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RCAA

Regional Commission on Airport Affairs

RCAA
Regional Commission on Airport Affairs

801 S.W. 174th St.
Normandy Park, WA 98166
(206) 248-7603

January 21, 1993

Dear Members Transportation Policy and Executive Board:

We are pleased to present materials to you regarding the topics of demand management, airport planning, and system alternatives.

We are proud of the quality and qualifications of the consultants who are working with us to find appropriate solutions to the long-term air capacity needs of the Puget Sound Region.

As you move through the decision-making process in the next few months we hope that you will avail yourself of our consultants' knowledge and experience. I would be happy to arrange telephone calls or meetings with interested PSRC members and our consultant team.

Best regards,

Jim Murphy

James T. Murphy

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Regional Commission on Airport Affairs

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SECTION II

REVIEW OF FLIGHT DELAY INFORMATION

Presented by

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J. Richard Aramburu, an experienced attorney specializing in the areas of land use, environmental and real estate law, is a lifelong resident of Washington state. He received both his undergraduate and law degrees from the University of Washington.

Aramburu is widely recognized for his familiarity with Washington environmental law as he has appeared before numerous local, regional, state and federal commissions, planning bodies, councils and agencies on related issues.

In recent years his work has focused on aviation cases in Port Townsend, Olympia, Sequim, and Portland, Oregon. He is a veteran of many large-scale local projects such as the Newcastle landfill, the Bellevue Convention Center, the Music Hall theatre, and WPPSS.

Aramburu's skills are called upon by a diverse client base ranging from local governments to citizen groups, from businesses to labor unions, and numerous state and national non-profit environmental organizations.

Admired for his intelligence, hard work and thorough research, Aramburu is listed in Best Lawyers in America (1988-90 Edition) and is a popular presenter of seminars on subjects ranging from the "Environmental Community Perspective of the Growth Management Act" to "Master-Planned Communities: Shaping Exurbs in the 1990s."

Community involvement includes:

- Chair, Legal Committee, Washington State Environmental Council
- Board Member, Allied Arts of Seattle
- Advisory Committee, Shoreline Management Committee, Washington State Department of Ecology
- Member, King County Growth Advisory Committee
- Chair, Continuing Legal Education Committee, State Bar Association
- Member, Environmental and Land Use Law Section, Washington State Bar Association
- Member, Law-Related Education Committee, State Bar Association

FLIGHT DELAYS: THEIR CALCULATION AND IMPORTANCE
REGIONAL AIRPORT SYSTEM PLAN
JANUARY 11, 1993

1. INTRODUCTION

The primary concern of the Regional Airport System Plan is to provide adequate airport facilities in the coming years. Capacity in this context is related to the ability of aircraft to land at a given airport at a chosen time without an inappropriate delay.

There must be a balance between the length and type of delay and the cost, in economic and environmental terms, of solving that delay. The cost of resolving delay issues chosen by the Port (constructio of a third runway) is a very expensive solution. It's cost approaches $500 million to construct and will be one of the most expensive runways in the country. See the chart attached hereto as Attachment A which compares the costs of other current and planned runway projects. As we note later in this paper, this public expenditure has almost no public benefit, but rather operates largely to subsidize air carriers. See Section 8 herein.

This paper reviews how delays are calculated and what standards are set to measure inappropriate delay. This paper also reviews the importance of delays to the various segments of society, and who are the real beneficiaries of reduced delays.

It is concluded that the methodology for reporting delays involves significant opportunity for error and that the measurement of future delays is significantly flawed. Finally, measured by any objective standard, current and anticipated delays must be considered insignificant.

2. WHAT IS FLIGHT DELAY?

Flight delay occurs when an aircraft's travel time from its origination to its destination exceeds the standard flight time, as expressed in the Official Airline Guide, plus standard taxi time by at least fifteen minutes. Delay times below 15 minutes are deemed insignificant by the Federal Aviation Administration and therefore are not even recorded. Delays can occur at the gate, during taxi-in or taxi-out procedures or en route.

The single largest cause for delay nationwide is poor weather conditions[1]. As shown on Attachment B hereto, weather delays constituted more than 53% of delays in 1990. "Terminal delays," such as delays from runway limitations, only account for a little more than a third of all delays. Weather delays for airports such as Sea-Tac add up quickly when low visibility conditions exist and as Sea-Tac add up quickly when low visibility conditions exist and no aircraft are operating. No amount of new runways can prevent these delays.[2] Other causes of delay to the U.S. aviation system include: 1) air traffic control safety measures; 2) over-scheduling of flights during peak travel hours; 3) terminal volume; 4) hub and spoke airports; and 5) construction or maintenance on airports.

3. IDENTIFYING DELAY AT SEA-TAC INTERNATIONAL AIRPORT

U.S. airports have kept delay statistics since the 1950's, but only recently has the FAA begun to create accurate systems. In the last decade has the FAA implemented the 15-minute rule as defining a delay. Only for the last three years has Sea-Tac International Airport kept daily records of aircraft flight delay with a uniform program called ATOMS. The ATOMS program requires that each operation experiencing any delay (even under 15 minutes) must be recorded with a brief explanation and minutes delayed.

Delays over 15 minutes are recorded again on a separate worksheet called OPSNET for each delay period throughout the day. Any delays of 15 minutes or more that are a result of aircraft mechanical/electrical problems or other pilot/airline problems beyond the purview of Air Traffic Control (ATC) shall not be reported, according to ATOMS. On average, STIA submits one OPSNET worksheet per day; on sunny days none and in bad weather up to three.

4. Limitations In The Delay Recording Methodologies

First, recording delays is not a precise science. ATOMS cannot identify "cumulative delay", i.e. five-minute hold at the departure gate, five-minute airborne hold, five-minute arrival hold. The ATOMS program says that given today's ATC equipment, delay due to multiple holds cannot be accurately recorded.[3]

Second, the FAA has not perfected methodologies to prevent the complications that arise when recording delay. For instance, no methods have been developed to identify the "ripple effect", or "when congestion at a major airport causes delay at other airports in the system."[4]

An example of the ripple effect occurred on June 13, 1992, when there were only five departure delays recorded over 15 minutes at STIA. (There were no arrival delays). All five aircraft were held on the ground at STIA due to runway repair at San Francisco Airport.[5] San Francisco undoubtedly inconvenienced other U.S. airports too. All of these delays are thrown into a national delay statistic.

data to the effect of airport improvement.[6] Since delay reports do not include those delays under 15 minutes and do not identify cumulative delays, delay estimates outline only major trends. Therefore, forecasting delays and dollars spent rely solely on computer models and formulas and not on actual data.

5. HOW MUCH DELAY DOES STIA CURRENTLY EXPERIENCE?

In the past 10-15 years, flight delay has been examined in several documents. These include: the 1988 Airspace Update Study, (AUS); the 1991 STIA Enhancement Plan, (EP); and the 1992 Final Environmental Impact Study, (FEIS). The two problems with these reports are: 1) the inconsistency, and 2) they do not use actual delay data.

First, the reports cannot agree on current delay or future delay. These inconsistencies as shown in Table 1-1.

Table 1-1
Delay Reported for 1985-1990

Document	Year	Operations	Annual Delay	Delay Per Aircraft
1. FEIS	'90	355,000	29,000 hours	5 minutes
2. EP	'89	335,000	48,000 hours	8.5 minutes

Second, the EP, for instance, generates its current and future delay estimates by plugging in the Official Airline Guide (OAG) flight data into the "Airport Machine," an airspace and an airfield simulation computer model.[7] By using the OAG, the computer models do not account for the many cancelled flights.

These computer models have inherent limitations, according to Transportation Computer Specialist Amedeo Odoni. For example, the Airport Machine, "cannot react dynamically to operating conditions as an Air Traffic Control Tower would in practice." Or if a major congestion problem developed on a taxiway system, the model would "continue sending aircraft to that location since the aircraft paths are fixed, instead of routing them around the bottleneck to relieve congestion."[8] Thus the program fails to include the common sense solutions that sensible managers put into effect.

In fact, cumulative records of actual delay by year have been maintained by certain employees of the FAA. These show a different record of delay predicted from computer program model. Rates of delay for STIA from 1990 and 1991 are shown on Attachment C, "Delay Rates at STIA." As that document indicates, delays at STIA are virtually nonexistent. Total hours of delay at STIA over the two years in question only to average about 3815 per year, well below the threshold for congestion at airports identified by the FAA. Indeed, an even more important statistic, the number of flights delayed over 15 minutes, shows ony about one percent (1%)) of flights in this category. Of course this is total delay, only part of which could be cured by an additional runway capacity.

We conclude that actual delays at STIA are few and serve no basis for additional major public expenditures, especially of $450 million.

6. HOW MUCH DELAY IS EXPECTED IN THE FUTURE?

To estimate delay hours in the year 2000, each document uses baseline figures for Million Annual Passengers and operations expected. These figures are approximately the same as shown in Table 1-2.

Table 1-2
Passengers and Operations Expected in 2000

Document	MAP	Operations	Annual Delay/Hrs.	Delay/Aircraft
FEIS	25	411,000	61,600	9 minutes
AUS	26	377,000	31,000	5 minutes
EP	*	390,000	168,000	16 minutes

* The Enhancement Plan does not include any Passenger statistics, current nor forecasted.

The comparable baseline figures given above are used in the reports to predict hours of delay for the year 2000. These are vastly varied as shown .

Remember that much of this delay is weather related (as much as 50%). See Attachment A, Primary Cause of Delay of 15 Minutes or More." Thus when considering delays, remember that at time of certain weather conditions, no amount of new runway will prevent delays. Thus a certain amount of delay is inevitable.

As might be expected, the "data" for expected delay shows the same extreme variation as does data concerning current delay.

7. HOW MUCH DELAY IS TOO MUCH?

To the FAA, any delay under 15 minutes per operation is not significant. The FAA uses 20,000 hours of annual delay as a threshold to indicate congestion, and according to the Aviation System Capacity Plan, STIA falls into this category. But at STIA, even if there were 29,000 hours of delay in 1990, they were spread over 355,000 operations and 16,000,000 passengers or 4.9 minutes of delay per operation. On the average, each individual passenger was delayed .11 minutes or 6.5 seconds.

In addition, there is no weighting of delay based upon length of trip. Obviously a delay of five minutes on a short trip (45 minutes) is more significant than on a longer trip of 2 1/2 hours (Los Angeles) or 14 hours (Tokyo).

Consider what a 7 minute delay means to a airplane passenger. If a passenger takes a non-stop flight from Boston, Massachusetts to Seattle, Washington, it will take five hours on the plane. Travel time would actually total about seven hours, (assuming passengers arrive one hour prior to departure as suggested by airlines and take one hour to wait for baggage and drive to a final destination). If these passengers faced a seven minute delay at STIA, they would travel for a total of 427 minutes rather than 420, or a 1.6% increase in travel time.

It is also useful to compare the "congestion" that occurs when planes are late on an average of 7 minutes, with other delays that occur in our society. Perhaps the best known "congestion" is freeway driving.

Suppose a traveler drives from downtown Seattle to Sea-Tac airport, about 12.5 miles. Driving at 55 MPH, the posted speed, without congestion, the trip should take about 16 minutes. But, according to Metro staff, the average speed on I-5 during rush hours is now down to 26 MPH. Assuming this rate, driving to STIA from downtown Seattle at .4 miles/minute, it would take 31 minutes, almost a 50% increase in travel time. This delay of 15 minutes to get to the airport from downtown is twice the delay experienced in aircraft operations. This delay doubles what should be a 16-minute trip, while as noted above, the aircraft delay would add only a fraction of time to an airline trip.

We are all familiar with other delays of 5-10 minutes in our society. It may be waiting to cash a check at a bank or a busy lunch hour, or checking out a movie at a video rental; or waiting for a bridge opening at the Fremont, University, Ballard or Montlake Bridge. We all have our personal examples. But do any of us really think this is a "big deal"? Remember that the event we are waiting for in each of these examples takes less time than the waiting (cashing a check, crossing the bridge, checking out the movie). How important can the seven minute delay at the airport be?

But remember that the airport and its overflights creates its own delay for the populace affected. Each time a plane goes over and creates a land noise, it disrupts human activity. For levels over 65 dba, the overflight interferes with speech. If areas receive 400 overflights which interrupt speech, disturb activity or the like for even as little as 10 seconds, that is 66 minutes of delay per day per individual. It is easy to see that these very real delays quickly outstr8ip any delays experienced by airport passengers.

More seriously, the overflight interferes with education and creates delay the transmittal of information. There are well known effect of "jet-delay education" in which the educational process is interrupted by jet aircraft noise. CITATIONS

On any given day there is the potential for 200 or more overflights during the school day. Unlike the travelers who are rarely inconvenienced in flight operations at STIA, students and teachers must contend with the "delays" each school day.

8. IS DELAY A SERIOUS PROBLEM WITH AIRPORTS/AIRLINES?

A recent report was published in the 1991 Fall issue of the Transportation Journal, "Identifying Service Gaps in the Commercial Air Travel: The First step Toward Quality Improvement." The article presents results from a survey asking airline managers, passengers, and federal transportation officials to define "quality air transportation" by ranking travel attributes that they deemed important.

The survey concluded that passengers define quality air travel differently than airline managers and airport executives. For example, passengers identified attributes such as: on-board comfort, being kept informed regarding delays, and being cared for when travel was disrupted as more important than did executives. For passengers, having enough leg room during a flight was of more importance than leaving a gate on time.

When it came to evaluating delays, the nearly 500 passengers had different opinions than airline management:

> Significantly, delays themselves were not much of an issue; rather passengers apparently feel as though they aren't being told what is happening in a delay situation and it is this lack of knowledge that they don't like.

(Emphasis supplied).[9]

In short, all of the concern about delays is not really related to passengers. Indeed, RCAA research has not found reports that attempt to quantify, in any terms, the cost of delay to passengers. This is no doubt the case because the delays involved are insignificant and incapable of quantification.

Indeed, the only quantification is for costs <u>to the airlines</u>. The delay costs are based on the average operating cost of an aircraft at about $1400/hour. We doubt even whether for small increments (line 5-10 minutes) there is really additional cost to the airlines for such delay.

All of this raises the question of who is really benefitting from the reduction of delays - the traveling public, for whom delays are "not much of an issue" or the airlines trying to maximize profits. It also raises question of large public subsidies to benefit the airlines.

1. <u>Airport System Capacities: Strategic Choices, 1990,</u> Transportation Research Board, National Research Council, p.14.

2. <u>Airport System Capacity, Strategic Choices 1990, #226</u>, Transportation Research Board of National Research Council, p.14.

3. <u>National Airspace Performance System,</u> NPRS, ATOMS, Federal Aviation Administration, 1989, Chapter 3, Order 6040.15B, p.61,

4. <u>National Plan of Integrated Airport Systems,</u> (NPIAS), 1990-1999, Federal Aviation Administration.

5. National Flow Control-define

6. <u>NPIAS</u>, p.25.

7. EP, p.2.

8. <u>Transportation Modeling Needs: Airports and Airspace</u>, Odoni, Amedeo R, 1991, p.34.

9. "Identifying Service Gaps In Commercial Air Travel: The First Step Toward Quality Improvement," Gourdin, K. and Kloppenborg, T., <u>1991 Fall Transportation Journal</u>, 28.

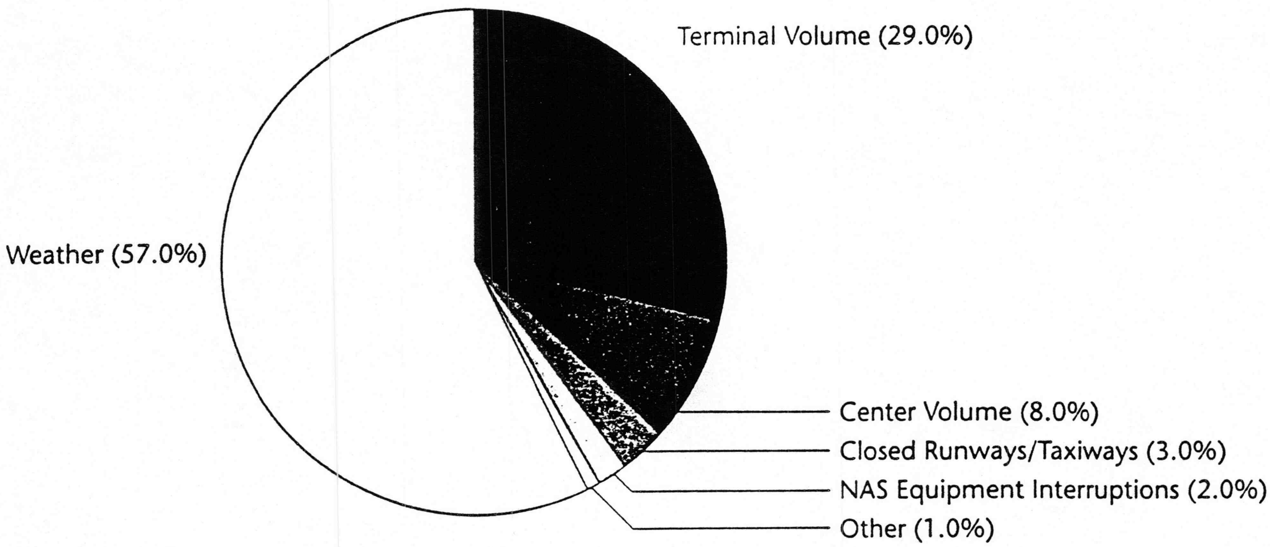
Recent Completed or Proposed Runways & Construction Costs

Airport/State	Cost (in millions)	# of Runways	Year Completed
1. Sea-Tac, WA	**$450-$500**	**1 Dependent**	**1998**
2. Dallas/Fort Worth, TX	$475	2 Independent 1 Dependent	1996 1986
3. Denver International, CO	$380	5 Independent	1993
4. Louisville, KY	$350	2 Independent	1992
5. Orlando, FL	$168	1 Independent	1990
6. Nashville, TN	$114	2 Independent	1989/90
7. Vancouver, B.C.	$100	1 Independent	1996
8. Cincinnati, OH	$70	1 Independent	1990
9. Houston, TX	$60	1 Independent	1987
10. Kansas City, MO	$50	1 Independent	1990

Total cost to pay off a $500 million debt over 20 years including interest and other carrying charges is 2.35 times the debt, or **$1.175 billion.**

ATTACHMENT A

FY 1989



FY 1990

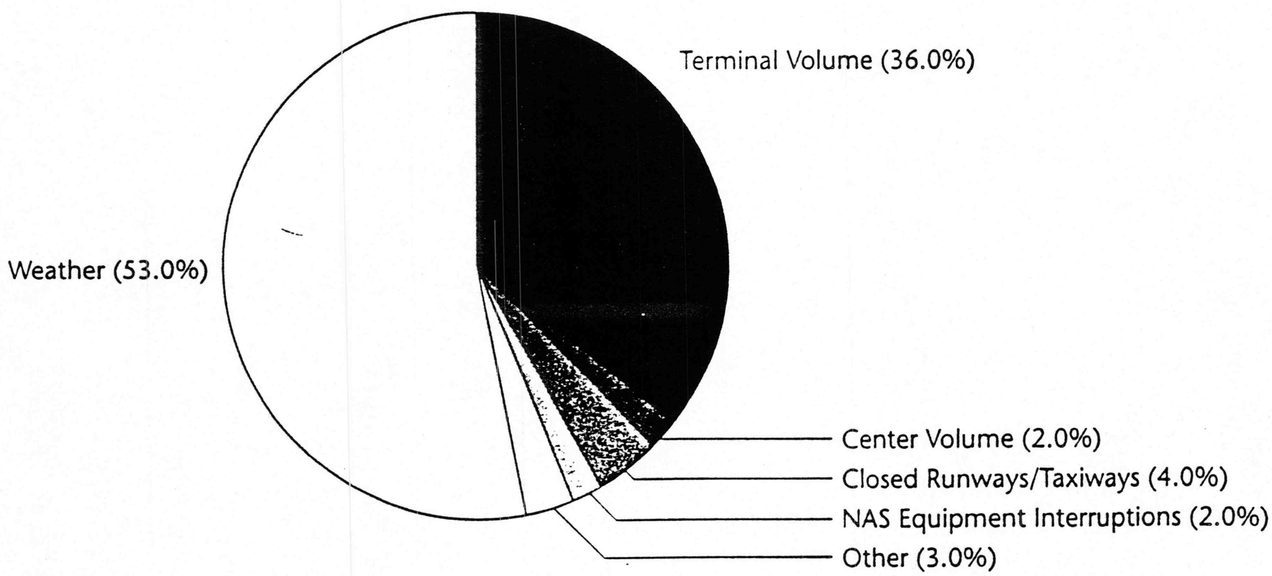


Figure 1-5. Primary Cause of Delay of 15 Minutes or More in FY89 and FY90

Source: Air Traffic Operations Management System (ATOMS) Data

DELAY STATISTICS
SEA-TAC 1990-1991[1]

	1990	1991
1. Annual Operations Delayed		
Total Operations Delayed[2]*	21,404	16,987
Total Annual Operations	355,007	338,607
% Of Total Operations	6%	5%
2. Annual Delay Time		
Total Hours Of Delay[3]	4451	3179
Total Annual Operations	355,007	338,607
Delay In Seconds Per Operation	45 seconds	34 seconds
Total Annual Passengers	16.2 M	16.3 M
Average Delay Per Passenger	1.0 second	.7 second
3. Delays More than 15 Minutes		
Total Operations Delayed 15 Minutes Or More[4]	5053	3414
Total Annual Operations	355,007	338,607
% Of Total Operations	1.4%	1.0%

* DELAY: Delay that has occurred for any length of time.

---

[1]Source: Personnal Communication with Jim Frala, Regional FAA, Air Traffic Proceedures, January 15, 1993.

[2]*Id.*

[3]*Id.*

[4]*Id.*

SECTION III

DISCUSSION OF AIRSPACE AND RUNWAY CAPACITY ISSUES AND ALTERNATIVES

Presented by

Gerald Bogan

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Gerry H. Bogan, president of G. Bogan & Associates, Inc., specializes in airport planning and air traffic control. Mr. Bogan is an internationally recognized expert on aviation matters bringing 38 years of experience in the field of air traffic control to bear upon a project.

During his career with the FAA, Bogan's responsibilities included planing and budgeting the national airspace system for the Western Region; managing the enroute air traffic control facility for Southern California; and developing the noise abatement section for the Western Region.

In recent years Bogan has been involved in numerous aviation projects including:

- Feasibility study for a new airport in China
- Air traffic control needs at Jeddah Airport, Saudi Arabia
- Improvement of air traffic control aids, Republic of Indonesia
- Impact of hypersonic aircraft on air traffic control system, NASA
- Study of capacity limits of air carrier airports and airspace review for possible sites for new air carrier airport, California Department of Transportation
- Advice on expansion and noise matters, Suburban O'Hare Commission
- Part 150 Noise Compatibility Study, City of Tempe, Arizona

Mr. Bogan's aviation consulting firm is based in La Quinta, California.

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SEATTLE TACOMA INTERNATIONAL AIRPORT
THIRD RUNWAY PROJECT
AIR CAPACITY

I INTRODUCTION

Seattle Tacoma International airport (Sea-Tac) is the major air carrier airport in the state of Washington. Most communities in the state are reached via connecting flights through Sea-Tac.

Currently air service at Sea-Tac is limited to two parallel **dependent runways** oriented north and south. The centerline of the runways are separated by 800 feet. Paraphrasing the Federal Aviation Administration (FAA) definition of dependent runways, they are runways separated by less than 4,300 feet and therefore, unable to accommodate instrument arrival and departure operations without considering the arrival and departure activities of the adjacent runway. Aircraft utilizing flight paths associated with dependent runways must be integrated which results in less hourly capacity than similar runways that are farther apart.

Weather conditions also impact the hourly capacity of a runway. When weather conditions are clear and visibility unrestricted, arriving and departing aircraft can utilize a separation,"visual separation", which is less than that required during restricted weather conditions. In general terms, during visual weather, inflight separation is reduced to see and be seen and one runway activity at a time. As weather deteriorates, pilots are unable to operate at the minimum separation criteria for visual operations. Air traffic controllers must provide increased separation between aircraft in poor weather. This results in fewer hourly operations and a reduced airport capacity.

If such weather exists during peak demand periods the end result is delay to arriving and departing aircraft. When delays become unacceptable, operational and/or airport configuration changes must be made. Weather and its impact on the proposed third runway at Sea-Tac will be discussed in more detail in section III of this report.

II OPERATIONAL BENEFITS/LIMITATIONS OF THIRD RUNWAY

The proposed third runway at Sea-Tac is to be constructed west of the existing parallel runways. It is planned to be 7,000 feet in length and located 2,500 feet west and parallel to runway 16L/34R (the eastern most runway). In order to attain the optimum criteria for such a runway configuration special radar equipment must be installed and special FAA operational procedures implemented.

Basic separation between arriving aircraft during instrument flight is three miles or approximately 36 arrivals per hour. This in-trail separation can be reduced to two and one half miles with the use of special radar and corresponding air traffic control procedures. When parallel runways are between 2,500 feet and 4,299 feet from each other, aircraft must also be horizontally separated by a minimum of two miles staggered separation. Again, with the use of special radar equipment and procedures the staggered separation could be reduced to one and one half miles. The diagonal separation requirement places speed and in-trail restrictions on aircraft which reduce the arrival rate and operational flexibility of dependent parallel approaches. This limits the capacity increase normally associated with two arrival streams. Therefore; a third runway at Sea-Tac, **if dependent**, will not provide a <u>full runway hourly capacity increase</u> as could be expected from an independent runway. At Sea-Tac air traffic controllers will be required to separate

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successive arrivals for the same runway, insure staggered separation between adjacent runways, and then also provide spacing intervals between arrivals to allow for departures. It quickly becomes obvious that runways constructed less than 4,300 feet apart (dependent), do not provide the hourly capacity of independent runways. To maximize the hourly runway capacity, Sea-Tac will require additional equipment and implementation of procedures designed for dependent runway operations. The Sea-Tac runway configuration planned, i.e., all runways dependent, will not handle the number of operations forecast in future years.

The use of special equipment and procedures are not the only considerations when determining true runway capacity. An airport's actual runway capacity is dependent on weather, runway length and interaction with other runways, taxiway to runway intersecting points, separation between runways at the holding locations, fleet mix, electronic landing aids, in addition to pilot/controller skills.

At Sea-Tac, pilot and controller skills are not in question. Therefore to understand the potential runway capacity of the proposed third runway the other influencing conditions must be analyzed.

The year 2000 forecast fleet mix in the "Airfield Capacity Review Working Group Study", concludes that 95.1 % of the fleet will be able to use the planned runway for landings and 72.5 % for takeoff. The high percentage of forecast fleet mix that will be able to use the runway is misleading. True, the runway will accommodate the aircraft size that justify the high percentages identified in the study. However, to determine total airport capacity, one must consider the real operational use of the new runway during peak hour periods. It is simple to land or depart a single aircraft without consideration of other air operations. However, air traffic control consists of many simultaneous actions. The total airport configuration must be considered when allocating fleet mix to runway usage in an attempt to determine hourly capacity of an airport.

Landing aircraft must clear the runway before the next aircraft can land or depart. If the current runway 16R/34L is being used for arrivals or departures, aircraft that land on the new runway will have to hold between runways until the other traffic is clear. During rush periods there would soon be no holding area between the runways and either the new runway or the center runway will lose its desired hourly capacity.

A ground taxi problem will exist when runway 16R is used for departures. There is not enough room between the runways to hold aircraft awaiting departure. Therefore aircraft would have to hold either in the gate area or on the ramp/taxiway east of the runway complex. This type of problem will complicate and congest the use of all the runways during rush periods. Maximum runway usage can not be attained under these conditions.

Practical air traffic control logic would conclude that during peak hour periods the new runway would be best used by limiting it to the smaller aircraft. They are easier to hold between runways and can quickly cross adjacent runways between other operations. While this fleet segregation can help to attain maximum runway usage, it does depend on the availability of such type aircraft during the peak periods, and the ability to efficiently assign them to that runway. Forecasts indicate a significant reduction in the smaller commuter type aircraft.

This will compound the problem of trying to segregate runway usage by aircraft size. Any time "special" actions are required air traffic control becomes more complex resulting in reduced operations, thus, less hourly capacity than expected.

Sea-Tac currently experiences delays caused by the lack of holding area between the two runways. Adding another runway without sufficient holding area will compound the delay problem.

The following is an example of the height and length of the larger aircraft that could use the proposed runway.

Boeing 737-200, 300, 400.	height	36' 6"	length	119' 6"
Boeing 767	height	52' 9"	length	180' 3"
Airbus 300, 310, 320.	height	55' 6"	length	175' 6"

During poor weather conditions all holding between runways will probably be prohibited. FAA has very strict criteria regarding holding areas that can interrupt navigational aids. Electronic navigational aids can easily become unusable if the electronic signal is subjected to reflection interference.

As stated above, it is highly unlikely that aircraft of this size could hold between the runways. Additionally, a metal surface the size of the above aircraft would certainly cause interference with electronic landing aids. An aircraft holding between runways as close as those at Sea-Tac can easily cause such signal interference. This further degrades the use of the proposed runway.

The Flight Plan Study Forecast for the year 2000 is 411,000 operations, with an average day peak month of 1243 operations. The fleet mix for that daily average is:

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Aircraft class	Arr.	percent	dept.	percent	total	percent
Heavy	104	17%	105	17%	209	17%
narrow body	279	45%	279	45%	558	45%
commuter	192	31%	192	31%	384	31%
small prop.	46	3%	46	3%	92	3%
total	621	100%	622	100%	1243	100%

The Airfield Capacity Study runway utilization plan allocates the percentage of arrival and departure traffic by runway and hour as follows:

DAILY PERCENT OF ARRIVALS/DEPARTURES BY RUNWAY

VFR (visual) weather conditions south flow

Runway	Arrivals	Departures
New runway (16W)	40 %	0 %
Runway 16R	50-55 %	10-15 %
Runway 16L	5-10 %	85-90 %

IFR weather conditions south flow

16W	40 %	0 %
16R	0 %	95 %
16L	60 %	5 %

VFR (visual) weather conditions north flow

34W	40 %	0 %
34L	50-55 %	10-15 %
34R	5-10 %	85-90 %

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IFR weather conditions north flow

Runway	Arrivals	Departures
34W	40 %	0 %
34L	0 %	95 %
34R	60 %	5 %

North flow has the same runway use by percentage, fleet mix, and daily/hourly operations as south flow for both VFR and IFR operations. North flow will have the same airside and landside problems that are encountered in the south flow scenarios. Therefore, for brevity this report will be primarily directed to south flow analysis.

DAILY ARRIVALS/DEPARTURES BY RUNWAY AND AIRCRAFT TYPE

VFR (visual) weather conditions south flow

Runway Used	Aircraft Operations	
	Arrivals	Departures
16W (heavy jet)	41	0
(jet)	111	0
(commuter)	76	0
(prop)	18	0
16R (heavy jet)	52- 57	10-115
(jet)	139-153	27-441
(commuter)	96-105	19-228
(prop)	23-25	4-7

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Runway Used	Aircraft Operations Arrivals	Departures
16L (heavy jet)	5-10	89-94
(jet)	14-28	237-251
(commuter)	10-19	163-173
(prop)	2-5	39-42
total operations (rounded)	621	622

IFR weather conditions south flow

Runway Used	Aircraft Operations Arrivals	Departures
16W (heavy jet)	42	0
(jet)	112	0
(commuter)	77	0
(prop)	5	0
16R (heavy jet)	0	98
(jet)	0	265
(commuter)	0	182
(prop)	0	44
16L (heavy jet)	62	5
(jet)	167	14
(commuter)	115	10
(prop)	28	2
total operations (rounded)	621	622

The hourly runway use breakdown that follows is a sample of two hours using the year 2000 forecast. The first sample hour

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is an hour at or near the airport capacity, 58 operations per hour. The second sample hour is the peak hour reported in the subject forecast.

VFR (visual) weather conditions south flow (58 operations/hr)

		air carrier hvy jet	jet	commercial	prop	total
16W	arr.	1	3	4	1	9
	dep.	0	0	0	0	0
16R	arr.	1	4	5	1	11
	dep.	1	1	1	0	3
16L	arr.	0	1	1	0	2
	dep.	5	14	10	2	31

IFR weather conditions south flow (58 operations/hr)

16W	arr.	1	3	5	1	10
	dep.	0	0	0	0	0
16R	arr.	0	0	0	0	0
	dep.	5	15	10	2	32
16L	arr.	2	4	6	1	13
	dep.	1	1	1	0	3

VFR (visual) weather conditions south flow (95 operations/hr)

16W	arr.	5	10	7	1	23
	dep.	0	0	0	0	0

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		air carrier hvy jet	jet	commercial	prop	total
16R	arr.	6	12	8	1	27
	dep.	1	2	1	0	4
16L	arr.	1	2	2	0	5
	dep.	9	17	9	1	36

IFR weather conditions south flow (95 operations/hr)

		air carrier hvy jet	jet	commercial	prop	total
16W	arr.	5	10	7	1	23
	dep.	0	0	0	0	0
16R	arr.	0	0	0	0	0
	dep.	9	18	10	1	38
16L	arr.	7	15	10	1	33
	dep.	1	1	1	0	3

The above tables identify the anticipated fleet mix, daily percent of arrivals and departures by runway, daily arrival and departure fleet mix by runway, and two sample hours of distribution of that data in both VFR and IFR conditions.

The 58 operations per hour breakdown was analyzed using prescribed arrival and departure separation standards. However, the current two runway configuration with improved electronic systems such as LDA, MLS, and state-of-the-art radar, will also satisfy the forecast demand.

The 95 operations per hour breakdown was analyzed in the same manner as the 58 operations per hour. At peak hours and IFR weather conditions, if the 95 operations per hour forecast and proposed runway assignments are correct, a two or even three dependent runway configuration at Sea-Tac would be hard pressed to accommodate the demand without encountering excessive delays.

However, to fully understand the third runway cost v benefits equation, a comparison of peak hour demand to weather must be explored. If a portion of the restrictive weather conditions (IFR), occur during non-peak demand periods then the need for a third dependent runway to temporarily resolve capacity demand may be overstated. Under such circumstances electronic and procedural enhancements of Sea-Tac (with the current two runway configuration) could very well be the prudent answer until a complete solution to the air capacity demand problem is accomplished.

Virtually every current study that has been conducted regarding future demand at Sea-Tac has concluded that a third runway is only a stop gap improvement. The ultimate solution to the fore-cast passenger demand is the expanded use of existing airports or the development of a totally new regional airport site.

Boeing Field is a prime candidate for use as a commuter airport for those short haul passengers who originate or terminate their travel in the Seattle area. The Port of Seattle 1991 Airport Activity Report states that flights of 150 miles or less accounted for 38 % of all 1991 aircraft operations. A significant reduction in annual operations at Sea-Tac could be realized by increased use of Boeing Field for commuter operations.

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Arrival/missed approach conflicts between Sea-Tac and Boeing can be resolved by the use of state-of-the-art navigational equipment, radar, and corresponding air traffic control procedures.

If these assumptions are correct then the installation such equipment and enhanced air traffic control procedures is a prudent near term solution to capacity problems. A third runway that only temporarily solves the problem is not a reasonable alternative. Instead the time and money spent on a **dependent runway** could be better used finding a permanent solution to the problem.

The 1991 Sea-Tac airport capacity enhancement plan identifies the savings in hours and dollars that can be realized in several scenarios including an "improvements to existing airfield" scenario. The Plan concluded that improving runway exits and taxiways, reducing in-trail spacing, installing enhanced landing aids and radar, providing a wake vortex advisory system, and refining the noise abatement effects on departures saves over 148,000 hours or $ 213 million dollars at the Future 2 forecast period.

III WEATHER CONDITIONS AS JUSTIFICATION FOR A 3RD RUNWAY

Section II detailed the fleet mix and runway use forecasts that are being offered as justification for the construction of a third dependent runway at Sea-Tac. To better understand the value of such a plan, an analysis of weather conditions is necessary.

Weather as it affects Sea-Tac air operations falls into two categories, airport weather, and weather conditions beyond the immediate airport area. Airport weather is the weather that effects the immediate airport environs. Surrounding weather affects arrival and departure operations outside the immediate vicinity of the airport. This weather determines departure flow and the arrival rate and spacing required to separate aircraft.

Air traffic controllers must provide separation between arrivals until the pilot is clear of all clouds, sees other arrival traffic and the airport, then a "visual approach" can be conducted. When weather conditions permit, visual approach operations maximize a runways acceptance rate.

Airport weather is determined by observations from a specific airport location. The ceiling and visibility determines whether visual or instrument flight rule conditions exist. Instrument weather conditions means that air traffic control is responsible for the separation of all air operations. IFR separation requirements mandated by Federal Air Regulations result in lower hourly capacity than the separation criteria used in visual flight operations.

The proposed third runway will be less than 4,300 feet from the existing runways. Prevailing weather will have a direct bearing on its use and the ultimate hourly capacity increase it will provide over the current two runway configuration.

Section II identified taxi and holding constraints that will be encountered during IFR weather conditions. The Sea-Tac taxiway/ramp congestion and potential electronic interference when holding between runways will result in less capacity potential than claimed in prior studies.

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An analysis of available weather data indicates that about 25 % of the year IFR or marginal VFR meteorological conditions exist, with one third occurring during low traffic demand periods. Approximately 75 % of the year weather is good enough to allow visual approaches to the existing runways. During high demand periods if aircraft are guided through the clouds using an electronic system such as an LDA, dual arrival streams can be conducted which will increase airport capacity without having to build a third runway. During non-visual weather conditions, building an additional **dependent runway**, will provide little relief to the delays anticipated at Sea-Tac.

During IFR or marginal VFR weather conditions **dependent runways are least productive.** As previously stated, a third runway at Sea-Tac that is dependent will not provide the needed capacity during peak demand periods. Electronic equipment and ATC procedural improvements to the existing two runways will improve capacity to an acceptable level until a permanent solution is found.

Multiple consultant studies refer to the weather as VFR 1, VFR 2, IFR 1, IFR 2, and IFR 3. Federal Air Regulations identify weather in only two categories VFR and IFR. VFR weather is defined as three miles visibility or greater and a cloud ceiling of one thousand feet or higher above the ground. IFR is when the visibility and or ceiling is less than that of VFR weather conditions. The type of air traffic control separation applied is based on the FAA definition of IFR and VFR weather.

An analysis of the Seattle weather pattern suggests that peak hour periods can be exposed to ceilings that will require air traffic IFR separation during descent to the airport.

When pilots encounter clouds during descent to Sea-Tac, controllers are required to provide standard IFR separation even though the airport weather is reported as VFR. To conduct visual approaches the cloud base in the arrival area (5 to 20 miles from the airport) should be 3,500 feet above the ground with visibility 4 miles or better. If the weather is less than what is required for visual approaches, a single arrival stream is required. When a single stream is necessary, by the time aircraft are clear of clouds arrival delays have already been encountered. A third runway will not prevent that delay.

IV ALTERNATIVES TO INCREASE CAPACITY WITHOUT A 3RD RUNWAY

Section II and III conclude that an additional **dependent runway** at Sea-Tac will not provide enough capacity to handle the future passenger and air operations demand forecasts of the airport. The consensus of virtually all recent studies of Sea-Tac capacity agree that an additional runway is an interim fix. Expansion of other existing airports and or the development of a new regional airport must be considered if forecast demands are to be satisfied.

A. Airport and electronic aid improvements

Near term delays can be mitigated by the installation of state-of-the-art equipment at Sea-Tac using the existing two runway configuration. Following is a summary of equipment that can be used to improve efficiency and reduce delays.

1. Microwave Landing System. An MLS would improve efficiency at Sea-Tac. It could provide multiple arrival and departure tracks which would maximize the use of available airspace. Potential flight path conflicts between Sea-Tac and Boeing Field (BFI) would be reduced.

2. Equip each runway end with full all weather lighting and electronic landing aids. This would allow air traffic controllers more flexibility in runway use. It allows arrivals and departures access to both runways during minimum acceptable weather conditions. All weather runway lighting will assist pilots in entering and exiting runways more quickly, thus reducing runway use time by each aircraft.

3. Install a Localizer Directional Aid (LDA) for runway 16R/34L to be used during visual approach weather conditions. This system provides the capability of two simultaneous arrival streams through the clouds.

4. Install state-of-the-art radar systems that will allow reduced in-trail separation for arrivals, and provide the coverage required for simultaneous arrival streams between runways separated by less than 4,300 feet.

5. Install wind sheer and wake vortex systems. This would provide safety information data when minimum separation standards are being used both for arrivals and departures.

6. Minimize runway occupancy time by improving the exit taxiway system to include high speed turnoff capability plus additional mid-field turnoff locations.

7. Temporarily use Boeing Field as a commuter airport for short haul passengers originating/terminating in the Seattle area.

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B. Overview of FAA "Four Post Plan"

The FAA Four Post Plan was designed to increase efficiency and thus airport hourly capacity rates. The concept of having arrivals approach an airport from four directions is successfully used in many major air carrier airports throughout the United States. At Sea-Tac the Plan is designed to provide enroute arrival tracks to the NW, NE, SE, and SW corners of the terminal radar approach control area. These tracks provide maximum separation from departure tracks. With minimum track crossing, arrivals are able to approach the airport with little or no delay in descent. During visual approach weather two arrival streams can be established which are separated from each other, provide dedicated arrival flows for each runway, and produce the best arrival rate with minimum delay.

This procedure is less efficient when only one arrival stream is used. With electronic aids such as LDA that allow dual arrival paths in marginal weather conditions the Four Post Plan should provide maximum arrival capacity regardless of weather.

The Plan reduces low level holding and maneuvering. Aircraft are less exposed to conflict situations with uncontrolled aircraft in the Seattle Area.

If annual operations can be reduced through the many available alternatives to where demands during optimum weather are less than 56/hour, the 4 Post Plan might not be required, or used only during peak operational periods.

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C. Overview of the 1991 Sea-Tac Enhancement Plan

The Enhancement Plan analyzes delay situations in detail. The two runway airport capacity analysis assumes a 50%/50% of arrivals and departures. The Airfield Capacity Review Study does not support this assumption. In that Study, the year 2000 forecast busy hours are not balanced. Virtually every hour that exceeds 57 operations per hour favors either arrivals or departures. Example; the 58 operations per hour is, 23 arrivals and 35 departures. The 95 operations per hour is, 55 arrivals and 40 departures. The Enhancement Plan delay conclusions may be overstated in comparison to actual delays encountered.

The Study concludes that visual approach weather prevails approximately 75 % of the year. The cloud base is 5,000 feet or higher 56 % of the year. The cloud base is between 2,500 and 4,999 feet 19 % of the year. To fully capitalize on the 19 % visual approach weather, electronic landing aids must be added. If the Capacity Review Study forecasts are reasonable and hourly arrival and departure activities are seldom balanced, two runways will accommodate the near-term forecasts. The addition of a third dependent runway would not appreciably increase capacity.

The Capacity Enhancement Study identifies numerous improvements that would reduce anticipated delays. Each improvement listed has a number of hours saved and the dollar value to that saving. The Study compares delays using 1989 (Baseline) figures. In 1989 more than 15 million passengers flew in and out of Sea-Tac and the airport recorded almost 355,000 operations. The study claims the delay experienced was 48,000 hours which represents a cost of about $ 69 million dollars.

The study forecasts that when annual operations reach approximately 425,000, without airfield improvements, delays will be approximately 241,000 hours with an associated cost of $ 347 million dollars. It estimates a delay savings of almost 96,000 hours and more than $ 137 million dollars even without providing for a dual stream of arrivals using s system such as an LDA.

The Study forecasts additional savings of more than 51,000 hours representing $ 74 million dollars can be anticipated if an ILS and LDA system were installed.

It would seem that by improving the airfield taxiway system, add electronic landing aids, vortex equipment, state-of-the-art radar, and associated improved operating techniques, Sea-Tac can function with minimal delay until a permanent solution can be developed. The cost of a third runway with all its flaws and limited usefulness does not seem to be an appropriate plan. The other recommended improvements should be the first priority for Sea-Tac capacity enhancement, followed by a concerted effort to find and implement a permanent solution to future capacity problems.

D. Overview of the next generation electronic aids

Research and development of electronic aids that will improve airport capacity, increase safety, and provide more precise navigation capabilities is an on-going project.

FAA and the aviation industry are testing equipment and procedures that will allow landings and departures in zero visibility weather which means airports will be operational almost all the time regardless of weather.

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At the present time independent runways must be laterally separated by a minimum of 4,300 feet. Tests are in progress to determine if independent operations can be conducted with runways separated by 3,500 feet and less.

The global satellite system is expected to provide precise flight track and landing guidance data that will reduce airspace congestion and reduce airborne separation standards.

High resolution rapid update radar systems are being tested to determine the minimum safe separation spacing between aircraft.

All of the above tests are expected to help reduce airspace congestion, reduce separation between aircraft, improve bad weather operations with the end result of more airport capacity with basically the same airport layout.

Sea-Tac like most other air carrier airports throughout the country have limited expansion capability. The present FAA Airport Capacity Planning Document suggests that a two dependent runway layout can accommodate approximately 275,00 to 365,000 annual operations. If the new equipment and procedures being evaluated are successful, annual operations for two dependent runways could be increased considerably.

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2. FAA AC 150/5060-5, Airport Capacity and Delay
3. FAA Handbook 7400.2, Airspace Procedures
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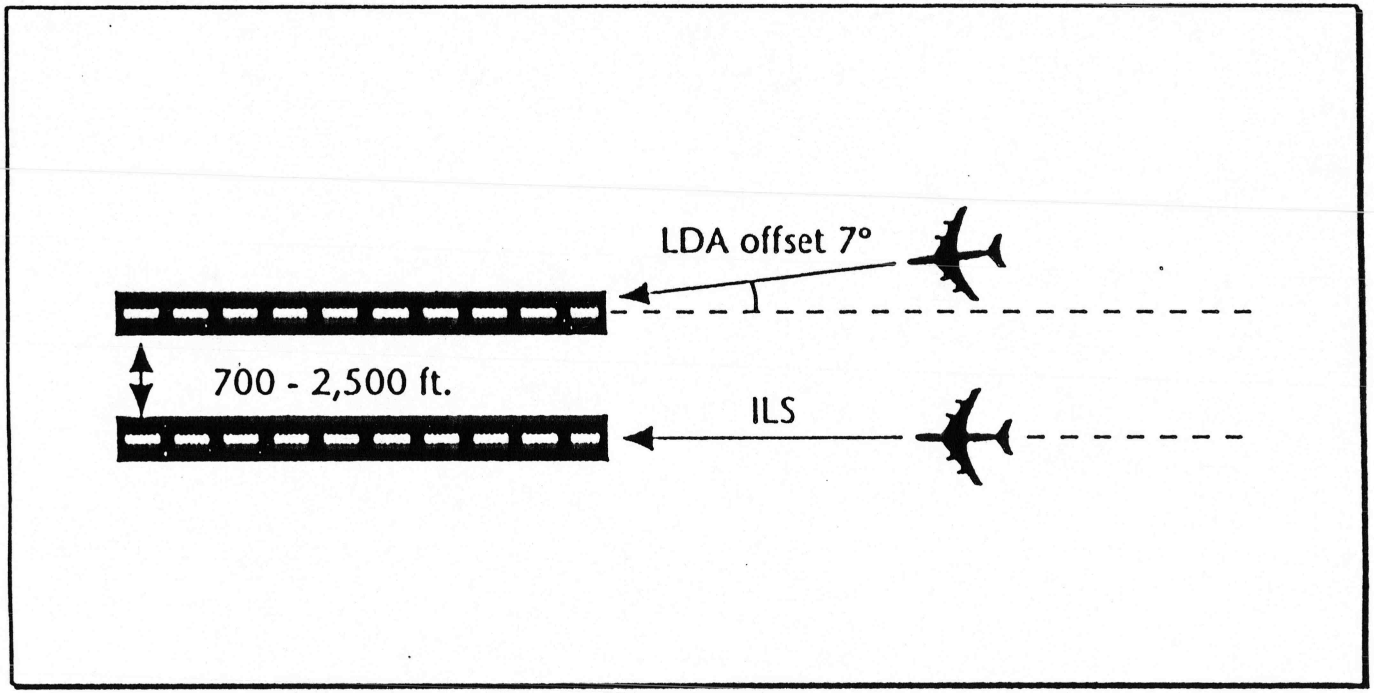
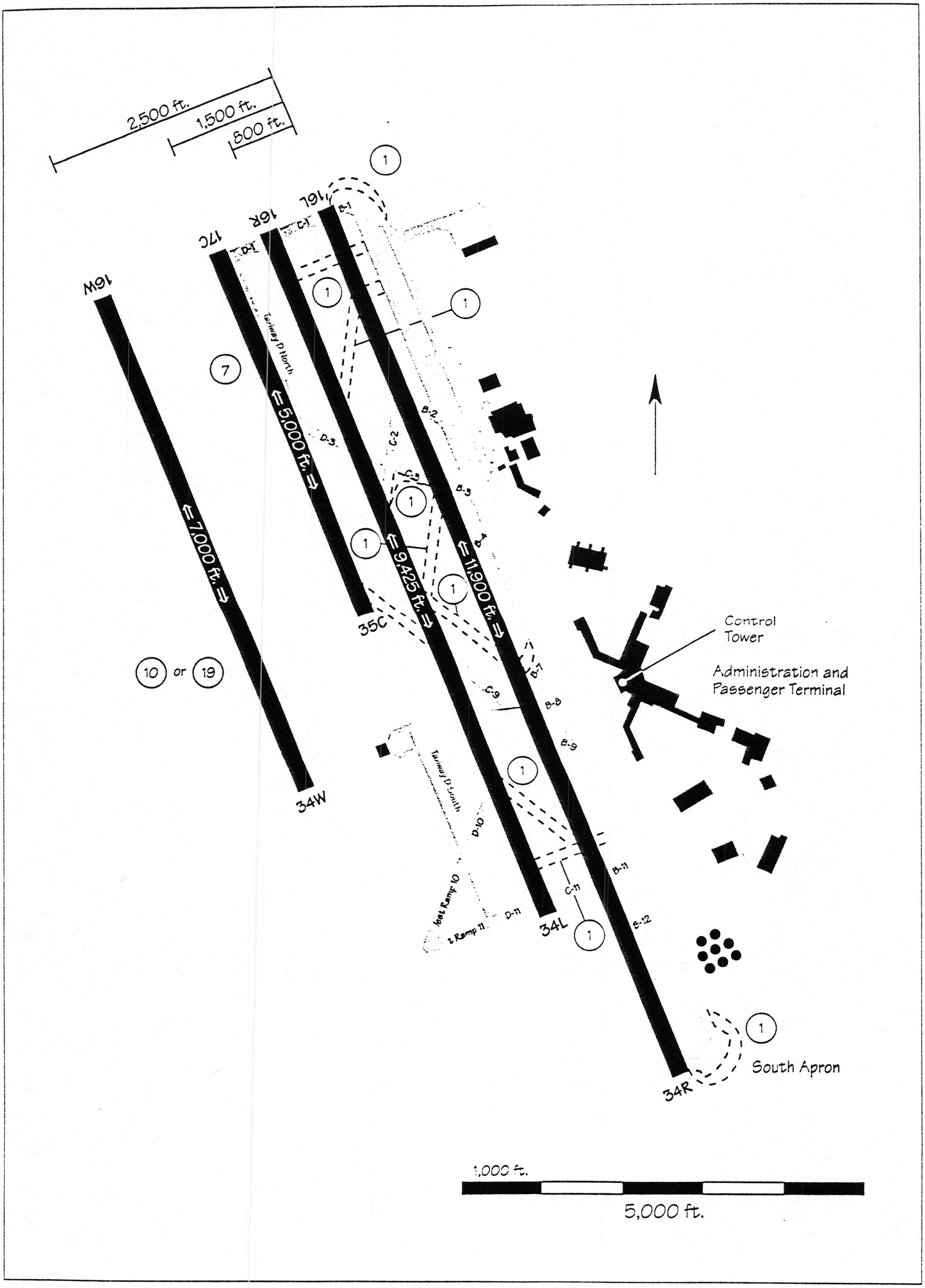
20. PSRC Public Information Documents



Simultaneous ILS & LDA Approaches


2,500 ft.
1,500 ft.
800 ft.
16W
17C
16R
16L
34W
35C
34L
34R
⇐ 7,000 ft. ⇒
⇐ 5,000 ft. ⇒
⇐ 9,425 ft. ⇒
⇐ 11,900 ft. ⇒
Taxiway D North
Taxiway D South
10 or 19
7
1
Control Tower
Administration and Passenger Terminal
South Apron
1,000 ft.
5,000 ft.

SECTION IV

LANDSIDE CAPACITY ISSUES

Presented by

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Gerald M. Dallas, a well-known and experienced airport planner, has a long history of work for the FAA and clients worldwide.

Mr. Dallas' career with the FAA included projects for airline terminal layout; FAR Part 150 noise and land use studies; air carrier and general aviation airport master plans; runway design and layout; airport economic studies; and runway landing system design and installation.

He has conducted airport planning studies for than 65 airports; produced regional aviation system plans for the Southern California Association of Governments and the San Diego Association of Governments; supervised and prepared air cargo facilities for Boeing Aircraft Company at various locations; and participated in new airport site evaluation studies for numerous cities in California and Oregon.

Recent consulting work has included:

- New air carrier facilities, Minneapolis Airport
- New terminal building, Phoenix Sky Harbor Airport
- New runway and terminal building, Los Angeles Airport
- New airport studies, Southern California
- Additions to terminal building, Monterey, California
- Planning for new runway, Nashville Airport
- Master Plan, John Wayne Airport, Orange County, CA
- Review of 3rd runway, Sydney Airport, Sydney, Australia
- Reuse study, Norton Airforce Base

Mr. Dallas' consulting firm is based in Laguna Hills, California.

I. INTRODUCTION

In the review of the various documents relating to the Flight Plan, it becomes apparent that almost the total concern was with airfield and runway capacity.

While such discussions are relevant, and important, equally important is the capability of "landside" areas to absorb the traffic transferred from the runways. Unless there is sufficient area available for expansion of aircraft parking, terminal facilities, vehicle parking areas, cargo facilities, vehicular access and the like, the airport complex lacks balance. In this paper, the issue of this balance will be discussed and reviewed in the context of regional airport planning.

If insufficient landside area is available, then these factors must be addressed. The size and type of such alternative facilities must be considered. It is also apparent that certain minimum economies of scale are required for alternative facilities, depending upon the purpose of the new facility. Thus this paper will also discuss minimum size requirements of secondary and reliever airports available in the Puget Sound region.

II. THE FLIGHT PLAN REPORT DOES NOT ADDRESS THE ABILITY OF STIA TO SUPPORT MASSIVE INCREASES IN PASSENGERS AND AIRPORT RELATED ACTIVITY.

Flight Plan predicts major increases in both total passengers and aircraft operations over the planning period. Aircraft operations for STIA under the preferred plan are expected to increase from about 355,000 in 1990 to 480,000 in 2020. The Flight

Plan recommendations also include STIA taking a vast majority of passengers in the year 2020, up to 39 million annual passengers (or "MAP") of the 45 MAP predicted for the region. Much discussion of providing adequate runway capacity for these operations and passengers is found in Flight Plan. But, is there sufficient land area left after runway expansion to provide the full complement of "landside" facilities?

Flight Plan concedes that STIA cannot be the sole major airport in the region. Indeed, recent correspondence from the STIA proprietor, the Port of Seattle, reinforces this proposition: "Sea-Tac alone can not meet the full air capacity needs of the region." Letter from Port Commissioners to PSRC, December 29, 1992. The question is how much growth can the current STIA absorb and when will STIA reach its practical limits?

Much of the answer to this question revolves around the utilization of current land areas and the feasibility for expansion. The overall area of STIA is small, only about 2400 acres. However, the area available for landside facilities is even smaller, only about 425 acres.

A review of the current airport layout plan reveals that airport "landside" is now essentially fully utilized. This area is developed with various items essential to a modern airport, including vehicular parking, aircraft parking, gates, air cargo, public parking, vehicular drives and the like. In short, any expansion of one facility will require replacement/removal of another facility.

The Port's recent draft Terminal Development plan ("TDP") also shows significant expansion of the passenger terminal. The TDP also concludes that the current terminal will not be capable, in its present configuration, to handle the passenger load much after the year 2015.

Indeed, the plans for the third runway directly impact space available for other purposes. The most current Master Plan (1985) for the airport proposes the expansion of landside facilities in the area in the southwest sector of the airport. However, the Port now proposes this expansion area as the location for the third runway.

The Flight Plan report itself stresses the need for space for cargo handling and other facilities. The report concludes that "because air cargo is growing so much faster than passenger transit, hundreds of passenger planes are being converted to all cargo carriers." Flight Plan Project Draft Final Report, p. C-36. Indeed, the report suggests that the "economy of the future" will be one in which "aviation and airports will supplant seaports, rail and highway systems as the world's primary generators of economic development." Id., p. C-34. The report next concludes that if all the foregoing is to happen:

> the ability to successfully compete in the growing world market will require an efficient aviation system with sufficient capacity and adequate facilities.

Id., p. C-37 (emphasis supplied). It is noted that, for the most part, sufficient air cargo facilities now and in the future will need to be located in the vicinity of passenger facilities. This is true because a vast majority of cargo is and will continue to be transported in cargo holds of passenger aircraft.

Thus the forecasts for STIA include not only major increases in passenger traffic, but greater increases yet in air cargo facilities. All of this also requires additional maintenance facilities, refueling areas and places to park aircraft. The areas to accommodate these activities have not been identified.

But, as the Port concedes, STIA simply cannot offer the space necessary for all this activity. To provide further background, a survey was made of major U.S. airports with passenger volumes similar to current STIA activity. Also included are airports with current passenger volumes that may be expected at STIA in the future.

A review of each airport was made to determine land areas available for "landside" airport activity, including terminals, cargo, maintenance areas, airport drives and other support areas. The results of this work are shown in Appendix A to this report.

Two primary conclusions may be drawn from this survey. First, STIA already has a very small area available for landside facilities. No other airport of comparable volume has such a small area available for landside facilities. Secondly, and important in a planning context, no other airport handling passenger volumes in the range of 20-30 MAP has less than 700 acres available to it for landside facilities.

A glimpse of these future problems with landside capacity were shown during the "airfare wars" of the summer of 1992. Anecdotal information and press reports indicate that these passengers "strained all airport services." See Seattle Post-Intelligencer, June 24, 1992, p. B-1. The report noted that some passengers drove for more than 20 minutes through Sea-Tac's garage before finding a parking space. Similar problems occurred elsewhere according to the P-I:

> Passengers waiting to check in at the American Airlines ticket counter jammed the walkway. Long lines stretched from security entrances to gate areas. Lines of travelers waited in the garage for elevators. Food service areas had lines.

Id., p. B-4.

Of significance, the occurrences during the month of June are nowhere near the number of passengers that will use the airport if the annual use approximates 40 MAP.

III. SEA-TAC APPEARS AVAILABLE TO TAKE ONLY A PORTION OF FORECAST DEMAND, EVEN IF OTHER NEEDS ARE IGNORED.

The foregoing information on landside uses at other airports is not an exhaustive study as there are many variables in "landside" configurations and operations. But such information points out that the "landside" is equally important as runway areas and these factors have not been considered in the Flight Plan documents.

Further, it appears that very serious consideration of this element is warranted since the Flight Plan proposes to accommodate over 45,000,000 annual passengers in the region by the year 2020 and the Sea-Tac site has a relatively small area to devote to these activities.

A constant sized terminal facility can provide a variable number of aircraft gates, depending on the size of the aircraft utilizing the gates.

In 1990 Sea-Tac enplaned and deplaned 15,726,000 passengers through 66 full-sized gates. Therefore, each gate averaged 238,272 passengers per year. Some "full-sized" gate areas were utilized by smaller commuter aircraft and approximately 77 gates were provided. Therefore, the average gate accommodated 204,234 passengers per year.

Expanding the terminal complex to 76 "full sized" gates, approximately 89 total gates, say 90, could be provided for all aircraft types, including commuter.

If each gate were utilized at the 1990 level, and the 1990 level of enplanements per aircraft operation remained, the terminal complex would accommodate 18,450,000 passengers per year through 90 gates.

In 1990 the airport averaged 44.4 passengers per aircraft operation. At 1990 terminal utilization rates, the airport would need to accommodate 415,540 aircraft operations to provide for 18,450,000 passengers.

Using the 1990 aircraft mix and gate utilization; annual operations would need to increase from 354,000 to 425,540 to increase annual passengers from 15,726,000 to 18,450,000.

Due to the relatively small area for terminal and other "landside" expansion, if aircraft mix and gate utilization is not significantly altered, the primary capacity issue at Sea-Tac is one of "landside" capacity, not runway or "airside capacity."

Gate utilization can be improved by using larger aircraft. But larger aircraft require larger gate areas. Preliminary investigations have indicated the terminal complex could be expanded to approximately 76 full sized gates. To provide a significant number of gates over 76 appears to require extensive analysis due to the small area available for terminal and other "landside" activities.

Assuming the existing terminal buildings could be expanded to accommodate 76 full sized gates AND passenger enplanements and deplanements per gate were increased from the current figure of 238,272 by 50% to 357,408, the terminal complex could handle 27,163,008 passengers per year. The gate use figure of 357,408 is an approximate figure for a busy airport; at LAX in 1990 each gate averaged approximately 362,000 passengers. This high gate utilization would increase peak hour passengers considerably and it would be necessary to determine that the facilities including access roads and parking structures could be reasonably modified to accommodate these peak volumes.

If aircraft serving Sea-Tac provided an average passenger capacity of approximately 120, the following analysis could be made. (The non-commuter commercial passenger aircraft currently using Sea-Tac would exceed an average 120 seats per aircraft. Using the year 2020 average of 87 passengers per departure/enplanement contained in one of the Sea-Tac terminal planning documents the number of aircraft operations needed to accommodate 27,163,008 passengers would be under 350,000 annual operations.

This analysis is for passenger traffic and gates only. However, other needs at STIA can be assumed to grow at similar rats, including parking, cargo, maintenance and other facilities. Given current utilization of space, there is little space within the airport complex available for expansion of these uses.

In summary, the existing runways can accommodate these operational volumes with delays under or at acceptable limits.

IV. ECONOMIC CONSIDERATIONS

Flight Plan documents do not consider how landside factors at Sea-Tac could impact the economics of the proposed third runway. However, the draft flight plan report does provide a chart comparing the cost of the project with the funds available. That chart is reproduced at Attachment B hereto. Some explanation about the use of AIP funds is appropriate.

4.1 AIP Entitlement Funds

With 16 million annual passengers, the maximum Sea-Tac could expect is approximately $6.5 million per year in entitlement funds, assuming maximum funding levels with the current legislation. If current operational procedures and aircraft mix is maintained, the landside capacity could be limited to 18,450,000, say 20,000,000 annual passengers. At 20 million annual passengers, entitlement funding could increase up to $7.8 million per year.

Due to the annual federal budgetary process, the 1993 AIP apportionments for Sea-Tac are $3,299,059 even though the legislation could provide over $6 million at current passenger levels.

4.2 AIP Discretionary Funds

These funds are just what the name implies. They are disbursed annually at the discretion of the FAA. Capacity improvements such as new runways have high priority. However, in the last published National Plan of Integrated Airport Systems (NPIAS), FAA lists 32 primary and commercial service airports in the U.S. that are congested. This list does not include Sea-Tac. Sea-Tac is included in a list of 64 additional airports that are expected to be congested by the year 2020.

The NPIAS states:

> commercial airports receive only 15% of their financing from the AIP. Recent studies on the self-financing capabilities of airports indicate that some of the largest airports have the earnings potential to finance their capital improvements without federal aid.

Therefore, the $31 million in AIP discretionary funds for a third runway at Sea-Tac is optimistic and certainly cannot be considered a firm amount. However, using this $31 million and immediately assigning all the increase (provided by current legislation) in passenger entitlements to the new runway, $57 million in additional federal funds might be expected for the $690 million annual passengers. Therefore, annual entitlements could increase up to an additional $6.5 million per year; and the additional third runway would NOT be required.

CAPITAL COSTS AND AVAILABLE FUNDS FOR AIRPORT CONSTRUCTION TO YEAR 2020

	SEA-TAC WITH DEPENDENT (3rd) RUNWAY	% OF TOTAL	PAINE FIELD (ONE RUNWAY)	% OF TOTAL
1. SOURCES OF FUNDS (Millions of Dollars)				
Net Operating Revenue	768.8	41	61.8	34
Passenger Facility Charges	935.1	50	75.2	42
FAA Funds:				
Entitlement	117.7	7	44.0	24
Discretionary	30.8	2	0.0	
TOTAL FUNDS AVAILABLE	1852.2		181.0	
COMBINED FUNDS AVAILABLE		$2033.2		
2. TOTAL CAPITAL COST	615.8		426.9	
COMBINED CAPITAL COST		$1042.7		

NOTE: Total FAA funds are only 9% of total cost

Source: Flight Plan Report, p. C-104

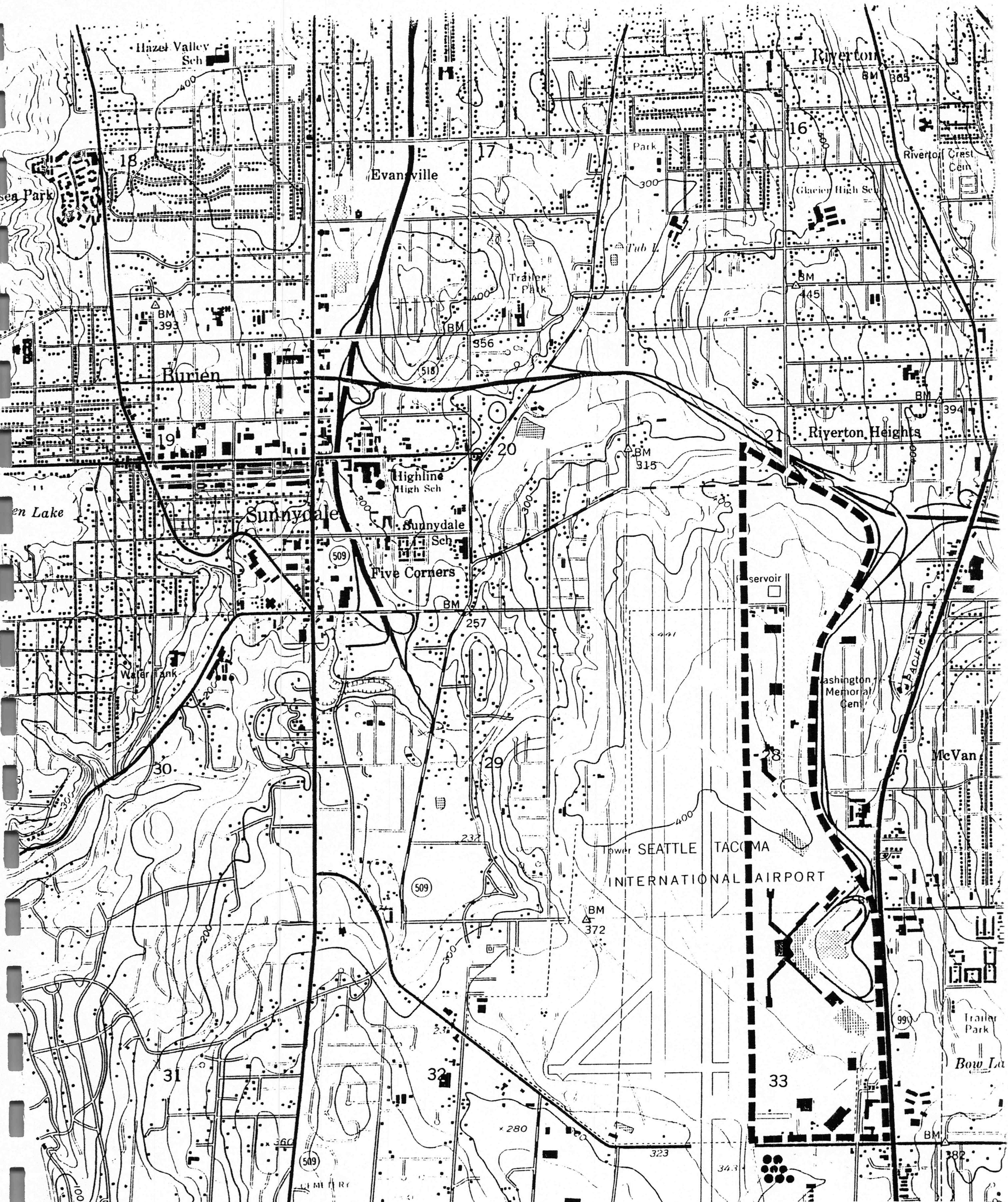
AREA AVAILABLE FOR LANDSIDE AND TERMINAL EXPANSION AT VARIOUS AIRPORTS

Airport	1990 Passengers	Area Available For Landside Facilities*
Ontario, CA	5,340,000	670 acres
Oakland	5,442,000	580
San Diego	10,976,000	360
Sea-Tac	15,726,000	425
Houston	16,254,000	950+
Orlando	17,368,000	2500
Las Vegas	18,602,000	900
Phoenix	21,754,000	885
Miami	24,384,000	1300
Kennedy (N.Y.)	28,902,000	2000
San Francisco	29,388,000	735
Los Angeles	44,554,000	1100
Atlanta	48,540,000	1600+
Dallas/Ft. Worth	48,540,000	3500+
O'Hare	55,898,000	3100+

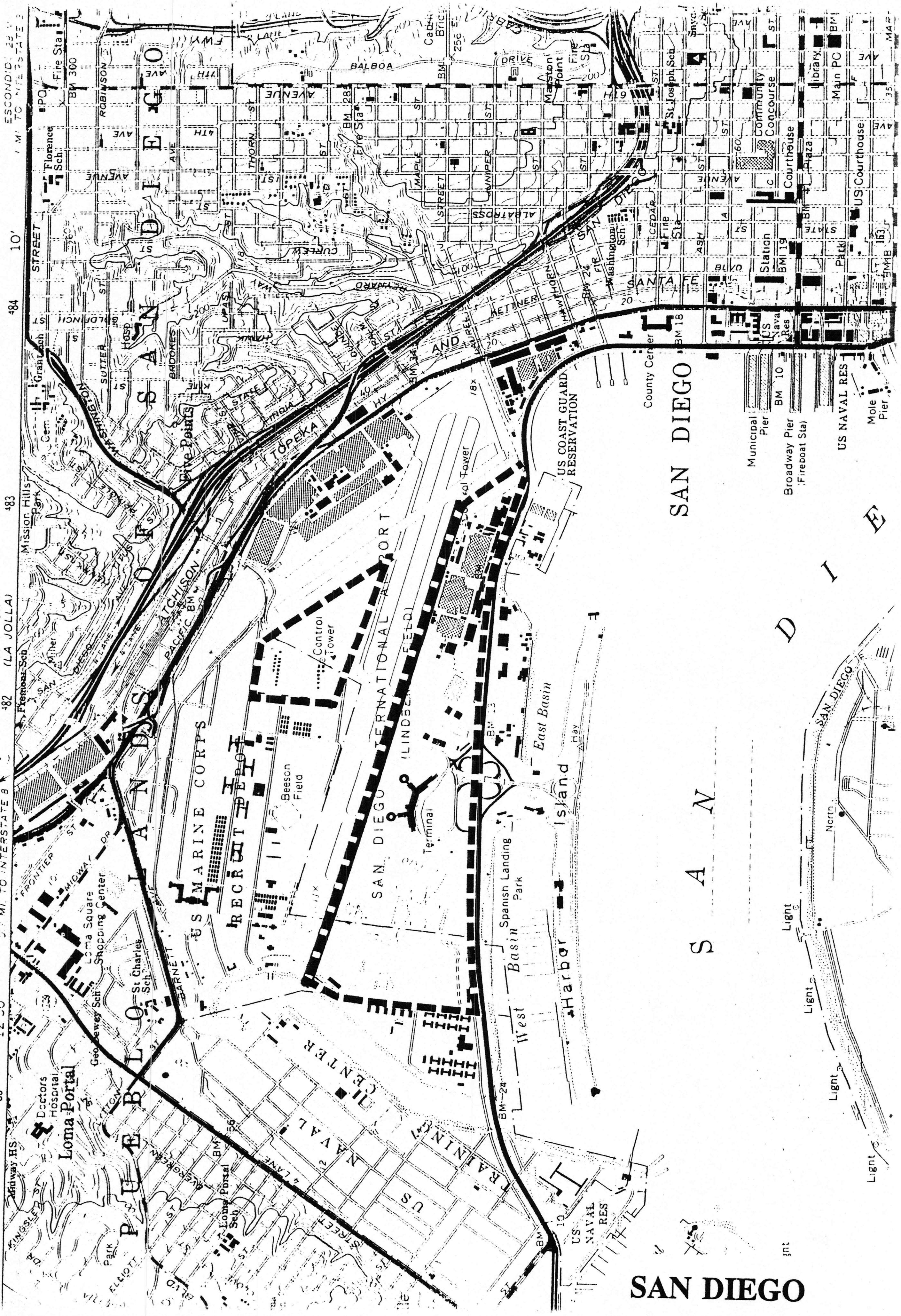
* "Landside" facilities are passenger terminals, maintenance areas, cargo facilities, parking, airport drives and the like.

Acreages given are those presently utilized by existing "landside" facilities or could be utilizied within current airport boundaries.

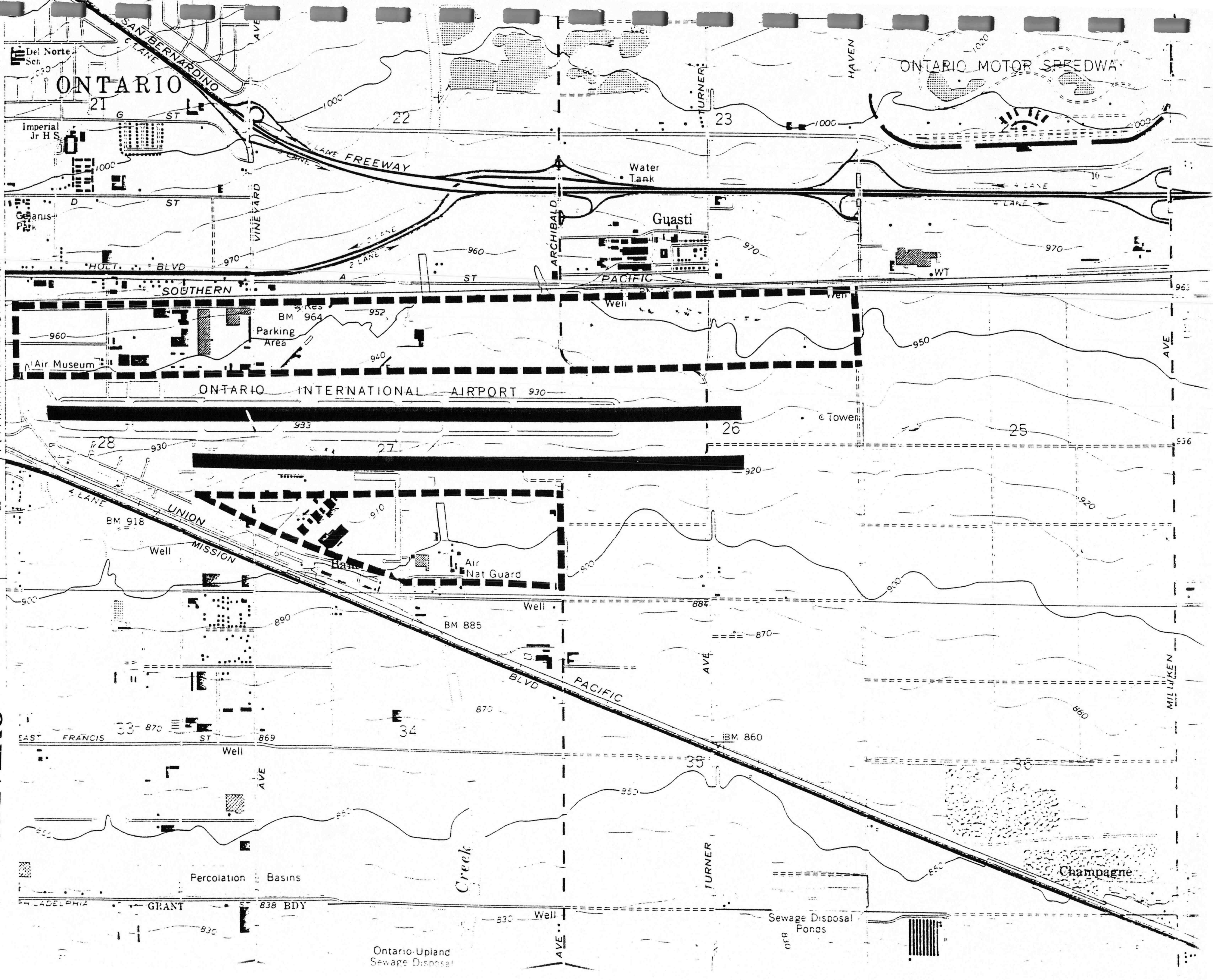
Maps showing the various airports discussed are attached hereto.



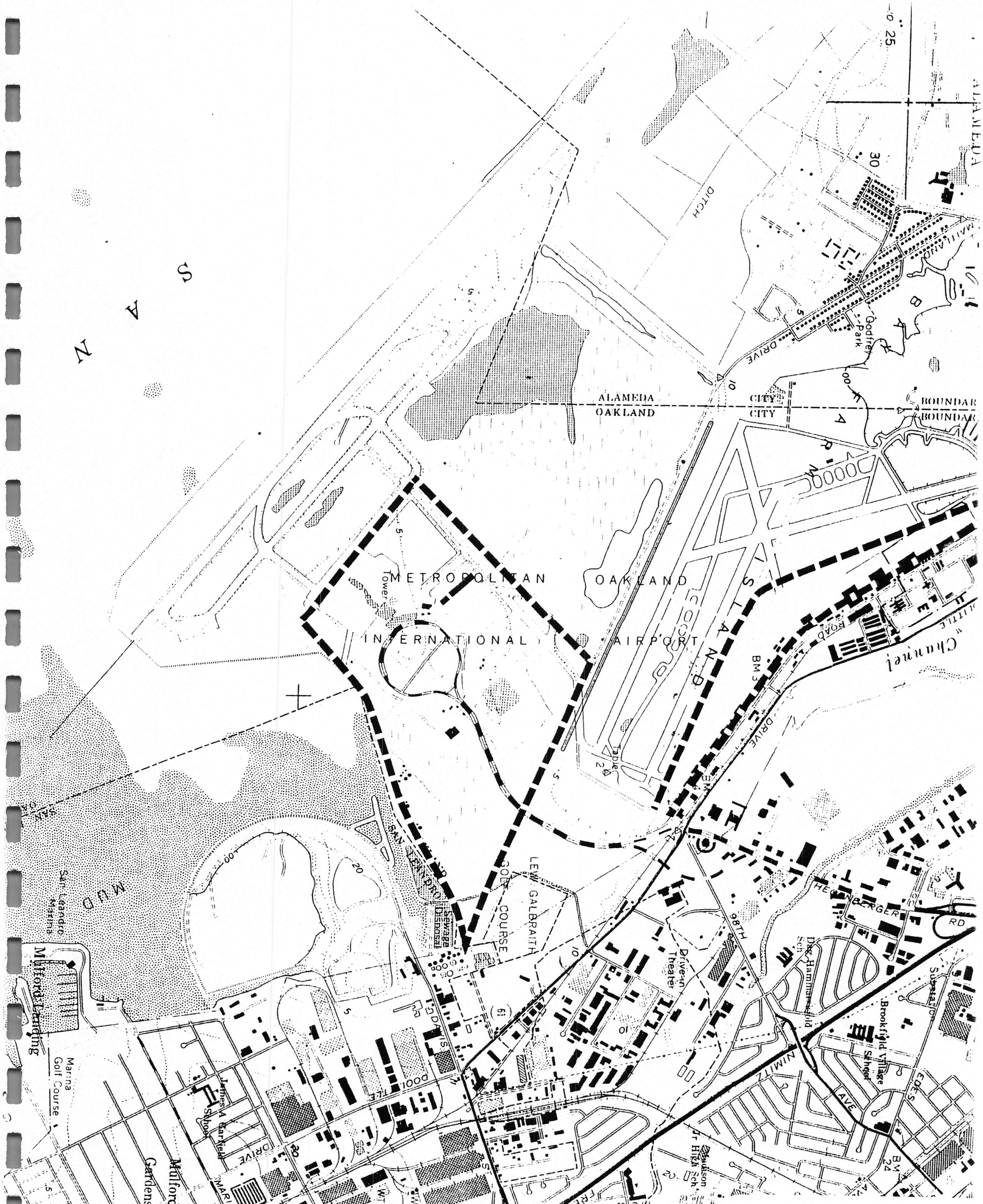
SEATTLE TACOMA INTERNATIONAL AIRPORT


SAN DIEGO
SAN DIEGO BAY
US MARINE CORPS RECRUIT DEPOT
SAN DIEGO INTERNATIONAL AIRPORT (LINDBERGH FIELD)
Terminal
Control Tower
US NAVAL TRAINING CENTER
US COAST GUARD RESERVATION
Harbor Island
East Basin
West Basin
Spanish Landing Park
Beeson Field
US NAVAL RES
Mole Pier
Broadway Pier (Fireboat Sta)
Municipal Pier
County Center
Community Concourse
Courthouse
US Courthouse
Main PO
Library
Station
Loma Portal
Loma Portal Sch
Doctors Hospital
Midway HS
Loma Square Shopping Center
St Charles Sch
Geo Dewey Sch
Fremont Sch
Mission Hills Park
Five Points
Washington Sch
St Joseph Sch
Florence Sch
Grant Sch
ATCHISON TOPEKA AND SANTA FE
PACIFIC HY
OCEANSIDE 34 MI. TO INTERSTATE 8
ESCONDIDO 28 MI. TO INTERSTATE 8
2549 I SW (LA JOLLA)
PUEBLO LANDS OF SAN DIEGO
Light

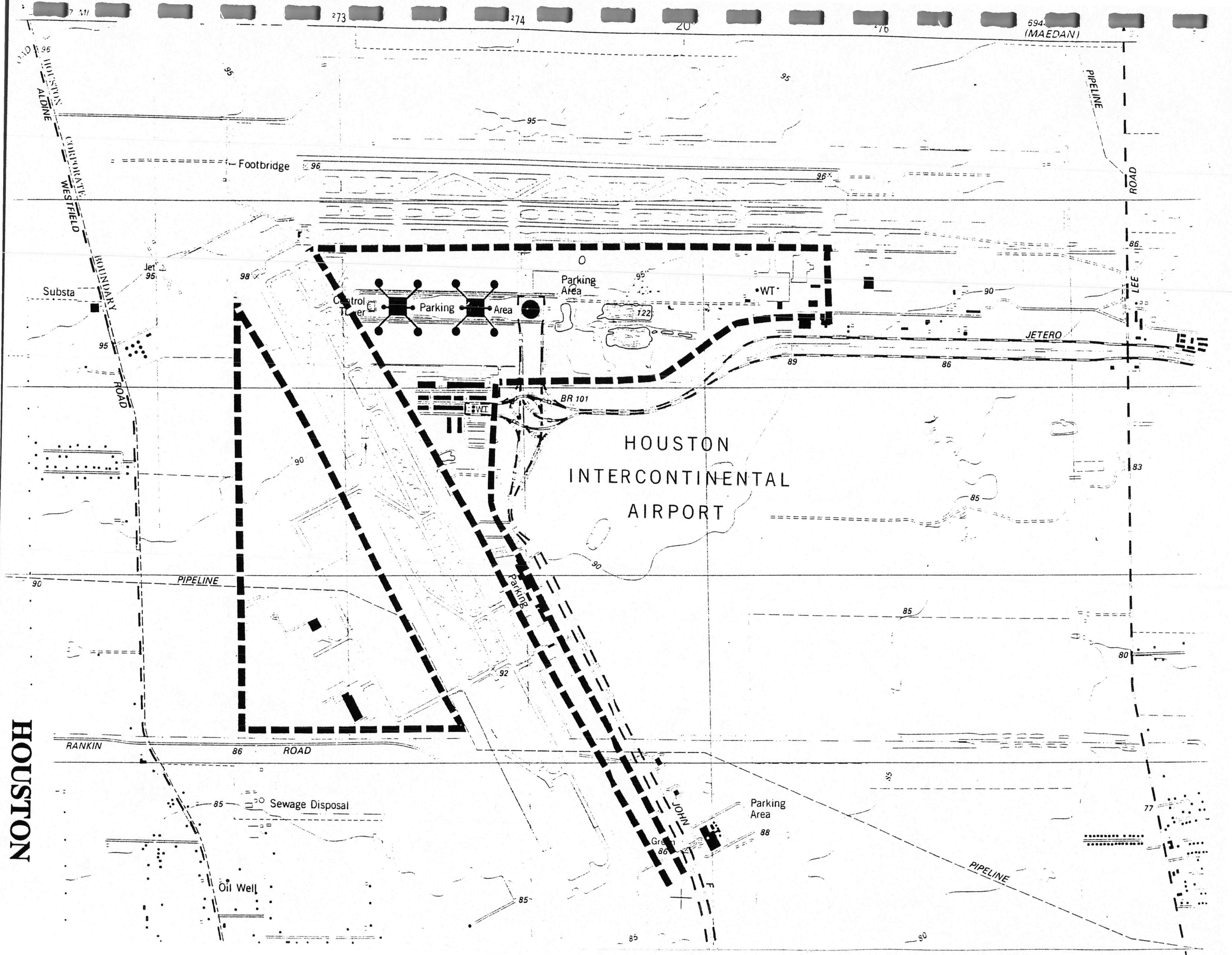
SAN DIEGO


ONTARIO
Del Norte Sch
Imperial Jr H S
SAN BERNARDINO
G ST
D ST
FREEWAY
ONTARIO MOTOR SPEEDWAY
Water Tank
Guasti
HOLT BLVD
A ST
SOUTHERN PACIFIC
Parking Area
Air Museum
BM 964
ONTARIO INTERNATIONAL AIRPORT
Tower
UNION
MISSION
BLVD
PACIFIC
Air Nat Guard
Well
BM 918
BM 885
BM 860
EAST FRANCIS ST
VINEYARD AVE
ARCHIBALD AVE
TURNER AVE
HAVEN AVE
MILLIKEN AVE
Creek
Percolation Basins
PHILADELPHIA GRANT ST
838 BDY
Sewage Disposal Ponds
Ontario-Upland Sewage Disposal
Champagne
WT

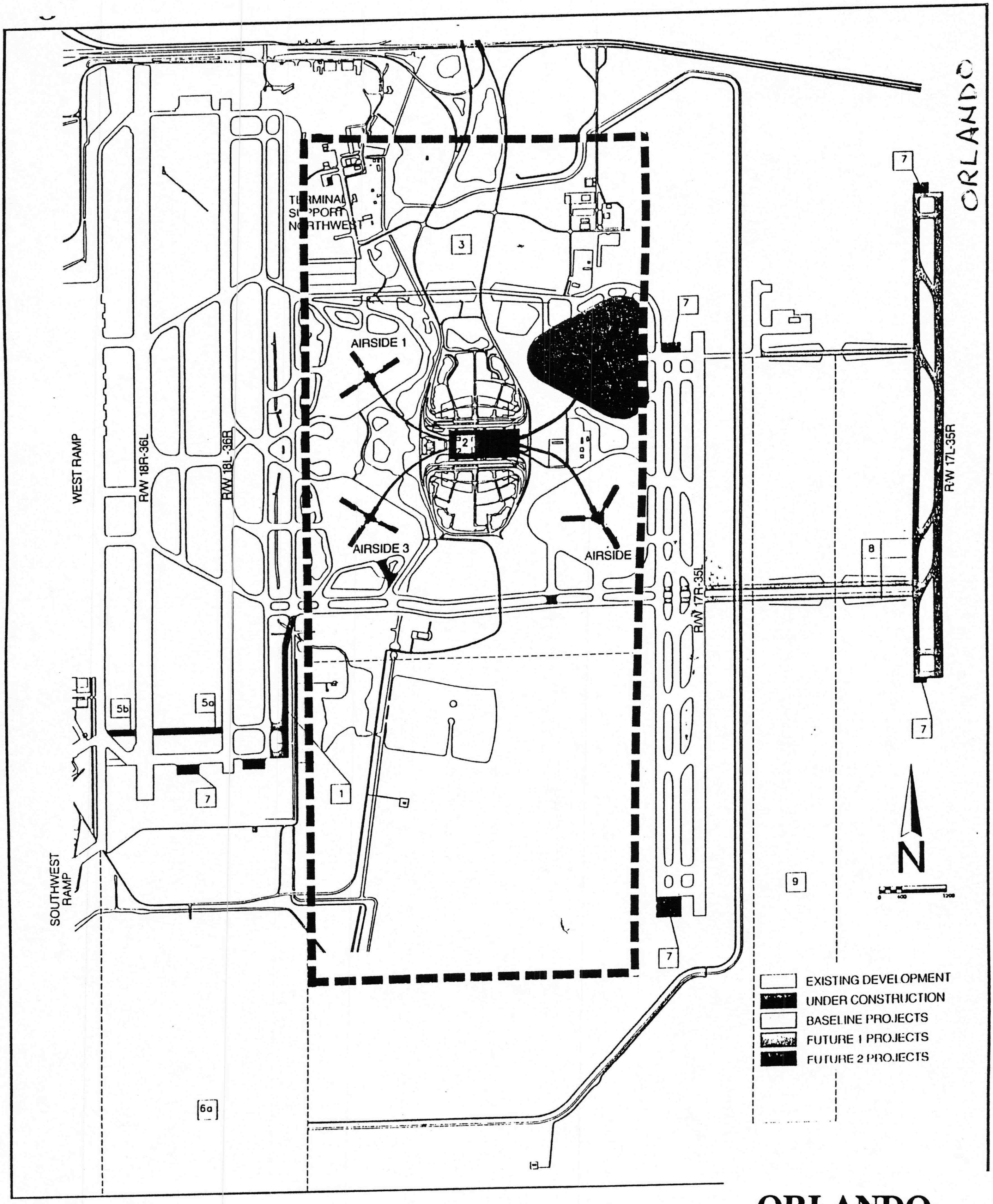
ONTARIO


METROPOLITAN OAKLAND INTERNATIONAL AIRPORT
ALAMEDA CITY BOUNDARY
OAKLAND CITY BOUNDARY
ALAMEDA
DITCH
Godfrey Park
DRIVE
Tower
Channel
MUD
San Leandro Marina
Mulford Landing
Mulford Gardens
Marina Golf Course
James A Garfield School
MARINA
DRIVE
DOOLITTLE
Sewage Disposal
LEW GALBRAITH GOLF COURSE
Drive-in Theater
98TH
Dag Hammarskjold Sch
HEGENBERGER RD
Substation
Brookfield Village School
NIMITZ FREEWAY
AVE
EDES
Madison Jr High Sch
School

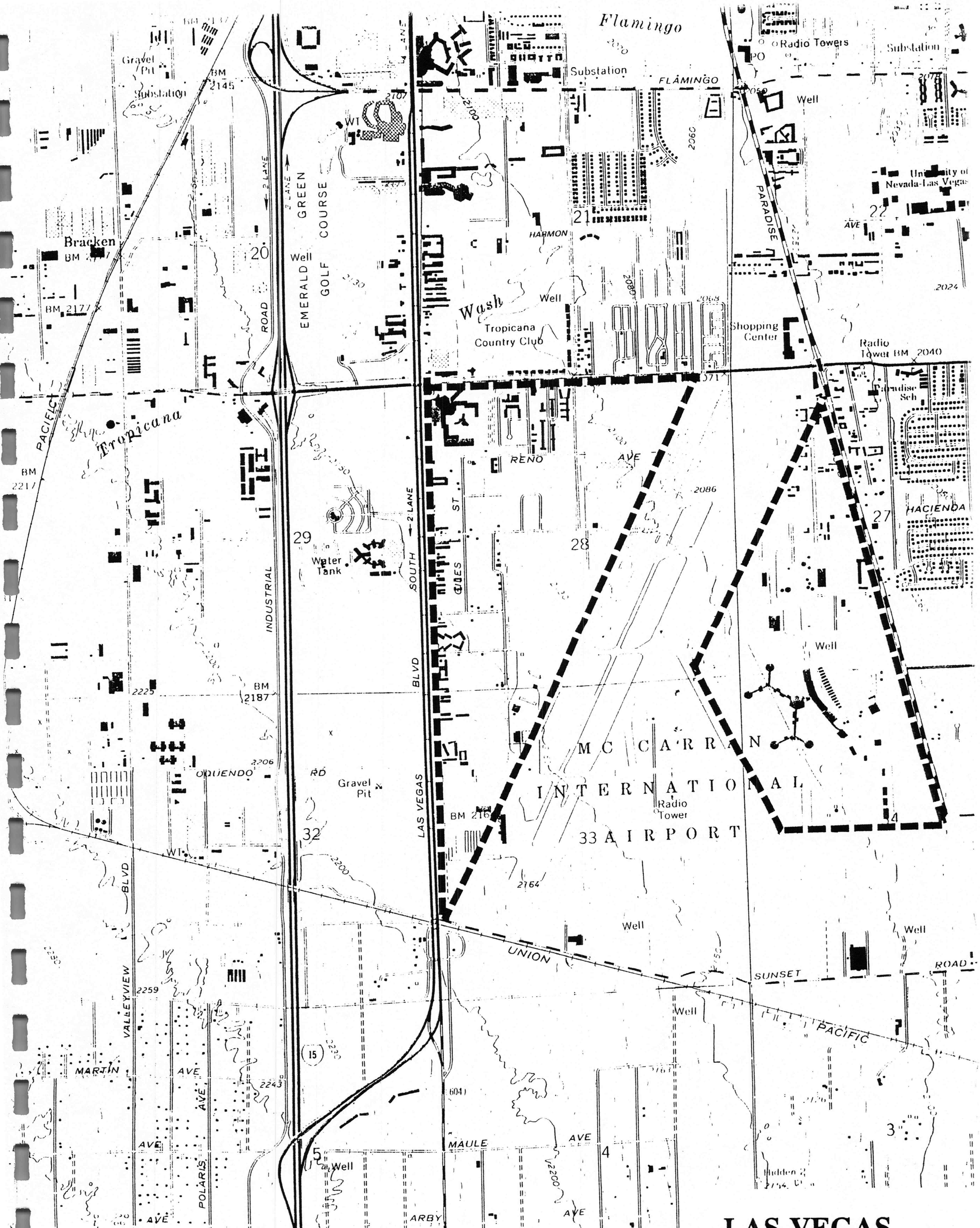
OAKLAND



HOUSTON
INTERCONTINENTAL
AIRPORT
HOUSTON
Footbridge
Substa
Jet
Control Tower
Parking Area
Parking Area
WT
WT
BR 101
JETERO
LEE ROAD
PIPELINE
PIPELINE
PIPELINE
RANKIN ROAD
Sewage Disposal
Oil Well
Parking
Parking Area
JOHN
Green
ALDINE
WESTFIELD
CORPORATE
BOUNDARY ROAD
(MAEDAN)


ORLANDO
R/W 17L-35R
R/W 17R-35L
R/W 18L-36R
R/W 18R-36L
WEST RAMP
SOUTHWEST RAMP
TERMINAL SUPPORT NORTHWEST
AIRSIDE 1
AIRSIDE 3
AIRSIDE
1
2
3
5a
5b
6a
7
8
9
N
0
400
1200
EXISTING DEVELOPMENT
UNDER CONSTRUCTION
BASELINE PROJECTS
FUTURE 1 PROJECTS
FUTURE 2 PROJECTS

ORLANDO



Flamingo
FLAMINGO
Radio Towers
Substation
Substation
Gravel Pit
Substation
BM 2145
Well
University of Nevada-Las Vegas
PARADISE
21
22
HARMON
AVE
Bracken
BM 2177
20
Well
EMERALD GREEN GOLF COURSE
ROAD
2 LANE
Wash
Well
Tropicana Country Club
Shopping Center
Radio Tower BM 2040
BM 2177
Paradise Sch
PACIFIC
Tropicana
RENO
AVE
2086
HACIENDA
27
BM 2217
29
28
Water Tank
2 LANE
SOUTH
ST
INDUSTRIAL
Well
BLVD
BM 2187
2225
MC CARRAN INTERNATIONAL AIRPORT
33
Radio Tower
OQUENDO
RD
Gravel Pit
2206
LAS VEGAS
BM 2164
34
32
WT
2200
2164
BLVD
Well
Well
UNION
SUNSET
ROAD
VALLEYVIEW
2259
Well
PACIFIC
15
MARTIN
AVE
AVE
2243
AVE
POLARIS
MAULE
AVE
4
3
5
Well
ARBY
AVE
AVE

LAS VEGAS