Runway Safety at LAX

The Case for Realigning the North Airfield

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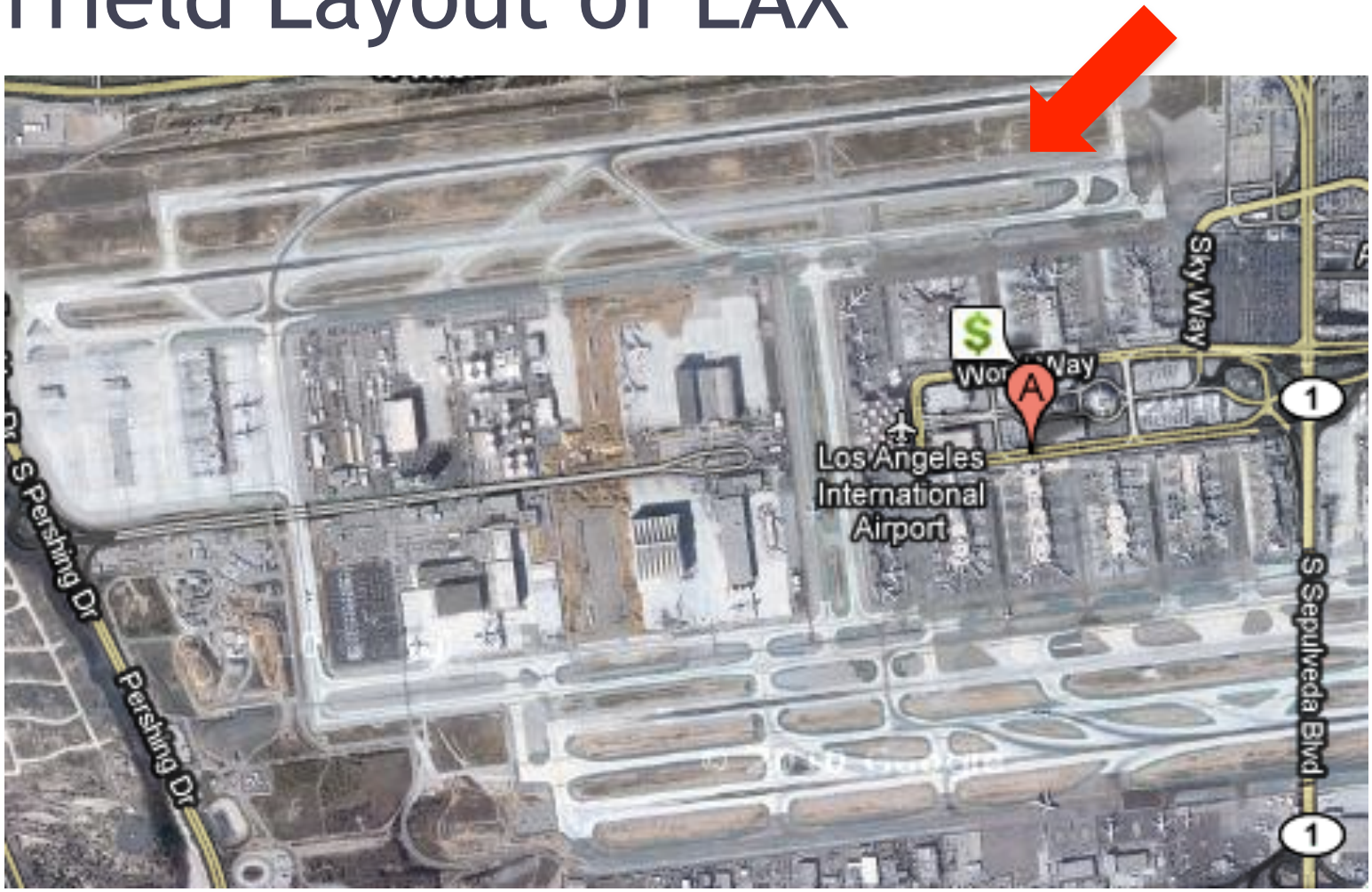
Introduction

General LAX Information

- Ranked (unlike our football team):
  - 6th worldwide for passengers
  - 13th worldwide for tonnage of air cargo
- World's busiest O&D airport.
- For 5 county Southern California region:
  - 70% passenger traffic
  - 75% air cargo
  - 95% international passengers

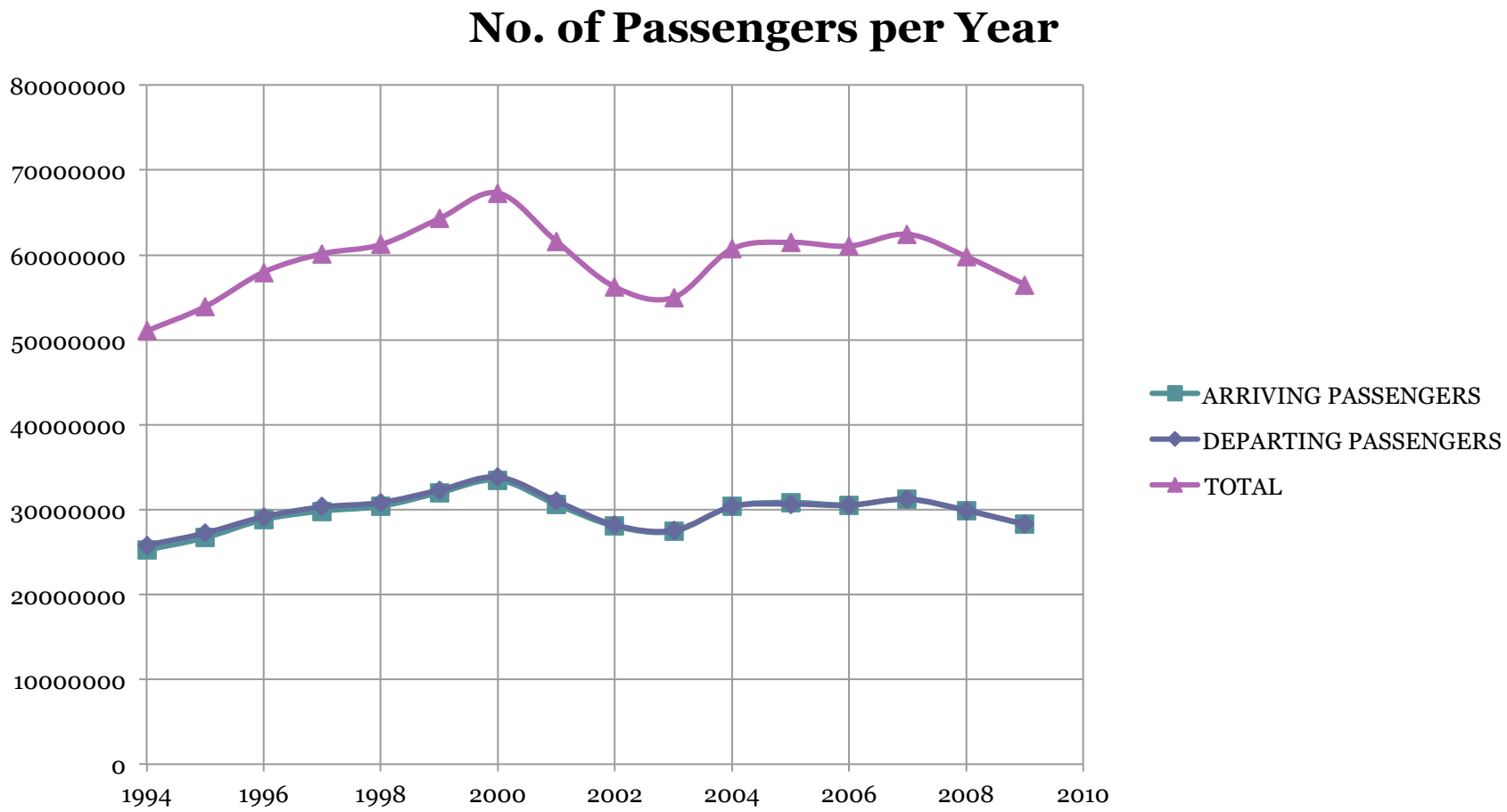
Note O&D airport means passenger either begins or ends flight at that airport.

Airfield Layout of LAX

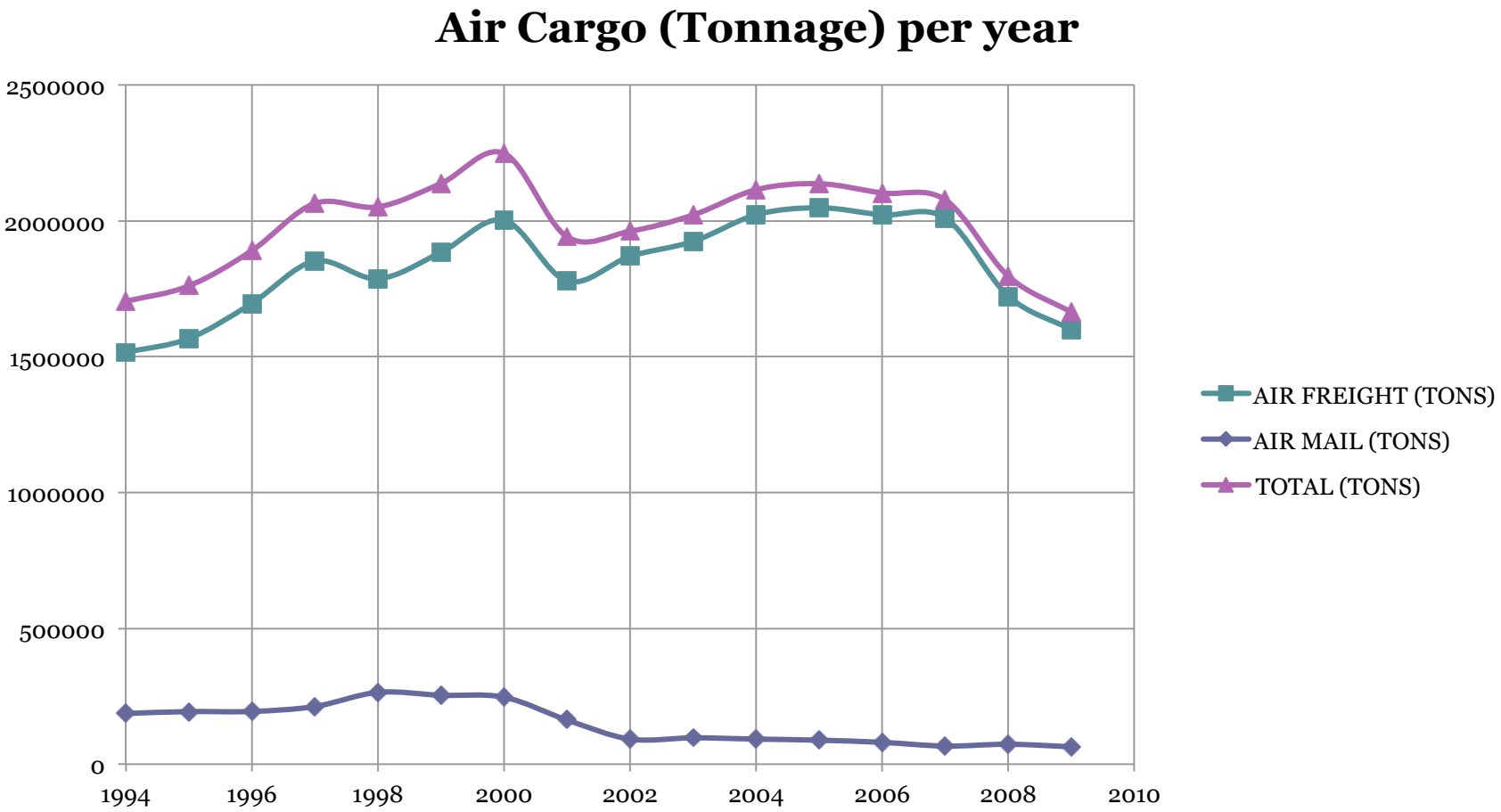


Decision we're examining: North Airfield reconfiguration to mitigate risk

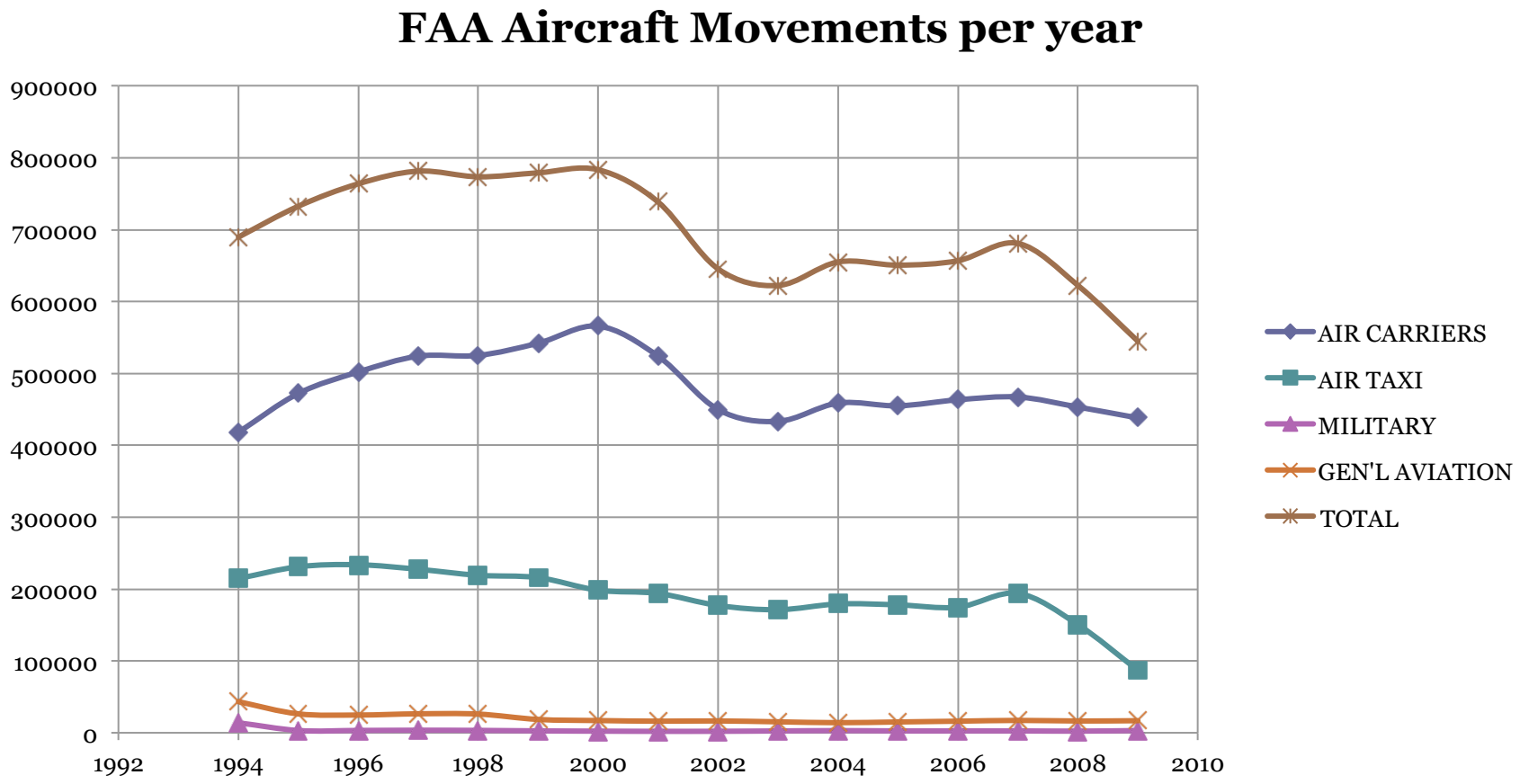
Passengers Through LAX



Air Cargo Through LAX



FAA Aircraft Movements in LAX



Note that one “aircraft movement” is one takeoff or one landing.

The Engineering Issue: Safety

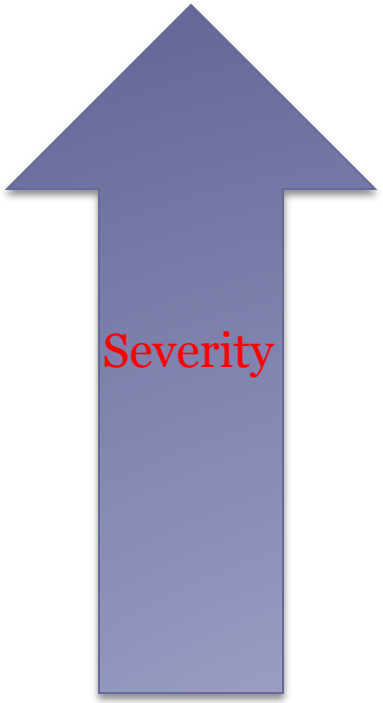
- Design variables:
  - Direct reduction of rate of runway incursions.
    - Safety systems, # of collisions/incursions per year
  - Indirect reduction of rate of runway incursions.
    - Capacity factors such as headway
- Factors in recommendation of final design:
  - SAFETY (in the context of this report)
  - NOT capacity

Runway Incursions

- Defined as “Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and take-off of aircraft”

Runway Incursion Classifications

Passengers are crapping their pants



Passengers don't even notice, pilot breaks a sweat

- Accident: An incursion that results in a collision.
- Category A: A serious incident in which a collision was narrowly avoided.
- Category B: An incident in which separation decreases and there is a significant potential for collision, which may result in a time critical corrective/evasive response to avoid a collision
- Category C: An incident characterized by ample time and/or distance to avoid a collision
- Category D: An incident that meets the definition of a runway incursion such as incorrect presence of a single vehicle/person/aircraft on the protected area of a surface designated for the landing and take-off of aircraft of aircraft but with no immediate safety consequences

Runway Incursions

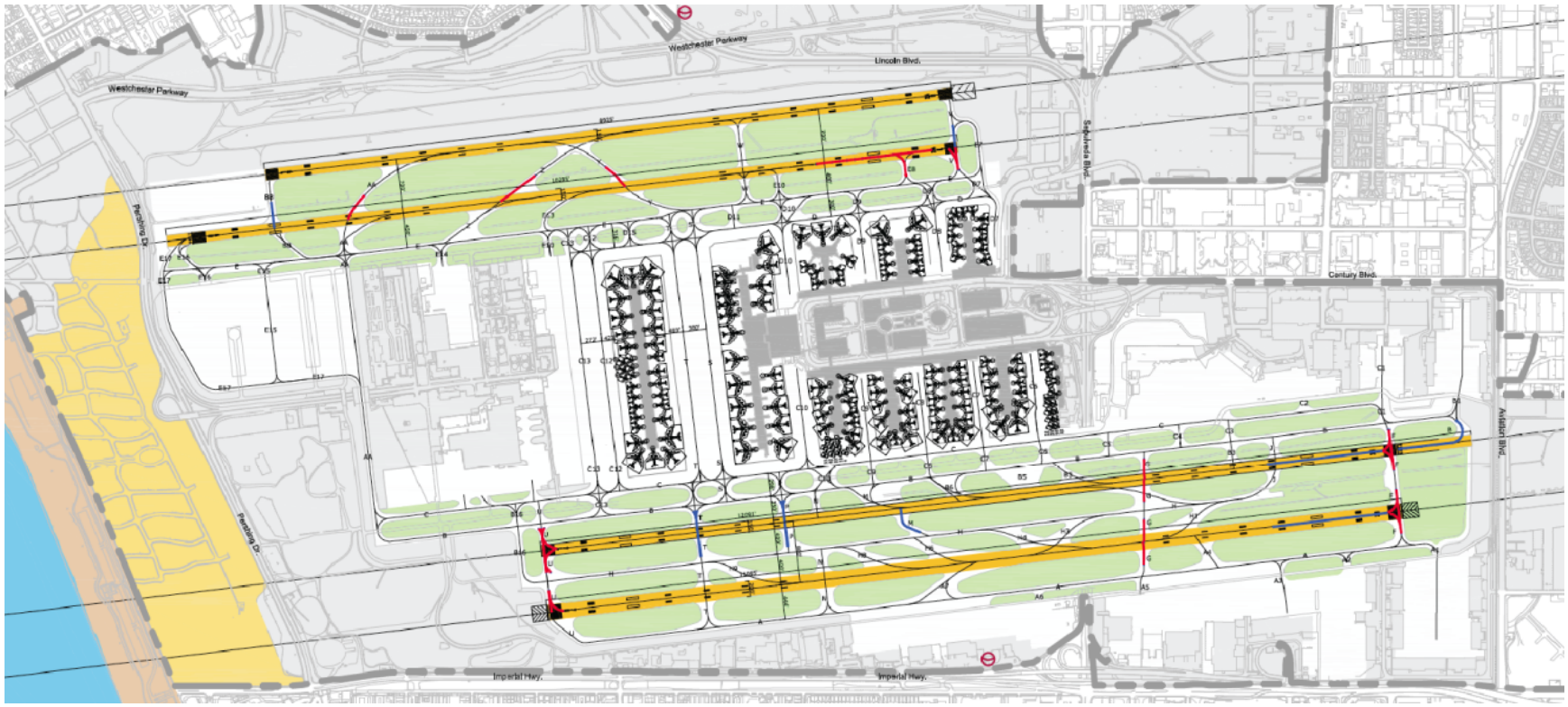
- Assuming 2020 traffic levels and use of all modern safety equipment, estimations place the frequency of fatal collisions at one collision every 8 years, nationally
- Fatal collision on February 2nd, 1991 at LAX (killing 34 people) was last fatal runway incursion in the US at any major, towered airport

Alternative Configurations

Alternative Configurations

- Existing configuration
- Modified existing configuration
- 100-North
- 340-North
- 340-South
- 3 runway configuration

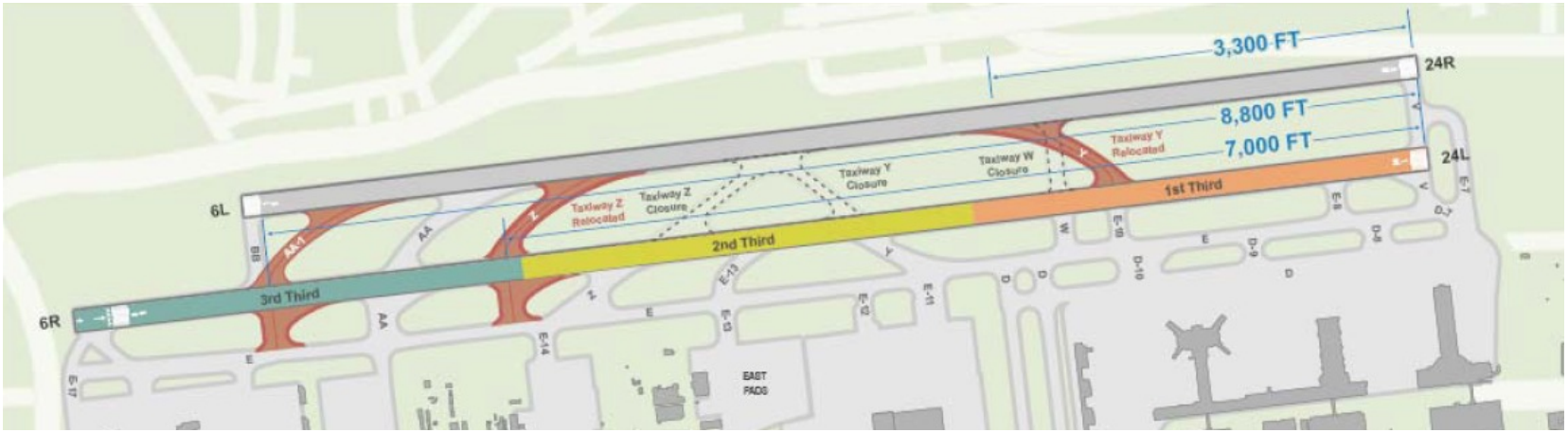
Existing Configuration



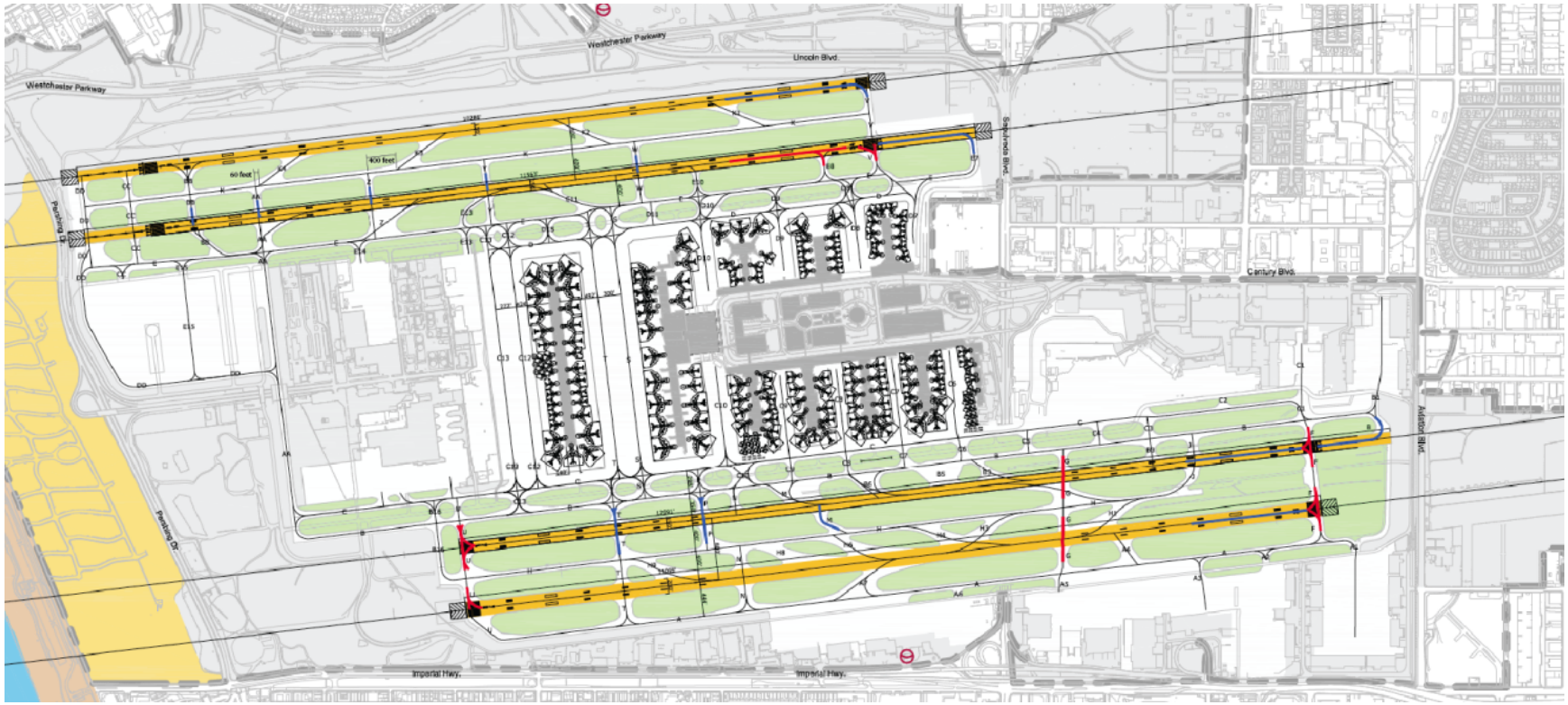
- Runways 24L and 24R are separated by 700 feet, with no centerline taxiway in between
- Meets 2020 capacity needs
- Fatality Risk: 1 in 150 million

Modified Existing Configuration

- Same as baseline configuration, with changes to the taxiways leading to runway 24R so that planes landing on 24R would cross runway 24L closer to its west end
- Reduced incursion rates



100-North



- Runway 24R would be moved north by 100 feet, and a centerline taxiway placed between runways 24L and 24R
- Meets 2020 capacity needs
- Fatality Risk: 40% reduction

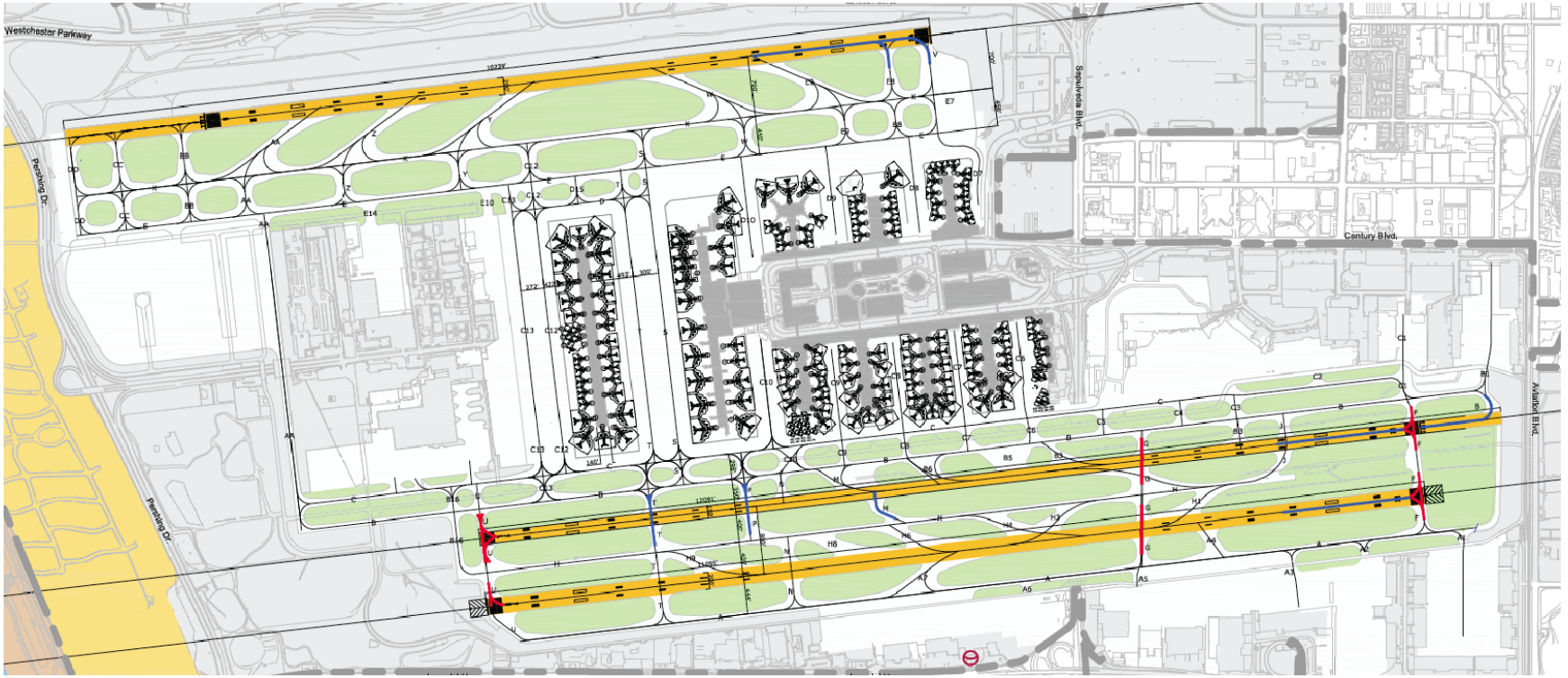
340-North

- Runway 24R would be moved north by 340 feet, and a centerline taxiway placed between runways 24L and 24R
- Surpasses 2020 capacity needs
- Fatality Risk: 55% reduction
- Efficiency gains reduce costs by $15M

340-South

- Runway 24L would be moved south by 340 feet, and a centerline taxiway placed between runways 24L and 24R
- Meets 2020 capacity needs
- Fatality Risk: 50% reduction
- Requires terminal reconfiguration (very costly)

3 Runway Configuration



- Runways 24L and 24R would be combined into a single runway
- Does not meet 2020 capacity needs
- Fatality Risk: 50% reduction

Comparison of Alternatives

Configuration	Safety	Capacity
Existing	1 in 150 million	Meets capacity
100-North	40% reduction	Meets capacity
340-North	55% reduction	Improvement & cost savings
340-South	50% reduction	Meets capacity
3 Runways	50% reduction	Reduces capacity

Baseline Analysis

Baseline Analysis

- Necessary to evaluate the current configuration to determine the impacts of alternatives
- Based on report done by Barnett, Paull, and Iadeluca (2000) – “Fatal US Runway Collisions Over the Next Two Decades”
- Forecasted rate of incidents for 2003-2022 period

Incident Rate vs. Traffic

- Past data has shown that incidents are directly proportional to N^2
  - N = amount of traffic
- i.e. Just a few more planes could potentially cause many more incidents

Bad Weather Risk Multiplier

- In doing previous analysis, discovered that the majority of incursions occurred during reduced visibility conditions (less than 3 miles visibility at ground level)
- About 6% of the time on average at towered US airports

Bad Weather Risk Multiplier

- 3 out of 7 collisions in 1989-98 occurred under adverse conditions
- Letting H = total number of operating hours at towered airports,

$$R = 3/0.06H\ /4/0.94H\ = 12$$

Incident Rate Equation

Assumed 3 visibility conditions:

1. Daytime (no haze/fog)
2. Dusk-Night-Dawn (no haze/fog)
3. Haze/fog

$$TR = Total\ collision\ risk = R_1 H_1 + R_2 H_2 + R_3 H_3$$

R_i = collision risk/hr associated with condition i
H_i = number of operating hours/yr when airport is in condition i

Incident Rate Equation

$R_i = N^2 r_i$ where r_i is a proportionality constant

$r_1 = 0$ because of clear weather
$r_3 = 12$ as calculated before

Let $B = r_1 H_1 + r_2 H_2 / H_1 + H_2 = 1$ so $r_2 = H_1 + H_2 / H_2$

Incident Rate Equation

Combining all terms into risk equation,

$$Total\ Risk = N^2 (r_1 H_1 + r_2 H_2 + r_3 H_3)$$

$$TR = N^2 (H_1 + H_2 + 12 H_3)$$

$$TR = N^2 (H + 11 H_3)$$

Incident Rate Equation

Final equation used:

$$R\downarrow ik = \beta N\downarrow ik\uparrow \uparrow 2\ (1+11Q\downarrow i\ )$$

R_{ik} = number of fatal runway collisions at airport i in year k

N_{ik}^2 = squared number of operations at airport i in year k

Q_i = percentage of bad weather at airport i

Incident Rate Equation

What about β?

- β is a proportionality factor
- Can be determined using previous data

- For 1989-98, there were a total of 4 fatal runway collisions at US airports
- After applying analysis to all 449 airports between 1989 and 1998, came up with β = 0.00016

Final Analysis

To obtain the number of runway collisions over 2003-2022, the analysis described above is applied to all 449 airports using their traffic forecasts and then summed up values

Grand total: 15 incidents/20 yrs on average (nationally)

In other words: 1 incident/16 months

Modifications

- Panel reasoned that growth rate in 2020 would be higher than the average growth rate of 2003-2022, so increased incident rate to 1 incident/yr

- Most importantly, Barnett, Paull, & Iadeluca report did not take into account effect of technological advances in air traffic safety

Air Traffic Safety Technology

Three new technologies:

- Airport Movement Area Safety System (AMASS)
  - Installed at the 32 largest airports
- Airport Surface Detection Equipment, Model X (ASDE-X)
  - Installed at 15 airports (most but not all of largest airports)
- Runway Status Lights (RWSL)
  - Installed at very few airports

Air Traffic Safety Technology

According to the FAA:

- Using AMASS with ASDE-3 would reduce incidents by 63%
- Using AMASS with ASDE-X would reduce incidents by 72.6%
- Using AMASS, ASDE-X, and RWSL would reduce incidents by 87.6%

Revised Incident Rate

So theoretically, incident rate can be reduced by 87.6% down to about 1 incident/8 years

- But not all airports have ASDE-X & RWSL, so rate should be higher
- Used conservative estimate of 1 incident/4 years

Application to LAX North Airfield

Estimate of 1 incident/4 years was the national average, so what about for LAX North Airfield?

- Can use historic as well as empirical data to determine share of incidents occurring on LAX North Airfield

LAX vs. Peers

- Incident rates also calculated for other airports that pilots consider as safe as LAX

- Airports include Atlanta, Chicago-O'Hare, Dallas-Forth Worth, Denver, Detroit, Miami, New York-JFK, San Francisco, and Washington DC-Dulles

Historical vs. Empirical Data

- Historical data involves calculating the percentage of Cat. A incursions as well as Cat. A, B, and C incursions that occur at LAX North Airfield
- Empirical data involves calculating the number of incursions based on the N^2 model and using traffic numbers for 2000 and 2020
- Both methods repeated for the peer airports

Incident Rate at LAX North Airfield

- Average share was 1.3%, so conservative share of 2% used
- Using national rate of 1 incident/4 years, rate at LAX North Airfield would be 1 incident/200 years
- Assuming 100 pax/plane and 50% mortality rate, 100 pax fatalities per incident per 200 years → equivalent to 5 deaths per decade

Perspective

- Assuming 75 million pax go through LAX in a year at 2020 traffic levels, there is a 1 in 150 million risk of death from runway incursions over a decade

- By comparison, the death risk per flight in the US is about 1 in 10 million per decade (Barnett 2009), so at LAX 75 people would die due to non-runway related incidents in a decade

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Criticisms

Criticisms:

- Safety vs. Capacity
  (motivation behind pitching safety)
- Basing renovation on 2020 demand forecast
- β parameter based on data from 1989-98 only which may or may not have been representative

- Consulting conflicts of interest
- Qualitative vs. Quantitative studies

- Thinking outside of the box: wing flaps

Questions?

Sources

- Barnett, A., Paull, G., and J. Iadeluca. "Effectiveness Fatal US Runway Collisons Over the Next Two Decades." *Air Traffic Control Quarterly* 8.4 (2000): 253-276.
- Barnett, A., Ball, M., Donohue, G., Hansen, M., Odoni, A., and A. Trani. "Los Angeles International Airport North Airfield Safety Study." May 11, 2010