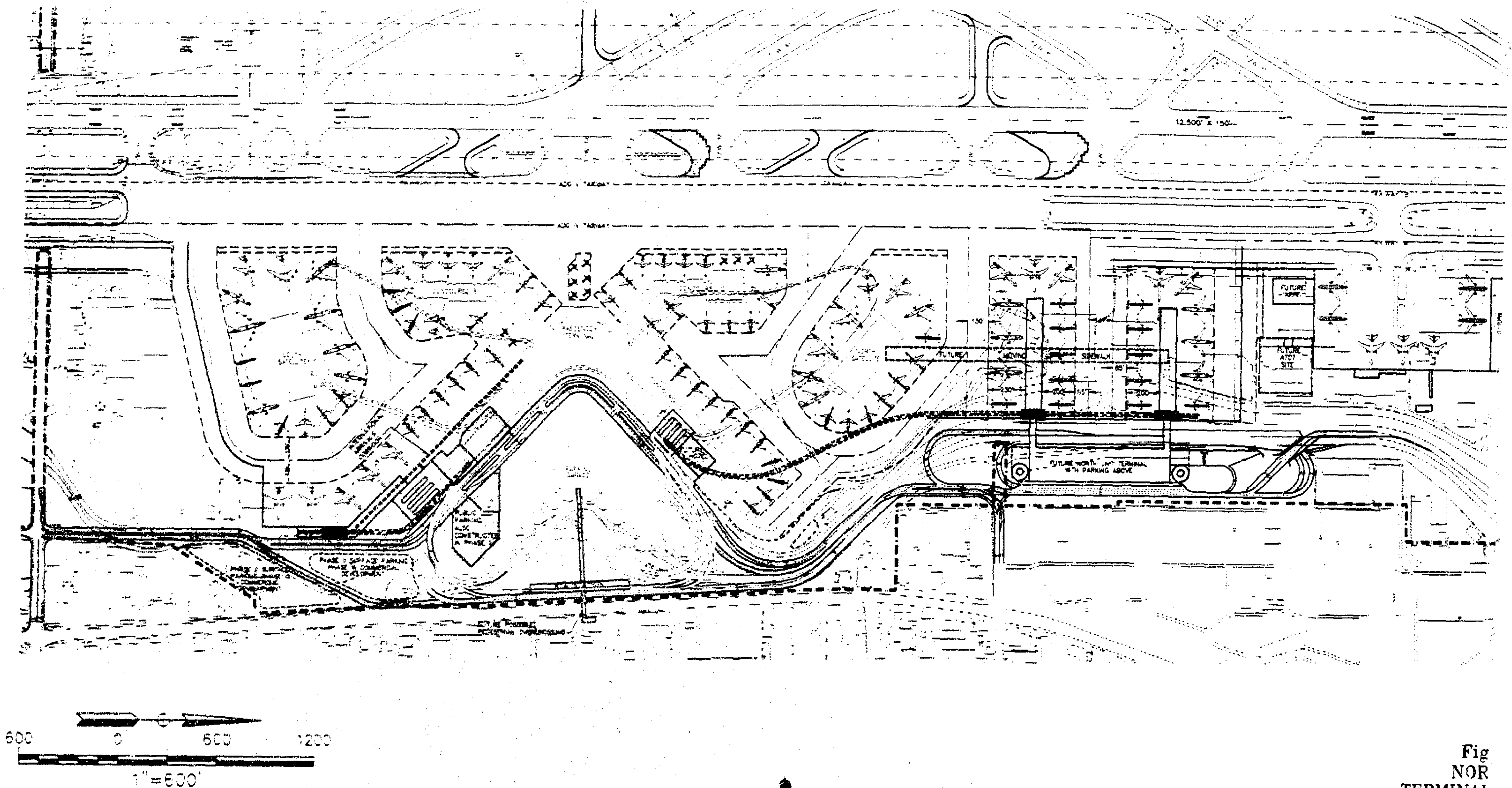


Figure 3-2
NORTH UNIT
TERMINAL OPTION



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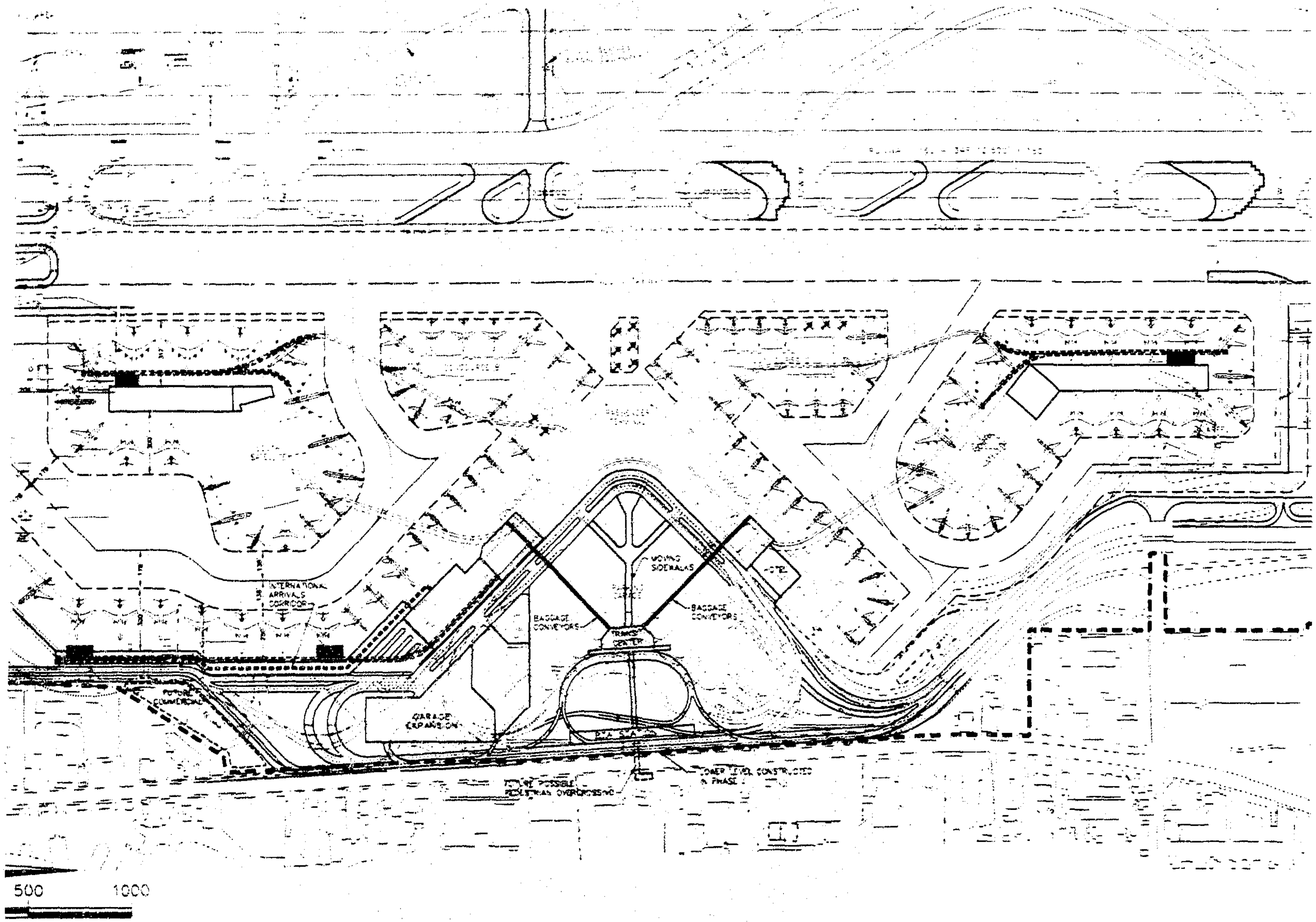
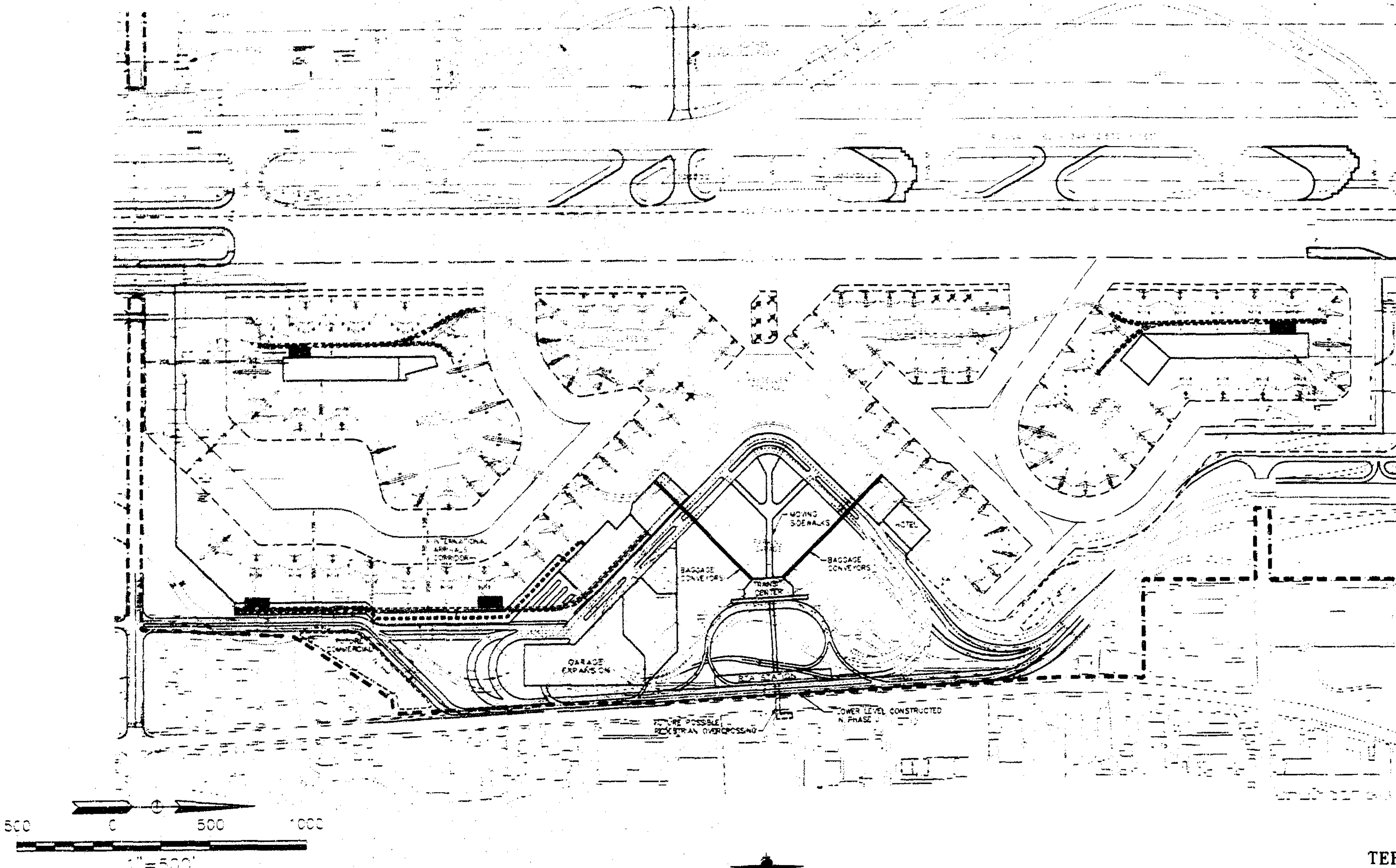


Figure 3–3
CENTRAL
TERMINAL OPTION



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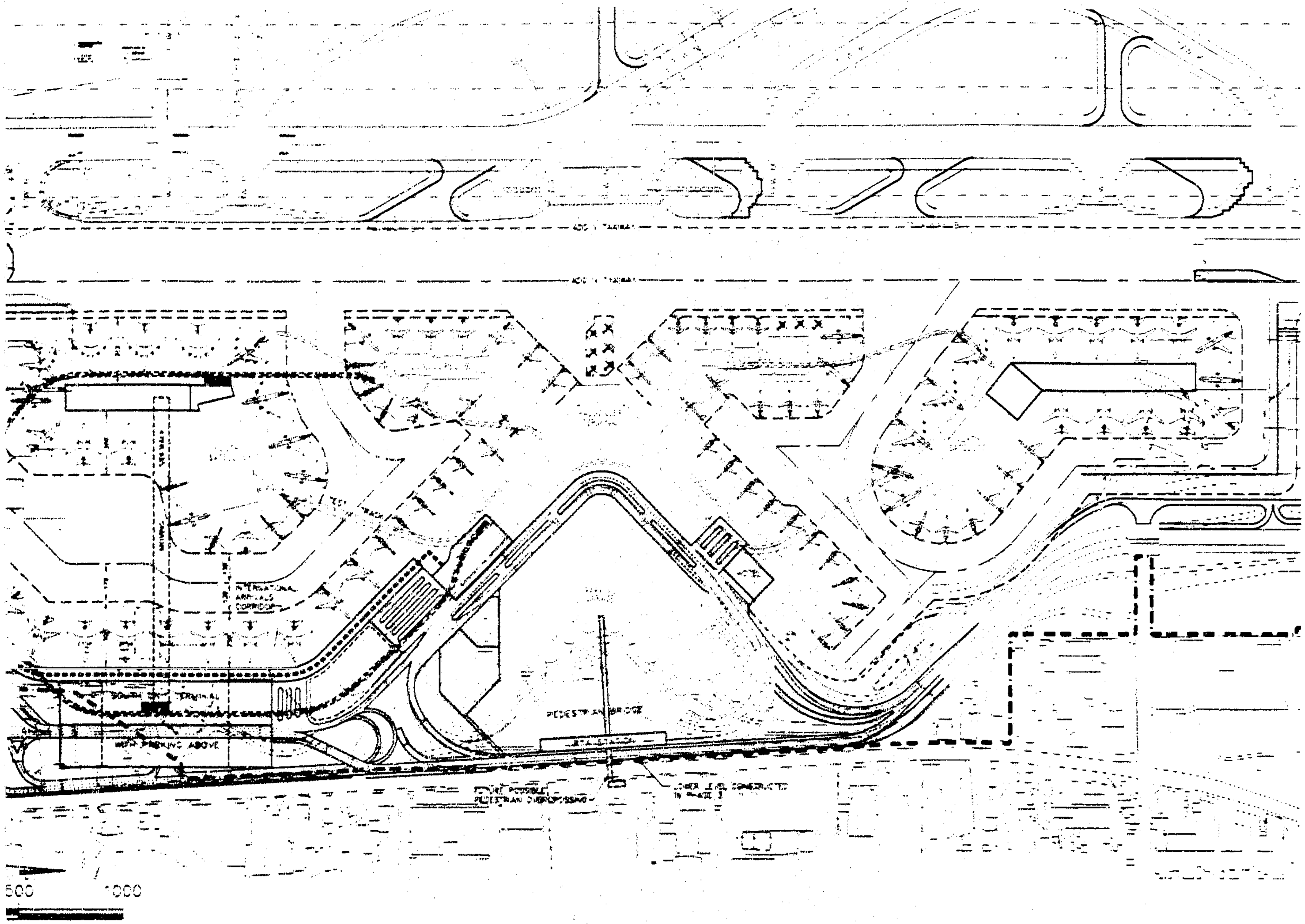
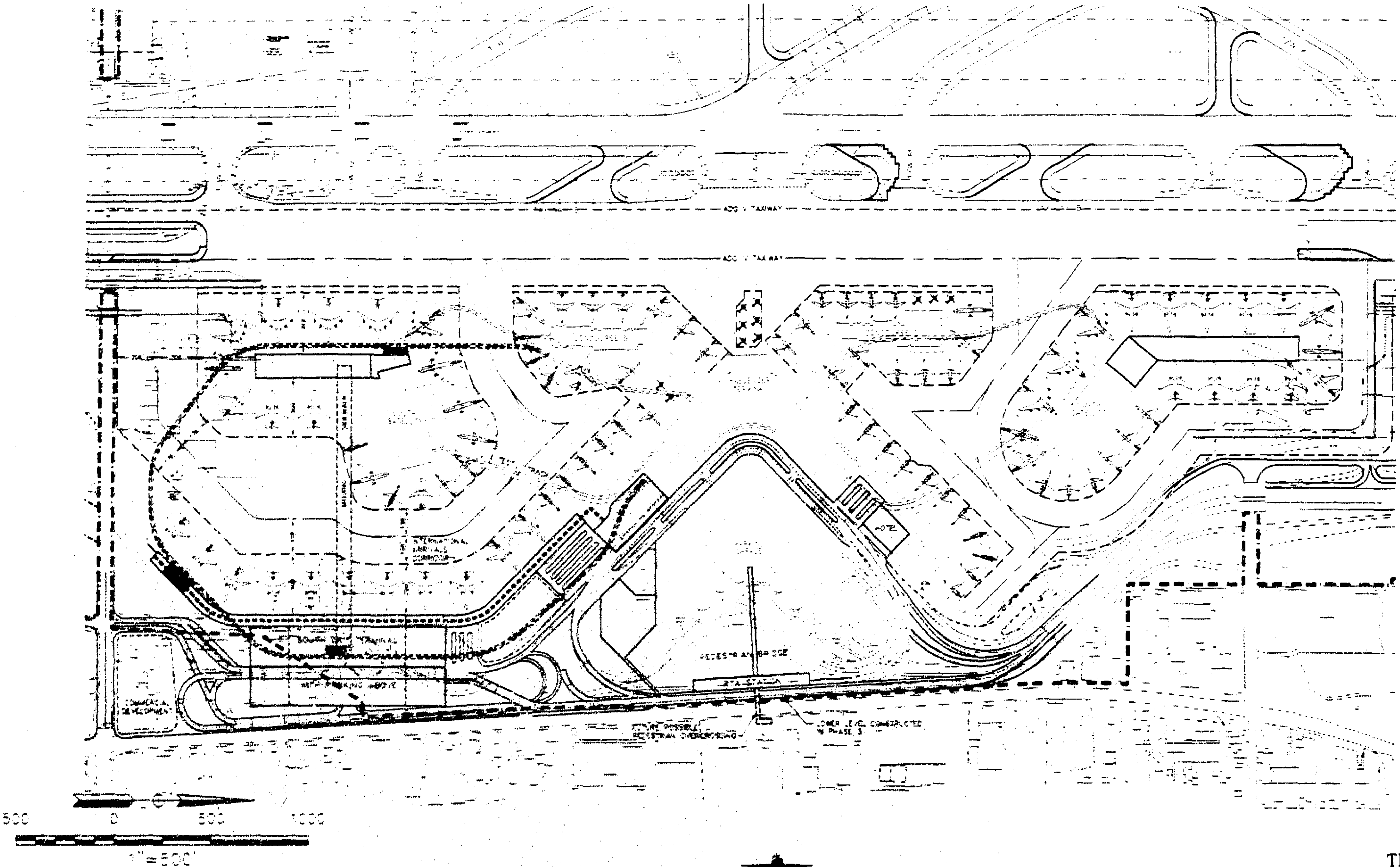


Figure 3-4
SOUTH UNIT
TERMINAL OPTION



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Requirements and Options, February 24, 1995. The description and evaluation of concepts for the two primary components of these other facilities are described below.

Air Cargo Facilities. Possible concepts considered for accommodating the 2020 cargo requirements are developing a centralized complex at a single location, or a decentralized complex by siting facilities at various locations on or off the Airport.

Two locations for centralized concepts were initially identified, the South Aviation Support Area (SASA) and a north site. Both sites met the two primary characteristics, plus provided advantages of promoting an efficient use of space, separating cargo and passenger traffic, and permitting phased development without interrupting existing cargo operations. However, each concept required overcoming major disadvantages in order to be implemented.

At the SASA site a centralized cargo development would utilize most of the SASA area and would not lend itself to accommodating other facilities such as aircraft maintenance, general aviation, etc. The north location presented a major conflict with existing development. It was concluded that accommodation of a centralized cargo option in the master plan was not practical and was dropped from further consideration.

The recommended option is a decentralized concept in which the existing cargo area would be modified and expanded to meet program requirements through 2010. After 2010, the projected demand can be met with supplemental cargo facilities in SASA, and in some cases, with warehouses north of SR518 as well.

Aircraft Maintenance Facilities. Three potential sites were investigated for new airline maintenance facilities and airline maintenance facilities that would be relocated due to terminal expansion:

- ***South Aviation Support Area (SASA) Site.*** A 1994 study recommended that the SASA area be used for the establishment of future aircraft maintenance facilities. The concept provided facilities for the three existing line maintenance facilities located south of the passenger terminal as well as the construction of a base maintenance facility that was envisioned by Alaska Airlines. Provisions were made to accommodate the alignment of the proposed South Access Freeway on the West side of the site, and a corridor for the 24th/28th Avenue arterial on the east side of the site.

- ***Northeast Maintenance Site.*** This site presently houses the air cargo terminals, hardstands, truck docks and parking for all operators except Northwest Airlines, whose cargo terminal is located in the southeast quadrant adjacent to their maintenance hangar. Since the recommended cargo option proposes continued use of the area for cargo operations, the site is not viable for an aircraft maintenance complex.

- ***Far North Maintenance Site.*** This site is the Port owned property located north of State Highway 518 and west of 24th Avenue South. This site was considered in the SASA study and was rejected because of the need to construct a taxiway bridge over State Highway 518. Use of the site is further complicated by existing development, proposed use of part of the area for airport employee parking, and the need for extensive fill.

Of the three locations discussed for possible airline maintenance, only one site is deemed feasible for consideration--the SASA site. It provides sufficient area for development of maintenance facilities and does not conflict with the recommended cargo facilities option.

The extent of aircraft maintenance development in the SASA should primarily be dictated by customer demand for continued use of those facilities that are displaced by passenger terminal expansion. Development of maintenance facilities should be reconciled with demands for other uses of the area such as cargo and general aviation.

Potential Commercial Development. The Airport Master Plan recognizes the need to promote commercial development on airport parcels not needed or suitable for other uses, as encouraged by the Airport Business Plan. A potential site for aviation-related commercial development is an "L-shaped" property north of SR 518 near the intersection with the North Airport Access Freeway.

SELECTION OF ALTERNATIVES FOR FINAL EVALUATION

In the Airport Master Plan Update and Environmental Impact Statement (EIS), a "do nothing" option and three development options were carried forward for a more detailed assessment:

- ***Alternative 1, Do Nothing/No Build.*** The Airport Master Plan Update requirements would not be addressed in the Do Nothing alternative. However, a number of other developments would occur: preparation of the SASA (as approved in the 1994 Final EIS and Record of Decision), completion of the Runway 34R RSA grading, development and implementation of declared distances for Runway 16R and 16L; installation of a Category IIIb Instrument Landing System on runway 16L; development of an on-airport hotel; and implementation of the Des Moines Creek Technology Campus.

- ***Alternative 2, Central Terminal (Figure 3-5).*** This alternative would include a new dependent (2,500-foot separation) parallel runway with a length of up to 8,500 feet; a 600-foot extension to Runway 34R; fill, clearing and grading of the 1,000-foot Runway Safety Areas for all runway ends; and completion of the landside and terminal development for centralized terminal facilities; and completion of the SASA.

- ***Alternative 3, North Unit Terminal (Figure 3-6).*** This alternative would include a new dependent (2,500-foot separation) parallel runway with a length of up to 8,500 feet; a 600-foot extension to Runway 34R; fill, clearing and grading of the 1,000-foot Runway Safety Areas for all runway ends; and completion of the landside and terminal development in a north unit terminal configuration with two concourses; and completion of the SASA.

- ***Alternative 4, South Unit Terminal (Figure 3-7).*** This alternative would include a new dependent (2,500-foot separation) parallel runway with a length of up to 8,500 feet; a 600-foot extension to Runway 34R, fill, clearing and grading of the 1,000-foot Runway Safety Areas for all runway ends; and completion of the landside and terminal development in a south unit terminal configuration; and completion of the SASA.

In addition to these alternatives for final evaluation, the Airport Master Plan Update, the EIS and other related planning studies have considered options with the specific purpose of addressing the issue of aircraft delay at Sea-Tac, especially during poor weather. These options would be alternatives to the construction of a

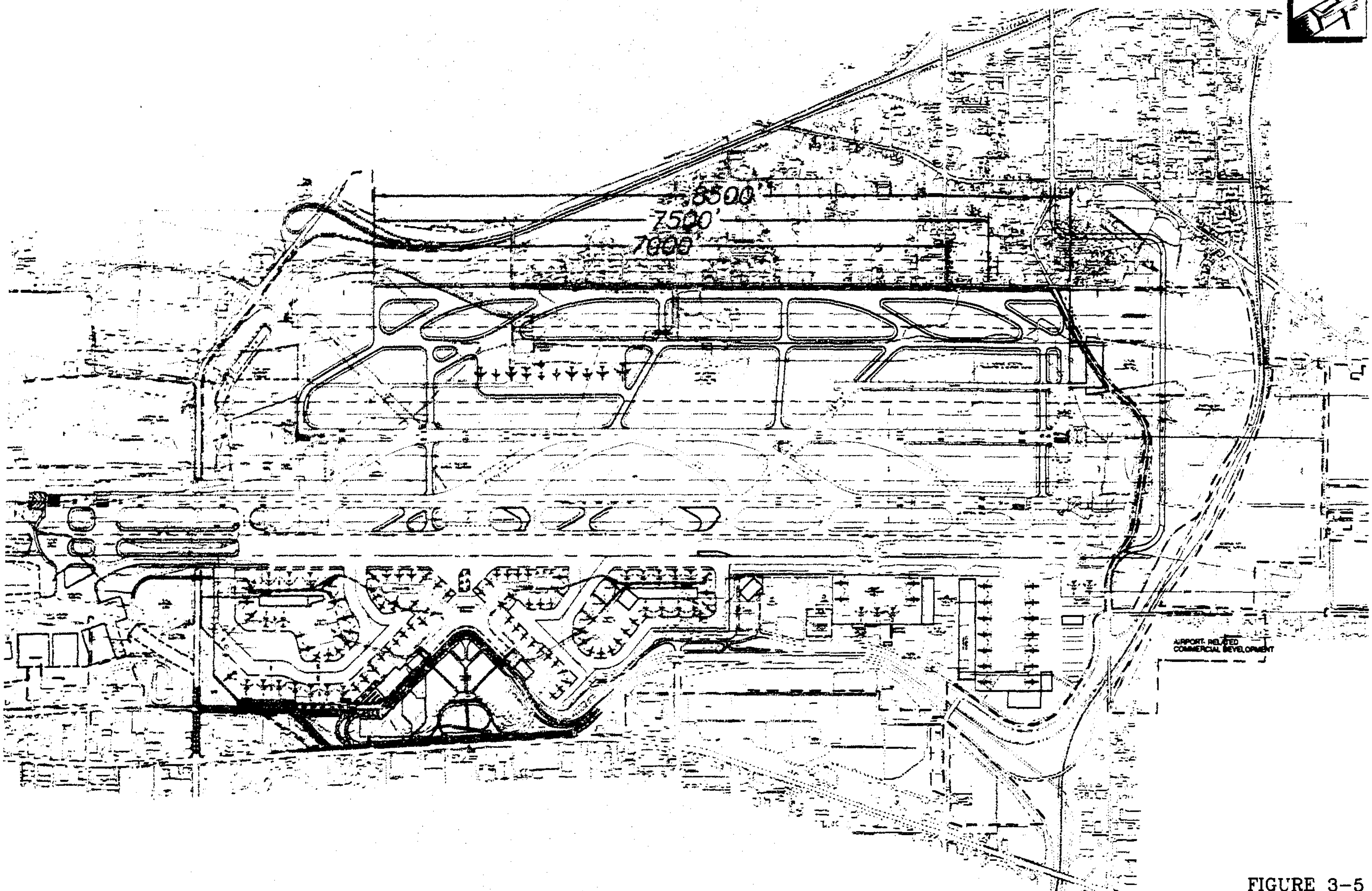
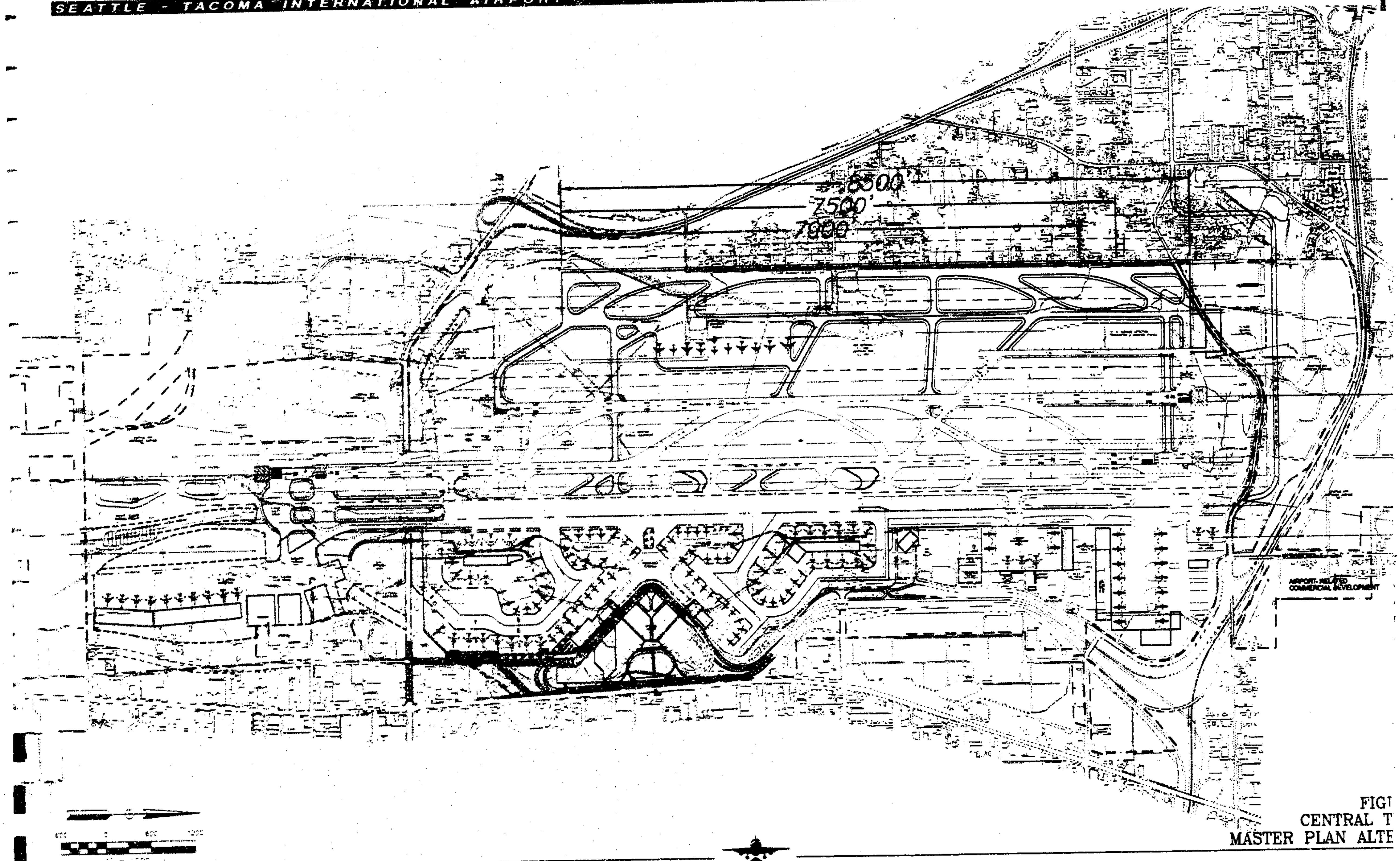


FIGURE 3–5
CENTRAL TERMINAL
MASTER PLAN ALTERNATIVE



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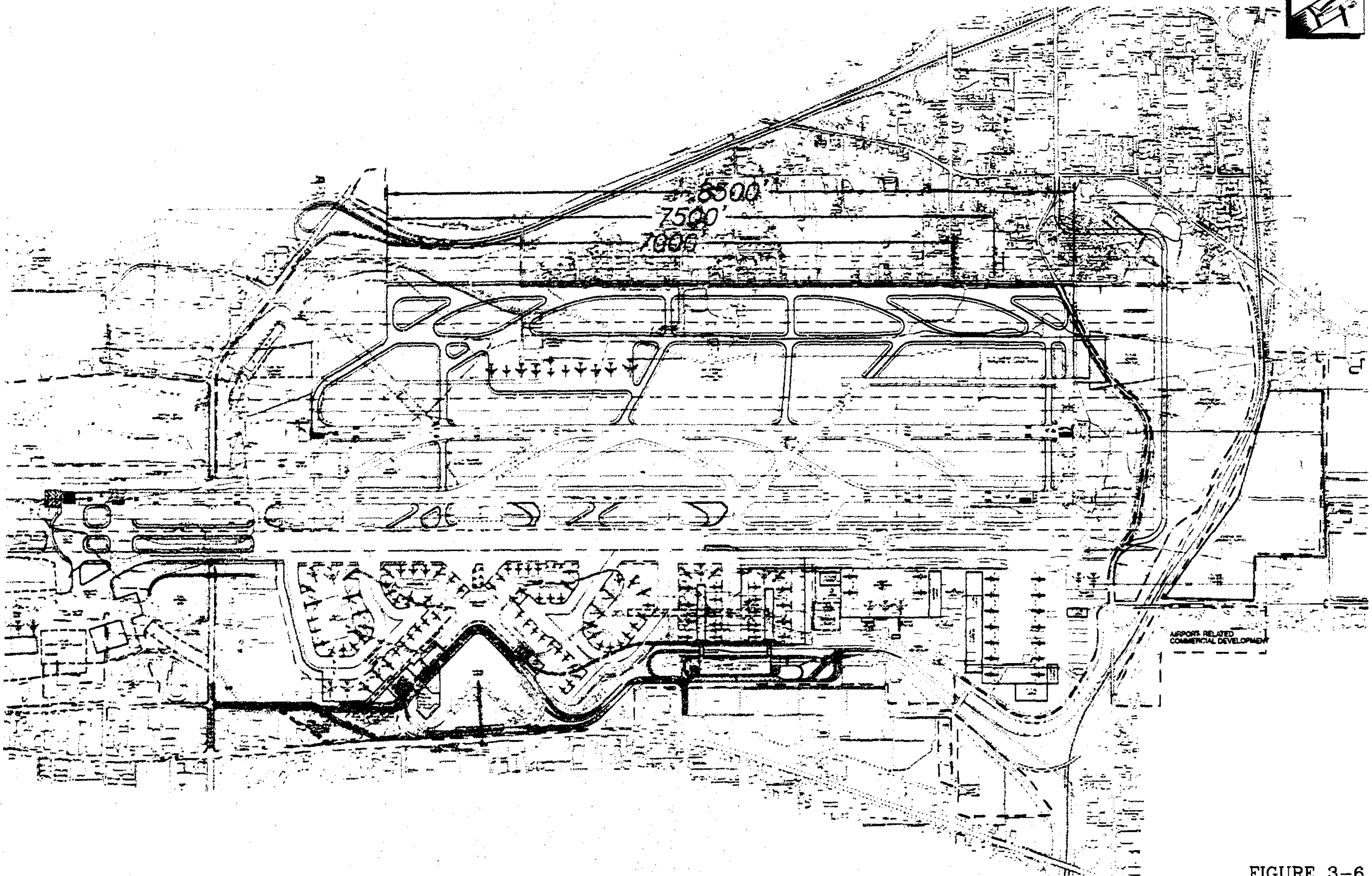
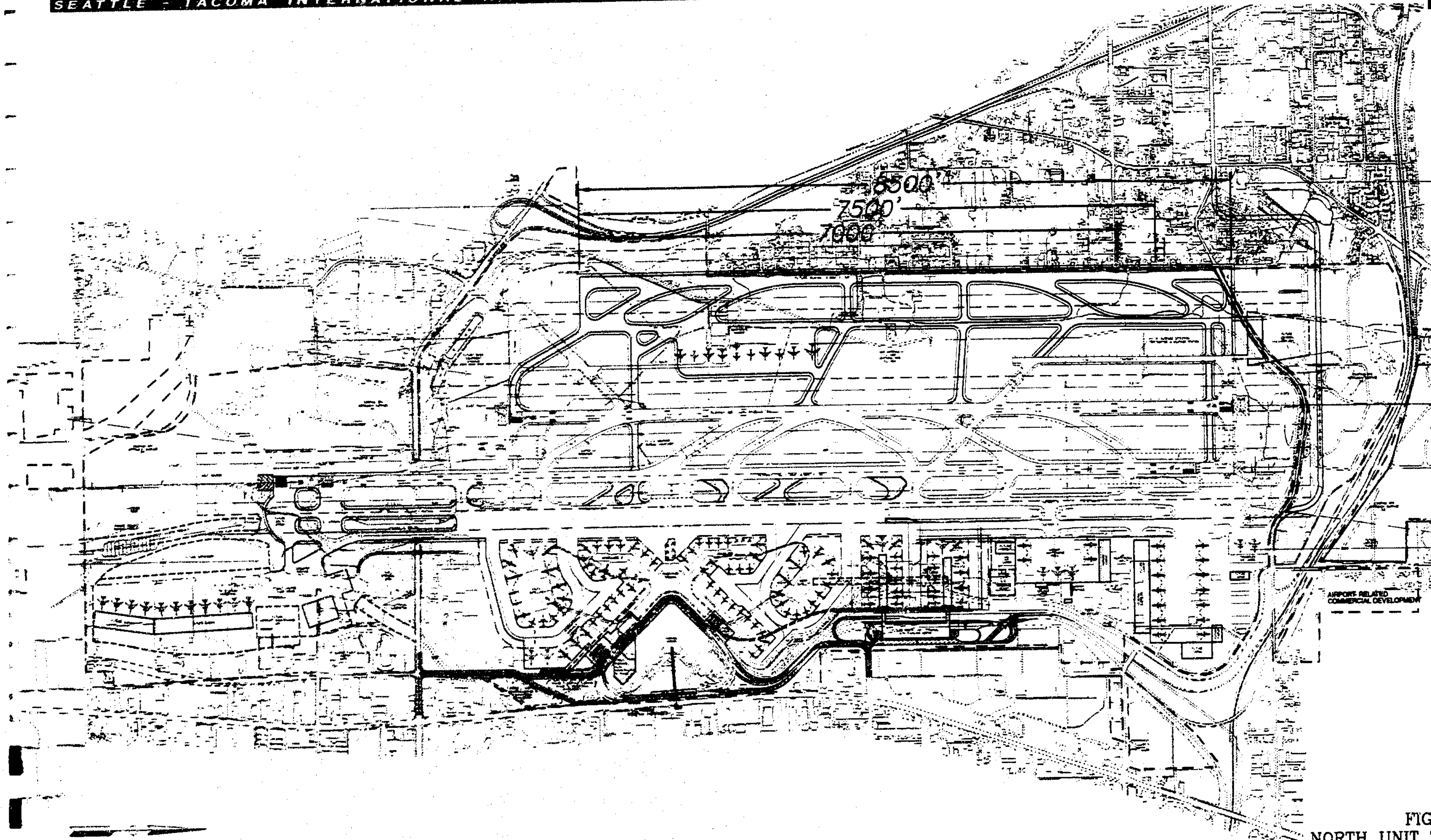


FIGURE 3-6
NORTH UNIT TERMINAL
MASTER PLAN ALTERNATIVE



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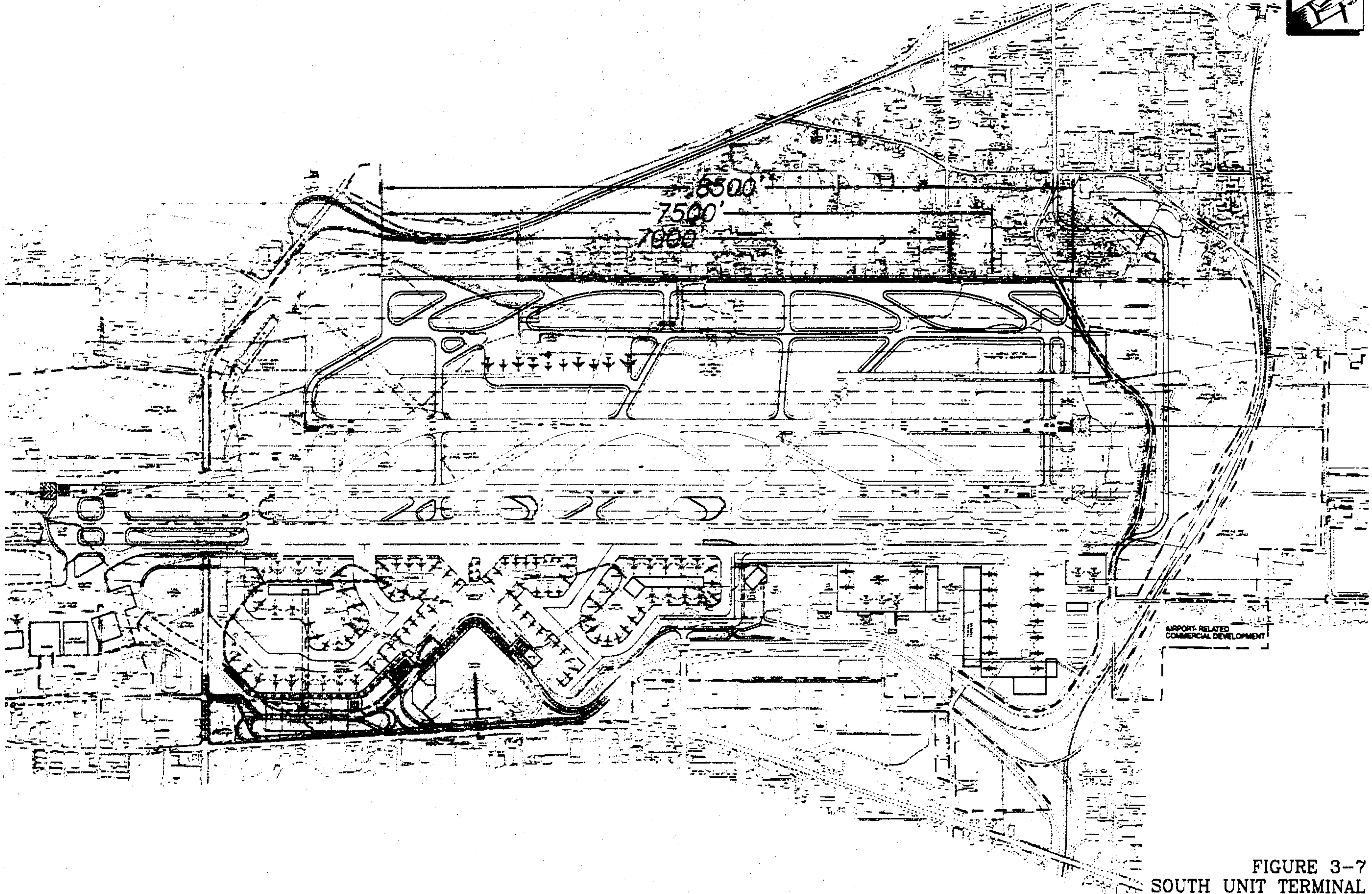

FIGURE 3-7
SOUTH UNIT TERMINAL
MASTER PLAN ALTERNATIVE

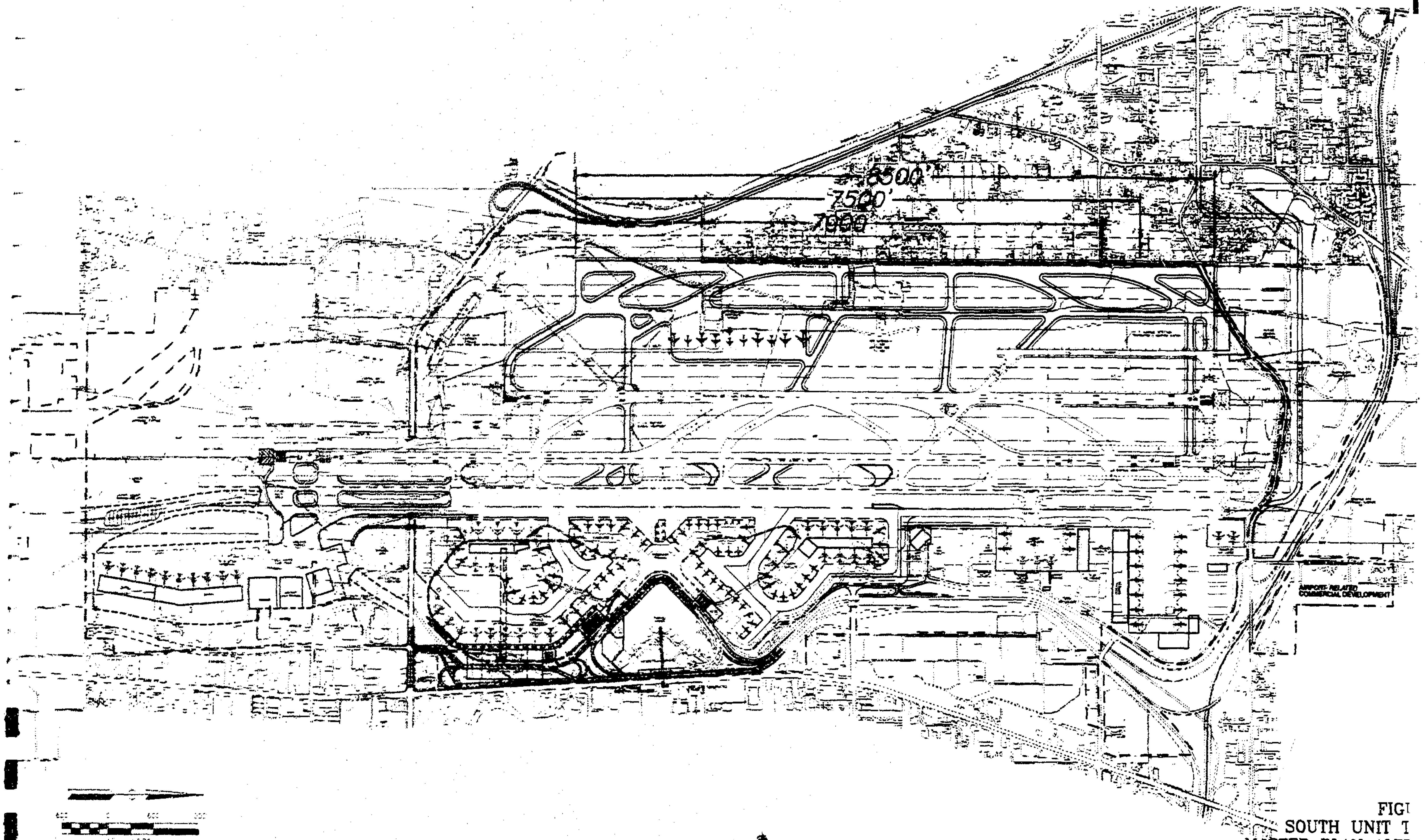

FIG
SOUTH UNIT T
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third runway at Sea-Tac and are listed below with a summary of the previous evaluation.

- ***Use of Other Modes of Transportation/Communication (Automobile, Bus, Rail, Teleconferencing).*** It has been found that this alternative will not address the poor weather operating issues at Sea-Tac. Less than 5 percent of passengers using Sea-Tac are traveling to distances where surface transportation is efficient and cost effective and likely to be used. FAA study has found that teleconferencing is likely to have little effect.

- ***Use of Other Existing Airports or Construction of a New Airport (Replacement or Supplemental).*** Regional consensus has been established through PSRC Resolution EB-94-01 that: 1) There is no sponsor or funding for a new airport; 2) Extensive studies of these alternatives indicate that there are no feasible sites; 3) If a site could be identified, market forces and planning and development requirements would prevent the airport from successfully serving regional demand until 2010 or later. The FAA and Port have independently confirmed that a new airport would not satisfy the needs addressed by the Airport Master Plan Update.

- ***Activity Alternatives (Demand Management/System Management).*** These actions will not eliminate the poor weather operating need as all feasible actions have been implemented.

- ***Use of Air Traffic and Flight Technology.*** No technologies currently exist, or are planned, which would address the poor weather operating constraint at Sea-Tac.

- ***Blended Alternative (Combination of Other Modes, Use of Existing Airports, and Activity/Demand Management).*** The net result of this alternative would be a delay in the implementation of the Master Plan Update alternatives. Because there is no commitment to any individual or combination of elements and because aviation activity levels are currently growing at a rate higher than forecast, this option would not be a viable solution to the aircraft delay problems.

It was concluded that none of the above options would adequately address the aircraft delay issue and that the only viable alternative to avoid excessive aircraft operation delays is to build a third runway at Sea-Tac.

Section 4
EVALUATION OF FINAL ALTERNATIVES

SECTION 4
EVALUATION OF FINAL ALTERNATIVES

APPROACH

The three final airport development options were evaluated extensively in the Airport Master Plan Update as well as the Environmental Impact Statement. The results of this evaluation are described in this section. The terminal and runway components of the three airport development options were addressed separately because runway options were not tied to terminal options.

TERMINAL OPTIONS EVALUATION

The evaluation of terminal options is summarized in Table 4-1 according to six criteria: airline/aircraft factors, passenger/terminal factors, ground access, environmental factors, acquisition and construction costs, and constructibility. Although other criteria were used to evaluate terminal alternatives considered earlier in the planning process, these factors were found to be the most pertinent and important characteristics distinguishing each of the three remaining terminal options.

Most of the terminal evaluation criteria shown in Table 4-1 are subjective. Accordingly, a ranking system where "plus" equals the best ranking and "minus" equals the worst ranking ("0" equals a tie for best) was used to provide a synopsis of the evaluation results. Although some factors such as the environmental factors and costs have been quantified, Table 4-1 uses the ranking system for all criteria for consistency.

Airline/Aircraft Factors

Airline/aircraft factors considered in this comparative evaluation summary are minimization of pushback/taxi conflicts, impact on airline maintenance and deferral of the need for SASA, and gate expandability beyond the planning period.

Minimization of Pushback/Taxi Conflicts. This criteria measures the ability of the terminal option to facilitate aircraft movement within the immediate terminal and gate areas. Maneuvering conflicts are created when taxiing aircraft or aircraft being towed block the taxi lane for other aircraft. This can cause delays in aircraft reaching their assigned gate or departing their gate for the runway.

The degree of potential taxiway congestion can be measured by the number of aircraft gate positions which an aircraft must pass by on a single taxilane to the destination gate. Currently at Sea-Tac, an aircraft utilizing the end gate of Concourse A must pass by at least 11 gates which could potentially impede its taxiing. Aircraft destined for the end gate position of Concourse D could potentially be impeded by seven gates.

The South Unit and Central Terminal Options increase the length of the taxi lanes at the north and south ends of the terminal and would create the potential for greater taxiing conflicts in the terminal gate area. In the South Unit and Central Terminal Alternatives, an aircraft would have to pass at least 14 gates to reach the most inaccessible gate at both Concourses A and D.

The most inaccessible gates under the North Unit Terminal Alternative would require an aircraft to pass only 11 gates from Concourse A and 9 gates from Concourse D. From the new north unit terminal, only 10 gates would be passed by an aircraft from the most inaccessible

TABLE 4-1
TERMINAL OPTIONS COMPARATIVE EVALUATION SUMMARY [a]

	South Unit Terminal Option	Central Terminal Option	North Unit Terminal Option
Airline/Aircraft Factors			
1. Minimization of Pushback/Taxi Conflicts			+
2. Impact on Airline Maintenance and Delay of SASA			+
3. Gate Expandability Beyond Planning Period			+
Passenger/Terminal Factors			
1. Centralization of Services/Concessions		+	
2. Terminal Expandability Beyond Planning Period		-	+
3. Passenger Comfort and Convenience	0		0
Ground Access			
1. Curb Space	0		0
2. Terminal Drive Capacity		0	0
3. Intersection Congestion			+
4. Parking Requirements		+	
Environmental Factors			
1. Social Impacts			
- Properties to be Acquired	-	0	0
2. Induced Socioeconomic Impacts			
- Loss in Property Tax	-	0	0
- Loss in Taxable Sales	-	0	0
- Jobs Displaced	-	0	0
Acquisition and Construction Costs			
1. Total Cost with Moving Sidewalk	-	0	0
2. Total Cost with STS Extensions	-	0	0
Constructability			
1. Continuity of Operations During Construction		-	+
2. Incremental Staging		+	

[a] "+" = Best, "-" = Worst, "0" = Tie for Best

gate location. The reduced potential for pushback/taxi conflicts under the North Unit Terminal Option is due to the construction of two relative short concourses with independent airfield access rather than relying only on extending the existing concourses and satellites as in the South Unit and Central Terminal Options.

Impact on Airline Maintenance and Deferral of the need for SASA. This criteria measures the need to relocate existing activities in the terminal area to expand or construct new terminal facilities. Activities particularly vulnerable to relocation are the aircraft maintenance hangars operated by Alaska Airlines, Delta Airlines and Northwest Airlines located south of the existing terminal. If the facilities need to be replaced, it could require the development of the South Airport Support Area (SASA) south of 192nd Street. This area will require extensive site preparation as well as the construction of aircraft parking aprons for tenant use.

All three terminal options require the use of the site occupied by the Northwest Airlines maintenance hangar located at the end of Concourse A. The Northwest hangar is owned by the Port of Seattle and leased to Northwest Airlines. Only the North Unit Terminal Option, however, allows the continued use of the Alaska maintenance hangar and Delta maintenance hangar in that area. For this reason, the North Unit Terminal Option will reduce disruption of existing airline maintenance activities at the airport and will eventually require less intensive development of the SASA area. The North Unit Terminal Option, however, will require the relocation of the air mail facility operated by the U.S. Postal Service north of the terminal, as well as other catering/cargo areas.

Gate Expandability Beyond Planning Period. An important airline/aircraft factor is the ability to expand the number of gates beyond those required for the planning period. The 75 air carrier gates operated at Sea-Tac today will need to be expanded to approximately 100 gates to meet demand at the projected 38 MAP level. Additional gates may be necessary beyond this demand level. This criterion measures the expandability of the terminal gate positions beyond the planning period needs.

In the South Unit and Central Terminal Options, the north satellite is programmed to be expanded initially in Phase 3 and again in Phase 5. The expansion of the north satellite under the South Unit and Central Terminal Options would not allow a new north unit terminal in the same location as in the North Unit Terminal Option. Consequently, further expansion of the airport terminal gate activity to the north in the South Unit and Central Terminal Options would require more relocations and result in a greater separation between the Main Terminal and a future North Unit Terminal. Moreover, the South Unit and Central Terminal Options cannot be expanded to the south due to the location of South 188th Street and, potentially, the South Access Freeway.

On the other hand, the North Unit Terminal Option can be expanded southward in a manner similar to the South Unit and Central Terminal Options and additional concourses could ultimately be constructed to the north of the North Unit Terminal if necessary (with corresponding facility relocations).

Passenger/Terminal Factors

Passenger/terminal considerations consist of centralization of services/concessions, terminal expandability beyond the planning period and passenger comfort and convenience.

Centralization of Services/Concessions. In the Central Terminal Option passenger services and concessions would predominantly be located in the Main Terminal. This would enhance passenger convenience and reduce passenger confusion and disorientation. On the other hand, the two-terminal concepts lack the simplicity of the single-terminal design and create the potential for passenger inconvenience and confusion if poorly implemented.

Terminal Expandability Beyond the Planning Period. The terminal expandability of the three terminal options is similar to the gate expandability discussed above. Terminal expandability addresses the flexibility to add space within the central terminal building for such functions as concessions, ticket counters, and baggage claim area.

The discussion relating to gate expandability applies here also. Under the Central Terminal Option further expansion of terminal facilities to the north or south would not appear to be feasible. Although a new North Unit Terminal could be constructed, the concourses would not be as well located with respect to the terminal as under the North Unit Terminal Option and a large portion of the air cargo area would have to be relocated. In the North Unit Terminal Option, Concourse A could be expanded to the south as under the South Unit Terminal Option.

Passenger Comfort and Convenience. The ability of the concept to facilitate passenger convenience and enhance the travel experience includes passenger orientation, walking distances, level changes, accessibility, amenities, and the minimization of connecting times. As used at Sea-Tac, this criterion needs to consider the requirements of both originating/terminating and connecting passengers. Options which provide short curb-to-gate distances as well as contiguous terminal facilities are generally more desirable, while options which increase both curb-to-gate and terminal-to-terminal distances are less desirable.

Both the North and South Unit Terminals share a similar degree of passenger convenience by improving curb-to-terminal and curb-to-gate access. Decreased walking distances in turn, decrease the dependence of the concept on mechanical people-movers such as moving sidewalks and/or the STS system. Furthermore, because these terminals would be new, they could be designed to provide contemporary amenities and sufficient space to enhance the passenger experience throughout.

Of these two alternatives, the South Unit Terminal has the benefit of being contiguous to the existing terminal, thereby facilitating (off-line) connecting passenger movements but with the negative of connecting to gates on the south satellite via a long underground connector. The North Unit Terminal provides direct access to all its gates via relatively short piers, and could provide a direct passenger connection back to the Main Terminal by an extension of the STS shuttle.

The passenger convenience of the Central Terminal Option becomes somewhat strained due to the dependence on the existing core terminal building and the Transit Plaza east of the parking garage. While curb-to-terminal activities remain relatively unchanged from the existing curb, passengers using the Transit Plaza would be required to travel nearly 1,000 feet across the parking structure to reach the terminal itself. All passengers would face increased curb-to-gate distances due to the lengthening of Concourse A and the North and South Satellites necessitating some form of mechanized people mover to render these distances manageable.

Ground Access

Ground access considerations addressed in the comparative terminal evaluation are curb space at the terminal, terminal drive capacity, intersection congestion in the airport area, and centralized airport parking.

Curb Space. The amount of curb frontage for passenger pick-up and drop-off along the face of the terminal building is an important element in minimizing terminal drive congestion. Both the upper and lower roadways of the existing terminal have about 1,600 feet of curb at the building face.

Curb frontage under each of the terminal options would be as follows:

Location	South Unit Terminal Option	Central Terminal Option	North Unit Terminal Option
Main Terminal			
Departure Level	1,980'	2,350'	2,050'
Independent Curb	1,400'	1,700'	1,500'
Transit Curb	750'	750'	750'
Transit Plazas	2	1	2
Arrival Level	1,980'	2,350'	2,050'
Unit Terminal			
Departure Level	1,000'	--	850'
Arrival Level	1,000'	--	850'
Transit Plazas	Yes	--	Yes
Total Curb Frontage	8,110'	7,150'	8,050'

Thus either the North or South Unit Terminal Option would provide the opportunity for the greatest amount of vehicle space in front of the terminal area for passenger loading and unloading. The Central Option does not meet forecast requirements for curb frontage.

Terminal Drive Capacity. The Main Terminal drive currently consists of three through lanes and two curb lanes on the lower level, and two through lanes and two curb lanes on the upper level. At the upper level, the innermost curb lane is 11 feet wide, while the rest are 9 feet or less in width; at the lower level, the three innermost lanes are about 10 feet wide, while the two outer lanes are 12 feet or more in width. With the proposed improvements under all three terminal options, the Main Terminal drive will be widened to four through and two curb lanes on the upper level. The new lanes would be 20 feet at the curbside and 12 feet for through traffic. The lower level roadway at the face of the terminal would remain essentially unchanged for all three options. Under all three terminal options, the Main Terminal drive would have through lane capacities of 1,970 vehicles per hour on the lower level and 4,540 on the upper level.

The terminal drive volume and volume-to-capacity ratio measured in vehicles per hour from 12:00 to 1:00 PM of the average day peak month in the year 2020 at the Main Terminal would be as follows:

Location	South Unit Terminal Option	Central Terminal Option	North Unit Terminal Option
Main Terminal			
Lower Level			
Volume	1,080	1,140	850
V/C	55%	58%	43%
Upper Level			
Volume	1,420	2,320	1,670
V/C	31%	51%	37%

Along the upper main terminal drive, which is a critical area for potential traffic congestion, the Central Terminal Option would have a volume/capacity ratio of 0.51 compared with 0.31 and 0.37 for the South Unit and North Unit Terminal Options, respectively. The South and North Options will result in a higher level of service on the main terminal drive.

Intersection Congestion. As described in the Draft EIS, continued regional population growth and growth of aviation demand will impact the surface transportation system in the vicinity of Sea-Tac Airport regardless of the improvements undertaken at the Airport. Total Airport surface traffic is expected to increase from approximately 87,600 vehicles per average day in 1994, to approximately 161,500 vehicles per average day in the year 2020 without airport improvements or under any terminal option. Year 2020 traffic volumes on the regional surface transportation system in the vicinity of the Airport are expected to be approximately 36 percent higher than current levels due to regional population and employment growth.

The Draft Environmental Impact Statement identified the following impacts (note that the Final Environmental Statement could show somewhat different results). The South Unit and Central Terminal Options would adversely impact the surface transportation system in comparison with the Do-Nothing Alternative. Adverse impacts were identified at the following three intersections:

- The intersection of Air Cargo Road and S. 170th Street would remain at Level of Service (LOS) F but the average delay would more than double. LOS is a measure of roadway or intersection congestion, with A being free flow and F being highly saturated.
- The intersection of Northbound Airport Expressway ramps and S. 170th Street would degrade from LOS B to LOS F.
- The intersection of International Boulevard and S. 170th Street would remain at LOS F but the average delay would more than triple.

No adverse impacts were identified at any of the freeway ramp junctions. Mitigation measures could eliminate these impacts, such as moving employee parking to a site north of SR 518.

The North Unit Terminal Option would not impact the surface transportation system in comparison to the Do-Nothing Alternative.

Parking Requirements

A detailed study of parking needs for all future options projected a need to expand parking on-site above existing levels. (Airport Parking Systems-Long Range Analysis. P&D Aviation.) Currently, the main terminal has 9,400 parking spaces allocated as follows: 1) Rental Cars: spaces for both ready-car access and on-site vehicle preparation - 1,400 spaces; 2) Employee Parking: 517 spaces; 3) Short-Term Metered Parking: 1,000 spaces; and, 4) Long-Term Spaces 6,483. The POS has 4,018 spaces for employee parking, mostly located away from the main terminal complex. The POS operates no remote parking areas for public use.

All three expansion options estimate that on-site public parking needs will increase to 14,800 spaces. This represents a Port policy of providing an estimated 50% of all parking demand at the 38 MAP operating level on the airport as opposed to off-site lots. The three options differ in parking space concentrations at terminal areas. The Central Terminal Option would retain all spaces at the main terminal to a maximum of 10,200 public spaces; the balance of public parking spaces (4,600) would be located at a remote facility on-site, connected to the main terminal complex with shuttle buses. The South and North Unit Terminal options cap public parking at the Main Terminal at 10,900 spaces, with either Unit Terminal having 3,900 public spaces.

It is anticipated that Short-term Metered Parking would double to 2,000 total spaces as demand increases and the balance of short and long-term spaces is divided proportionally among the terminal option schemes. Any additional public spaces required would be operated off-site by private operators or by the POS at on-site remote locations away from the terminal area.

In addition, car rental ready car spaces must be increased to 3,100 spaces, with an equivalent area (approximately 25 acres) on-site for car preparation. In the Central Option all ready car rental spaces would be at the Main Terminal, while the North and South Unit Terminal Options would shift 900 spaces to either unit terminal from the Main Terminal, reducing the number of ready car spaces there to 2,200. The site noted will be needed for rental car preparation, storage, and quick-turn around preparation located on airport property. The three terminal options have some differences in how rental-car ready spaces would be phased into operation, but total ready-car space would be the same in all three options, as is the need for on-site rental car support facilities.

Finally, employee parking will also have to expand to about 6,800 spaces from the existing 4,100 spaces, using the POS standard of 2.5 employees per parking space or to 5,500 spaces if the POS switches its parking allocation factor to one parking space per 3 employees. Data collected in 1995 strongly recommends that the POS consider using the higher space allocation factor. Thus, about 1,400 added parking spaces are needed in all three options to accommodate employee parking. The three options do have immediate and continued impacts on employee parking facilities due to phased development proposed in all three options. Therefore, most employee parking is planned to shift to a site north of SR 518, near South 24th Avenue in all three options.

In summary, the Central Terminal Option would have 13,500 spaces (public parking and ready-car rental area) at the terminal, with 4,600 spaces located at a remote location on-site. The North and South Unit Terminal options would leave 13,300 spaces at the Central Terminal and 4,800 at the Unit Terminal for public parking and rental car ready spaces. Summarized below are the parking requirements for each terminal option.

OVERALL TERMINAL AREA PARKING REQUIREMENT (NON-EMPLOYEE FACILITIES) [1]

Central Terminal Garage - Central Terminal Option

	Year 2020 Requirement
Public Parking [2]	10,200
Employee Parking	200
Car Rental	3,100
Subtotal	13,500
Remote Parking	4,600
Total	18,100

Central Terminal Garage - North or South Unit Terminal Option

Public Parking [2]	10,900
Employee Parking	200
Car Rental	2,200
Subtotal	13,300
Remote Parking	0
Total	13,300

North or South Unit Terminal Garage

Public Parking [2]	3,900
Car Rental	900
Subtotal	4,800
Remote Parking	0
Total	4,800

[1] All numbers rounded to the nearest hundred.
[2] 15%-20% of spaces assigned to short term parking.

Environmental Factors

Environmental factors addressed in the comparative evaluation summary of terminal options are social impacts and induced socioeconomic impacts. These criteria were found to be the most relevant characteristics distinguishing each of the three remaining terminal options. An in-depth analysis of the full range of potential environmental impacts and potential mitigation measures is included in the Final Environmental Impact Statement (FEIS) on the Airport Master Plan Update.

Social Impacts. The Central and North Unit Terminal Options would not require the acquisition of property by the Port for terminal construction or related roadway and vehicle parking development. The South Unit Terminal Option would require the acquisition of 12 commercial properties north of South 188th Street and west of International Boulevard. No residential or other properties would need to be purchased for any of the terminal options. The impacts described here apply to only the relocations due to terminal construction.

Induced Socioeconomic Impact. Sea-Tac Airport, a major passenger and cargo transportation facility, directly and indirectly contributes to the economic structure of the Puget Sound Region. Induced socioeconomic impacts are generated in the region by changes in employment opportunities, payroll generation, business expenditures for goods and services, and tax revenue. The existing and forecast induced socioeconomic impacts as reported in the Draft EIS are:

	1993	2020
Total Jobs	205,690	418,632
Personal Income ($ millions)	2,585.6	5,262.4
State and Local Taxes ($ millions)	406.6	827.9

The displacement of businesses described in the preceding subsection would result in losses in property tax, taxable sales and jobs for the South Unit Terminal Option, compared with the Central and North Unit Terminal Options. The Draft EIS estimates these induced socioeconomic affects of the South Unit Terminal Option as follows:

	Socioeconomic Effect of South Unit Terminal Option, 2020
Loss in Property Tax/Year ($ thousands)	64.4
Lost Taxable Sales Transactions/Year ($ millions)	13.4
Jobs Displaced	195

This analysis assumes that the displaced businesses will not relocate in the area.

Acquisition and Construction Costs

Costs include property acquisition, relocations and demolition, terminal construction, terminal equipment (loading bridges, baggage handling systems, moving sidewalks), Satellite Transit System improvements, roadways and vehicle parking, engineering and architectural services and allowance for contingency and other costs not specifically itemized. All costs were estimated in 1994 dollars.

Costs were prepared for two assumptions to estimate the low and high cost range of Satellite Transit System (STS) improvements (which are currently under study). Each of these is described below. Capital cost estimates for the Sea-Tac Airport Master Plan Update are included in a memorandum by P&D Aviation to the Port of Seattle dated April 21, 1995 and subsequent data submitted April 26, 1995.

Total Cost with Moving Sidewalks. The lower cost estimate assumes the new terminal areas would be served by moving sidewalks and expanded curbside shuttle service, rather than the extension of existing STS lines. The STS system would be upgraded in the first phase by a major overhaul of existing vehicles and the procurement of new vehicles to accommodate increased passenger levels on the existing lines. Total terminal-related costs for each of the terminal options are estimated as follows:

Terminal Option	Terminal and Roadway/Parking Cost Without STS Extension: Cost (millions of 1994 dollars)	Cost per Narrowbody Equivalent Gate
South Unit	1,035.4	32.4
Central	820.2	25.6
North Unit	820.3	24.9

The number of new narrowbody equivalent gates is 32 for the South Unit and Central Terminal Options and 33 for the North Unit Terminal Option.

Total Cost with STS Extension. The higher STS cost estimate assumes the STS system would be upgraded as described above and in addition the existing shuttle and loop systems would be expanded to serve the new terminal areas for inter- and intra-terminal passenger movements. Under the STS extension alternative, moving sidewalks would also be provided to enhance the movement of passengers along concourses and to connect the expanded South Satellite with the extended Concourse A in the South Unit Terminal Option and to connect the North Satellite with the new north unit terminal concourses in the North Unit Terminal Option.

Terminal Option	Terminal and Roadway/Parking Cost With STS Extension: Cost (millions of 1994 dollars)	Cost per Narrowbody Equivalent Gate
South Unit	1,073.4	33.5
Central	881.6	27.5
North Unit	866.6	26.3

Constructibility

Issues addressed under constructibility are the continuity of operations during terminal construction and the flexibility for incremental staging of terminal development.

Continuity of Operations During Construction. It is important to maintain ongoing terminal operations throughout construction with a minimum of disruption and inconvenience. Related considerations include the proximity of construction to ongoing operations, the need for temporary construction and detours, the availability and location of construction staging areas, construction access, and the degree of renovation necessary in existing terminal areas. In the North Unit Terminal Option, the existing terminal and concourse areas are relatively unaffected, with most of the new terminal and concourse construction occurring to the north. Moreover the North Unit Terminal Option is estimated to require the renovation of only 150,000 square feet of existing terminal areas. This option, therefore, would disrupt existing terminal operations the least for construction and/or renovation.

Construction of the Central Terminal Option would impact both ends of the existing terminal as well as the South and North Satellites and Concourses A and D. Because of the existing airside and landside site constraints, this option would provide limited areas for construction lay-down and phasing. Furthermore, the Central Terminal Option is estimated to require the renovation of over 300,000 square feet of existing terminal structures. Disruption of terminal activities is correspondingly anticipated to be the greatest under the Central Terminal Option.

The South Unit Terminal Option could require the renovation of over 200,000 square feet of existing terminal space. Construction of this option would also impact one end of the existing terminal as well as the South and North Satellites and Concourse A. While the new south unit terminal could be constructed outside of the immediate terminal area, development of the new pedestrian tunnel to the south satellite could necessitate temporarily closing the existing taxiway. While less disruptive than the Central Terminal Option, it is significantly more disruptive than the North Terminal Option.

Incremental Staging. Another important aspect of constructibility is the ability to construct the new terminal space in stages to meet demand in a cost effective manner as it occurs. In the Central Terminal Option, expansion of the terminal area consists of extensions of the North and South Satellites, extension of Concourse A, and additions to the existing terminal at the south and north ends. The central parking garage would be expanded in an incremental fashion to the south. These additions could be accomplished in an incremental fashion as needed to meet passenger demand.

On the other hand, the South and North Unit Terminal Options require a major unit terminal addition, which involves substantial road relocations as well as terminal construction. Although these unit terminals could, to some degree, be expanded in phases (such as phasing of concourse development), the unit terminal options would not offer the flexibility of staging new terminal development that the Central Terminal Option would offer.

RUNWAY OPTIONS EVALUATION

Runway evaluation criteria addressed in this stage of the analysis are: airline/aircraft factors, environmental factors, and acquisition and construction costs. Most of the runway criteria shown in Table 4-2 could be quantified. Therefore, Table 4-2 is shown in terms of numerical values rather than rankings. Similarly to the terminal options, other criteria besides those shown in Table 4-2 were evaluated during earlier runways studies. The criteria shown in Table 4-2 are the most relevant for this stage of analysis where the final three runway options are being evaluated.

Airline/Aircraft Factors

Airline/aircraft factors relate to the effectiveness of the runway option in reducing aircraft operations delays and improving the overall efficiency of the airfield operations.

Percentage of Fleet Mix Accommodated in 2020. Using an analysis similar to that described above, it was concluded that the 7,000 foot runway would be sufficiently long to accommodate 91 percent of the types of aircraft expect to be using the airport, the 7,500 foot runway 96 percent and the 8,500 foot runway 99 percent. Landing lengths were based on typical landing weights, wet pavements and an allowance for accommodating Category III operations in accordance with FAA requirements. The longer runways would allow more aircraft to land on the new runway, thereby increasing airfield efficiency.

Percentage of Takeoffs Accommodated in 2020. Although the new runway will be used predominantly for landings, it is important to identify its takeoff capabilities for those times when it would be used for departures. In Technical Report No. 6, Airside Options Evaluation, runway lengths were evaluated according to the percentage of aircraft which each could accommodate in takeoffs and landings. The aircraft mix is based on the projected percentage of aircraft arrivals and departure in 2020. This analysis revealed that the 7,000 foot runway would be sufficiently long to accommodate 77 percent of the types of aircraft expected to be using the airport for

TABLE 4-2
RUNWAY OPTIONS COMPARATIVE EVALUATION SUMMARY [a]

	7,000' Runway Option	7,500' Runway Option	8,500' Runway Option
Airline/Aircraft Factors			
1. Percentage of Takeoffs Capable of Using this Runway Length, 2020	77%	85%	90%
2. Percentage of Landings Capable of Using this Runway Length, 2020	91%	96%	99%
Environmental Factors [b]			
1. Noise Impacts (Year 2020)			
- Number of People Affected by DNL65	10,800	10,800	11,300
- Housing Units Affected by DNL65	4,600	4,600	4,800
- Non-Airport Area Affected by DNL65 (sq. mi.)	3.2	3.2	3.3
2. Social Impacts			
- Single Family Homes to be Acquired	346	359	386
- Condominium/Apartment Units to be Acquired	26	260	260
- Businesses to be Acquired [c]	96	104	105
3. Wetlands			
- Wetland Acres Affected	9.1	8.9	9.7
4. Earth Resources			
- Million Cubic Yards of Fill	13.52	16.77	17.25
Acquisition and Construction Costs [d]			
1. Estimated Property Acquisition and Relocation Cost ($ millions)	82.9	105.3	109.7
2. Estimated Construction Cost ($ millions)	224.8	240.1	295.9
	307.7	345.4	405.6

[a] Note that data in this table were updated after the initial airside options analysis (Table 3-1).
[b] Based on the Draft EIS by Landrum & Brown released in April 1995.
[c] Assumes businesses in South Runway Protection Zone are acquired rather than the acquisition of an avigation easement.
[d] Includes only costs associated with a new runway. Excludes costs associated with extension of Runway 16L-34R, new taxiways to Runway 16L-34R, RSA improvements to existing runways, and environmental mitigation. (Revised since April 1995).

takeoffs, the 7,500 foot runway 85 percent and the 8,500 foot runway 90 percent. Takeoff requirements were based on typical maximum flight distances, zero runway gradient, zero wind and a temperature of 84°F. Aircraft departing to the south (runway gradient of -0.71 to -0.72) would require a shorter runway takeoff distance; aircraft departing to the north (runway gradient of 0.71 to 0.72) would require a longer takeoff distance. Aircraft requiring the longest takeoff distances are generally widebody aircraft flying long stage lengths. The longer runways would accommodate a greater percentage of the airport's operations and therefore would provide greater flexibility and efficiency in the use of the airfield.

Pilot Rejection Rate. When multiple landing runways are available, a pilot has the option (subject to any airline rules applicable) of rejecting the landing runway assigned to him by the air traffic control tower and requesting another runway. The Airline Transport Association (ATA) and airline pilots have stated that the pilot rejection rate for the shorter runway lengths compared with the 8,500 foot option will be significant due to the less desirable length and the proximity of the two longer parallel runways. FAA tower controllers have commented that this type of pilot rejection will complicate air traffic management and contribute to delays.

In an effort to collect additional information related to this concern, a survey was conducted of 10 commercial airports which have similar characteristics of traffic and airfield configuration. Results of the interviews show a pattern of rejection of shorter landing runways, especially if longer runways are closer to the terminal building.

Environmental Factors

The principal environmental factors considered in this stage of planning are noise impacts (numbers of people, housing units and non-airport area affected by DNL65), social impacts (single family homes, condominium/ apartment units and businesses to be acquired), wetland acres affected, and the volume of fill required. These criteria were found to be the most relevant characteristics distinguishing each of the three remaining runway options. An in-depth analysis of the full range of potential environmental impacts and potential mitigation measures is included in the Final Environmental Impact Statement (FEIS) on the Airport Master Plan Update.

Noise Impacts (Year 2020). For this comparative evaluation, the extent of noise impacts of DNL65 and greater include number of people affected, housing units affected and non-airport area affected. In the noise analyses presented in the Draft Environmental Impact Statement, April 1995, impacts were quantified only for the 8,500 foot runway option. In earlier environmental documentation, noise contours were prepared for the 7,000 foot and 7,500 foot runway options using somewhat different runway use assumptions. The earlier screening analysis was prepared using the best information available at the time but subsequent analysis has resulted in refined operating assumptions. The data in Table 4-2 for the number of people affected, housing units affected, and non-airport area affected for the 7,000 foot and 7,500 foot runway options were estimated by P&D Aviation on the basis of the data for the 8,500 foot runway documented in the April 1995 Draft EIS and the percentage relationships in the data for the three runway options contained in the earlier analysis.

The results of this estimation procedure indicate that the shorter runways would affect slightly fewer people, housing units and off-airport area than the 8,500 foot runway (Table 4-2). The 3.2 square miles of off-airport property in the year 2020 DNL65 for the 7,000 foot and 7,500 foot runway options would encompass an estimated 10,800 people and 4,600 housing units. The 3.3 square miles off-airport area affected by 2020 DNL65 for the 8,500 foot runway is estimated to include 11,300 people and 4,800 housing units. These results are due to the differences in mix of aircraft and number of aircraft which would use the new runway according to its length.

Social Impacts. The social impacts of residential and business displacement required by the construction of a new runway are addressed in the Draft EIS. Included are estimates of the number of single family homes, condominium/apartment units and businesses which could be required for the runway development. The acquisition of these properties could be needed to provide for runway construction, to clear the runway protection zones (RPZs) and to mitigate adverse environmental impacts. The mitigation area is located to the west of the primary acquisition area and east of State Route 509. State Route 509 would be considered an existing boundary which would protect properties to the west from adverse impacts and also minimize splitting of neighborhoods. Land parcels to be acquired in the primary construction area, runway protection zone area and mitigation area were identified using September 1994 King County Assessor's office data and the Seattle Common Land Database.

Estimated acquisitions for the 7,000 foot runway option are 346 single family homes, 26 condominium/apartment units and 96 businesses. Acquisition for the 7,500 foot runway would be 359 single family homes, 260 condominium/apartment units and 104 businesses. The 8,500 foot runway option is estimated to require the acquisition of 386 single family homes, 260 condominium/apartment units and 105 businesses.

Wetlands. Each of the runway options would affect a portion of the existing wetlands around Sea-Tac Airport. Wetland impacts would include placement of fill material, dredging, removal of existing vegetation, and changes in hydrologic regimens as a result of increased impervious surface area and storm water management system restructuring.

About 33 individual wetlands could be directly affected by development at the airport including fill for the following: 9.1 acres for the 7,000 foot runway option, 8.9 acres for the 7,500 foot runway option and 9.7 acres for the 8,500 foot runway option. These quantities include wetland areas on the airport which could potentially be used as borrow areas for fill material (2.2 acres of wetlands) and the South Airport Support Area (SASA) (2.2 acres of wetlands). The SASA wetlands impacts have been addressed in another EIS but are included here for overall evaluation.

Earth Resources. The potential impacts on earth resources that could result from runway construction (including clearing, grading, excavation and fill placement) were evaluated in the Draft EIS. The sources of fill materials, depth of fill placement and methods of placement and compaction were also addressed.

The following quantities of earth fill would be required for runway construction: 13.52 million cubic yards for a 7,000 foot runway, 16.77 million cubic yards for a 7,500 foot runway and 17.25 million cubic yards for an 8,500 foot runway. Preliminary investigations indicate that the required fill would be obtained from a combination of Port of Seattle-owned property and off-site borrow sources.

Acquisition and Construction Costs

Property acquisition and construction costs were estimated in 1994 dollars. Acquisition costs include property purchase, relocations of residents and businesses, and allowance for contingency and administrative and legal costs. Construction costs in Table 4-2 associated with the new runway include mobilization, relocated items, demolition, earthwork, drainage, utilities, paving, radar, lighting, navaids, engineering, and an allowance for contingencies. Environmental remediation requirements have not been identified at this stage of planning, and therefore those costs are not included.

Detailed cost estimates were provided by P&D Aviation to the Port of Seattle in a memorandum dated April 21, 1995 and supplemental data prepared April 26, 1995. The cost estimates contained in Table 4-2 were summarized from these data sources. The estimated cost of the 7,000 foot runway is $307.7 million. The estimate cost of the 7,500 foot runway is $345.4 million, approximately 20 percent greater than the 7,000 foot runway option. The estimated cost of the 8,500 foot runway option is $405.6 million, approximately 18 percent greater than the 7,500 foot runway option.

SUMMARY OF OPTIONS EVALUATIONS

Terminal Options Summary

The North Unit Terminal Option clearly ranks above the South Unit Terminal and Central Terminal Options. Although the Central Terminal Option is ranked best under three criteria, the North Unit Terminal Option ranks equal or better than the Central Terminal Option in all of the remaining 15 evaluation criteria. No weighting has been given to the criteria in Table 4-1. Nevertheless, the North Unit Terminal Option would generally be viewed as superior to the other options.

Runway Options Summary

As Table 4-2 indicates, the 8,500 foot runway would clearly perform best in aeronautical terms. An 8,500-foot runway would be sufficiently long to accommodate 99 percent of all arrivals by the types of aircraft projected for Sea-Tac and 90 percent of departures by the types of aircraft projected for the Airport. Furthermore, the pilot rejection rate is expected to be minimized. For these reasons an 8,500-foot runway would provide maximum efficiency in aircraft flow and therefore allow the greatest benefit in minimizing aircraft delays.

Although the 8,500-foot option would be more expensive and have slightly greater environmental impacts than the shorter runway options, the added expense of the 8,500 foot runway is financially feasible. Further, the incremental increase in environmental impacts must be weighed against the aeronautical benefits. A runway length of up to 8,500 feet, pending final design, is preferred as the ultimate runway development option.

Section 5
AIRPORT DEVELOPMENT RECOMMENDATIONS AND POLICY ISSUES

SECTION 5
AIRPORT DEVELOPMENT RECOMMENDATIONS AND POLICY ISSUES

RECOMMENDED MASTER PLAN DEVELOPMENT

As a result of the evaluations described in Section 4, Airport Development Alternative 3, a North Unit Terminal with a runway of up to 8,500-feet, is the recommended long-term Master Plan development. The recommended Airport Master Plan improvements are shown in Figure 5-1. Terminal improvements are illustrated in Figure 5-2.

Terminal Recommendation

The North Unit Terminal is superior to both the Central Terminal and the South Unit Terminal options for a number of reasons. Under this concept, several new gates could be added to Concourse A by 2000 with the new North Unit Terminal to be constructed in about fifteen to twenty years as dictated by level of service and actual demand. The North Unit Terminal option offers the following advantages over other terminal options:

- Lowest overall cost per new aircraft gate.
- Shorter walking distances from parking areas and curbs to the aircraft gates.
- Adequate curb frontage to meet future traveler demands.
- Minimizes vehicle congestion on the existing terminal drives.
- Minimizes traffic impacts in the City of SeaTac.
- Greater flexibility for aircraft gate and terminal expansion beyond the year 2020.
- Less aircraft taxiing congestion around the terminals.
- Preservation of the Alaska and Delta Airlines maintenance hangars and postponement of the need for full build out of the South Aviation Support Area (SASA) site.
- No impact to City of Sea-Tac tax base by virtue of no additional property acquisition.
- Less passenger disruption and inconvenience during construction.
- Connection to the Main Terminal by an extension of the STS shuttle.

Runway Length Recommendation

An 8,500-foot runway would maximize the operational benefit of having a second poor-weather arrival stream. A runway length of 8,500 feet offers several benefits when compared with the 7,000-foot and 7,500-foot options.

- Sufficient landing length for 99 percent of the types of aircraft anticipated to use Sea-Tac in the future (compared to 96 percent for a 7,500-foot runway and 91 percent for a 7,000-foot runway). This becomes increasingly important because more larger size aircraft will be using Sea-Tac.
- Lesser rejection by pilots opting to use the existing long runway. The Air Transport Association and extensive discussion with

airline pilots support an 8,500-foot runway for this reason.

- Increased aircraft delay savings potential by accommodating more aircraft types and by reducing air traffic controller work loads associated with pilot rejection and cross over "sorting" associated with different aircraft operational requirements.

- Sufficient departure length for 90 percent of the aircraft operations anticipated to use Sea-Tac in the future (compared to 85 percent for a 7,500-foot runway and 77 percent for a 7,000-foot runway) which provides increased operational flexibility for the overall airfield.

- Provides the highest safety margin during poor weather landings (which is when the runway would be used the most).

- Greater flexibility of aircraft operations if one of the other runways is closed for maintenance or an emergency. Maintenance costs on the existing runways could be reduced by reducing the need for expensive nighttime work as is currently done.

- The additional environmental impacts of an 8,500-foot runway are minimal and can be sufficiently mitigated, as described in the Environmental Impact Statement.

Facility Improvements

The Master Plan Update proposes the following facility improvements:

- A new Runway 16X-34X with a length up to 8,500 feet pending final design. The runway would be equipped to enable Category IIIb precision approaches on 16X with Cat I capability on 34X. Instrumentation improvements would include a glide slope, localizer, RVRs, PAPI, ALSF-II/ MALSR, and inner/middle,outer approach markers:

  - Relocation of the Airport Surveillance Radar (ASR) and Airport Surface Detection Equipment (ASDE)

  - Relocation of S. 156th Way and 154th Street South

- A midfield overnight aircraft parking apron between the new runway and Runway 16R-34L

- Construction of a new Air Traffic Control Tower and TRACON

- Installation of a Cat IIIb ILS on Runway 16L (localizer, glideslope, middle marker, and ALSF-II)

- Extension of dual parallel Taxiways A and B the full length of Runway 16L-34R and taxiway bridge over 188th Avenue South

- Removal of displaced threshold from Runway 16L

- Additional taxiway exits on existing runways

- Extension of Runway 34R by 600 feet and relocation of the glideslope

- Clearance, grading and development of expanded Runway Safety Areas at each runway end

- Limited expansion of 4-6 gates of Concourse A and the Main Terminal depending on configuration and use.

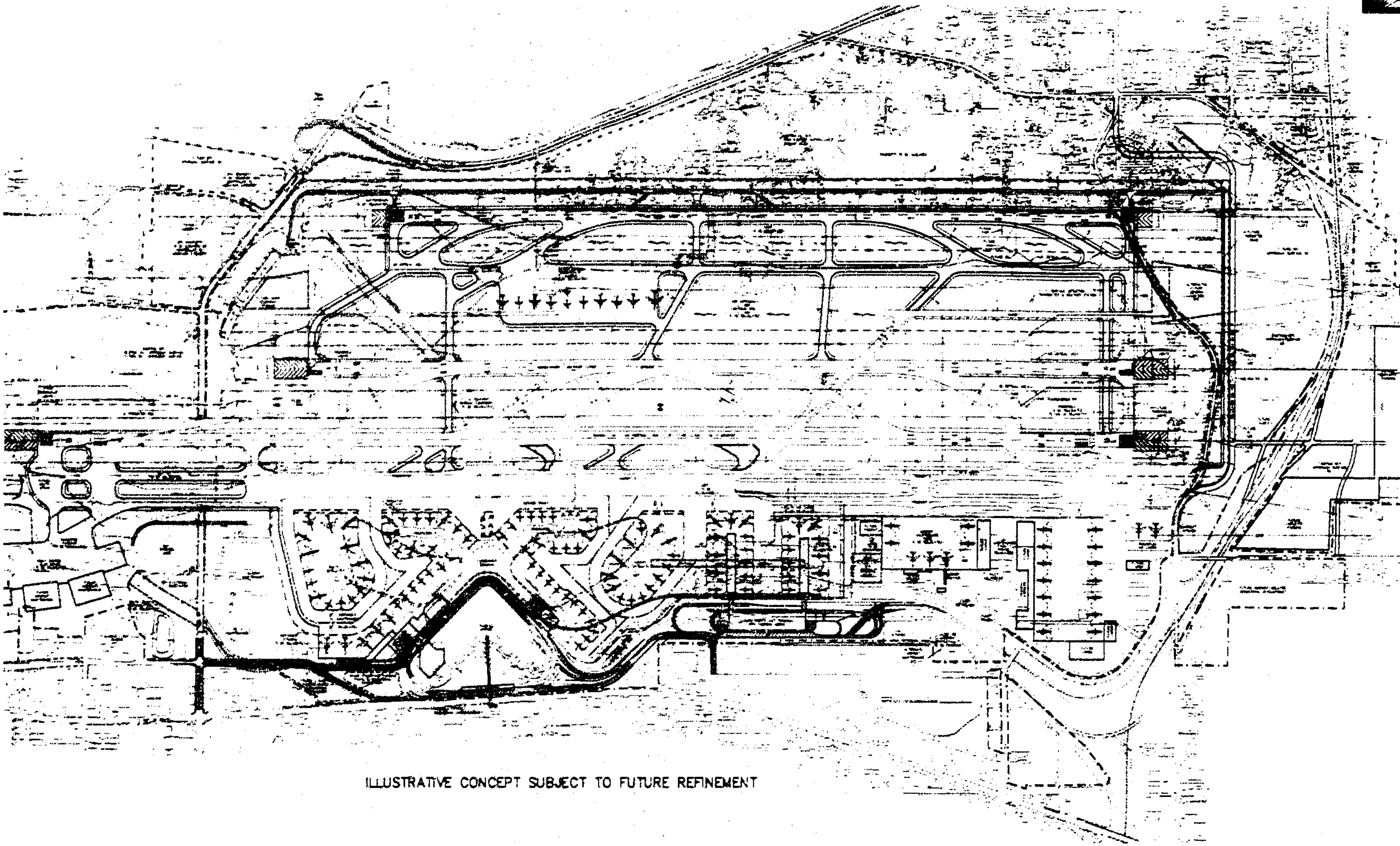
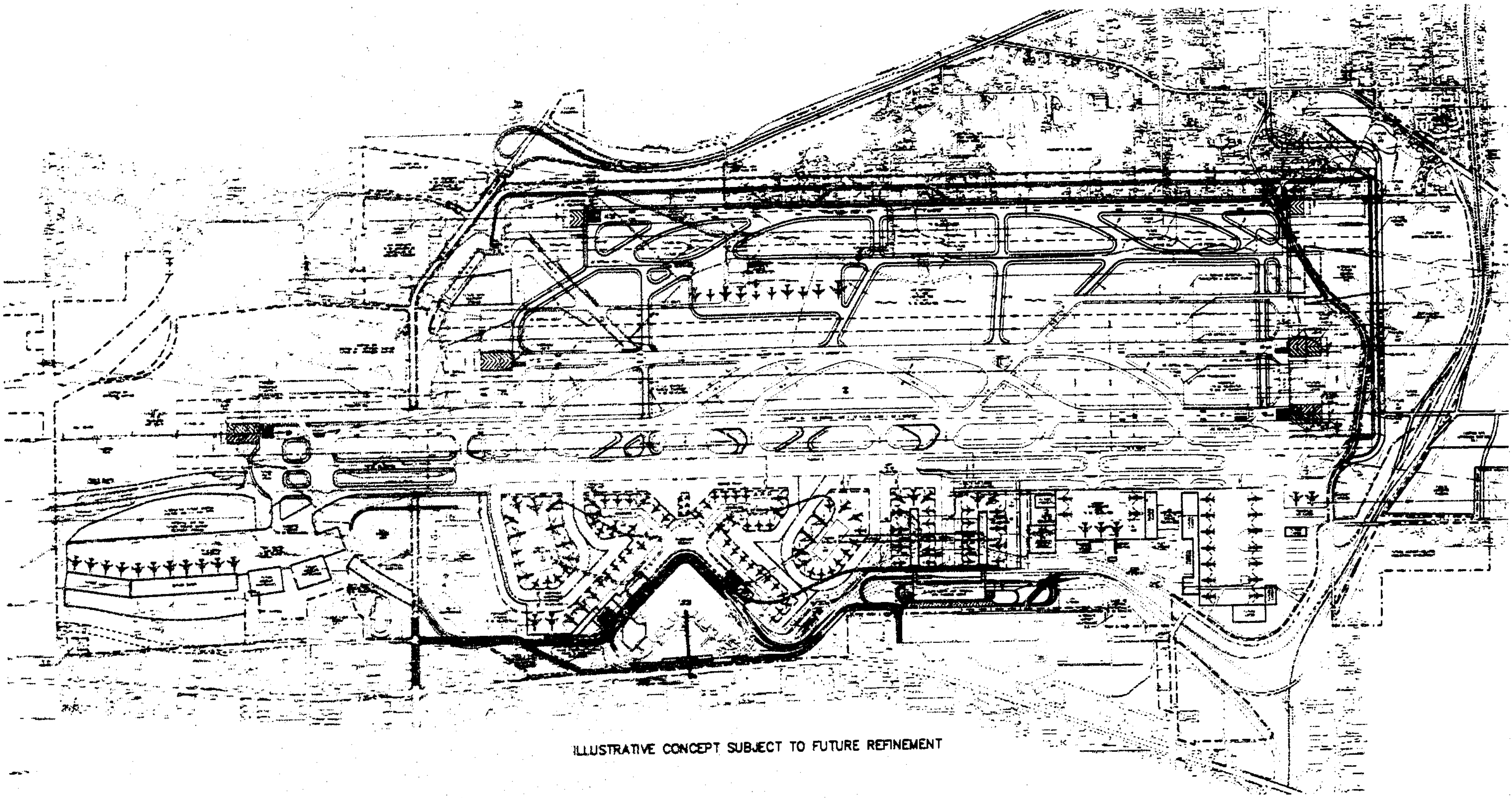


Figure 5-1
RECOMMENDED AIRPORT
MASTER PLAN



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RECOMMENDED
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- Relocation of Northwest flight kitchen, possibly to an area north of SR 518, if necessary
- Development of displaced Northwest aircraft maintenance facilities in the SASA if necessary
- Development of a by-pass roadway connecting the New North Unit Terminal with South 188th Street at 24th Street
- Expansion of the Central Parking Garage
- Development of an On-Airport hotel on Concourse D adjacent to the terminal

■ Development of the North Unit Terminal

- Development of the North Unit Terminal access system
- Development of access ramps from SR 518 at 20th Avenue for access to the existing cargo area and new cargo facilities
- Potential overhaul of the Satellite Transit System (currently under study)
- Displacement of the Doug Fox Parking facility
- Relocation of the U.S. Post Office Air Mail Facility to SASA
- Relocation of the ARFF to the existing UAL air cargo area

● Potential relocation of Airborne cargo for an alternate site for the construction of the Air Traffic Control facility

■ Development of the SASA:

- If required, relocate Northwest hangar
- Expansion capacity for cargo/maintenance
- Cargo facility for 11 hardstand positions
- Ground support equipment area
- Replacement of Air Mail Facility

■ Development of additional airport employee parking north of SR 518 west of 24th Avenue South

■ Development of a new airport maintenance facility

■ Development of a new snow equipment storage site between the RPZs of Runways 34L and 34X (subject to a study currently underway for approval of this site)

■ Development of new general and corporate aviation facilities in SASA or alternatively between the RPZs of Runways 16R and 16X (subject to further detailed study)

DESCRIPTION OF MASTER PLAN RECOMMENDATIONS AND POLICY ISSUES

Recommended Master Plan improvements are described below. Relevant policy issues associated with the airport development recommendations are addressed.

Airside Improvements (Figure 5-1)

Recommended Master Plan airside improvements consist of new taxiway exits to Runway 16L-34R, a 600-foot extension of Runway 16L-

34R, extensions of Taxiways A and B, expansion of Runway Safety Areas (RSAs) and Runway Object Free Areas (ROFAs) for Runways ·L, 34R and 16R, a new parallel runway and associated taxiways, navaids for the new runway, and new overnight (RON) aircraft parking.

Taxiway Exits to Runway 16L-34R. Under a three-runway configuration, Runway 16L-34R is expected to be used frequently as an arrival runway, especially during poor weather conditions and peak arrival periods. In light of this, enhancements of exits to Runway 16L-34R are recommended to reduce the weighted average runway occupancy time (WAROT).

It should be noted that extensive development of exit taxiways for the present primary arrival runway (16R-34L) has recently been completed. These improvements have significantly reduced ROT. Over time, as increased use of Runway 16L-34R for arrivals occurs, changes in taxiway geometry to improve exit performance should be considered.

In south traffic flows, runway occupancy times for Runway 16L can be substantially reduced by adding 30° exits located 5,568 and 7,756 feet from the landing threshold. Earlier in the planning analysis an assessment of runway exits was performed using a simulation model called REDIM (Runway Exit Design Interactive Model). Briefly described, for a given mix of aircraft, the model simulates landing operations and quantifies runway occupancy time, exit utilization, as well as identifying optimal exit locations. The model simulates landing operations and measures ROT from the time an aircraft crosses the landing threshold to the time it clears the runway. Based on a number of modelling runs using the existing taxiway configuration for Runway 16L and the long range aircraft fleet mix, reductions of ROT on the order of 20 percent were identified as possible through the addition of the above stated two exits.

The simulation indicated that most aircraft are capable of regularly exiting at the "Broad Ramp" (Taxiway N), except for B747 and MD-11, especially during wet runway conditions. The shorter exit would allow many aircraft currently turning off at Taxiway N to exit earlier, while the longer exit would also permit most B747s and MD-11s to exit earlier.

Likewise, in north traffic flows, substantial reductions in ROT were identified as possible by adding turnoffs at approximately 5,500 and 7,700 feet from the present landing threshold of Runway 34R. Ultimately, these can be implemented by expanding Taxiways M and J to provide a 30° exit geometry.

The additional exits will allow aircraft to clear the runway sooner, and thus provide greater opportunities to release departures.

It should be noted that these improvements should not be confused with recently constructed exit taxiways on Runway 16R-34L. However, in south flows, the locations of the proposed exits for Runway 16L correspond with locations of recently constructed runway turnoffs for Runway 16R (Taxiways M and P). Therefore, similar reductions in ROT should accrue. Full realization of the ROT reduction would depend on traffic volumes and ground traffic flows (use of dual parallel taxiways and Broad Ramp).

These improvements are intended for implementation in later development phases of the planning program (approximately 2011 to 2015), as the fleet mix changes and activity levels rise. As such, the benefits of the proposed exits should be reevaluated in view of factors such as aircraft mix, operational efficiency, aircraft performance, runway utilization, etc., prior to implementation. Since an extension of the end of Runway 34R is planned for the same general time frame, the final location of exit taxiways must also be reconciled with the ultimate location of the runway threshold.

Extension of Runway 16L-34R. It is recommended that Runway 16L-34R be extended from 11,900 feet to 12,500 feet. The 600-foot runway extension would be at the south end. It would provide the runway length required at Sea-Tac to accommodate the full range of aircraft and weather conditions.

Extension of Taxiways A and B to Full Length of Runway 16L-34R. Dual parallel taxiways are proposed east of Runway 16L-34R for the full length of the runway due to the increasing need for opposite direction taxiing. By providing unidirectional dual parallel taxiways, interference with opposite flow traffic is minimized. A partial dual parallel system exists for the north half of the airfield (Taxiways A and B North). The apron on the west side of the passenger terminal presently is used as a dual taxiway for narrow-body aircraft. However, the apron pavement is not marked for dual taxiways.

The projected density of traffic in the terminal area suggests that dual taxiway capability on the terminal apron will be necessary in the future. The depth of the terminal apron under the Master Plan recommendations will be increased to allow a dual taxiway capability for aircraft up to Aircraft Design Group (ADG) IV on Taxiway A and ADG V on Taxiway B, provided that aircraft parking at some gates in Concourses B and C are limited to certain aircraft models. The arrangement of aircraft parking positions would need to be modified as well as the configuration of loading bridges. This could involve replacement, removal or modification of some loading bridges. In addition, there may be modifications required to the end of Concourse C to ensure that the line of sight from the north ATCT site is maintained if it is selected. As such, the V/IV configuration is planned for the out years and when the North Terminal is fully operational.

Table 5-1 indicates the affected gates and the aircraft that could be parked with Taxiway A designed to ADG IV standards. The aircraft models indicated as being accommodated are typical of the mix of aircraft contained in the forecasts of air traffic activity previously presented in Technical Report No. 5. Note that the end of Concourse C adjacent to Taxiway A would be limited to commuter aircraft gates. A controlled survey will need to be conducted to verify the aircraft gate sizes that could be accommodated with dual taxiway capability.

Pertinent criteria for taxiway separations are:

	Aircraft Design Group	
	IV	V
Taxiway centerline to parallel taxiway/taxilane centerline (feet)	215	267
Taxiway centerline to fixed or movable object (feet)	130	160

As depicted on Figure 5-1, the proposed dual taxiway system will ultimately allow the following categories of aircraft to taxi simultaneously in opposite directions:

- From the Runway 16L threshold to the future North Unit Terminal location; ADG V on both taxiways.
- From the future North Unit Terminal location to the end of Concourse C: ADG V on Taxiway A and ADG IV on Taxiway B or ADG IV on Taxiway A and ADG V on Taxiway B.

TABLE 5-1
AIRCRAFT ACCOMMODATED AT SELECTED SEA-TAC GATES WITH PROPOSED DUAL PARALLEL APRON TAXIWAYS [a]

Gate	Accommodated Aircraft
B7	B727, B737-500/300/400, MD80, MD90, A319, A320, B757-200, B767-200, A310, A321
B9	B737-500/300/400, MD80, A319, A320, A321
B11	B727, B737-500/300/400, MD80, MD90, A319, A320, A321, A310
C6	B737s, B727, MD80, MD90, A320, A319
C8	B737-500/300/400, A319, A320, A321
C10	B737-500/300/400, MD80, A319, A320, A321
C12	B737-500/300/400, B727, A319, A320
C14	B737-500
C16	ATR 72, RJ 70/85
S12	B727, B737-500/300/400, MD80, MD90, A319, A320, A321, A310, B757-200

[a] A controlled survey is needed to verify this information.

Note: Aircraft accommodated assumes airport service road is relocated outside taxiway object free area for a parallel apron taxiway, Taxiway A, designed to ADG IV standards and Taxiway B designed to ADG V standards.

- From the end of Concourse C to the south end of the terminal apron: ADG IV on Taxiway A and ADG V on Taxiway B.

- From the south end of the terminal apron to the Runway 34R threshold: ADG V on both taxiways.

It is proposed that this taxiway system be implemented between Runway 16L and the south end of the terminal apron when the first phase of the North Unit Terminal is constructed (Phase 3) or sooner if traffic and resulting delays warrant it. The percentage of ADG IV aircraft (e.g., B767, B757, MD-11, A300) and ADG V aircraft (e.g., B747, B777, MD12, A340, A330) in the air carrier passenger mix of Sea-Tac is projected to increase in the future:

Aircraft Design Group	Percent of Air Carrier Passenger Operations 1993	2000	2010	2020
III	73.8	68	59	50
IV	25.6	30	37	45
V	0.6	2	4	5
	100.0	100	100	100

Therefore, there will be a increasing need for opposite direction taxiing of aircraft adjacent to the terminal by ADG IV and V aircraft.

As an interim measure, the Port is currently considering marking the terminal apron to provide a dual taxiing capability for ADG V/III operating configuration in Phase 1. Because this would be an interim measure, reflectors could be considered rather than lights for taxiway illumination. Implementation of this interim measure will require further coordination with the FAA and airlines. Longer term impacts of an ultimate ADG V/IV configuration would involve a revised aircraft parking plan and modification, removal or replacement of loading bridges. Additionally, impacts to Concourse C would have to be considered.

Runway Safety Areas and Runway Object Free Areas. A runway safety area (RSA) is defined as a rectangular area centered about the runway that is cleared, drained, graded and usually turfed. Under normal conditions, this area should be capable of accommodating occasional aircraft that may veer off the runway, as well as fire fighting equipment. For Sea-Tac, the requirement for the RSA is an area 500 feet wide centered on the runway centerline and extending 1,000 feet beyond each runway end.

The existing runway safety areas for Runways 16L, 16R and 34R do not meet current FAA criteria. The existing RSA for Runway 34R is 535 feet long and 500 feet wide. The Runway 16L RSA is 700 feet long with varying widths from 180 to 500 feet. The RSA for Runway 16R is 645 feet long with the width varying from 180 to 500 feet. The reasons for not meeting the FAA standards are steep terrain and/or the presence of roads at the ends of the runways.

In addition to dimensional standards, FAA has established longitudinal and transverse gradient standards for safety areas. For the first 200 feet of RSA beyond runway ends the longitudinal grade must be between zero and three percent with any slope being downward from the runway end. For the remainder of the extended RSA the maximum longitudinal grade is such that no part of the runway safety area penetrates the approach surface as specified in FAR Part 77. The maximum longitudinal grade allowed is 5 percent. Transverse (lateral) grades are limited to between 1.5 and 5 percent with the maximum recommended to promote drainage.

The runway object free area (ROFA) is a two dimensional ground area surrounding the runway. Its clearing standard precludes parked aircraft and objects, except objects whose location is fixed by function. At Sea-Tac, the ROFAs extend 400 feet on either side of the runway centerlines, along the entire length of runways and 1,000 feet beyond each end.

The following objects are located within the ROFA at Sea-Tac:

- Runway 16R - road (South 154th Street).
- Runway 16L - road (South 154th Street), localizer transmitter building and ALS regulator building.
- Runway 34L - localizer antenna and equipment shelter, RVR transmissometer and receiver, VORTAC and rotating beam ceilometer (RBC).
- Runway 34R - ALS substation.

With the exception of the road, all object locations are fixed by function and related to navaids and airport electronic equipment. Therefore, these navaids and electronic equipment are allowed to be within the ROFAs by FAA standards. The Master Plan recommends that the RSAs and ROFAs be modified to fully comply with FAA criteria.

To obtain compliance with FAA standards full 1,000 foot RSAs and ROFAs are proposed beyond the present Runway 16L and 16R ends. This approach will require fill material to maintain necessary grades and relocating South 156th Way/South 154th Street to the north but will not require the relocation of the thresholds of Runways 16L and 16R in order to provide adequate safety area.

The RSA for Runway 34R will be extended to the south. To accomplish this, additional fill material will be required to maintain the necessary grades. Furthermore, the existing approach light towers and electrical systems in the RSA area must be modified. The RSA for Runway 34L has been extended to 1,000 feet.

New Parallel Runway and Associated Taxiways. The Master Plan recommendations include the construction of a new runway up to 8,500-foot by 150-foot pending final design, 2,500 feet west of Runway 16L-34R. The north end of this runway would be in alignment with the north ends of the existing runways. It is recommended that construction begin in Phase 1. South 154th Street/South 156th Way will be relocated to the north. With the north threshold of the new runway located as described above, 8,500 feet is the maximum length obtainable to comply with RSA and ROFA standards.

The layout of the runway and associated taxiway system for the new runway was developed by the HNTB Corporation (Seattle-Tacoma International Airport, Third Dependent Runway, Preliminary Engineering Report, Volumes 1 and 2, First Draft, March 31, 1994). The HNTB Preliminary Engineering Studies include topography and soils investigations, roadway and utility relocations, and other factors which potentially would be involved in the construction of the new runway.

Navaids. The 2,500-foot separation between outboard runways is sufficient to permit parallel ILS approaches. To provide maximum IFR benefits, each end of the new runway would be equipped for precision instrument approaches. Since Runway 16L will be equipped for Category IIIb approaches if a new runway is constructed, and adequate separation will exist between it and the new runway, it is recommended that the new runway also be equipped for Category IIIb approaches. This will permit parallel Category IIIb ILS approaches and thus enhance capacity during periods of extremely low visibility (less than

800 feet RVR). Use of Runway 16R as the Category IIIb runway should continue in the interim until such time that demand indicates the need for dual, low visibility arrival streams.

Overnight Aircraft Parking Apron. An aircraft parking apron for overnight (RON) aircraft will be located between Runway 16R-34L and the new runway. The RON apron construction will be split between Phases 1 and 2. The RON apron will ultimately be approximately 1,800 feet long and 550 feet wide. Due to Federal Aviation Regulations (FAR) Part 77 restrictions, the remote parking ramp will not accommodate aircraft with tail heights greater than that of the B767.

Terminal Improvements (Figure 5-2)

Upon reviewing the various terminal development options for Sea-Tac, the North Unit Terminal concept was selected as the most appropriate for the future development of terminal facilities. During the process of this review, the North Unit Terminal concept was refined, to include two concourses extending from the North Unit Terminal rather than an extension of the North Satellite. While this concept reflects a consensus among Airport staff and the Master Plan team regarding the most appropriate direction for further terminal development at Sea-Tac, it should be recognized that this concept has been developed to only a preliminary level of detail. As such, it should be considered a general plan for further terminal development at the airport leading to more definitive design and engineering studies in the future as the identified projects are initiated. For example, ultimate expansion of the North Unit Terminal (beyond 2020) could include a third concourse to the north. Although this area is proposed for development of ARFF and Air Traffic Control facilities, their configuration and design could possibly be developed to accommodate a third concourse.

Ongoing studies including those of the future use of the STS system, traffic demand management, and others will provide valuable information which may be incorporated in the further design of terminal facilities at the airport. In addition, future changes in passenger demand, airline service, and the regulatory environment may all create opportunities for further refining of this concept to more closely meet the needs of all airport users.

Finally, the conclusions of the master plan should not preclude continued enhancements and improvements to the existing terminal facilities. Rather, they define a broad range of future conditions which should be considered when making interim improvements. The following sections provide a summary of those conditions, as well as issues which may require further study.

Aircraft Gates and Ramp Area. The initial airside expansion of the North Unit Terminal option is the extension of the existing Concourse A to the south providing for between 4 and 6 additional widebody and narrowbody gates. This concourse extension requires the demolition of the existing Northwest hangar area but does not impact the Delta and Alaska maintenance facilities and ramp areas to the south of the terminal. Development of the Concourse A extension should recognize the potential for its development as an international arrivals concourse, should the FIS be relocated to the Concourse A location. In this regard, any design for Concourse A should consider the possibility of a future mezzanine level to provide for a secure passenger corridor as well as design of vertical circulation near each gate which may permit cross-utilization by either international or domestic traffic.

At some point in the future, when activity levels require, the ramp area directly west of the terminal will need reconfiguration to create two parallel taxiways. Because of the proximity to Concourses B and C, the outer taxiway will provide for design Group V (B747 sized) aircraft, and the inner will be limited to design Group IV (MD-11 and smaller) aircraft. This configuration will also limit the size of aircraft parked on Concourses B and C to narrowbody aircraft only, with the end of Concourse C further limited to commuter aircraft. This reconfiguration will also likely require the relocation and/or replacement of a number of loading bridges along the west side of Concourses B and C in order to serve the revised aircraft positions. Airlines located along these gates providing widebody service will require relocation elsewhere at the airport.

Use of the terminal by potential future very large aircraft (VLA) with a wingspan of greater than 213 feet have been provided for at the west ends of the South and North Satellites only. Because these aircraft would primarily serve long-haul international traffic, these locations should prove adequate. Use of the terminal area taxiways by these aircraft would require special procedures to be established by the FAA, and would inevitably require the temporary closure or restrictions on the use of the future inner parallel taxiway.

The North Unit Terminal concept consists of two pier-type concourses on an east-west axis, each providing a mix of between 10-15 widebody and narrowbody gates. A third concourse to the north could potentially be added. The concept provides for B747 parking on the west ends, widebody aircraft parking on the outer sides of the north and south concourses, and B757 parking elsewhere between the concourses. A dual B757 taxilane has been provided between the concourses which could also be converted to a single widebody taxilane with widebody parking alongside. The concourse to the south would share the taxilane currently serving the North Satellite and Concourse D. The North Unit Terminal concourses would be connected via pedestrian bridges to terminal facilities located to the east across the North Access Freeway.

The sizing and positioning of these concourses has been planned to allow construction of the south concourse, while maintaining ongoing operations at facilities immediately to the north. Construction of the concourses in this area, however, will require relocation of the existing ARFF facility as well as closure of the non-secure service road.

During the terminal planning process, the potential for a 3 pier variant of the North Unit Terminal was identified. This variant is desirable in that it provides additional terminal expansion flexibility. This flexibility should be protected when designing future improvements. Therefore, it is recommended the final designs for the control tower and ARFF facilities should protect the possibility of an eventual third pier expansion wherever possible.

The New North Unit Terminal. The initial terminal concept itself may be developed as a relatively conventional two level terminal, with adjoining parking (possibly above), served by an upper and lower level roadway, but several unique conditions must be accommodated due to its position on the site. The most significant of these is the alignment of the North Airport Access Freeway which separates the concourses from the terminal. This condition necessitates that all passenger and baggage movement between the terminal and concourses be accommodated via bridges or tunnels crossing the on-grade alignment of the North Airport Access Freeway. Given the geometry of the site, the most likely configuration for the terminal is to provide for outbound baggage handling in either a sub-grade level with vehicular tunnels connecting the terminal to the apron areas, in an interstitial level between ticketing and baggage claim, on the ramp underneath the concourses, or in a combination of these locations. From an interstitial level, baggage could be transported to and from the ramp via conveyors mounted alongside the pedestrian bridges.

Ticketing, concessions and other passenger services would be provided at the level of the upper terminal curb. Enplaning passengers would flow directly from ticketing, across the pedestrian bridges to the concourses without needing to change levels. Depending on the concession layout desired and any ultimate connection to the STS system, security screening could be located at either the terminal or the concourse.

Baggage claim and arrival services would be provided at grade facing the lower level terminal curb. If necessary or desirable, a full floor or mezzanine could be created above the ticketing lobby to provide for Port and tenant offices.

Passenger and Baggage Connection Between the North Unit Terminal and Main Terminal. Passenger and baggage movement between the North Unit Terminal and the existing terminal will be provided along one of three general alignments. While the exact design and system will be contingent on the ultimate design of the facilities themselves as well as the outcome of ongoing studies by the Port, provision for these three means of connecting the North Unit Terminal and main terminal should be preserved in any future development areas to the north of the existing terminal. The first alignment is that of a tunnel connecting a midpoint of the concourses to the North Satellite. As envisioned in the Master Plan, this tunnel would accommodate secure passenger movement between the North Satellite and North Unit Terminal via moving sidewalks. Passengers wishing to continue on to the Existing Terminal would do so via the existing STS system. Alternatively, this connection might be made via an extension to the north loop of the STS system.

The second preserved alignment is that for an extension of the existing STS shuttle to a point near the base of each of the two new piers. Because the existing STS system operates from the secure side of the terminal, the connections at the North Unit Terminal would need to be on the secure side of the concourse or the area in the main terminal reconfigured to non-secure. In addition to the STS system, provision for one or more high-speed baggage conveyors and/or a dedicated service road in each direction should be provided to enable transfer of connecting passenger baggage between the two buildings.

The third connection between the two terminals would be via the surface roadway system using regularly scheduled shuttle vehicles and would provide for non-secure transportation of passengers and employees between the two buildings.

It should be noted that the ultimate use of the STS is uncertain. An independent study is currently underway which will examine in detail the preferred long term plan for passenger conveyance systems. The conclusions may be variants of concepts shown in this Master Plan. As such, the alignments indicated on plans in this report are conceptual. The final alignments and systems will depend on the STS study recommendations and design of the systems as well as the needs of airlines who will use the terminal.

North Unit Terminal Roadways. The location of the terminal will require the demolition of the existing bridge connecting the North Airport Access Freeway with the airport service road and 170th Street. Access from

170th Street will need to be integrated into the design of the terminal roadways, while the service road providing access to the north end of the main terminal will require relocation, elimination, or conversion for other uses. As this service road is located along one of the terminal connecting alignments noted previously, its redesign should be an integral consideration of eventual STS extension or inter-terminal baggage movement.

Roadway access to the terminal from the North Airport Access Freeway is from the northwest in order to retain a conventional right-handed passenger loading area at the two level terminal curbside. The exit roadways allow the vehicles to exit the terminal in both the northbound and southbound directions. The southbound exit also provides a ground transportation connection between the North Unit Terminal and the Main Terminal but will require more detailed engineering to provide for all of the various horizontal, vertical, and merging vehicular movements required in this confined location.

Short term, daily, and some rental car parking will be provided in structural parking levels directly above the terminal building which will be accessed directly from helical ramps off of the terminal curbside. The parking exits will be provided on the north of the terminal, with provisions for traffic to exit to both the north and south.

Modifications to the Existing Terminal. The existing terminal will require various ongoing modifications and upgrades over time to allow it to serve the traveling public well into the next century. Many of these were identified in the Terminal Development Plan (TDP) prepared in 1991. The most notable of these recommendations included substantial improvements to the main outbound and interline baggage system, relocation of the Federal Inspection Services (FIS) facility to Concourse A, and extensions to both the North and South Satellites and Concourse A. Changes in the TDP recommendations which impact the existing terminal include the elimination of the North and South Satellite extensions, retention of the FIS in the South Satellite, and the inclusion of a future hotel on the north end of the terminal complex.

Because of the somewhat constrained airfield geometry at the North Unit Terminal, the South Satellite and/or Concourse A remain the most viable locations for accommodating the large aircraft typical of international activity. In the longer term, expansion of the terminal to the south is also anticipated to provide for improved ticketing and baggage claim facilities to serve domestic passengers. While an extension of Concourse A was previously considered as a potential location for a relocated FIS facility in the TDP, practical considerations have resulted in this concept being dropped in favor of maintaining FIS operations at its existing location at the South Satellite. The original intention of this relocation was to eliminate the need for double-handling of bags and to provide for a more pleasant arrival experience for international passengers. The limited area for Group V aircraft along Concourse A, combined with the significant cost required to replace this facility resulted in an interest on the part of the Port to maintain continued use of the existing FIS facility. Furthermore, current trends and forecast activity levels suggest that the existing FIS facility has, or may be adapted to provide, sufficient capacity to accommodate international arrivals activity throughout the master plan timeframe. Ongoing operational improvements combined with the potential for a dedicated passenger and baggage tunnel for arriving international passenger movements to the main terminal may provide opportunities for qualitative improvements in the arriving international passenger experience.

However, in the interest of maintaining maximum flexibility, it is suggested that the Port maintain the potential for the relocation of FIS facilities to the south end of the terminal adjacent to Concourse A. As a result, any future development and design of Concourse A should consider the ability to adapt those gates for use at some future time into an international arrivals facility. This primarily means consideration of a sterile passenger connector on the mezzanine level of the concourse and some provision for a vertical core to serve them. It is therefore suggested that this issue be reviewed in further detail and a final determination on the ultimate location of the FIS be made during the design of the Concourse A or any terminal expansion to the south.

As a part of the Concourse A extension, some accommodation of outbound baggage sortation will need to be made to replace that currently performed in part of the Northwest hangar facilities. While these facilities may be relocated on the ramp underneath the Concourse A extension, design of this extension should be consistent with a comprehensive plan for the long-term development of the south extension of the terminal building. In addition, expansion of the existing security screening area will likely be required to facilitate the higher passenger volumes entering Concourse A.

Access, Circulation and Parking Improvements (Figures 5-1 and 5-2)

Vehicular traffic to the airport is projected to double by 2020 when the 38 MAP activity level is reached, growing from about 87,000 vehicles per day in August 1994 to over 160,000 vehicles in 2020. Therefore, a number of roadway, access, circulation, parking, and transportation policies are recommended. These recommendations complement the development of a North Unit Terminal as well as the other recommended improvements.

Roadway Access Improvements and Issues. Roadway access improvements recommended in the Master Plan and related policy issues are described below.

- The North Access Road has the greatest traffic moving capacity of any facility serving the terminal area and will remain at acceptable service levels at the 38 MAP level. Since 70 percent of all airport users and visitors come from this direction, the North Unit Terminal will intercept traffic without impacts to other area roadways and will reduce traffic volumes before reaching the Main Terminal complex area.

- Access from SR 99 and areas south of South 188 Street will be constrained, although the North Unit Terminal will alleviate future congestion on SR 99 and South 188 Street somewhat. A number of traffic improvements at intersections adjacent to the existing terminal complex on these two roads can reduce congested intersection operations to acceptable levels.

  The POS recognizes the importance of SR 509 extension and the proposed South Airport Access Road and supports this development. It is a regionally significant improvement to the freeway system. Both facilities must work in concert to provide true traffic relief from areas south of the airport complex, which is subject to increased congestion not only due to airport traffic, but considerable growth based on local and regional land use patterns and roadway plans and programming.

- The North Unit Terminal placement will require a change to the access to the north cargo area. A proposed new SR 518 interchange on the north side of the airfield is proposed to provide access to the north cargo area, plus the relocated employee parking area, and possible other development opportunities in the vicinity of South 24th Avenue. This new interchange will have to be designed so it works with existing interchanges at SR 99 and Des Moines Memorial Drive, plus the constraints placed by SR 518's alignment and adjacent topography.

- Major improvements are recommended for the access ramps and upper and lower curbside roadways at the Main Terminal. The North Unit Terminal option will improve the traffic flow pattern at the Main terminal when the airport is at 38 MAP. Phasing of substantial increases in parking and support facilities for public use, rental cars, and employees will be provided.

- While the north unit terminal will absorb 30 percent of all passenger activity, the central terminal will still have more passengers than it does today, and connections for access to and from the south of the terminal are sensitive local and regional issues. To accommodate passengers coming from south of South 188th Street, the terminal roadway system would be extended southward. This can be done to link to the proposed South Access Road, or the proposed 24th/28th Avenue connection leading to South 188th Street. Thus, inbound passengers from the south will enter the terminal area at South 188th Street, placing them on the terminal roadway system rather than using SR 99 (the SR 99 entry point will be used only by transit vehicles to reduce congestion on International Boulevard). To compliment this movement a southbound roadway, decked over the northbound existing roadway east of the parking garage complex is proposed. If other roads are built, and the southbound deck is not, then all traffic going south from the North Unit Terminal would: use the already congested curbside roadways in from the main terminal building to go south; or use SR 99 to go south. Without this southbound roadway, congestion in the most congested portion of the terminal complex would be unacceptably increased, or SR 99, the most sensitive regional roadway would have to handle southbound traffic from the North Unit Terminal.

- While the North Unit Terminal plan shows that access to the terminal complex from 170th Street and a new interchange to be developed on SR 518 would provide connections to Air Cargo Road and the employee parking facility on South 28th Avenue at SR 518, other options need to be examined in detail. These proposed improvements have some impacts that other concepts might alleviate.

  Access options could include developing 160th Street as an access point and eliminating 170th Street, and the need to consider the SR 518 interchange in conformance with Washington State DOT and Federal Highway guidelines for limited access highway interchange spacing and development. In addition, traffic conditions on SR 99 could be impacted by any of these options and proper connections to roadway improvements south of the terminal complex have to be addressed as they reach final development stages. On-airport traffic improvements and traffic mitigation will require constant attention to design and traffic flow issues both in the vicinity of the existing terminal and as refinements to the North Unit Terminal concept.

Circulation Issues. Circulation issues related to Master Plan improvements are discussed below.

- The future status of regional rail or City of Sea-Tac people mover facilities are not clear, however all terminal improvement schemes allow integration or connections to these potential rail systems. It is important to appreciate that with or without rail facilities, regional access is a major issue. The placement of regional rail systems has not alleviated access problems in most other American cities with rail service to airports. The local people mover system has other impacts and potential benefits but are within the City of Sea-Tac and are not regional in nature.

- Regional park-and-fly systems, using express buses from large parking areas 10 or more miles from airport terminals have been shown in the United States and Europe to be more effective than regional rail systems, when using HOV express lanes, in getting passengers to leave their cars far away from airport terminal areas. Likely candidate areas are those sections of the Puget Sound region far from the terminal, near major roadways that can intercept travelers well before the airport area. Express shuttle service to park-and-fly lots have been shown capable of absorbing 20 percent of passenger traffic from specific high demand corridors when coupled with easy parking access, low parking rates and high quality transit service. Actual operations can be by public or private agencies, often at break-even operating cost.

- Transportation Demand Management (TDM) strategies can reduce both employee and private passenger vehicular traffic by up to 20 percent through a number of different coordinated actions. Employee trips can be managed through parking pricing, car pooling programs, and ridesharing incentives. Experience has shown that park-and-fly lots, congestion pricing, improved transit services, private transit vehicle access charges, and balancing parking rates to optimize traffic can reduce private vehicle traffic to the terminal area.

  The Port of Seattle, the City of SeaTac and Metro are currently working together to explore ways to improve public transit service at the airport and to help Metro implement its Six Year Transit Development Plan, 1996-2001. Improved public transit service could reduce single-occupant vehicles accessing the terminal and reduce traffic congestion on arterial roads near the airport and the region. Metro's Six-Year Plan identifies the City of SeaTac area as a transit hub location and Sea-Tac Airport as a major regional destination. Potential public transportation improvements include enhancements to the current airport bus stop and alternative locations for a transit hub at or near the airport. Discussions are expected to continue as Metro implements the Six-Year Plan.

- Rental car activity, both on-site and off-site, plus the siting of parking areas both on and off-site can impact overall vehicle traffic at the terminal and in the immediate surrounding areas. Transit connections from off-site private operations are a major source of traffic based on actual facility location, with private autos and transit vehicle both using the same location on roadways near the terminal. Working with the City of Sea-Tac to implement congestion reducing traffic policies and regulating off-site facilities can help improve traffic flow on arterial roads near the terminal.

Parking Improvements. The following improvements in airport parking are recommended.

- On-site parking for both short and long term parking should increase from the current level of about 7,500 spaces all in the Main Terminal to about 14,800 total spaces to meet the demand placed by 38 MAP. Thus, considerable parking garage expansion and some opportunities for remote on-site parking are called for.

  Parking will be allocated to meet passenger demand at both the existing terminal and new North Unit Terminal. This will allow the POS to handle 50 percent of the projected parking demand without TDM strategies. Congestion reduction strategies would call for remote park and fly lots, plus remote parking areas located in areas around the airfield and off-site that minimize traffic congestion and site traffic problems.

- Rental Car facilities will be expanded from the approximately 1,400 spaces now in the Main Terminal parking garage for both ready car areas and car preparation area(s) to nearly 3,100 spaces for ready-car area and about 25 to 30 acres for vehicle quick-turn-around preparation. To minimize traffic congestion off-site, all these facilities should be located on-site. All 2020 plans allocate the 3,100 ready car spaces among the terminal parking facilities based on terminal passenger traffic for the three terminal expansion options. Quick-turn-around auto preparation areas now inside and next to the main parking garage could be relocated to other areas on-site to reduce the cost of housing these facilities while minimizing traffic impacts on adjacent arterials if located off-site.

- Employee parking is subject to changes in airline and terminal employment. While projected to grow from about 10,000 jobs today to about 17,000 jobs by 2020, recent trends suggest that this employment expansion could be optimistic. The current 4,100 spaces provided for employees would grow to match employment trends.

  To reduce capital outlay, recent surveys of employee parking show that one parking space per three (3.0) employees, rather than the current practice of one space for every 2.5 employees, could be used to reduce the total amount of employee parking in the future. However this formula would still require an added 1,400 spaces for employee parking to meet projected demand.

  Because of the phased nature of long-term expansion of the terminal, cargo, and aircraft maintenance programs, new sites for existing employee parking are required. Concentrating most, or all, employee parking north of SR 518 at South 24th Avenue would be desirable from traffic flow impacts and long-term shuttle bus operations.

Other Facility Improvements (Figure 5-1)

Air Cargo Facilities. Future air cargo needs will be met by modifying and expanding the existing cargo area north of the passenger terminal and constructing additional cargo facilities in SASA after 2010.

It was determined that the area between the present United cargo building and POS maintenance building offered the greatest opportunity for expanding parking for cargo aircraft. In order to accomplish this it is necessary to remove the POS maintenance building. This building is one of the oldest in the cargo area and its use is inconsistent with the cargo function. By redeveloping the apron in this area an additional two aircraft parking positions will be created. The following highlights the phasing plan for expansion of cargo facilities at the Airport. All cargo building construction will be done by private entities in response to market demands. An illustration of a potential phasing plan is as follows.

- ***Phase 1 (1996-2000)***

  Construct a cargo building (240,000 square feet) on the south side of the main cargo apron.

- ***Phase 2 (2001-2005)***

  - Construct a new POS Airport maintenance facility at the site of the existing Cater Air flight kitchen east of the North Airport Access Freeway or alternately west of the North Access Freeway near Concourse D.
  - Demolish the POS maintenance building.
  - Demolish United Airlines maintenance building.
  - Modify Alaska Air Cargo and Air Freight Distribution Center buildings to allow construction of hardstand area for seven widebody (DC-10 sized) aircraft.
  - Construct hardstand.
  - Construct cargo building (81,000 square feet) on the north side of the newly constructed hardstand area.
  - Expand Transiplex A to the south (25,125 square feet).
  - Construction new Transiplex warehouse (25,000 square feet).

- ***Phase 3 (2006-2010)***

  - Construct a cargo building (80,000 square feet) east of the main hardstand area.

- ***Phase 4 (2011-2015)***

  - Begin development of cargo facilities in SASA. It is noted that the existing Delta cargo terminal will be relocated because of ultimate passenger terminal expansion in this phase. While development of SASA for cargo use can be deferred until Phase 4, construction of cargo facilities earlier should be considered under certain circumstances. An example would be if a cargo carrier desires to significantly expand operations at the Airport.

- ***Phase 5 (2016-2020)***

  - Expand SASA cargo facilities.

Airline Maintenance Facilities. The SASA site is the recommended location for replacing airline maintenance facilities lost due to cargo area construction (United Airlines maintenance facility) or terminal expansion (Northwest Airlines maintenance facility in Phase 1) and the addition of new airline maintenance facilities. The SASA site provides sufficient area for the development of maintenance facilities and does not conflict with recommended air cargo and passenger terminal improvements. Figure 5-1 shows all recommended and potential functions in the SASA site to indicate that there is available space if demand exists and alternate sites are not selected.

Airport Rescue and Fire Fighting (ARFF). The ARFF facility must be relocated to allow the construction of the North Unit Terminal. It is recommended that the new ARFF building be located on the site presently occupied by United Airlines' air cargo facility, immediately north of the new North Unit Terminal.

Based on analysis contained in the Seattle-Tacoma International Airport Third Dependent Runway Preliminary Engineering Report (HNTB, March 1994), it was determined that this location will support response time requirements contained in FAR Part 139. This requires that at least one firefighting vehicle be able to reach the midpoint of the farthest runway and begin application of fire retardant within 3 minutes from the time of alarm. Within 4 minutes from time of alarm, all other firefighting vehicles shall be capable of reaching the midpoint of the farthest runway and begin application of fire retardant.

The design of the ARFF building should consider possible northern expansion of the North Unit Terminal with a third concourse. All efforts should be made, where practical, to develop a design that avoids precluding such terminal expansion. It is also important that the design consider unimpeded access for vehicles responding to emergency alarms.

General and Corporate Aviation Facilities. General and corporate aviation facilities at Sea-Tac are the Signature Flight Support facility and the Weyerhaeuser corporate flight department. Signature, the only fixed-base operator doing business at the Sea-Tac, fuels and parks general aviation aircraft. Weyerhaeuser maintains a hangar and fueling facilities for its own aircraft and rotorcraft. Signature must be relocated to extend Taxiway A to the south and Weyerhaeuser must be relocated for the construction of the parallel runway. While both operators can generically be categorized as general aviation uses, they are independent operations and do not have to be moved to the same location on the airport. In fact, the operations are quite different in that Signature services the public, whereas, the Weyerhaeuser hangar is intended for company aircraft. The ultimate location of these facilities will depend on the operators' desire for expansion, and financial ability to support relocation.

In the siting analysis of facilities, two locations were identified for these uses. These were SASA and a north end location between the RPZs of Runway 16R and a new runway. Due to questions on the timing of SASA development and development costs of the north location, the two sites are retained to provide flexibility for the potential relocation of these facilities.

Subsequent to the completion of the siting analyses, the Port also indicated that there may be potential on the west side of the new runway for development of a corporate aviation hangar. The configuration of such development will depend on the final design of the new runway, Part 77 imaginary surfaces, navaid critical areas, and earthwork. The location may also be suitable as a possible replacement for View Point Park.

The option of expanding the Signature Flight Support area to accommodate future FBO requirements is not feasible. The site will be severely impacted by object free area clearances and a service road associated with the recommended development of a dual south parallel taxiway.

Lastly, there may also be some future opportunities in the southeast corner of the terminal area around the Delta hangar. This will depend on the final disposition of the hangar which at the time of this writing has not been determined.

Air Traffic Control Tower and TRACON. A new air traffic control tower and TRACON at Sea-Tac is proposed by the FAA. Two alternative sites have been identified by the "Air Traffic Control Tower Siting Study" conducted by HNTB: a location in the area of the existing Airborne Freight building, and a site at the end of Concourse B. The existing control tower would remain for ramp control. The new control tower is scheduled for development during Phase 1. If the new control tower is constructed in the cargo area, the roof at the end of Concourse C would need to be lowered to provide adequate line of site to a Group V/IV configuration along Taxiways A and B.

Both locations would give the controllers a clear line of sight to all runway thresholds, departure queues and holding aprons.

Flight Kitchens. The Northwest Airlines Flight Kitchen will be relocated in Phase 2 due to terminal expansion to the south. The United Airlines flight kitchen could be impacted by terminal roadway development for a North Unit Terminal. The facility presently totals 65,000 SF and was constructed in 1990. Only a small portion of the building would be required for roadway development. It also appears possible that a roadway alignment that avoids the flight kitchen is feasible. It should also be noted that the above described roadway development would be implemented in later phases consistent with the timing of the North Unit Terminal.

Space will be available for relocated flight kitchens in the area north of State Highway 518 and east of 24th Avenue South. These parcels are east of the area identified for future employee parking. Uses shown for the site are airport maintenance and remote cargo warehouses. Sufficient area would be available to accommodate relocated flight kitchens and the other uses considered such as a cargo warehouse or airport maintenance.

Aviation Fuel Storage Facility. Planned future eastside airport facilities will not effect the location of the main fuel storage tanks. New underground fuel storage tanks to supply the new hydrant system at the expanded terminal will be integrated into the hydrant system design.

The truck fill stand will require expansion to improve the road geometry for the large refueler trucks. A new truck fill stand is also planned in the vicinity of the new North Unit Terminal. Only commuter aircraft and all-cargo aircraft will be fueled by trucks.

Airport Maintenance Facility and Snow Equipment storage. It is recommended that the existing airport maintenance facility be relocated to allow cargo aircraft apron expansion. There are several opportunities on the airport to develop a new maintenance area. The building plus parking, fueling and vehicle wash rack could be developed on a 4 to 5 acre plot, having direct access to the airfield. A building area of approximately 65,000 SF is required. The existing facility, which totals 50,000 SF, does not adequately address existing requirements. Possible sites would include the area east of the north access freeways, (Cater Air), and the southeast corner of the terminal area around the Delta hangar. The latter will depend on the final disposition of the hangar, which as yet, has not been determined.

Another site suggested as a possible location for an airport maintenance facility is the old fuel farm located off the end of Concourse D. While the location may be attractive in terms of STS maintenance, the ultimate use of the site is dependent on the disposition and proximity of operational fuel facilities. More importantly, the location does not provide sufficient area to develop required facilities and would mix airport maintenance related traffic with terminal traffic.

Additional space will be required for storage of snow removal equipment. FAA AC 150/5220-18, Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials, suggests an area of approximately

1,000 SF per vehicle. Based on the 26 present vehicles a building totalling approximately 50,000 SF would be adequate for vehicle and material storage (this area requirement will be verified in subsequent study). A south field location near the threshold of Runway 34L has been identified for the snow equipment storage facility.

Development of SASA

As seen from prior discussion, SASA is intended to accommodate several other future facility requirements (cargo, aircraft maintenance, possibly general aviation). The eventual development of this site for these uses will rely on certain factors. While the site remains an option for providing space for facilities that will be relocated or expanded as a result of continued growth, the following should be noted.

SASA is currently listed in the airport CIP for site design and construction beginning in 1999. However, it will be very expensive to develop, and incurring expensive site preparation costs would likely require the commitment of a major tenant/user such as a maintenance base or cargo facility operator. It is not likely that smaller operators, such as general aviation, would consider such an investment required for the initial development of SASA.

Also, the displacement of certain facilities identified in the Master Plan will not necessarily result in their eventual replacement. Final decisions to build replacement facilities will rest with private companies (airlines, operators, etc.) and other agencies. The required space to accommodate these facilities is protected in the Master Plan at the SASA location, but the actual build-out of SASA will depend on demands of operators who may or may not choose to build replacement facilities.

As envisioned in the SASA Final Environmental Impact Statement (FEIS) completed in March 1994, the relocation of Des Moines Creek and the related stormwater detention ponds must begin two years prior to SASA site work. Unless this requirement were to be altered through discussions with permitting agencies, there is a four-year lead time before the site would be available for aviation use.

Since the timing of SASA development is uncertain, where possible, alternative sites for certain relocations have been identified. This will permit relocations in the event that demands materialize before the development of SASA.

Westside Land Use

Should a new parallel runway be constructed, some vacant land would result in the acquisition area. This land would have excellent development potential for airport compatible uses (as noted on the official future airport layout plan. At this time the Port of Seattle does not have specific development plans for these areas and is coordinating with the City of SeaTac in the development of the West SeaTac Subarea Plan.

PHASING OF IMPROVEMENTS

The following identifies the general phasing schedule for Master Plan Update improvement projects (moving sidewalk alternative):

- Phase 1, 22-24 million passengers (1996-2000):
  - Acquisition of property for new runway and RPZs
  - Begin construction of the new parallel Runway 16X - 34X and associated taxiways and navaids. Construction will continue into Phase 2.

- Completion of RSA upgrades for existing runway ends
- Expansion of Concourse A
- Overhaul of Satellite Transit System (STS) and addition of STS vehicles (currently under study)
- Development of On-Airport hotel
- Relocation of Airport Surveillance Radar (ASR) and Airport Surface Detection Equipment (ASDE)
- Relocation of South 156th Way and 154th Street South
- Construction of the first phase of a midfield overnight aircraft parking apron between Runways 16R-34L and 16X-34X
- Potential relocation of Northwest aircraft maintenance facilities to SASA if necessary, depending on tenant needs and site availability.
- Potential relocation of Airborne cargo facilities for an alternate site for construction of a new Air Traffic Control Tower
- Construction of a new FAA Air Traffic Control Tower/TRACON
- Relocate general aviation and corporate aviation facilities if necessary to SASA or alternatively to an area between the RPZs of Runway 16L and 16X
- Development of new snow equipment storage site between the RPZs of Runways 34L and 34X
- Develop a site for ground support equipment
- Add spaces to Central Parking Structure for public and rental cars (about 1,700 spaces)
- Develop additional airport employee surface parking north of SR 518 west of 24th Avenue South
- Improve access and circulation roadways at the Main Terminal
- Development of a site for a new cargo facility on the south side of the main cargo apron

- Phase 2, 24-27 million passengers (2001-2005):
  - Expansion of Main Terminal at Concourse A
  - Construction of second phase of the midfield aircraft overnight parking apron between Runways 16R-34L and 16X-34X
  - Improve access and circulation roads at the Main Terminal, including a partial connection to the South Access Roadway scheme
  - Add spaces to the Central Parking Structure for public and rental cars (about 1,500 spaces)
  - Expand employee north parking lot
  - Develop new airport maintenance facility
  - Remove the existing airport maintenance facility

- Potentially relocate United Airlines maintenance facility to SASA, depending on tenant needs
- Redevelop main air cargo area by modifying and expanding existing cargo buildings, expanding hardstand areas and constructing new cargo buildings.

■ Phase 3, 27-31 million passengers (2006-2010):

- Development of the first phase of the new North Unit Terminal (South Pier)
- Development of the North Terminal roadways
- Additional improvements for the South Access Roadway connection scheme
- Extension of dual parallel Taxiways A and B to the south end of the existing terminal apron.
- Construct first phase of North Unit Terminal parking structure for public and rental cars (about 3,000 spaces)
- Expand employee north parking lot
- Develop an area for a new cargo facility east of the main cargo hardstand area and relocate United air cargo there or to SASA
- Provide upper roadway transit plaza at Main Terminal; restrict access from the SR 99 entrance/exit
- Relocate ARFF facility to the north of North Unit Terminal

■ Phase 4, 31-34 million passengers (2011-2015):

- Develop North Pier at North Unit Terminal and construct gates on south side of North Pier.
- Four additional taxiway exits on Runway 16L-34R
- Expand Central Terminal parking by about 500 spaces
- Expand north parking structure by about 1,800 spaces for public and rental cars
- Expand employee north parking lot
- Develop cargo and airline maintenance areas in SASA
- Relocate Delta cargo facilities to SASA
- Relocate the U.S. Airmail facility to SASA
- Develop connections to RTA system

■ Phase 5, 34-38 million passengers (2016-2020):

- Completion of North Unit Terminal (gates on north side of North Pier)
- Extend Runway 34R by 600 feet and extend dual parallel Taxiways A and B the full length of extended Runway 16L-34R and a taxiway bridge over 188th Avenue South
- Expand North Unit Terminal parking structure by about 1,800 spaces

- Expand employee north parking lot
- Expand SASA cargo facilities
- Complete connectors to south access roadway scheme.

The timing of Master Plan improvements will be triggered by passenger levels as identified above. The time periods indicated above correspond to the Master Plan Update forecasts. Passenger activity in 1994 exceeded the forecast as seen below:

	Total Passengers (Millions)	
Year	Actual	Projected
1993	18.8	–
1994	21.0	19.5
2000	–	28.8

If this trend continues, improvements would be needed sooner than the time periods indicated.

CAPITAL COST ESTIMATES OF RECOMMENDED IMPROVEMENTS

Capital cost estimates for the recommended Master Plan improvements are shown in Table 5-2. Costs are shown for five phases represented by ranges of passengers to be accommodated. The corresponding time period is shown based on the Master Plan Update forecasts.

Costs include property acquisition, relocations and demolition, construction, engineering and architectural services and allowances for contingencies and other costs not specifically itemized. Costs are shown in 1994 dollars for the following categories: Property Acquisition and Relocations, Airside Elements, Passenger Terminal Elements, Satellite Transit System (STS) Improvements, Roadway and Vehicle Parking Elements, and Other Landside Elements.

Costs are shown in the table for two assumptions to estimate a low and a high cost range of satellite transit system (STS) improvements:

- ***Moving Sidewalk Alternative.*** The lower STS cost estimate assumes the new terminal areas would be served by moving sidewalks and expanded curbside shuttle service, rather than the extension of existing STS lines. The STS system would be upgraded in the first phase by a major overhaul of existing vehicles and the procurement of seven new vehicles to increase the capacity of the system.

- ***STS Expansion Alternative.*** The higher STS cost estimate assumes the STS system would be upgraded as described above and in addition the existing shuttle systems would be expanded to serve the new terminal areas, replacing moving sidewalks as the primary means of inter- and intra-terminal passenger movements.

As previously stated, the ultimate passenger conveyance systems will be determined from an independent study of the STS which is presently underway.

Note that not all costs reported here would likely be borne by the Port. Specifically, costs of a new air traffic control tower, TRACON facility and navaids are typically funded by the FAA through the FAA's Facilities and Equipment (F&E) program (although some navaids costs may be borne by the Port). These typical F&E costs, Items B10 and F5 in Table 5-2, are assumed to be funded totally by the FAA in the financial feasibility analysis, described in Section 6. Furthermore, all costs associated with the development of site improvements (such as roads and aprons, but not buildings) for new air cargo, aircraft maintenance, and corporate aviation facilities are conservatively included in Table 5-2 and the financial analysis,

TABLE 5-2

CAPITAL COST ESTIMATES FOR RECOMMENDED AIRPORT MASTER PLAN IMPROVEMENTS, 1996 TO 2020 (NORTH UNIT TERMINAL / 8,500-FOOT RUNWAY OPTION) SEA-TAC INTERNATIONAL AIRPORT [a]

Item No.	Description	Estimated Cost in Thousands of 1994 Dollars					
		Total	Phase 1 (22-24 MAP)	Phase 2 (24-27 MAP)	Phase 3 (27-31 MAP)	Phase 4 (31-34 MAP)	Phase 5 (34-38 MAP)
A	*PROPERTY ACQUISITION AND RELOCATIONS*						
A1	RUNWAY AREA [b]	91,420	91,420	0	0	0	0
A2	TERMINAL AREA	0	0	0	0	0	0
	ITEMIZED PROPERTY ACQUISITION AND RELOCATIONS COST	91,420	91,420	0	0	0	0
	CONTINGENCIES AND ADMINISTRATIVE / LEGAL COSTS (20%)	18,284	18,284	0	0	0	0
	TOTAL PROPERTY ACQUISITION AND RELOCATIONS COST	109,704	109,704	0	0	0	0
B	*AIRSIDE ELEMENTS*						
B1	MOBILIZATION	14,975	10,950	350		150	3,525
B2	RELOCATED ITEMS						
	Southwest Suburban Miller Creek Interceptor	1,962	1,962	0	0	0	0
	Sewer Dist. Local Service Abandonment	38	38	0	0	0	0
	Seattle Water Dept. Watermain Relocation	1,744	1,744	0	0	0	0
	Port of Seattle Sanitary Sewer Relocation	156	156	0	0	0	0
	Water Dist. No 20 Local Service Abandonment	17	17	0	0	0	0
	Water Dist. No 49 Local Service Abandonment	18	18	0	0	0	0
	Water Dist. No 125 Local Service Abandonment	15	15	0	0	0	0
	Wash. Natural Gas Local Service Abandonment	16	16	0	0	0	0
	Miller Creek	4,960	4,920	0	0	0	0
	Subtotal	8,924	8,924	0	0	0	0
B3	DEMOLITION						
	Demolition of Small Structures	838	838	0	0	0	0
	Demolition of Weyerhaeuser Hangar	179	179	0	0	0	0
	Demolition of Airfield Pavement	34	34	0	0	0	0
	Demolition of Streets and Roads	102	102	0	0	0	0
	Demolition of Miscellaneous Utilities	250	250	0	0	0	0
	Subtotal	1,402	1,402	0	0	0	0
B4	EARTHWORK						
	Clearing and Grubbing	220	220	0	0	0	0
	Erosion Control	150	150	0	0	0	0
	Common Excavation	9,300	9,300	0	0	0	0
	Borrow - Zone A	21,000	21,000	0	0	0	0
	Borrow - Zone B	69,200	69,200	0	0	0	0
	Borrow - Zone C	18,750	18,750	0	0	0	0
	Subtotal	118,620	118,620	0	0	0	0

Item No.	Description	Estimated Cost in Thousands of 1994 Dollars					
		Total	Phase 1 (22-24 MAP)	Phase 2 (24-27 MAP)	Phase 3 (27-31 MAP)	Phase 4 (31-34 MAP)	Phase 5 (34-38 MAP)
B5	DRAINAGE						
	Conveyance System	6,893	3,447	3,447	0	0	0
	Flow Diversion	1,265	1,265	0	0	0	0
	Detention Ponds	20,456	10,228	10,228	0	0	0
	Subtotal	28,614	14,940	13,675	0	0	0
B6	ON-SITE WATER						
	Lateral Water Lines	108	108	0	0	0	0
	Trunk Water Lines	725	725	0	0	0	0
	Hydrants	5	5	0	0	0	0
	Subtotal	838	838	0	0	0	0
B7	ELECTRICAL						
	Restoration of Sea-Tac Third Metering Point	523	523	0	0	0	0
	Rerouting of Main Telephone Service	800	800	0	0	0	0
	Modifications to Airfield Lighting in Control Tower	100	100	0	0	0	0
	Modifications to Stop Bar in Control Tower	250	250	0	0	0	0
	Rearrangement of Control Panels in Control Tower	75	75	0	0	0	0
	Vault Building	150	150	0	0	0	0
	Vault Building Generators	280	280	0	0	0	0
	Vault Building Regulators	320	320	0	0	0	0
	Electrical System	1,300	650	650	0	0	0
	Runway Lighting	3,570	1,785	1,785	0	0	0
	Taxiway Lighting	3,653	1,596	1,597	0	276	184
	Stop Bar/Hold Bar Lighting	316	158	158	0	0	0
	Airfield Signs	665	0	665	0	0	0
	Utility Work	400	400	0	0	0	0
	Subtotal	12,202	6,887	4,855	0	276	184
B8	PAVING						
	Runway Pavement	5,668	2,834	2,834	0	0	0
	Taxiway Pavement	9,888	4,434	4,434	0	1,020	0
	Runway Shoulder Pavement	513	256	256	0	0	0
	Taxiway Shoulder Pavement	1,300	617	617	0	66	0
	Blast Pad Pavement	151	75	75	0	0	0
	Perimeter Road and Airfield Access Roads	308	308	0	0	0	0
	Parking Apron Pavement	4,800	2,400	2,400	0	0	0
	Apron Shoulder	78	39	39	0	0	0
	Road Relocations for Airfield Improvements	900	900	0	0	0	0
	Subtotal	23,605	11,863	10,655	0	1,086	0
B9	RUNWAY EXTENSION AND RSA IMPROVEMENTS						
	Runway 16L Safety Area and Road Relocation	5,000	5,000	0	0	0	0
	Runway 34R Safety Area and Road Relocation	9,350	9,350	0	0	0	0
	Runway 16R Safety Area and Road Relocation	12,250	12,250	0	0	0	0
	Runway 34L Safety Area and Road Relocation	0	0	0	0	0	0
	Extension of Runway 16L and Taxiways A & B (600')	13,740	0	0	0	0	13,740
	Subtotal	40,340	26,600	0	0	0	13,740

Item No.	Description	Estimated Cost in Thousands of 1994 Dollars					
		Total	Phase 1 (22-24 MAP)	Phase 2 (24-27 MAP)	Phase 3 (27-31 MAP)	Phase 4 (31-34 MAP)	Phase 5 (34-38 MAP)
B10	RADAR AND NAVAIDS (c)						
	ASR Relocation	2,000	1,000	1,000	0	0	0
	ASDE Relocation	350	175	175	0	0	0
	North Approach Glide Slope	600	0	600	0	0	0
	South Approach Glide Slope	600	0	600	0	0	0
	North Approach Localizer	600	0	600	0	0	0
	South Approach Localizer	600	0	600	0	0	0
	RVR Facilities	300	0	300	0	0	0
	North Approach Markers (Outer)	175	0	175	0	0	0
	South Approach Markers (Outer)	175	0	175	0	0	0
	VASI	100	0	100	0	0	0
	Approach Lighting - North Approach (ALSF-2)	1,500	0	1,500	0	0	0
	Approach Lighting - South Approach (ALSF-1)	1,500	0	1,500	0	0	0
	Subtotal	8,500	1,175	7,325	0	0	0
B11	MISCELLANEOUS						
	Bridge Structures	750	750	0	0	0	0
	Retaining Walls	3,051	3,051	0	0	0	0
	Fencing	210	0	210	0	0	0
	Seeding	225	0	225	0	0	0
	Landscaping	40	0	40	0	0	0
	Subtotal	4,276	3,801	475	0	0	0
	ITEMIZED AIRSIDE ELEMENT COST	262,298	208,000	37,335	0	1,512	17,[illegible]
	ALL OTHER CONSTRUCTION ITEMS (20%)	50,759	40,965	6,002	0	302	3,[illegible]
	SUBTOTAL	313,056	248,965	43,337	0	1,814	20,90[illegible]
	ENGINEERING AND CONTINGENCIES (15%)	45,683	36,869	5,402	0	272	3,141
	TOTAL AIRSIDE ELEMENT COST	358,738	283,834	48,739	0	2,086	24,0[illegible]

Item No.		Description	Estimated Cost in Thousands of 1994 Dollars					
			Total	Phase 1 (22-24 MAP)	Phase 2 (24-27 MAP)	Phase 3 (27-31 MAP)	Phase 4 (31-34 MAP)	Phase 5 (34-38 MAP)
C		***PASSENGER TERMINAL ELEMENTS***						
	C1	EARTHWORK	4,153	0	210	2,105	995	843
	C2	DEMOLITION	18,280	7,000	1,280	2,640	7,360	0
MOVING SIDEWALK ALTERNATIVE	C3	TERMINAL CONSTRUCTION						
		New Construction	229,480	16,200	39,200	90,560	50,400	33,120
		Renovation	12,000	7,680	4,320	0	0	0
		Subtotal	241,480	23,880	43,520	90,560	50,400	33,120
	C4	TERMINAL APRON						
		Pavement	24,492	1,755	1,560	11,011	4,465	5,681
		Hydrant Fueling System	25,652	1,166	1,166	16,907	3,498	2,915
		Subtotal	50,144	2,921	2,726	27,918	7,963	8,596
	C5	SPECIAL EQUIPMENT						
		New Loading Bridges	14,520	660	660	9,570	1,980	1,650
		Inbound Baggage	6,000	0	900	3,000	0	2,100
		Outbound Baggage	10,560	0	960	6,960	1,440	1,200
		Moving Sidewalks	8,640	2,700	1,620	2,520	1,800	0
		FIDS/BIDS	3,388	154	154	2,233	462	385
		Security System	5,737	405	960	2,264	1,260	828
		Subtotal	48,845	3,919	5,274	26,547	6,942	8,163
		ITEMIZED PASSENGER TERMINAL ELEMENT COST	362,902	37,720	53,010	149,770	73,680	48,722
		CONTINGENCIES AND OTHER CONSTRUCTION ITEMS (25%)	90,725	9,430	13,253	37,443	18,420	12,181
		SUBTOTAL	453,627	47,150	66,263	187,213	92,099	60,903
		ENGINEERING / ARCHITECTURAL SERVICES (10%)	45,363	4,715	6,626	18,721	9,210	6,090
		TOTAL PASSENGER TERMINAL ELEMENT COST	498,990	51,865	72,889	205,934	101,309	66,993
D		***SATELLITE TRANSIT SYSTEM (STS) IMPROVEMENTS***						
MOVING SIDEWALK ALT	D1	VEHICLE OVERHAUL/PURCHASE	35,210	35,210				
	D2	LINE EXTENSION	0					
	D3	MAINTENANCE FACILITY	0					
	D4	WAYSIDE AND CONTROL ROOM	20,000	20,000				
		ITEMIZED STS IMPROVEMENT COST	55,210	55,210	0	0	0	0
		CONTINGENCIES AND OTHER CONSTRUCTION ITEMS (25%)	13,803	13,803	0	0	0	0
		SUBTOTAL	69,013	69,013	0	0	0	0
		ENGINEERING / ARCHITECTURAL SERVICES (10%)	6,901	6,901	0	0	0	0
		TOTAL STS IMPROVEMENT COST	75,914	75,914	0	0	0	0

STS EXTENSION ALTERNATIVE

Item No.		Description	Total	Phase 1 (22-24 MAP)	Phase 2 (24-27 MAP)	Phase 3 (27-31 MAP)	Phase 4 (31-34 MAP)	Phase 5 (34-38 MAP)
			Estimated Cost in Thousands of 1994 Dollars					
C		***PASSENGER TERMINAL ELEMENTS***						
	C1	EARTHWORK	3,431	0	210	1,704	674	843
	C2	DEMOLITION	18,280	7,000	1,280	2,640	7,360	0
	C3	TERMINAL CONSTRUCTION						
		New Construction	208,680	16,200	39,200	79,040	41,120	33,120
		Renovation	12,000	7,680	4,320	0	0	0
		Subtotal	220,680	23,880	43,520	79,040	41,120	33,120
	C4	TERMINAL APRON						
		Pavement	24,492	1,755	1,560	11,011	4,485	5,681
		Hydrant Fueling System	25,652	1,166	1,166	16,907	3,498	2,915
		Subtotal	50,144	2,921	2,726	27,918	7,983	8,596
	C5	SPECIAL EQUIPMENT						
		New Loading Bridges	14,520	660	660	9,570	1,980	1,650
		Inbound Baggage	6,000	0	900	3,000	0	2,100
		Outbound Baggage	10,560	0	960	6,960	1,440	1,200
		Moving Sidewalks	8,640	2,700	1,620	2,520	1,800	0
		FIDS/BIDS	3,388	154	154	2,233	462	385
		Security System	5,217	405	980	1,976	1,028	828
		Subtotal	48,325	3,919	5,274	26,259	6,710	6,163
		ITEMIZED PASSENGER TERMINAL ELEMENT COST	340,860	37,720	53,010	137,561	63,847	48,722
		CONTINGENCIES AND OTHER CONSTRUCTION ITEMS (25%)	85,215	9,430	13,253	34,390	15,962	12,181
		SUBTOTAL	426,074	47,150	66,263	171,951	79,808	60,903
		ENGINEERING / ARCHITECTURAL SERVICES (10%)	42,607	4,715	6,626	17,195	7,981	6,090
		TOTAL PASSENGER TERMINAL ELEMENT COST	468,682	51,865	72,889	189,146	87,789	66,993
D		***SATELLITE TRANSIT SYSTEM (STS) IMPROVEMENTS***						
	D1	VEHICLE OVERHAUL/PURCHASE	44,210	35,210		9,000		
	D2	LINE EXTENSION	37,200		10,510	26,690		
	D3	MAINTENANCE FACILITY	2,000			2,000		
	D4	WAYSIDE AND CONTROL ROOM	27,500	20,000		7,500		
		ITEMIZED STS IMPROVEMENT COST	110,910	55,210	10,510	45,190	0	0
		CONTINGENCIES AND OTHER CONSTRUCTION ITEMS (25%)	27,728	13,803	2,628	11,298	0	0
		SUBTOTAL	138,638	69,013	13,138	56,488	0	0
		ENGINEERING / ARCHITECTURAL SERVICES (10%)	13,864	6,901	1,314	5,649	0	0
		TOTAL STS IMPROVEMENT COST	152,501	75,914	14,451	62,136	0	0

STS EXTENSION ALT

Item No.	Description	Estimated Cost in Thousands of 1994 Dollars					
		Total	Phase 1 (22-24 MAP)	Phase 2 (24-27 MAP)	Phase 3 (27-31 MAP)	Phase 4 (31-34 MAP)	Phase 5 (34-38 MAP)
E	*ROADWAY AND VEHICLE PARKING ELEMENTS*						
E1	MOBILIZATION	3,200	589	992	645	618	361
E2	DEMOLITION - PAVEMENT						
	Road Demolition	287	0	0	287	0	0
	Bridge Demolition	720	0	0	720	0	0
	Building Demolition	2,362	0	0	2,362	0	0
	Subtotal	3,370	0	0	3,370	0	0
E3	ROADWAYS						0
	Access / Circulation Road at Grade	1,787	65	1,078	644	0	0
	Circulation Road on Structure	51,700	2,520	34,280	14,900	0	0
	Subtotal	53,487	2,585	35,358	15,544	0	0
E4	RETAINING WALL	182	0	182	0	0	0
E5	VEHICLE PARKING						
	Public/Rental Parking - South Structure	0	0	0	0	0	0
	Public/Rental Parking - Central Structure	38,900	25,250	13,650	0	0	0
	Public/Rental Parking - North Structure	60,940	0	0	12,820	30,450	17,670
	Public/Rental Parking - North Lot	0	0	0	0	0	0
	Employee Parking - North Lot	3,288	1,604	441	520	343	380
	Subtotal	100,128	26,854	14,091	13,340	30,793	18,050
E6	TRANSIT PLAZAS						
	Lower Roadway Transit Plaza	182	0	0	182	0	0
	Upper Roadway Transit Plaza	6,050	0	0	6,050	0	0
	Subtotal	6,232	0	0	6,232	0	0
E7	SIGNAGE AND LIGHTING	13,088	2,402	4,048	2,632	2,513	1,473
E8	LANDSCAPING	3,297	601	1,012	658	628	398
	ITEMIZED ROADWAY AND VEHICLE PARKING ELEMENT COST	185,916	33,030	55,663	42,420	34,550	20,252
	CONTINGENCIES AND OTHER CONSTRUCTION ITEMS (20%)	37,183	6,606	11,133	8,484	6,910	4,050
	SUBTOTAL	223,099	39,636	66,796	50,904	41,460	24,302
	ENGINEERING SERVICES (10%)	22,310	3,964	6,680	5,090	4,146	2,430
	TOTAL ROADWAY AND VEHICLE PARKING ELEMENT COST	245,409	43,600	73,476	55,994	45,606	26,732

Item No.	Description	Estimated Cost in Thousands of 1994 Dollars: Total	Phase 1 (22-24 MAP)	Phase 2 (24-27 MAP)	Phase 3 (27-31 MAP)	Phase 4 (31-34 MAP)	Phase 5 (34-38 MAP)
F	*OTHER LANDSIDE ELEMENTS*						
F1	MOBILIZATION	617	43	467	1	72	35
F2	AIR CARGO AREA SITE IMPROVEMENTS						
	Demolition of Buildings	4,187	1,011	3,176	0	0	0
	Demolition of Parking Pavement	27	0	0	27	0	0
	Aprons	10,180	416	4,776	0	3,300	1,588
	Access Road	314	89	0	9	198	18
	Security Fence	89	6	0	0	0	83
	Lighting and Signage	838	59	381	3	286	100
	Subtotal	15,836	1,581	8,333	39	3,784	1,898
F3	AIRLINE MAINTENANCE AREA SITE IMPROVEMENTS						
	Apron	1,960	1,104	0	0	856	0
	Taxiway Extension	0	0	0	0	0	0
	Access Road Extension	86	45	0	0	41	0
	Lighting and Signage	120	48	0	0	72	0
	Subtotal	2,166	1,197	0	0	968	0
F4	AIRPORT RESCUE AND FIREFIGHTING (ARFF) IMPROVEMENTS						
	Demolition of Buildings	2,440	0	0	2,440	0	0
	Building	2,400	0	0	2,400	0	0
	Vehicle Parking	13	0	0	18	0	0
	Access Road	9	0	0	9	0	0
	Apparatus Ramp	56	0	0	56	0	0
	Fencing	20	0	0	20	0	0
	Lighting	155	0	0	155	0	0
	Subtotal	5,088	0	0	5,098	0	0
F5	AIR TRAFFIC CONTROL TOWER (ATCT) [c]						
	Demolition of Buildings	900	900	0	0	0	0
	Access Road	9	9	0	0	0	0
	Vehicle Parking	18	18	0	0	0	0
	ATCT Facility	10,000	10,000	0	0	0	0
	TRACON Facility	10,000	10,000	0	0	0	0
	Fencing	26	26	0	0	0	0
	Lighting	3	3	0	0	0	0
	Subtotal	20,956	20,956	0	0	0	0
F6	GENERAL AVIATION / FBO AREA SITE IMPROVEMENTS						
	Taxiway						
	Apron	356	358	0	0	0	0
	Access Road Extension	54	54	0	0	0	0
	Security Fence	26	26	0	0	0	0
	Lighting	28	28	0	0	0	0
	Subtotal	462	462	0	0	0	0
F7	CORPORATE AVIATION SITE IMPROVEMENTS						
	Apron	133	133	0	0	0	0
	Access Road	34	34	0	0	0	0
	Taxiway	267	267	0	0	0	0
	Lighting and Signage	51	51	0	0	0	0
	Subtotal	485	485	0	0	0	0

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		Estimated Cost in Thousands of 1994 Dollars					
F8	AIRPORT MAINTENANCE AREA IMPROVEMENTS						
	Building	8,000	0	8,000	0	0	0
	Access Road	9	0	9	0	0	0
	Fencing	600	0	600	0	0	0
	Vehicle Parking	48	0	48	0	0	0
	Lighting and Signage	693	0	693	0	0	0
	Subtotal	9,350	0	9,350	0	0	0
F9	SNOW EQUIPMENT STORAGE IMPROVEMENTS						
	Building	4,000	4,000	0	0	0	0
	Access Road	9	9	0	0	0	0
	Fencing	40	40	0	0	0	0
	Vehicle Parking / Ramp	240	240	0	0	0	0
	Lighting and Signage	343	343	0	0	0	0
	Subtotal	4,632	4,632	0	0	0	0
F10	OSE SITE IMPROVEMENTS						
	Taxiway Extension	332	332	0	0	0	0
	Access Road	162	162	0	0	0	0
	Lighting and Signage	39	39	0	0	0	0
	Subtotal	533	533	0	0	0	0
	OTHER ITEMIZED LANDSIDE ELEMENT COST	59,933	29,889	18,149	5,138	4,824	1,933
	CONTINGENCIES AND OTHER CONSTRUCTION ITEMS (30%)	17,980	8,967	5,445	1,541	1,447	580
	SUBTOTAL	77,913	38,856	23,594	6,679	6,271	2,513
	ENGINEERING SERVICES (10%)	7,791	3,886	2,359	668	627	251
	TOTAL OTHER LANDSIDE ELEMENT COST	85,704	42,741	25,953	7,347	6,898	2,765
	TOTAL ESTIMATED MASTER PLAN COSTS						
	MOVING SIDEWALK ALTERNATIVE						
A	PROPERTY ACQUISITION AND RELOCATIONS	109,704	109,704	0	0	0	0
B	AIRSIDE ELEMENTS	358,738	283,834	48,739	0	2,088	24,080
C	PASSENGER TERMINAL ELEMENTS	498,990	51,865	72,869	200,934	101,309	68,993
D	SATELLITE TRANSIT SYSTEM (STS) IMPROVEMENTS	75,914	75,914	0	0	0	0
E	ROADWAY AND VEHICLE PARKING ELEMENTS	245,409	43,600	73,476	56,994	45,608	26,732
F	OTHER LANDSIDE ELEMENTS	85,704	42,741	25,953	7,347	6,898	2,765
	TOTAL	1,374,459	607,658	221,036	266,275	155,900	120,570
	STS EXTENSION ALTERNATIVE						
A	PROPERTY ACQUISITION AND RELOCATIONS	109,704	109,704	0	0	0	0
B	AIRSIDE ELEMENTS	358,739	283,834	48,739	0	2,068	24,080
C	PASSENGER TERMINAL ELEMENTS	468,682	51,865	72,889	189,148	87,789	68,993
D	SATELLITE TRANSIT SYSTEM (STS) IMPROVEMENTS	152,501	75,914	14,451	62,136	0	0
E	ROADWAY AND VEHICLE PARKING ELEMENTS	245,409	43,600	73,476	56,994	45,608	26,732
F	OTHER LANDSIDE ELEMENTS	85,704	42,741	25,953	7,347	6,866	2,765
	TOTAL	1,420,739	607,658	235,508	314,624	142,379	120,570

(a) Source: P & D Aviation

(b) Includes costs for full acquisition of Runway Protection Zone property, rather than avigation easements.

(c) Costs for these items are typically funded by the FAA through its Facilities and Equipment Program.

although some of these improvements may be paid for by the tenant.

While demolition costs are included, costs to reimburse airport tenants for existing hangars, cargo facilities, flight kitchens and other tenant improvements which must be relocated to allow for new construction have not been included due to the uncertainty of these costs. Costs of new tenant improvements are also excluded.

Environmental remediation requirements have not been identified at this stage of planning, and therefore those costs are not included.

Specific assumptions regarding costs in each category are itemized below.

- Property Acquisition and Relocation
  - The property acquisition and relocations cost for runway construction was taken from Table 5-11 in Technical Report No. 6, Airside Options Evaluation.

    Full acquisition costs for property and businesses in the south Runway Protection Zone of the new runway are included in Table 5-2 and the financial feasibility analysis. Currently, the Port and FAA are investigating whether full acquisition (rather than avigation easements) will be necessary and consequently property acquisition costs could be lower than identified in Table 5-2.
  - The property acquisition and relocations cost for the South Unit Terminal construction were preliminary estimates provided by Landrum & Brown. These costs were based on assessed value plus 25 percent with an additional 25 percent for relocation costs of property owners.
- Airside Elements
  - Costs for airside elements were taken from Table 5-6 (North Unit Terminal Option) and Table 5-10 of Technical Report No. 6, Airside Options Evaluation. These costs were modified (a) to include parallel Taxiways A and B at the south end of Runway 16L-34R, (b) to reduce the extension of Runway 34R from 900 feet to 600 feet and (c) to relocate South 154th Street to the north and provide full Runway Safety Areas at the north ends of Runways 16L and 16R.
  - Contingencies and engineering costs are not applied to navaids because they are included in the unit navaid costs.
- Passenger Terminal Elements
  - The passenger terminal requirements are described in Technical Report No.7A, Terminal Options Evaluation.
  - Terminal element costs do not include RTA station construction but do include estimates for transit center and/or supporting special equipment for the conveyance of people and baggage to and from the terminal which were not included in the original facility program (Technical Report No. 7A).
- Satellite Transit System (STS) Improvements
  - The STS is a major component of the existing terminal's people-handling capability, and an overhaul of the existing system is needed. Future expansion of the STS system can be weighed against costs for moving side-walks or other options. Short term STS

improvements included in the cost estimates are: (a) a major overhaul of the existing equipment, including the 24 vehicles, the wayside equipment and the control room and (b) increasing the existing fleet by seven vehicles to a total of 31 vehicles. Train size would be increased to three 3-car trains per existing loop and one 2-car train shuttle.

- The STS option involving extension of the STS line assumes increasing the fleet to a total of 39 vehicles and the extension of the shuttle line to the north to serve the new north unit terminal and to the south to serve the extension of Concourse A.

■ Roadway and Vehicle Parking Elements

- Roadway and vehicle parking improvements were described in Technical Report No. 7A, Terminal Options Evaluation (November 15, 1994) and Preliminary Traffic Study, Master Plan Update Impact Study Alternatives (January 30, 1995), although some revisions have been made since the publication of those documents. Parking improvements are described in Airport Parking System, Long Range Analysis, April 1995.

- Roadway costs associated with airside improvements are included under Airside Elements. Access costs associated with airline maintenance, cargo and other tenant areas are included under Other Landside Elements.

- Costs for the south access freeway tunnel (approximately 1,600 feet in length) are not included.

- Expansion of the central parking structure Sections A, B, C and D to nine floors is assumed to occur in Phase 1.

■ ***Other Landside Elements***

- Cost estimates for the new air traffic control tower and TRACON facility are preliminary numbers supplied by the FAA. Costs of new equipment are not included due to the uncertainty of requirements at this time.

- Access and site improvement costs for a new off-site regional ARFF training area are not included because a site has not yet been identified.

- Costs associated with airline maintenance and air cargo facilities do not include tenant improvements such as buildings but include site improvements such as utilities, ground access and airside access (taxiway/taxilane and aircraft parking apron).

The cost estimates exclude the on-going capital improvement program. The development projects would be funded by airport operating revenues as well as private and Federal funding. Funding from the following sources may be sought: FAA grant from the Aviation Trust Fund, Special Facility Bonds, General Airport Revenue bonds, and airline capital expenditures. General Airport Revenue Bonds would be issued by the Port of Seattle. Funding from the Aviation Trust Fund would be requested for capacity and airfield related projects as well as all other projects eligible under the program. The Aviation Trust Fund is funded primarily by a nationwide airline passenger ticket tax and cargo air bill tax. The Port of Seattle also anticipates the collection of user fees to fund expansion projects, such as the Passenger Facility Charge (PFC).

The following section describes the results of a financial analysis to assess the feasibility of funding the recommended improvements.

Section 6
FINANCIAL ANALYSIS

SECTION 6
FINANCIAL ANALYSIS

INTRODUCTION

The premise of the baseline capital program (Table 5-2) is that demand for new facilities (discussed in detail in Technical Report #5) is the primary determinant of overall Master Plan phasing. In reality, however, the phasing of the development program will be determined by both demand and the financial capacity of the Port to provide these new facilities on a timely basis.

The purpose of this analysis is to test the financial implications of developing the Master Plan according to the demand-driven phasing schedule. The results are evaluated in the context of the Aviation Division's overall financial capacity and using conservatively defined financial constraints, potential alternative program scenarios will be discussed. Toward this end this section is organized as follows:

- Definition of Baseline Capital Program
- Financial Structure and Capital Financing Resources
- Financial Analysis of Baseline Capital Program
- Strategies to Address Potential Financial Constraints
- Financially Constrained Scenario, An Illustrative Example
- Summary of Findings

BASELINE CAPITAL PROGRAM

The baseline capital program assumes construction of the North Unit Terminal with the moving sidewalk circulation system and the 8,500 foot runway, phased according to the demand for new facilities. The relationship between the activity at the airport and the demand for new facilities is governed by the definition of acceptable levels of service. The demand-driven phasing program is based on the Master Plan forecast of activity growth and an assumption that a high level of service will be maintained throughout the planning horizon. If it were deemed acceptable to develop to a lower standard of service, the phasing plan would need to be adjusted accordingly.

Table 6-1 presents the capital funding requirements based on the cost estimate and project phasing for this Master Plan configuration. To evaluate the financial implications of accomplishing this program, the analysis must also account for the Port of Seattle capital facility needs that are beyond the scope of the Master Plan effort, since all capital projects will be competing for the same sources of capital funds.

The Master Plan identifies facilities that are required to accommodate the growth in demand at Sea-Tac International Airport. There are substantial capital needs beyond these expansion projects. The Port of Seattle has identified about $440 million worth of major maintenance that is required over the next 10 years to preserve existing infrastructure. Beyond the major maintenance needs, there are background capital project needs that are in addition to the items identified in the Master Plan, such as environmental and other regulatory related projects. Table 6-1 presents these items as Other Capital needs.

The cost estimate of the non-Master Plan portion of the capital program was estimated using the long-range Port of Seattle Capital Improvement Plan (CIP) cash flow projection.

TABLE 6-1
CAPITAL COST SUMMARY [a]
(IN THOUSANDS OF 1995 DOLLARS)

Master Plan Phase	Master Plan Items	Other Capital	Total Capital
Phase I (1996-2000)	$ 617,658	$458,930	$1,076,588
Phase II (2001-2005)	$ 241,057	$280,786	$ 521,843
Phase III (2006-2010)	$ 289,277	$ 30,907	$ 320,184
Phase IV (2011-2015)	$ 155,900	$ 8,957	$ 164,858
Phase V (2016-2020)	$ 120,569	$ 18,186	$ 138,755
Total Capital Needs	$1,424,462	$797,766	$ 222,228

[a] Source: Berk and Associates.

[b] Due to cost adjustments made during the planning process, there are negligible differences in master plan costs shown here and in Table 5-2. These differences are not large enough to affect the results of the analysis shown in Section 6.

TABLE 6-2
COST PER ENPLANEMENT PROJECTIONS
U.S. PEER AIRPORT COMPARISON [a]

Year	Los Angeles	San Francisco	Denver	Portland	Salt Lake City	Peer Facility Averages	
						with Denver	w/o Denver
Actual/Estimated							
1991	$0.90	$3.42	$5.50	$5.93	$4.10	$3.97	$3.59
1992	$0.55	$3.14	$5.50	$5.83	$3.92	$3.79	$3.36
1993	$3.38	$3.31	$5.50	$5.41	$3.66	$4.25	$3.94
1994	$3.43	$3.95	$20.00	$4.66	$3.46	$7.10	$3.88
1995	$3.26	$4.19	$20.00	$4.88	$3.77	$7.22	$4.03
Projected							
1996	$3.20	$4.91	$20.00	$5.75	$3.80	$7.53	$4.42
1997	$3.20	$6.33	$20.00	$6.12	$3.84	$7.90	$4.87
1998	$3.23	$7.35	$20.00	$7.26	$3.95	$8.36	$5.45
1999	$3.50	$10.36	$20.00	$7.08	$4.14	$9.02	$6.27
2000	$3.70	$12.30	$20.00	$6.91	$4.63	$9.51	$6.89

[a] Source: Port of Seattle, 1995.

This forecast of capital expenditures through the year 2020 identifies all capital requirements, including the Master Plan elements. By converting these annual expenditure forecasts to a constant dollar estimate and summing according to the phasing categories assumed in the Master Plan, the total capital needs were identified. The difference between the total needs and the Master Plan figures was assumed to be the non-Master Plan CIP projects. The result is an additional $800 million of capital needs over the 25-year planning horizon, with approximately $740 million worth of these projects coming in the first 10 years of the program.

The baseline capital program includes an allowance of $50 million for environmental mitigation. This allowance is a rough order-of-magnitude estimate of new environmental mitigation costs resulting from the development of the Master Plan elements and proposed in the Draft Environmental Impact Statement. These costs would be for mitigation requirements above and beyond the Port's existing mitigation programs and will be subject to refinement in the Final EIS and FAA Record of Decision. They also include provisions for additional noise mitigation, as well as wetlands and water resources remediation needs.

The single largest component of this mitigation allowance is a $35 million estimate for land acquisition within the Approach Transition Zone (ATZ) for the proposed new runway. This is a proposed program that would address low overflights in residential areas that are just beyond the proposed runway protection zones. The program would be voluntary, and for the purposes of this analysis, assumes that all eligible properties would participate. The $50 million allowance was distributed through the first 3 phases of program development, with $10 million in the first phase and $20 million in each of the following 2 phases. It is assumed that these costs would be escalated at an annual rate of 4.0%.

This is an aggressive program with a significant concentration of capital requirements in the first years of implementation. The timing and magnitude of the proposed investments will require careful financial management to ensure the Port's ability to fund this program.

FINANCING AVIATION IMPROVEMENTS

Aviation facilities have historically been developed and operated as public facilities. This is a result of the capital intensive nature of these facilities, their relative monopolistic characteristics and the relationship between airports and regional economic vitality. These facilities however, are for the primary use of private businesses. The airlines and other private tenants of the airport support the operation, maintenance and expansion of facilities through the fees and charges imposed under their respective lease agreements. As a result, there are often conflicting views in terms of the desire of the public for a first class public facility and the competing desire of the tenants who wish to maintain a low cost of operation.

Achieving a balance among the interests of the public constituencies and the private facility tenants will be a key challenge as the Port of Seattle begins to implement the recommendations of the Master Plan. This section provides an overview of the capital financing structure of the Port's Aviation Division, identifies the major sources of capital funding, and sets the overall context for the financial analysis chapter.

Financial Structure of the Port of Seattle Aviation Division

As discussed above, the airport is essentially a user supported enterprise, and as such there are two general sources of capital funding. The first are those supported by the operation of the airport facilities, such as landing fees and parking revenues. These funds can either come from the issuance of revenue bonds, to be repaid through future operating revenues, or from the annual net income from operations. Net income is the cash left over after the costs of facility operations, maintenance, administration and debt service have been paid.

The second major source is dedicated capital funds such as federal and state grants or the locally generated passenger facility charges. These funds can be considered outside sources since they are not generated directly by the tenants of the facility. The Port has limited ability to influence the availability of these outside sources, and given the current fiscal environment at both the state and federal levels, it may be unrealistic to expect significant increases in grant funding.

Therefore, the ability of the Port to finance any capital development program will be primarily regulated by its capacity to generate additional net operating revenues, for capital spending or to cover the debt service on new debt. This can be accomplished by increasing gross user revenues and controlling annual operating and maintenance costs. The majority of operating revenues are derived from one of the following: landing fees and terminal rents paid by the airlines; concession revenues from non-airline tenants such as the retail and rental car operators; and, public parking fees at the Port owned facilities.

The Port has recently undergone a major business planning effort to identify opportunities to maximize operating revenues, increase the utilization of its facilities, and manage the growth in Port operating and management costs. As a result of this effort programs and strategies have been identified that will optimize the operations at the airport and enhance the Division's capital financing capacity. Because several of these strategies envision a significant departure from the traditional business environment at the airport, it was determined that to maintain an appropriately conservative approach, this analysis of financial implications should be based on more conservative, historically based assumptions.

Airline Agreement

The current Basic Airline Lease Agreement is structured according to a residual approach to rate making. As a result, any short-term gains in productivity and net revenues will accrue to the benefit of the airlines by effectively reducing the landing fees required. In effect, the landing fees are determined using a cost recovery methodology that allocates all remaining financial requirements not recovered through other fees and charges to the airlines. Therefore any increase in concession revenues will serve to reduce the residual value to be allocated through the landing fee.

The other side of the equation is that any increase in annual operating costs or capital financing requirements that are not covered by a commensurate increase in non-airline revenues will also be borne by the airlines. As a result the structure of the airline agreement gives the airlines a significant amount of control over the capital spending decision process. If the annual costs related to funding a capital program increase substantially faster than the Port's ability to generate net operating revenues from the non-airline sources, then the airlines will be asked to make up the balance through increased landing fees. Therefore, the Port's ability to pass these costs through to the airlines will be the primary consideration for the evaluation of the financial implications of program development.

The measure that is used to track the total costs borne by the airlines is a ratio of airline cost per total enplanements. The cost per enplanement (CPE) figure provides a measure of the cost effectiveness of airport service delivery, since it relates the cost to the volume of activity. As a point of reference, the average cost per enplanement at Sea-Tac was $7.16 in 1993, dropped to $6.16 in 1994, and is estimated to be approximately $5.64 in 1995.

While the current airline agreement is in effect, the airlines have the ability to regulate capital spending to ensure an appropriate CPE is maintained. However the current agreement expires after 2001, at which time this relationship may be amended. Currently, the goal of the Port is to maintain CPE levels consistent with the midrange of competing peer-city airports in the western United States and Canada. Table 6-2 presents a summary of recent CPE experience and projected future CPE's at U.S. peer facilities. The policy target adopted by the Port Commission during the business planning process was to keep the CPE at or below $7.35 until the year 2000.

It should be noted that there are some significant limitations in the usefulness of the CPE as a measure of comparative airline costs among different airports. Because the CPE only measures the airline costs charged by the airport authority, an airport that has contracted a number of services to private operators will likely have a lower CPE than a comparable facility which provides these services directly. For example, Los Angeles has been very aggressive in its privatization efforts and as a result, the cost of some services such as baggage handling or terminal maintenance may be billed directly to the airline by a private operator and as such not included in the CPE calculation.

Aviation Operations

The Port of Seattle's Aviation Division is divided into 5 lines of business, each with particular responsibility over a key operating element of the airport. The following is a brief description of these lines of businesses.

- **Airfield.** The airfield line of business is responsible for the operation and maintenance of the airside elements at the airport. Over 95% of the operating revenues available for capital programming at Sea-Tac are generated through landing fee charges. The landing fees are assessed on the basis of the total landed weight and are paid by all commercial and general aviation operations.

- **Terminal.** The terminal line of business has primary responsibility for the airline portion of the terminal space, including the maintenance of gate areas, a share of general terminal operations and maintenance, and general airport security. The primary source of revenue is generated through lease income paid by the airlines.

- **Concessions.** The concessions line of business is responsible for the non-airline elements of the terminal areas, including retail concessions, rental car areas, non-airline office space and other service related spaces. The principal source of income is rent generated by the commercial users of the terminal space. The retail concessions are currently under an exclusive master agreement that expires in 2004, as a result the Port's ability to affect its share of these revenues is somewhat constrained by the parameters of this agreement.

- **Ground Access.** The ground access line of business is responsible for providing parking and access facilities for the airport. The principal source of revenue for this line of business is the parking fees generated in the Port-owned parking garage. Currently, the Port meets approximately 50% of the total parking demand with its owned facilities. The Master Plan includes the necessary parking facility development to maintain this share of parking over the 25 year planning horizon.

- **Commercial Properties.** The commercial properties line of business includes all other business functions of the airport such as cargo facilities, real estate ventures, and aviation fueling and maintenance areas. Much of the aviation support revenues are in the form of lease income for land and facilities. This is an area that has been identified through the business planning process as having significant upside potential as the Port moves to maximize the utilization of its real estate assets.

Sources of Capital Funding

To stretch the Port's financial capacity while keeping airline costs consistent with Port policy, it is assumed that grant funding and outside sources of capital will be utilized to the maximum extent possible. The traditional outside sources include grant funds and other capital sources that are not tied to airline rates and charges. The following are the major sources of capital funding analysis assumed for the Master Plan financial analysis.

Airport Improvement Program (AIP). The Airport Improvement Program (AIP) is a federal program that provides capital funding assistance for airport planning, development, land acquisition and noise program implementation projects. Project eligibility is determined by the requirements called out in the federal Airport and Airway Improvement Act. In general, however, most aeronautical related projects that are consistent with local comprehensive plans and where local match funds have been identified are eligible for AIP grant funds. Exceptions include decorative landscaping, provision of art work, the construction of public parking facilities for passenger automobiles, and airplane hangars.

Passenger Facility Charges (PFC). The Passenger Facility Charge is a special fee authorized by the FAA and imposed on passengers using an airport facility. The fee is collected by the airlines and remitted to the airport development authority. Generally, the project eligibility requirements for PFC funds are the same as those in effect for AIP funds.

Aviation Development Fund (ADF). The Aviation Development Fund is a Port of Seattle capital development fund where annual net operating revenues are deposited and used for capital improvements. Due to the structure of the current airline agreement, the amount deposited into the ADF annually is roughly equal to the debt service coverage requirements of the outstanding revenue bonds.

Other Grant Sources. The financial analysis assumes that the Port will aggressively seek other grant funding sources in particular federal and state roadway and transit capital assistance. There are major roadway and transit investments called for in the Master Plan program, which will likely be eligible for federal and state assistance. The following are the major federal and state programs that are applicable.

- **Federal Transit Administration.** Capital and operating funds are available for transit projects in urban and rural areas and for the elderly and disabled. The main categories are Section 3, transit capital, and Section 9, transit formula funds for capital and operations. The transit elements of the Master Plan may be eligible for FTA funding.

- **Federal Highway Administration.** The

Surface Transportation Program (STP) is the most likely source of federal roadway assistance. Eligible projects include roads, transit, bicycle and pedestrian facilities, car and vanpool facilities, and marine and airport access. Within STP, funds are set aside for enhancements, roadway hazards, railway crossings, and flexible funding for a variety of uses. These federal funds are distributed by direct regional allocation. The process provides evaluation criteria to be used by local, regional and state agencies to share responsibility for prioritizing projects. All projects are ranked, and the most competitive projects are included in the Regional Transportation Improvement Plan (TIP), and eligible for federal assistance.

- **Central Puget Sound Public Transportation Account.** This fund was created by the 1990 Legislature as a new funding source specifically for public transportation in the Central Puget Sound area. Funds are allocated in a competitive process by a 21-member Multimodal Committee that includes representatives of cities, counties, transit, WSDOT and other interests. Since funds must be requested by a transit agency, a joint funding effort for the transit elements of the Master Plan could be undertaken, with King County Metro as the applicant for these funds.

- **Transportation Fund.** The Transportation Fund was also created by the 1990 Legislature. It was intended as a new general purpose transportation funding source not limited by the 18th Amendment to highway funding. The motor vehicle excise tax (MVET) is the source and the Fund is subject to legislative appropriation every two years. During the most recent two biennia, monies in the Transportation Fund were primarily dedicated to the Department of Transportation's Category C program to expand the capacity of state highways. Future allocations will be determined by legislative priorities, and the ground access transportation improvements could potentially qualify for funds from this source.

Transportation Improvement Board (TIB). The TIB is an independent agency founded in 1988 that distributes funds through the Urban Arterial Trust Account (UATA) and the Transportation Improvement Account (TIA). Competition for funding is fierce and projects are ranked based on specific criteria. The UATA funds city and urban county road and street projects to reduce congestion, improve safety, and address geometric and structural problems. The TIA funds projects to alleviate congestion resulting from economic development and population growth.

Revenue Bonds. The unfunded balance of the annual capital needs are assumed to be funded through the issuance of new revenue bonds. The debt is assumed to be offered at tax-exempt rates and repaid through operating revenues. While the current airline agreement is in force the debt coverage requirements are assumed to remain at 1.35. This ratio establishes that for every $1.00 of principal and interest owed in a given year there must be a minimum of $1.35 available for debt service. There are no other constraints placed on the Port's capacity to issue revenue bonds under the current airline agreement, as long as the existing bond covenants are met. This assumption does not address some of the practical issues, such as the acceptability of these debt loads on the part of the airlines. Some of these issues are incorporated in the analysis indirectly through the evaluation of CPE impacts. By testing the financial implications in terms of CPE, the practical limits of debt issuance will be included, since debt service is a major component of airline costs.

When the current airline agreement expires in 2001, the assumption is the Port of Seattle would move to some form of compensatory methodology to determine airline fees and charges. In a compensatory approach to rate making, the airport authority is free to negotiate rates with the airlines according to actual market conditions and policy guidance providing additional flexibility in financial management. The agreement no longer provides a guarantee of full cost recovery as in the residual approach. The advantage of this approach is any improvements in operating efficiency or non-airline revenues no longer accrue to the sole benefit of the airlines by reducing the landing fee requirements.

This change in approach would likely result in the need for a higher debt service coverage preserve the Port's high credit rating, since the airport's revenues would not be directly supported by language in the airline agreement. Therefore, for all ensuing years, it is assumed that a demonstrated debt coverage ratio of 1.5 will be maintained in the years following the expiration of the current airline agreement. The result of using a higher ratio is that the Port would have to generate more revenues to cover its debt service needs. The effect of this assumption will be to reduce the effective debt capacity of the airport ensuring that the financial analysis is appropriately conservative.

Trends in Aviation Finance

The Seattle-Tacoma International Airport serves a strong regional origin and destination market with service provided primarily by air carriers facing tough price competition. The long-term goal of the Port is to maintain a first rate facility and provide for the growing demands of the regional market for air transportation services. The significant activity growth projected for the airport combined with the continuing financial pressures facing the airline industry has resulted in new ways of thinking about how aviation facilities are developed and operated.

Since deregulation in the late 1970's, the airline industry has undergone substantial changes, as the large carriers faced competition from small upstarts and fare wars became a common marketing strategy. Over the years there has been a great deal of rationalization in the industry as airlines have adjusted to reduced profit margins and increased competition. Those that have survived, have generally done so by keeping costs down and equipment utilization up.

In this environment, airlines are looking to airport authorities to be partners in keeping airline costs manageable. As a result, a premium is placed on maximizing the return on the non-airline airport facilities and assets. This emphasis was a major catalyst for the recent aviation business planning efforts at the Port of Seattle. The outcome of this effort was to focus management resources on non-airline revenues. The following areas were identified:

- Development of Port real estate to its highest and best use.
- Maximize the utilization of current Port facilities.
- Establish an aggressive cost management program.
- Maximize the Port's share of terminal concession revenues.
- Enhance parking revenues by expanding the Port's share of the local parking market by developing additional parking facilities.

FINANCIAL ANALYSIS OF BASELINE CAPITAL PROGRAM

The goal of the financial analysis is to provide a reasonableness check of the Master Plan capital program and preliminary phasing plan relative to the financial capacity of Port. To accomplish this, the full capital program was assumed to be developed according to the demand at the assumed level of service. Since the Port's ability to pass costs to the airlines is the primary financial consideration, the impact of this development program on the costs to the airlines was estimated and compared to recent experience.

Restated, the purpose of this analysis is to establish the long-range financial capability of the Port to take on a capital program of the scale envisioned in the Master Plan. Once this threshold determination has been made, then the actual development of the program will be undertaken at a significantly greater level of detail as part of the Port's normal capital planning process. Thus the results of this analysis should only be considered valid in the context of the overall long-term financial capacity, and should not be interpreted as an evaluation of any specific financing plan for near-term capital improvements.

The benchmark test of the threshold capacity to fund the Master Plan program and the other aviation related capital needs is assumed to be the current Port policy of maintaining a CPE at or below $7.35 until the year 2000. This level of airline costs has been established by policy and as such is not an explicit limit on the Port's financial capacity. A capital program that resulted in greater CPE impacts could be undertaken with the concurrence of the Port Commission and the affected airlines. However, for the purposes of this analysis, the policy will be treated as an actual measure of financial capacity and acceptability.

Methodology

A sketch planning model was developed to analyze the financial implications of the Master Plan capital program. The model is based on existing Port of Seattle models including the aviation debt model, the capital funding model and the aviation business plan model. The debt model was modified for the 25-year Master Plan planning horizon and used as the core of the sketch model. Simplified versions of the capital improvement planning and business plan models were developed, and incorporated into the debt model structure. The result is a model framework that analyzes the CPE impact of alternative capital development scenarios at a conceptual level of detail appropriate for the purposes of this analysis.

For the most part the assumptions underlying the analysis are based on historical data. This was done to ensure that the analysis be appropriately conservative and that revenue forecasts be reasonably achievable. The following are the major assumptions used in the financial analysis.

Phasing of Capital Spending. The capital program is organized according to phases and defined in terms of constant dollar estimates. To analyze the financial implications of developing the projects according to the proposed schedule the program must be redefined in terms of annual capital expenditures reflecting general cost escalation. To accomplish this the dollar value estimate of each Master Plan phase was divided equally by the number of years in the phase and the resulting cash flow was inflated at an annual rate of 4.0%.

Capital Funding Sources. The specific assumptions about the availability of capital funding resources are discussed for each of the major sources of funds.

- ***Airport Improvement Program (AIP)***: The available AIP grant funds are assumed to be $20 million per year for the first 5 years. After the year 2000, it is assumed that AIP grants will be reduced to entitlements only. The estimate of AIP entitlements is taken directly from the Port of Seattle business plan up to the year 2005 when the AIP contribution reaches $5.0 million, subsequent years are inflated from this level assuming an annual rate of 4.0%. Since discretionary grant funds are not assumed after the first phase, a higher balance of capital projects must be funded through other sources, which will likely increase the estimated impact on the cost per enplanement. The result will be a conservative estimate of the financial implications.

- ***Passenger Facility Charges (PFCs)***. The projected PFC revenues are based on the growth in total enplanements. The estimated enplanements for a given year are multiplied by the rate of the PFC. Currently the Port receives an average of $2.45 per enplanement. This amount is assumed to remain constant with the exception of 2 future adjustments to the fee, the first in 2006 and the other in 2016. These adjustments are assumed to account for the loss of purchasing power due to inflation. Inflation is assumed to be an average of 4.0% per year. As a result the PFC is increased to an average of $3.63 per enplanement in 2006 and $5.37 in 2016.

- ***Aviation Development Fund***. The projection of available ADF funds is determined by the annual cash available after all other operating, maintenance and debt service expenditures have been addressed. Thus ADF funds are equal to the net income from operations. The assumptions about operating revenues and expenses are discussed below.

- ***Other Grant Revenues***. The other grant sources that are assumed to be available include: federal and state roadway and transit sources. For the purposes of this analysis it is assumed that the Port of Seattle will qualify for matching grants for all of the roadway and transit elements of the Master Plan. The amount of these grant funds is assumed to be 50% of the construction costs. Given the relatively small share of total capital requirements that would be eligible for these funds, the impact is not expected to be substantial.

- ***Use of Revenue Debt***. The balance of the annual capital needs are assumed to be funded through the issuance of aviation revenue debt. All new debt is amortized at 8.0% per year for a period of 25 years. As previously discussed, the debt service coverage requirement will be 1.35 for remaining years of the basic airline agreement. For all ensuing years the coverage requirement is assumed to be 1.5.

Airline Revenues. As discussed earlier, the key financial indicator is the change in airline costs. In this analysis, the airline costs are estimated by forecasting the future revenues from the airline-related Port businesses. The forecast of these revenues is based on the methodologies established in the current basic airline agreement. After 2001, adjustments were made to these methodologies consistent with a shift to a compensatory approach to rate making. The following are the specific assumptions underlying the revenue estimate for the 2 classes of airline supported revenues:

- ***Airfield***. The airfield revenues are predominantly derived from landing fees. The landing fee is calculated as a residual value until 2001. For these years, all costs that have not been accounted for from other aviation revenues are recouped through the landing fee. After 2001, the landing fee is determined as the larger amount between using the current residual approach or an inflation adjusted minimum compensatory rate of $2.10 per 1,000 lbs of landed weight. The minimum landing fee is inflated using a 3.0% annual escalation rate.

- ***Terminal.*** The terminal revenues are based on the three-part rental charge currently in use. The rental rate provides the Port with a return on its terminal assets, its land assets and a recovery of terminal operating and maintenance costs. The terminal return is determined by the annualized value of the Port's investment (amortized over 40 years at 8.5%) divided by the total rentable square feet of terminal space. The investments in facilities are updated annually based on the construction program. The land component of the terminal rental rate is based on the increase in the value of the land under the terminals. The annual charge is determined by applying an 8.5% return to the value of the land. Finally, the O&M charge is based on the total terminal operating costs less the terminal concession revenues, up to a maximum of 75% of the operating costs. The only change after 2001, is to increase the recovery of the O&M expenses, by assuming full recovery of the airline's share of terminal operating and maintenance expenditures.

Non-Airline Revenues. Since the key financial issue is the Port's ability to fund capital needs while minimizing the increase in the rates and charges to the airlines, the most important determinant of the overall financial capacity to fund the Master Plan improvements is the projection of non-airline revenues. The greater the funding share that comes from non-airline sources, the greater the financial capacity. The following are the key assumptions underlying the projections of non-airline revenues:

- ***Ground Access***: The ground access revenues are tied to the growth in the number of available parking spaces. A ratio of the current total revenues per available parking stall was derived. This estimate of gross parking yield per stall was assumed to continue throughout the planning horizon, adjusted for inflation using a conservative escalation factor of 2.5%. The per stall revenue yield is applied to the number of parking stalls available in each year. Growth in the number of available stalls is tied to the development program. Revenues associated with the employee parking at the airport were estimated using a cost recovery approach to the required investment in these facilities.

- ***Concessions***: The concession revenues are based on a factor relating gross terminal non-airline concessions with total enplanements. Concession revenues are expected to increase as a result of enplanement growth, inflation, and an emphasis on improving the current concession yields. As a result, for the first 10 years, the current revenue per enplanement figure was increased for both inflation and to reflect the Port's commitment to optimizing its concession yields. For the years after 2005, the only growth in the per enplanement income factor is due to price inflation, which for the purposes of this analysis is assumed to be a conservative 2.5% per year. In each forecast year, the per enplanement figure is applied to the number of enplanements to estimate gross revenues.

- ***Commercial Properties***: The commercial properties revenue projections are based on analysis developed during the current business planning process for the period 1996-2005, which project an average annual growth rate of 10.3%. For the subsequent years, annual growth in revenues is assumed to be 6.3% per year. This assumes that the commercial properties line of business would directly provide all relevant facilities and services called out in the Master Plan. One of the key business planning strategies calls for turning some of these facilities and services over to private interests, which would reduce the revenues accruing to this line-of-business in exchange for outside investment in Port facilities. This issue is discussed in greater detail later in this section.

Aviation Division Operating Costs. The annual net operating income is a key factor in the funding capacity of the Aviation Division. As such, the projections of annual operating costs are a key element in the estimation of the overall financial capacity. The estimates of annual operating costs are based on the current business planning assumptions for 1996-2000. Consistent with Port policy, these estimates assume that all administrative cost categories remain constant at current levels throughout this period, while other costs grow by an annual rate of 3.5%. The current cost breakdown by cost center is presented in Table 6-3 along with the assumed escalation factors throughout the planning horizon.

For the cost centers where no cost escalation is assumed for 1996-2000, costs are increased by 3.5% per year to the year 2020, the same rate of inflation assumed for the non-administrative functions. The overhead allocation, including the Pier 69 allocation, is assumed to remain constant, consistent with Port policy goals. The costs of debt service account for both the current outstanding debt and all new issues to fund the Master Plan and other improvements.

These cost assumptions are based on an aggressive cost management program and will require ongoing management scrutiny in order to ensure adequate levels of service are provided to accommodate the projected demand. Since these goals are integral to the Port's general management policies they are appropriate for planning purposes.

Distribution of Costs. The distribution of costs to each of the lines of business is an important assumption, since some of the revenues are based on cost recovery mechanisms. The distribution of operating costs is shown in Table 6-4. Overhead allocations are distributed differently than aviation operating and maintenance costs. These assumptions are consistent with current Port Business Planning assumptions and Port policy direction.

Capital Funding Program

Attempting to fund the demand-driven Master Plan schedule would result in the capital funding program presented in Table 6-5. As is shown, the total capital program would require approximately $3.3 billion over the next 25 years to fund the Master Plan items and the other non-Master Plan projects. The difference between this figure and the total capital program estimates presented in Table 6-1, is due to the cost of general inflation (assumed to be 4.0% per year).

The source of the largest share of capital funding, over $1.1 billion, is estimated to come from the issuance of new revenue debt. An almost equal share of the capital requirements, just over $1 billion, would be raised through the passenger facility charges. Combining these sources with the ADF funds of over $800 million, means that almost $3 billion would be generated or supported by the users and tenants of the airport over the 25 year period. This amounts to over 90% of the total capital funding

TABLE 6-3
OPERATING COST SUMMARY
(IN THOUSANDS) [a]

Operating Expenses	1995 Budget	Escalating Assumed	
		1996-2000	2001-2020
Administration	$1,010	0.0%	3.5%
Communications	955	0.0%	3.5%
Marketing	1,922	0.0%	3.5%
Airport Environmental Engineering	60	0.0%	3.5%
Operations	10,265	3.5%	3.5%
Fire	4,968	3.5%	3.5%
Police	8,962	3.5%	3.5%
Planning	1,861	0.0%	3.5%
Property Management	5,457	3.5%	3.5%
Facilities and Maintenance	26,613	3.5%	3.5%
Sub-total O&M Expenses	**$62,073**	—	—
Allocated Administrative Overhead	12,175	0.0%	0.0%
Aviation Debt Service	39,919	—	—
Pier 69 Allocation	1,012	0.0%	0.0%
Total Aviation Operating Expenses	**$115,179**	—	—

[a] Source: Berk and Associates.

TABLE 6-4
OPERATING COST DISTRIBUTION BY LINE OF BUSINESS [a]

Line of Business	O&M Cost Centers	Allocations
Airfield	28.2%	30.1%
Terminal	32.8%	30.5%
Concessions	12.8%	11.6%
Ground Access	17.6%	16.7%
Commercial Properties	8.5%	11.1%

[a] Source: Berk and Associates.

TABLE 6-5
ESTIMATED CAPITAL FUNDING PROGRAM
DEMAND DRIVEN SCENARIO (IN THOUSANDS) [a]

Master Plan Phase	Total Capital Spending	AIP Funds	PFC Funds	ADF Funds	Other Grant Funds	Debt Financing	Percent Debt Funded
Phase I	$1,235,464	$100,000	$136,207	$153,653	$1,514	$844,089	68.3%
Phase II	733,447	23,861	157,032	276,726	25,201	250,627	34.2%
Phase III	555,309	28,249	263,568	244,608	18,884	0	0.0%
Phase IV	347,865	34,370	217,262	96,233	0	0	0.0%
Phase V	356,219	41,816	245,774	68,629	0	0	0.0%
Total	$3,228,303	$228,296	$1,019,843	$839,848	$45,599	$1,094,717	33.9%

[a] Source: Berk and Associates.

TABLE 6-6
FINANCIAL IMPLICATIONS OF MASTER PLAN DEVELOPMENT [a]

Year	Total Airline Fees (thousands)	Total Enplanements (thousands)	Cost per Enplanement (CPE) Inflated Dollars	Cost per Enplanement (CPE) Constant Dollars (1995 base)
Actual				
1993	$68,044	9,385	$7.16	$7.74
1994	$59,706	9,706 [b]	$6.16	$6.41
1995	$62,626	10,039 [b]	$5.64	$5.64
Projected				
1996	$ 73,991	10,383	$ 7.13	$6.85
1997	$ 87,443	10,738	$ 8.14	$7.53
1998	$101,093	11,106	$ 9.10	$8.09
1999	$113,881	11,487	$ 9.91	$8.47
2000	$127,635	11,880	$10.74	$8.83
2001	$128,051	12,183	$10.51	$8.31
2002	$136,303	12,493	$10.91	$8.29
2003	$136,027	12,811	$10.62	$7.76
2004	$111,825	13,137	$ 8.51	$5.98
2005	$116,469	13,473	$ 8.65	$5.84
2010	$153,228	15,275	$10.03	$5.57
2015	$188,624	17,067	$11.05	$5.04
2020	$228,106	19,069	$11.96	$4.49

[a] Source: Berk and Associates.

[b] The constant dollar CPE estimate is based on a cost deflator which assumes future inflation of 4.0% per year and a base year of 1995.

requirements, with the balance coming from grant sources.

The phasing of the demand-driven scenario requires a substantial portion of the capital program to be funded in the early years of the program. However, new debt is only needed to make up funding shortfalls in only the first 10 years. After 2005, the program is funded entirely using available cash sources.

Impact on Airline Costs

To fund such a program will require a significant increase in the revenues generated by the activities at the airport. As discussed earlier, any costs which cannot be met through increases in the net income from non-airline activities will pass through to the airlines in the form of increased landing fees. Figure 6-1 graphically presents the projected operating revenues required to fund the demand-driven scenario.

As Figure 6-1 demonstrates, a large share of the capital requirements in the early years are recouped through airline fees and charges. In fact the proportion of operating revenues paid by the airlines increases from approximately 50% to 56% by the year 2000, before returning to lower levels. Once the initial spike in the capital program is addressed, the airline share of operating revenues gradually declines until it reaches approximately 44% in 2020.

Table 6-6 focuses directly on the financial impact to the airlines resulting from the development of the demand-driven capital program. This table presents the projected airline fees required and the resulting cost per enplanement impacts. The CPE is shown in both inflated dollar terms and constant dollar terms, adjusted for a base year of 1995.

Funding the baseline program would result in an increase in the airlines' CPE, above the Port's target of $7.35, measured in inflated dollar terms and after adjusting for the effects of inflation. The estimated CPE for the Year 2000 of $10.74 is $3.39 above the current policy target.

As Table 6-6 shows, the airline costs are growing faster than enplanements. This is reflected in the large increases in the CPE over the first 5 years of program development as compared to subsequent years. These values are gradually reduced over the next 5-year period, and finally return to current levels by the year 2005. The large drop in CPE between 2003 and 2004 is due to the retirement of existing revenue bonds, which reduces the debt service requirements substantially.

While the baseline program would result in a CPE that is significantly higher than the target level, it is not beyond levels experienced at other airports. Thus, if the CPE impact of the demand driven scenario could not be substantially lessened, then the Port could, with the concurrence of the airlines, proceed with the baseline Master Plan program. However, it is the policy of the Port to provide an appropriate level of service at a reasonable cost to its airline tenants, therefore, the following section explores the options for reducing the CPE impact of the Master Plan.

FINANCIAL STRATEGIES

Relative to the current CPE of $5.64 and the Port's target of $7.35 the funding picture presented in the demand-driven scenario involves a significantly higher cost impact to the airlines. As a result, to achieve the policy target the gap between the current CPE and the levels projected under the baseline conditions needs to be narrowed. Since the financial constraint appears to be more of a function of the timing of program development, the solution could lie with strategies that would reduce the

Figure 6-1
Projected Operating Revenues
Demand-Driven Scenario

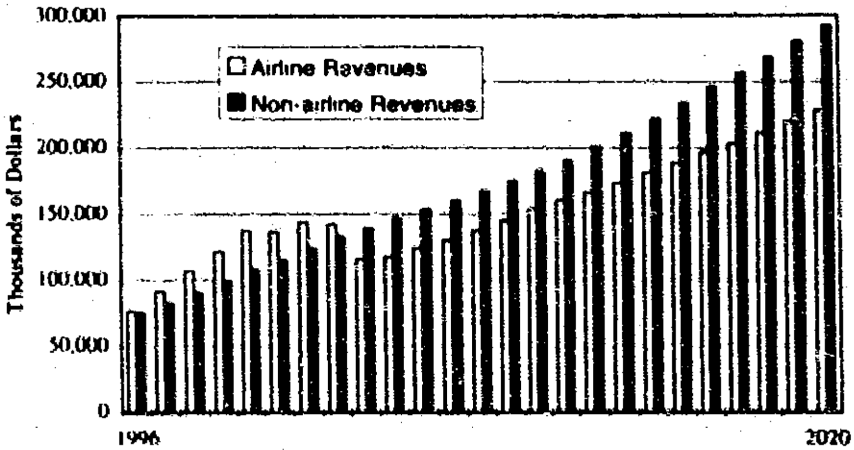
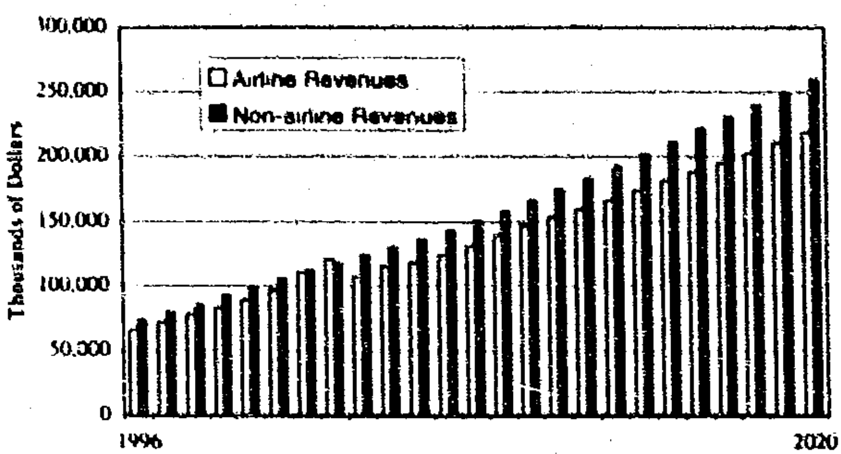


Figure 6-2
Projected Operating Revenues
Financially-Constrained Scenario



cost impact during the early phases, by reducing the scale of the program, deferring costs, or increasing available resources.

There are a number of potential mechanisms that would accomplish these goals. This section discusses some of the strategies that could be employed to reduce the impact on the airlines, and provides an evaluation of the potential impact on projected CPE levels. Many of these strategies are currently part of the Aviation Business Plan, but were not assumed in the baseline analysis to ensure the approach was appropriately conservative, defensible and consistent with previous Master Plan reports.

In the CPE comparisons presented in this section, the constant dollar (1995$) trend is used. This estimate provides the best opportunity to compare future CPE levels with current experience and with respect to the baseline assumptions, since the effects of the capital program are isolated and the impact of general inflation is removed. As a result, the real effect of each strategy can be evaluated without the distorting effects of when the CPE impact occurs.

Program Cost Reductions

One of the areas which may provide opportunities to reduce the cost of facility development is in the definition of the program. The following are examples of strategies that could be employed to achieve program cost savings.

- ***Design Changes***. The cost estimates presented in the Master Plan assume a level of design and architectural finish that is consistent with the Port's desire for a high quality public facility. There may be opportunities to reduce the costs of the program during the next phase of design development by reducing the level of architectural finish or engineering complexity for some projects. In addition, the current estimates assume generous design and construction contingencies, which may overstate the final construction cost amounts.

- ***Use Existing Fill Material***. A substantial element of the airside costs can be attributed to the need to purchase fill material for the grading under and near the third runway area. A strategy which could reduce this cost element would be to look for possible fill material on existing Port properties. In addition, the costs assumed for the fill were based on known rates. Given the large volume required, those costs are likely to vary and could be lower depending on sources and suppliers.

- ***Scheduling***. Stretching the program development could offer opportunities to reduce the costs of some aspects of the program. For example, longer construction schedules could reduce the need for long work shifts and provide some cost efficiencies. Another potential area for savings would be the increased flexibility in timing for the purchase of fill material, which would allow for greater price competition and reduce the influence of seasonal price fluctuations.

- ***Changes in Program Elements***. Another way to reduce the scale of the program is to choose lower cost development options. For example, rather than building in the ability to expand concourse "A" to accommodate international service, the program could be reduced to only accommodate the needs of domestic flights. By selecting a lower cost option, the impact to the airlines would be reduced.

To illustrate the maximum sensitivity of the CPE analysis to changes in program elements a scenario was run which assumes the construction of a 7,500 foot runway instead of the baseline assumption of 8,500 feet. Since the investment in the third runway is one of the largest capital elements in the Master Plan program, this scenario would represent the largest potential cost difference resulting from changes in the early phases of the Master Plan. This approach would reduce the airfield related costs by approximately $54 million in the first phase of the program. Individual reductions to other program elements would have a smaller impact, though a series of program changes could be implemented that would have a similar CPE impact.

Table 6-7 compares the constant dollar (no inflation effects) CPE in the Baseline scenario with the estimated constant dollar CPE assuming the lower runway costs. The constant dollar estimates are used so that impacts from changes in different years will be comparable. As the table shows the reduction in the cost per enplanement reaches a maximum of $0.45 in the year 2000, which represents an improvement in that year of approximately 5.0%.

To evaluate the effect on the CPE relative to the policy target of $7.35 the effects of inflation must be considered. The CPE in the year 2000, measured in inflated dollars, is estimated to be $10.19, or above the current policy target.

Program Phasing

Another strategy for reducing the cost impacts to the airlines is to change the timing of the new development activity. As was shown in the baseline analysis, most of the financial capacity issues arise early in the development program, where over $1 billion is required in the first phase alone. Once this initial burden is overcome, there is excess financial capacity in the later years of the program. Therefore, mechanisms that would serve to delay the need for certain projects, defer costs to later phases, or extend capital outlays over a longer period of time, would likely reduce the CPE impacts of the program during the initial phases.

- ***Improved Facility Utilization.*** One method of delaying the need for new facilities is to improve the utilization of existing facilities. This has been identified by Port staff as a major short term objective. An example of this approach include the expansion of the Federal Express facility which will enhance operating revenues without affecting the capacity of the airfield, since most of these flights occur during the off-peak periods where significant excess capacity exists.

- ***Defer Costs.*** Potentially the most effective mechanism available to reduce the costs in the early years is to defer projects to later phases. The result of this would likely be a reduction in the level of service, as congestion in the peak periods would strain the terminal and airside capacity of existing facilities. In addition, the cost of the deferred projects would likely increase due to the effects of inflation. Therefore, the implied tradeoff is between the comfort and level of service in the terminal spaces and the short-term financial impact to the airlines. Projects that are needed to maintain the safety and security of the airport facilities would receive top priority and not be subject to deferral.

To evaluate the potential impact resulting from changes in program phasing, a deferred cost scenario was developed. As with the program elements analysis, a scenario was developed whereby runway construction costs were extended over a longer period of time. Due to the magnitude of the airfield costs requirements, this scenario likely represents the outside range of the sensitivity of the CPE analysis to the deferral of projects, relative to the demand-

TABLE 6-7
IMPACT OF POTENTIAL PROGRAM REDUCTIONS
7,500 FOOT RUNWAY SCENARIO [a]

Year	Cost per Enplanement (CPE) Baseline Constant Dollars	Cost per Enplanement (CPE) Adjusted Constant Dollars	Reduction/ (increase) in CPE
1996	$6.85	$6.73	$0.12
1997	$7.53	$7.31	$0.22
1998	$8.09	$7.78	$0.31
1999	$8.47	$8.09	$0.39
2000	$8.83	$8.38	$0.45
2001	$8.31	$7.89	$0.42
2002	$8.29	$7.87	$0.42
2003	$7.76	$7.37	$0.39
2004	$5.98	$5.98	$0.00
2005	$5.84	$5.84	$0.00
2010	$5.57	$5.57	$0.00
2015	$5.04	$5.04	$0.00
2020	$4.49	$4.49	$0.00

[a] Source: Berk and Associates.

driven Master Plan. The total deferred Master Plan costs resulting from this change amount to over $170 million, or approximately 17% of the baseline Phase I program. The balance of the program is assumed to be phased as in the baseline scenario.

In addition to the deferred cost items in the Master Plan program, projects in the background capital program were also identified for deferral. Of the $459 million of "Other Capital" projects in Phase 1, approximately $67 million were determined to be appropriate for deferral. Therefore the total value of projects deferred from Phase 1 to Phase 2 is approximately $287 million.

Table 6-8 presents the results of using the deferred cost scenario. This option provides greater cost relief than the shorter runway length in the previous example. The maximum cost savings occur in the year 2000 where the constant dollar CPE is reduced by $1.84, which represents a savings of approximately 20%. The CPE in the year 2000, measured in inflated dollars, is estimated to be $8.51, or $1.16 above the current policy target.

The airline costs are projected to be marginally higher in the later years when the deferred projects are added. However, since the financial capacity is greater in these years the impact is small, as evidenced by the small increase in the CPE and especially when compared to the savings in the early years. While the option of deferring projects offers the potential of significant cost relief, service levels may not be acceptable if this were the only method used to bring the CPE costs down to the $7.35 level.

Non-airline Revenue Enhancements

Since the total costs that can be passed through to the airlines is the major consideration in determining financial capacity to fund the Master Plan program, increasing the non-airline generated operating revenues would provide additional financial capacity for capital development. This was one of the key objectives identified in the Port's Business Planning efforts. As such some of the non-airline revenue enhancement strategies have already been accounted for in the baseline revenue forecasts though to maintain a conservative posture, many of the Business Plan strategies were not included. The following are some examples of potential strategies which could be employed to improve the performance of the non-airline lines of business. The Business Plan has evaluated these and many more potential strategies and Port staff are currently in the process of implementing those which offer promising returns.

- ***Pricing of Port Provided Public Services.*** The Port could look to raise non-airline revenues through increases in prices charged for Port provided services. Price adjustments for public on-site parking is perhaps the best opportunity to achieve significant benefit from this option, though it would likely come at a public relations cost.

- ***Front-load Revenues from Leases.*** Another strategy that could be used to enhance the non-airline revenues would be to structure future leases to achieve more up-front revenues, most likely in the form of tenant provided capital improvements. If these improvements were programmed, then capacity would be freed up for other capital needs.

- ***Improve Retail Concession Revenues.*** Under the current master concession agreement the Port is allowed to retain earnings to pay for capital projects. To optimize the revenues generated by retail concessions and increase the potential for

TABLE 6-8
IMPACT OF DEFERRED COST PROGRAM [a]

Year	Cost per Enplanement (CPE) Baseline Constant Dollars	Cost per Enplanement (CPE) Adjusted Constant Dollars	Reduction/(Increase) in CPE
1996	$6.85	$6.37	$0.48
1997	$7.53	$6.63	$0.90
1998	$8.09	$6.83	$1.27
1999	$8.47	$6.91	$1.57
2000	$8.83	$7.00	$1.84
2001	$8.31	$7.08	$1.23
2002	$8.29	$7.53	$0.76
2003	$7.76	$7.54	$0.22
2004	$5.98	$6.23	($0.24)
2005	$5.84	$6.41	($0.57)
2010	$5.57	$5.57	$0.00
2015	$5.04	$5.04	$0.00
2020	$4.49	$4.49	$0.00

[a] Source: Berk and Associates.

retained earnings, the Port has proposed instituting a monitoring program to track pricing and service levels for retail concessions. Another strategy that has been proposed is to develop a comprehensive concessions master plan to evaluate the types of retail activities offered and to optimize revenues by improving the mix of activities.

- ***Accelerate the Development of Parking Facilities***. The Port-owned public parking facilities are the most significant, directly controlled, contributor to non-airline revenues. As a result, the Port has an opportunity to enhance the non-airline revenues by accelerating the development of new parking facilities and capturing more of the projected parking demand. The tradeoff for this strategy is that it requires substantial up-front capital investments to achieve these higher revenues.

To evaluate the potential impact of enhanced non-airline revenues, the accelerated parking development scenario was analyzed for its effects on total airline costs. The baseline parking program was adjusted by moving half of the number of parking stalls in each phase up to the previous phase. The total number of stalls would remain the same, only the rate of construction is accelerated.

Table 6-9 shows the impact on airline costs of accelerating parking development is relatively small. The maximum savings in the first 10 years occurs in 2001 where $0.13 is reduced from the baseline CPE, which represents a 1.5% savings. If measured on a percentage basis the benefit increases somewhat after 2001, as the total impact remains at a minimum of $0.12 per enplanement until 2003 while the total CPE continues to decline throughout these years. However, this does not appear to provide a significant opportunity to reduce the airline cost burden. The CPE in the year 2000, measured in inflated dollars, is estimated to be $10.63, or $3.28 above the current policy target and only $0.11 better than the baseline scenario.

Other Financing Mechanisms

The final category of financial strategies addresses non-traditional financing mechanisms to stretch the Port's capacity to fund capital improvements. This collection of strategies includes a number of privatization options that either provide an opportunity to attract outside financing, or provide an opportunity to reduce the cost of project development or operation, which would in turn provide additional capital financing capacity. The following are some of the potential public-private ventures that could be considered.

Third Party Developers. One mechanism which has been proven to attract outside investment is a Build-Operate-Transfer (BOT) approach to project development that brings private financing. In this case, a project with a clearly identifiable market could be turned over to a private entity with responsibility to finance and build the project. The private concern would then have the opportunity to recoup its capital and earn a return on the investment by operating the facility for a finite period of time, after which, the facility would be transferred to the Port. The hydrant fueling system is an example of a project that might be a candidate for this type of mechanism. The advantage of this approach is that needed improvements are funded by outside sources, which extends the Port's capacity to address other needs. The disadvantage is that, from the airlines point of view, this mechanism may simply transfer the costs associated with this service to another entity which may not provide an actual reduction in airline costs.

Special Facility Financing. The use of special

TABLE 6-9
IMPACT OF ACCELERATED PARKING DEVELOPMENT [a]

Year	Cost per Enplanement (CPE)		Reduction/(Increase) in CPE
	Baseline Constant Dollars	Adjusted Constant Dollars	
1996	$6.85	$6.87	($0.02)
1997	$7.53	$7.52	$0.01
1998	$8.09	$8.05	$0.04
1999	$8.47	$8.41	$0.06
2000	$8.83	$8.74	$0.09
2001	$8.31	$8.18	$0.13
2002	$8.29	$8.17	$0.12
2003	$7.76	$7.64	$0.12
2004	$5.98	$5.98	$0.00
2005	$5.84	$5.84	$0.00
2010	$5.57	$5.57	$0.00
2015	$5.04	$5.04	$0.00
2020	$4.49	$4.49	$0.00

[a] Source: Berk and Associates.

facility financing is similar to the previous example, in that the proposed facility is financed independently based on its revenue generating capacity. To be effective, the Port would need to demonstrate that revenues that would otherwise be available to support existing debt obligations were being diverted to this new project. The most likely candidate projects would involve a single large tenant with solid corporate credit, since this source of financing may require the tenant to use its corporate credit as security for the debt issue. Essentially the tenant would be providing recourse to the bondholders, in the event that debt service commitments were not met. The Port would continue to own the facilities, however, the tenant would be providing credit support for the financing. In return for putting up this security, the tenant would gain access to tax-exempt financing rates.

Turnkey Project Development. A privatization option which may provide opportunities to reduce the cost of project development is the turnkey approach, which involves the private sector in the design, construction and possibly the operation of the facility. The turnkey approach assumes that the Port would prepare a Request for Proposals to design, build and possibly operate a candidate facility. The RFP would contain general design and performance parameters and some preliminary engineering analysis, to allow the bidders a reasonable understanding of the design, construction and operations expectations and potential constraints. The successful bidder would then negotiate a contract with the Port's expectations regarding the facility they are buying in exchange for a guaranteed maximum price from the bidder. The only reason to pursue this approach is if it could be demonstrated that a private entity could build the facility at a lower cost than the Port, even after the successful bidder is compensated for their efforts.

Management Contract. Another mechanism that may offer opportunities for enhanced capital finance capacity through cost savings is contract management. The public operation and maintenance of facilities can be hampered by inflexible civil service provisions, labor agreements and cumbersome hiring and recruiting regulations. These tendencies can increase the cost of providing services. As with the turnkey option, if cost savings could be demonstrated as a result of a contracting for services that would otherwise be performed by Port staff, the financial capacity of the Port would enjoy marginal benefits.

To evaluate the potential impact of improving the financial capacity through the use of third party financing mechanisms, a scenario was developed whereby certain projects that offer the potential to attract interest from outside investors where assumed to be funded through one of these mechanisms. A total of 10 projects valued at $250 million were identified. All of these projects are scheduled to be completed during the first 2 phases, with the majority of the investment required in the first phase of program development where the greatest financial capacity improvement is possible.

Since it is assumed that funds would be available from outside sources, these projects were simply removed from the capital funding analysis. If this were the only change in the analysis then it is obvious that this would significantly reduce the impact on airline costs. However, since these projects are turned over to private interests to finance, build and operate, the Port will lose the operating revenues that would have been generated by these facilities. As a result, the operating revenues must also be reduced by an amount approximately equal to the Port's expected return on these investments.

After making adjustments for the reduced capital needs and the offsetting reductions in operating revenues the impact on the CPE was evaluated. Table 6-10 presents the results of this analysis, and compares this scenario with the baseline conditions.

The net effect of turning these projects over to the private sector is a significant improvement in the overall financial capacity to accomplish the Master Plan according to the demand driven phasing schedule. The airline costs are reduced in all years, peaking in 2000 with a savings of $0.84 per enplanement, a 9.5% reduction over the baseline CPE. The maximum CPE, measured in constant dollars terms, is reduced from $8.83 to $7.99. The CPE in the year 2000, measured in inflated dollars, is estimated to be $9.72, still substantially above the current policy target of $7.35.

The basic financial benefit from using these non-traditional financing mechanisms is to trade income that would be earned in the future, where there is projected excess financial capacity, for up-front capital financing during the period of maximum capacity constraints. Given the development schedule, this approach is particularly effective in reducing the cost impacts on the airlines.

FINANCIALLY CONSTRAINED SCENARIO, AN ILLUSTRATIVE EXAMPLE

The financial strategies discussed in the previous section all provided some improvement in the overall capacity of the Port to undertake the capital program envisioned in the Master Plan. None of the strategies that were evaluated were sufficient to independently allow for the completion of the capital development plan without a substantial increase in the historic cost per enplanement in constant dollar terms or within the current policy parameters. However, combining some of these strategies may provide a scenario that meets these objectives.

To evaluate such a scenario, the baseline Master Plan was adjusted to reflect following changes: assume the deferred cost plan; provide parking facilities based on an accelerated development schedule; and, assume the maximum use of outside financing. This scenario maintains the 8,500 foot runway option.

Capital Funding Program

Developing the Master Plan improvements assuming the application of the financial strategies defined for the financially constrained scenario would yield the funding plan presented in Table 6-11. As is shown, the total capital program needs are slightly less than $3 billion, over the next 25 years, with the largest share of these funds, more than $1 billion, coming from passenger facility charges. The next largest share of funds is estimated to be from the issuance of almost $1 billion of new revenue debt, or 32.4% of the program costs. The total capital program that is supported through the operating income of the facilities is over $2.7 billion, with the balance coming from grant sources. This table does not include the $250 million of projects that were assumed to be funded through outside sources.

Impact on Airline Costs

As with the baseline scenario, a majority of the capital program needs are met through growth in operating revenues. Figure 6-2 graphically presents the projections of operating revenues for both airline and non-airline sources. As is shown the proportion of total revenues raised through fees and charges to the airlines increases during the first phase of the program, and gradually returns to levels more consistent with current experience. However, the short-term financial impact is substantially lower than was projected in the demand-driven scenario.

Looking at these projected revenues from a CPE

TABLE 6-10
IMPACT OF MAXIMUM THIRD PARTY FINANCING [a]

Year	Cost per Enplanement (CPE)		Reduction/(Increase) in CPE
	Baseline Constant Dollars	Adjusted Constant Dollars	
1996	$6.85	$6.56	$0.30
1997	$7.53	$7.04	$0.48
1998	$8.09	$7.47	$0.63
1999	$8.47	$7.73	$0.75
2000	$8.83	$7.99	$0.84
2001	$8.31	$7.50	$0.80
2002	$8.29	$7.48	$0.81
2003	$7.76	$7.09	$0.67
2004	$5.98	$5.72	$0.26
2005	$5.84	$5.58	$0.26
2010	$5.57	$5.34	$0.23
2015	$5.04	$4.84	$0.20
2020	$4.49	$4.31	$0.18

[a] Source: Berk and Associates.

TABLE 6-11
ESTIMATED CAPITAL FUNDING PROGRAM
FINANCIALLY CONSTRAINED SCENARIO
(in thousands)

Master Plan Phase	Total Capital Spending	AIP Funds	PFC Funds	ADF Funds	Other Grant Funds	Debt Financing	Percent Debt Funded
Phase I	$773,517	$100,000	$136,207	$114,610	$1,514	$421,185	54.5%
Phase II	972,532	23,861	157,032	222,745	25,201	543,693	55.9%
Phase III	575,489	28,249	263,568	264,788	18,884	0	0.0%
Phase IV	330,067	34,370	217,262	78,435	0	0	0.0%
Phase V	326,279	41,816	245,774	38,689	0	0	0.0%
Total	$2,977,884	$228,296	$1,019,843	$719,268	$45,599	$964,878	32.4%

[a] Source: Berk and Associates.

point of view yields the results presented in Table 6-12. The cumulative effect of implementing these financing mechanisms and strategies is to reduce the constant dollar CPE to the point where it generally stays within a range consistent with recent airline experience at Sea-Tac. The airline cost savings relative to the demand-driven scenario are significant as demonstrated in the table, which presents the constant dollar difference between these options.

Due to the significant improvements in the cost per enplanement figures, the financially constrained scenario comes very close to meeting the Port policy target of $7.35 in the Year 2000 falling short by only $0.01. Given the proximity to the policy target, it appears that the basic capacity check could easily be achieved by incorporating more of the strategies and mechanisms discussed earlier in this chapter.

The key financial concept in this analysis has been the ability of the Port to pass costs through to the airlines. The threshold of level of airline costs for planning purposes is set by policy direction and is measured in terms of the airline cost per enplanement. There is another potential financial constraint that must be considered. The level of indebtedness that would be required to fund this program must be within the Port's overall debt capacity. Since the Master Plan would require almost $1 billion in new debt and the Marine Division is anticipating significant capital outlays as well, it is possible that the Portwide capacity may be an issue.

Based on preliminary analysis of the current Port debt obligations, marine and aviation capital programs and Port financial policies, it appears that the level of indebtedness assumed could maximize the Port's overall financial capacity. If the Port maintains a constant levy rate, as is the current policy, the overall debt service coverage would drop below the adopted policy level. This would likely result in a downgrade in the Port's bond rating and increase the Port's cost of funds, however, this would not necessarily make the program unfundable. The debt service coverage of 1.6, though not optimal for revenue debt, is still within reasonable financial parameters.

Should the Port decide to maintain is current bond rating during the initial phase of the Master Plan it could improve the debt coverage by increasing the levy rate or replacing some of the revenue debt with general obligation debt. It is important to note that these financing considerations are based on preliminary, conservative and conceptual level analyses. There are a number of details that remain to be evaluated, including additional financing options which could affect the actual debt capacity of the Port.

The previous analysis shows that the Master Plan program can be developed within the financial constraints at the Port of Seattle. It is important to reiterate, however, that the analysis presented in this chapter is a conceptual level evaluation and is not intended as a plan of finance. The details of individual project funding will be addressed by the Port during the implementation of the Master Plan and subject to Commission review and approval.

SUMMARY OF FINDINGS

The implication of this analysis is that while the program is quite ambitious, there are mechanisms available that could reduce the program cost impacts on the airlines and bring the Master Plan program within the Port's current policy and financial parameters. No financial fatal flaws were identified, though the implementation of the Master Plan program will require careful management to balance the tradeoffs between level of service, capital

TABLE 6-12
FINANCIAL IMPLICATIONS OF MASTER PLAN DEVELOPMENT
FINANCIALLY CONSTRAINED SCENARIO [a]

Year	Total Airline Fees (thousands)	Total Enplanements (thousands)	Cost per Enplanement (CPE)		
			Inflated Dollars	Constant Dollars (1995 base)	Savings over Baseline
Actual					
1993	$68,044	9,385	$7.16	$7.74	n/a
1994	$59,706	9,706 [b]	$6.16	$6.41	n/a
1995	$62,626 [b]	10,039 [b]	$5.64	$5.64	n/a
Projected					
1996	$65,796	10,383	$6.34	$6.09	$0.76
1997	$71,233	10,738	$6.63	$6.13	$1.40
1998	$76,981	11,106	$6.93	$6.16	$1.93
1999	$81,732	11,487	$7.12	$6.08	$2.39
2000	$87,488	11,880	$7.36	$6.05	$2.78
2001	$94,469	12,183	$7.75	$6.13	$2.18
2002	$108,324	12,493	$8.67	$6.59	$1.70
2003	$118,078	12,811	$9.22	$6.73	$1.02
2004	$106,886	13,137	$8.14	$5.72	$0.26
2005	$112,258	13,471	$8.56	$5.63	$0.21
2010	$146,978	15,275	$9.62	$5.34	$0.23
2015	$181,020	17,067	$10.61	$4.84	$0.20
2020	$218,855	19,069	$11.48	$4.31	$0.18

[a] Source: Berk and Associates.

spending and airlines cost impacts.

The Port has already begun the difficult task of addressing the financial implications of the Master Plan. During its recent short-term Business Planning effort many of the strategies discussed in this chapter were identified. The integration of the Master Plan into the normal capital development process is underway. Financial management and implementation options to address the short-term financial capacity issues are being evaluated in substantially greater detail than was possible in this effort.

The following summarizes other key findings of the financial analysis of the Master Plan development program.

The demand-driven Master Plan development program as currently defined would significantly impact the cost to the airlines as measured by the CPE. The net effect is a sharp near-term increase in the costs passed through to the airlines.

There is adequate financial capacity to fund the Master Plan improvements, however, much of the capacity is in the later years of the planning horizon. The demand-driven schedule would require a substantial investment in the early years of program implementation causing airline costs to rise from a current CPE of $5.64 to $10.74 in the year 2000.

Based on preliminary analysis of the Port's overall debt obligations, the debt required under the financially constrained scenario may result in a downgrade in the Port's bond rating and increase the Port's cost of funds. However, while the estimated debt service coverage of 1.6, is below the Port's financial policy standard, it is still within reasonable financial parameters. In addition the Port could improve the debt coverage by increasing the levy rate or replacing some of the revenue debt with general obligation debt. As a result, the proposed level of spending does not appear to be outside the Port's ability to issue new capital debt.

The Port of Seattle has established aggressive operating cost management goals, which are reflected in the financial analysis of Master Plan options. If the Aviation Division were to experience higher than expected cost escalation, then the estimated impact to the airline costs would be understated.

Deferring costs from the baseline demand-driven scenario is a necessary component of a capital program that meets the current policy of keeping the CPE below a target of $7.35 until the year 2000. Strategies for increasing the utilization of existing facilities to help maintain an acceptable level of service will be key components of a successful cost deferral program.

By itself the $60 million savings resulting from assuming the 7,500 foot runway instead of the 8,500 foot alternative provides marginal cost relief for the airlines.

While the PFC's are a major contributor to the overall funding program in each scenario evaluated, the assumption of increased PFC charges does not have a significant bearing on the issue of financial capacity. The first time the PFC is assumed to be adjusted for the effects of inflation is in the year 2006, well after the principal financial capacity concern is addressed. In fact, in the years after the retirement of Port debt, in 2003 there generally is excess financial capacity relative to the Master Plan requirements.

The greatest potential for reducing the impact on the airlines, is through the utilization of non-traditional sources of capital. In particular, the attraction of private capital may offer the best opportunity to meet both the service objectives and extend the fiscal capacity of the Port. The use of these mechanisms should be carefully considered, however, since in some cases a perceived reduction in airline costs may actually result in a transfer of costs from fees charged by the airport to fees charged by the new third-party operator. Privately operated facilities, however are increasing common in the airport industry, which is one of the reasons that CPE comparisons between airports are difficult.