

Airport Master Planning

Dr. Antonio Trani

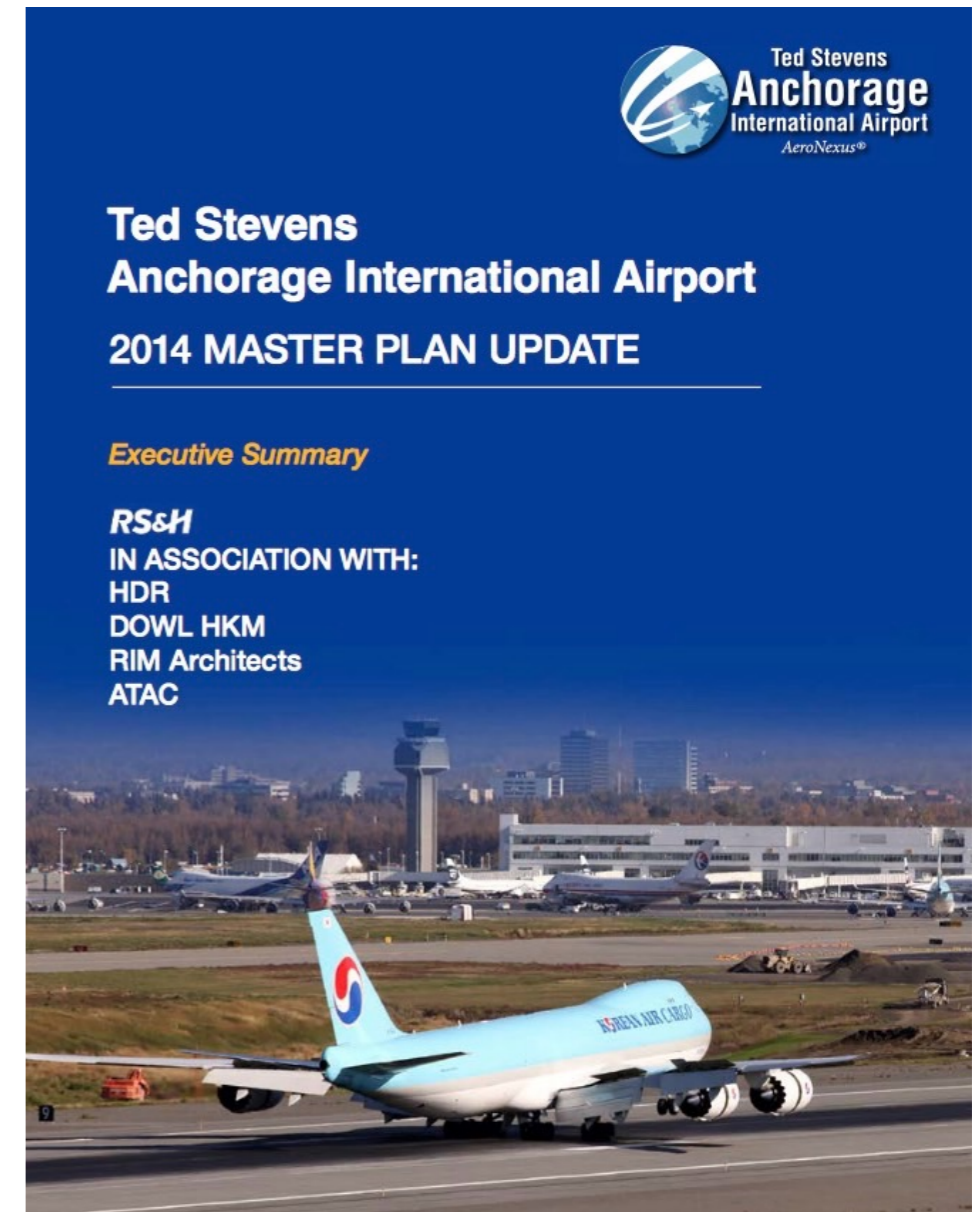
Department of Civil and Environmental Engineering

Virginia Tech



The Master Plan

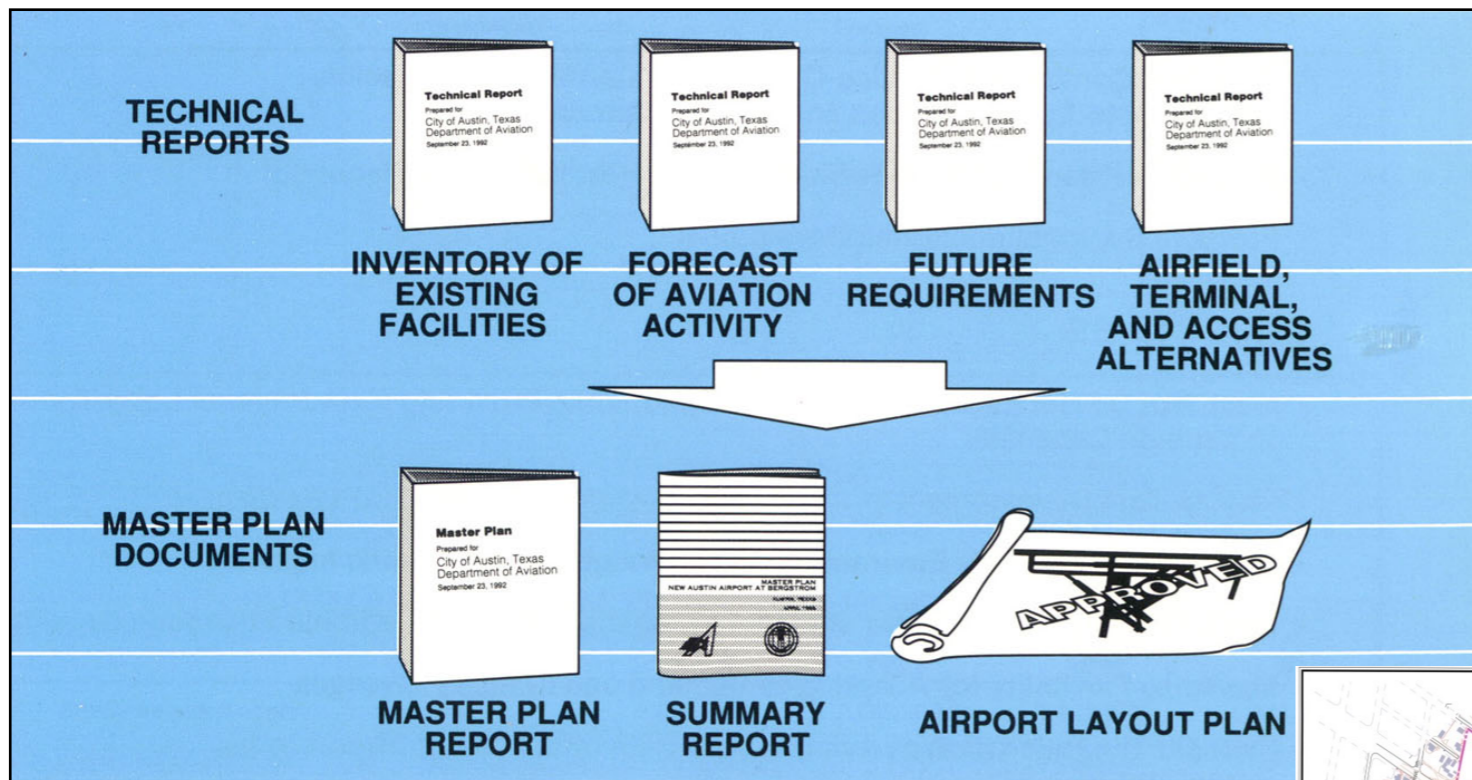
- Planning concept to develop the ultimate version of an airport
- Includes aviation and non-aviation related sectors
- Provides guidelines for future development of the airport
- Considers land use impacts and airport noise compatibility standards
- Schedules priorities in the development process



Source: Anchorage International Airport



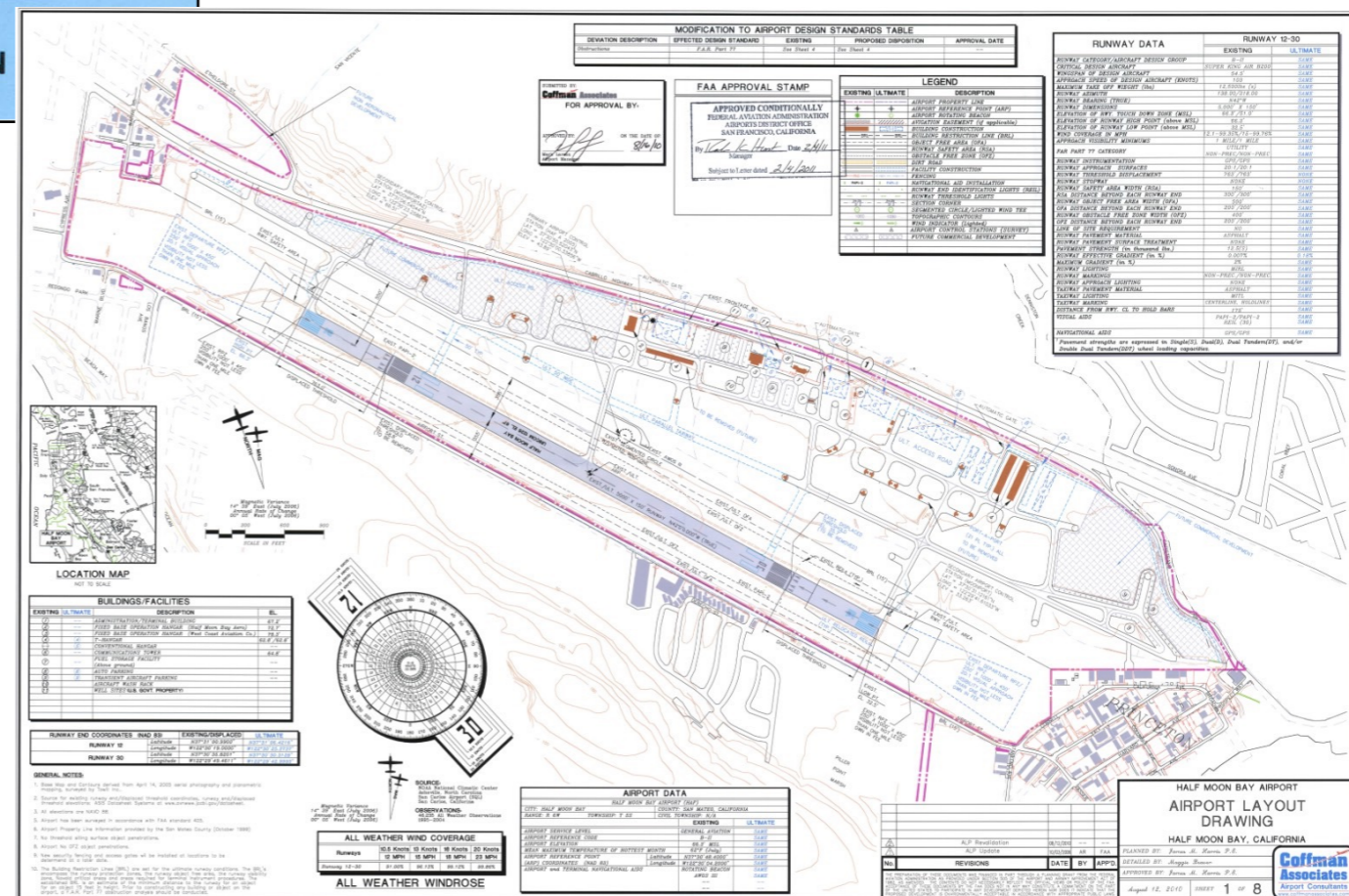
Products of the Master Plan



- The Master Plan produces two key technical reports and the airport layout plan

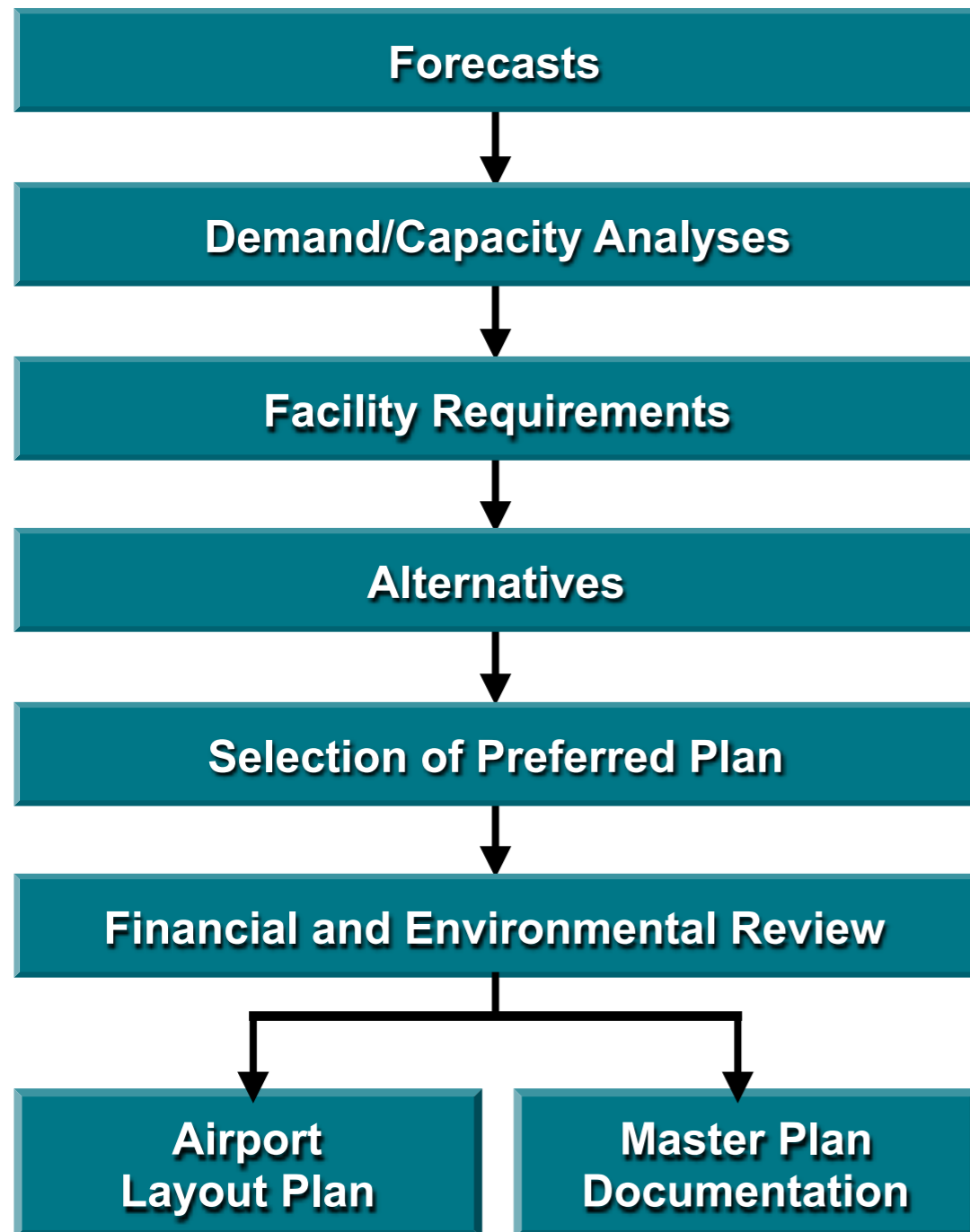
Source: Leigh-Fisher Associates

Example Airport Layout Plan
Source: Half Moon Bay Airport





Traditional Elements of the Master Plan

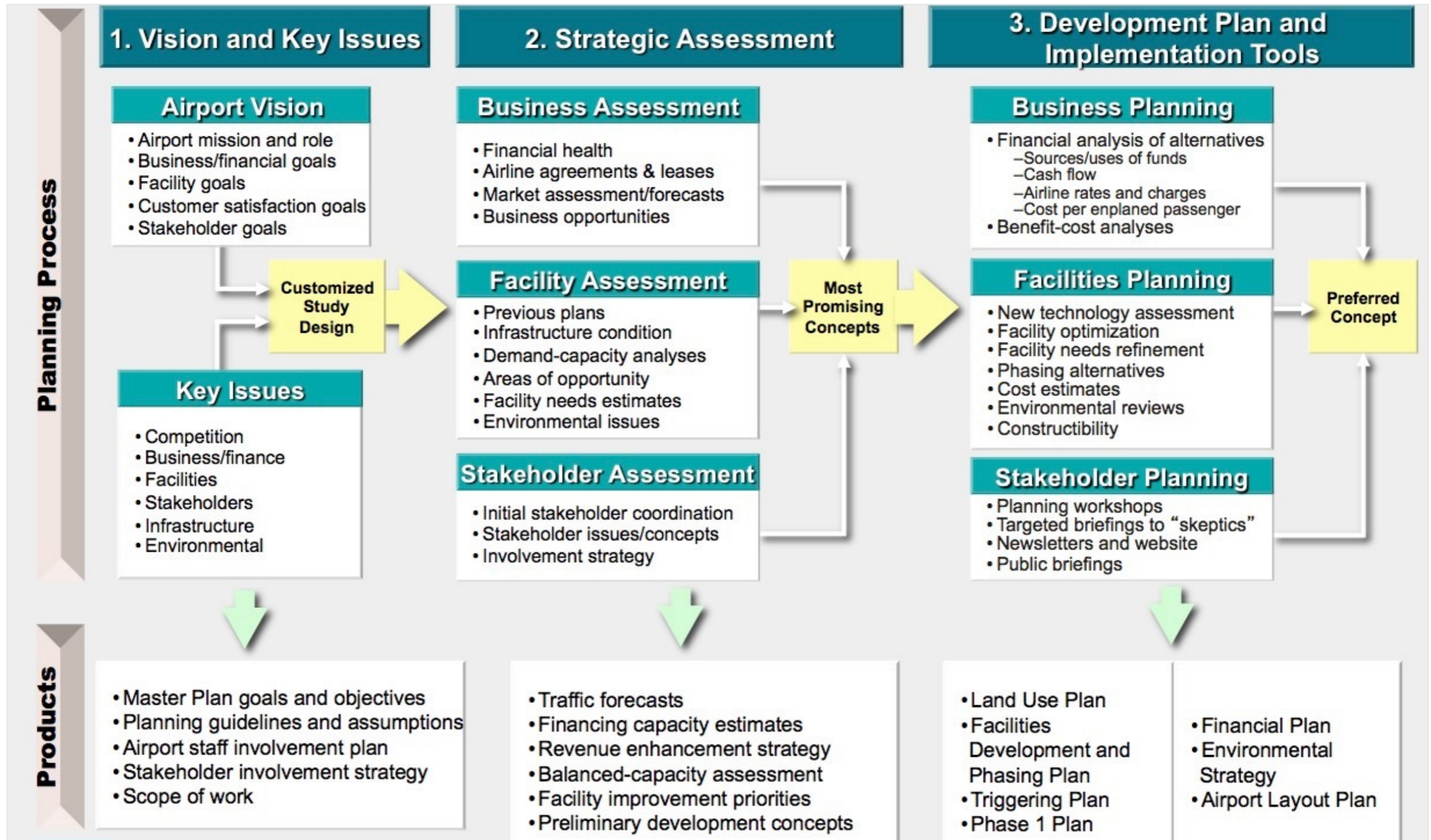


- Traditional master plans tend to follow a **very linear process**
- **Financial and environmental** processes require more integration
- Requires involvement of airport stakeholders, airport designers, architects and the community
- Many airport consuming firms now include better integration of various aspects of the master plan

Source: Mark Lundsford, Leigh-Fisher Associates



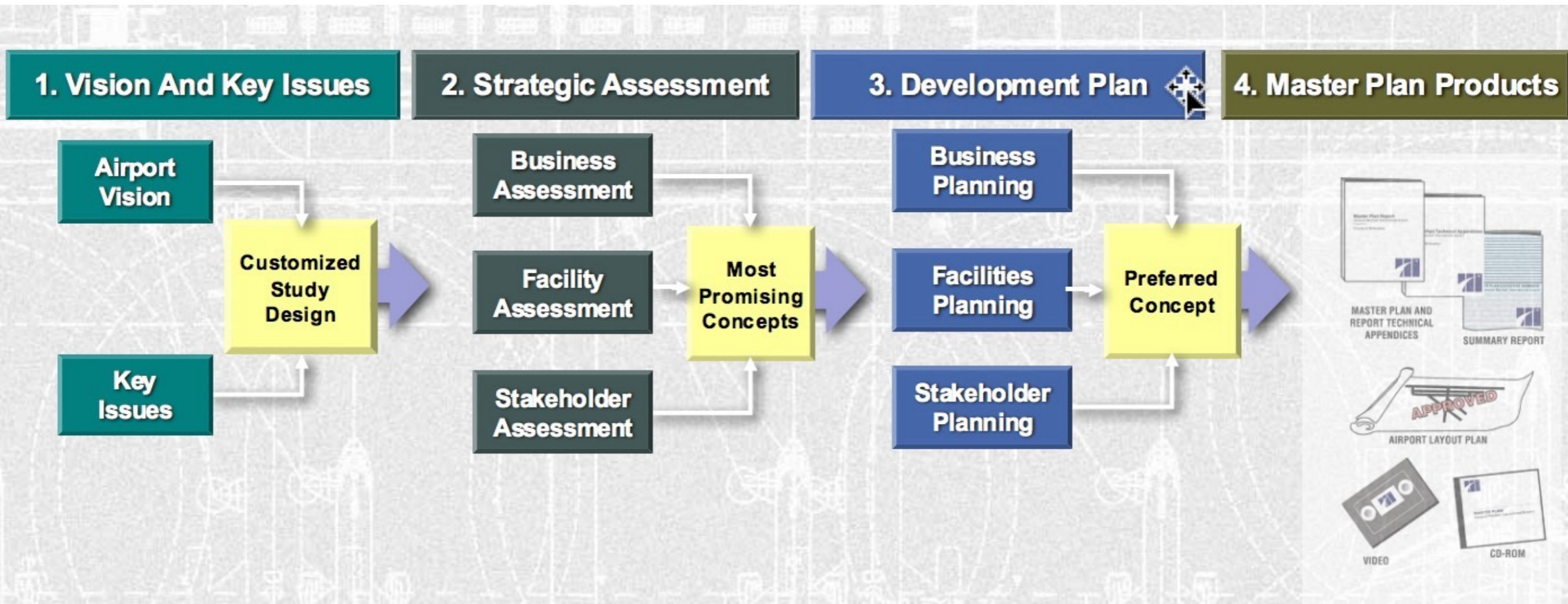
Integrated Approach: Master Planning



Source: Mark Lundsford, Leigh-Fisher Associates



Integrated Approach: Master Planning



Source: Mark Lundsford, Leigh-Fisher Associates



Other Outputs of the Master Planning Activity

Document(s) that detail the development of the airport including future expansion/construction of the airport

Possible complementary documents:

- Environmental Impact Statement (EIS)

- Regional air transportation needs

- Regional economic impact study



Why Integrated Plans Are Needed?

- Airports are complex inter-modal transportation facilities that are connected to other transportation facilities (thus integration is needed)
- Need to consider regional plans for integrated airport facilities and regional transportation plans





Master Planning : A Coordinated Effort

Groups involved in master planning

- Airlines
- Airport authorities
- Engineering team
- Environmental groups
- Financial groups
- City council and the community

NOTE: Get the community involved from the start

Example of What Happens When the Community is not in Agreement with an Airport Project



Americas Program
A new world of action and communication for social change

CIP Americas
The Americas Program
<http://www.cipamericas.org>

Machetes Undercut Plans for Mexico's International Airport

[printer-friendly
PDF version]
Citizen Action in the Americas

Machetes Undercut Plans for Mexico's International Airport
by John Ross | July 24, 2002

[Editors' preface]

The grassroots movement to block the new international airport in the Valley of Mexico has been building a head of steam since last Oct. 22, when Mexican President Vicente Fox declared the expropriation of 15,000 acres for the \$2.5 billion project.

Infuriated by the threat of seizure of their ancestral turf, a few hundred Nahua Indian farmers picked up their machetes and called for the formation of a people's front to defend the land, instigating a struggle that achieved the astonishing result of the president's offer this July to reconsider the location.



Source: sopitas.com



Master Plan Check List

- Inventory of existing facilities
- Forecasts of future aeronautical demand
- Capacity and delay analysis
- Facility requirements and concept development (phases and alternatives)
- Airport site selection (or infrastructure site selection if the airport is in place)
- Environmental procedures analysis (noise and water pollution)
- Operational simulations (capacity and delay analyses)
- Airport plans (ALP)
- Plan implementation

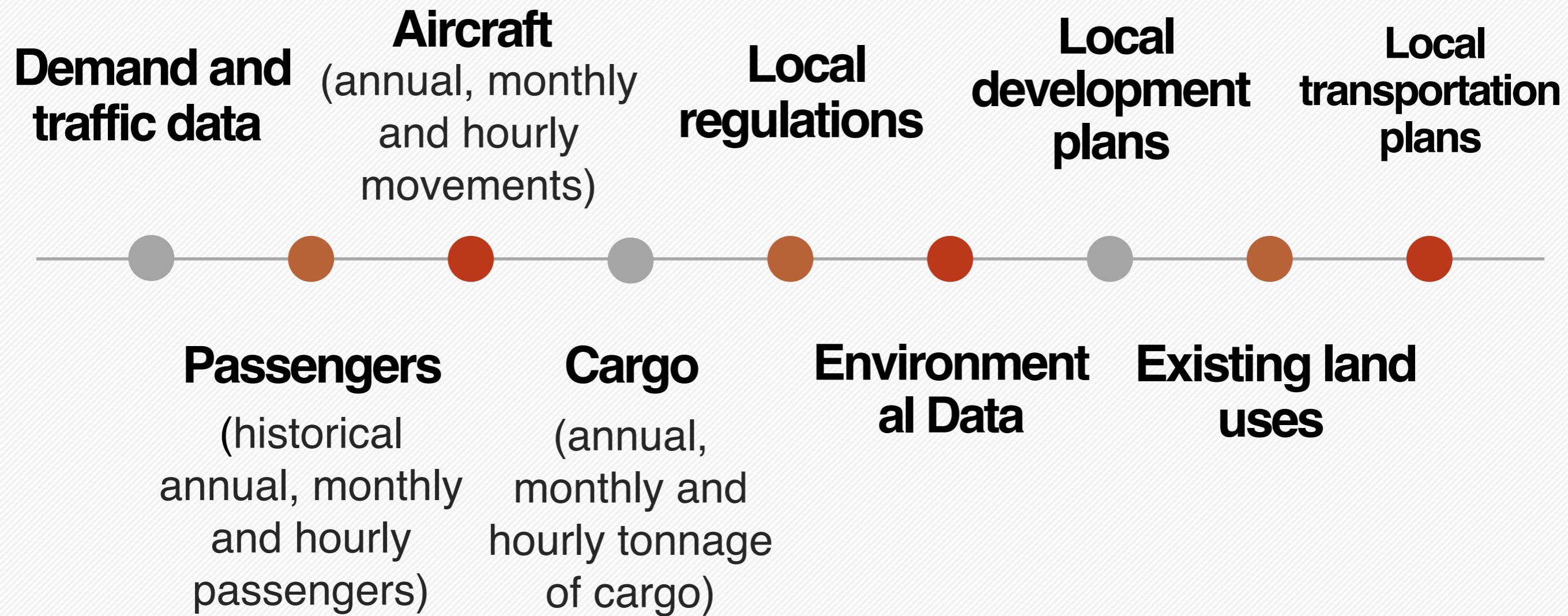


Factors Considered in Airport Site Selection

- Operational capacity (airspace issues, obstructions)
- Capacity potential (land available, weather conditions)
- Ground access (distance from city centers, existing highways, etc.)
- Development costs (terrain, land acquisition, cost, soil conditions, utilities, etc.)
- Environmental consequences (noise, impact on flora and fauna, air quality, endangered species)
- Socioeconomic factors (relocation of people, changes in employment patterns, impact on industry, taxes, etc.)
- Consistency in area wide planning (impact on land use, effort on metro/regional plans, etc.)

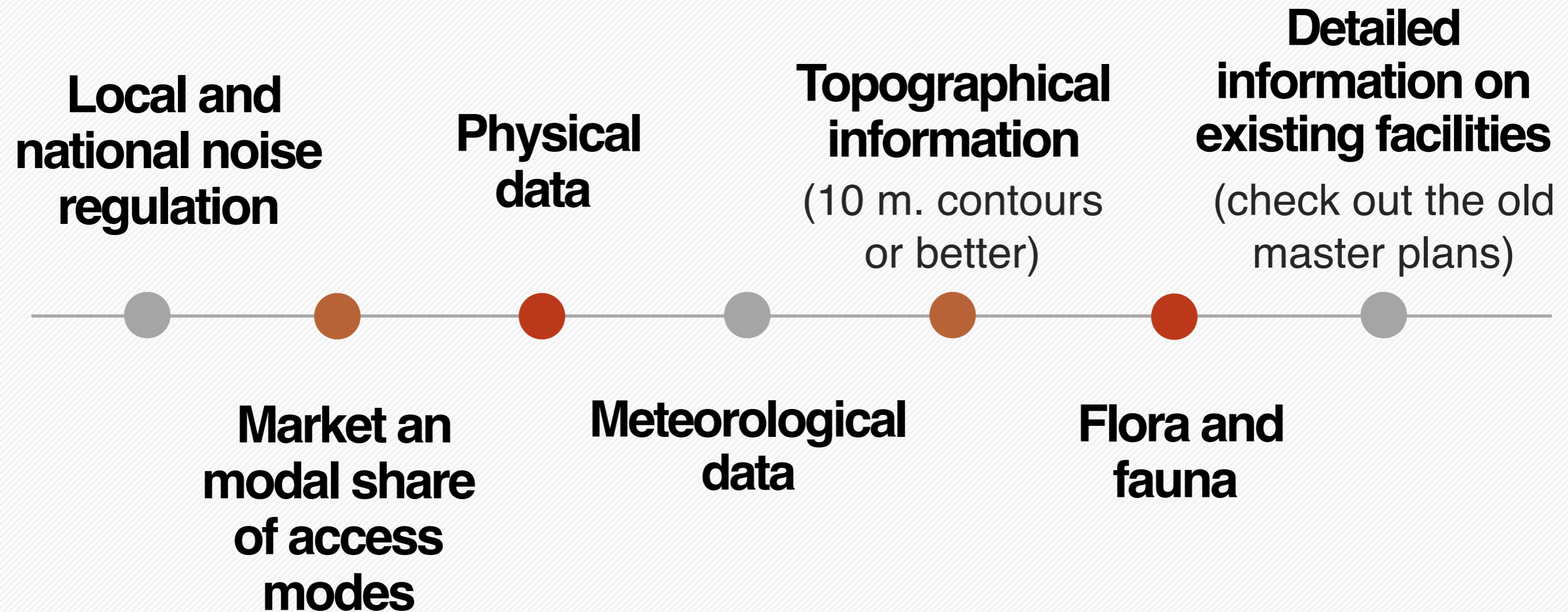


Data Requirements





Data Requirements (cont)



Data Requirements

Aeronautical data

Holding stacks, approaches, and climb out procedures

Nav aids

Airways

Financial Information

Revenue/expenses

Debt structure

Capital expenditures

Assets and liabilities

Legal limitations

Costs

Construction

Detail costs

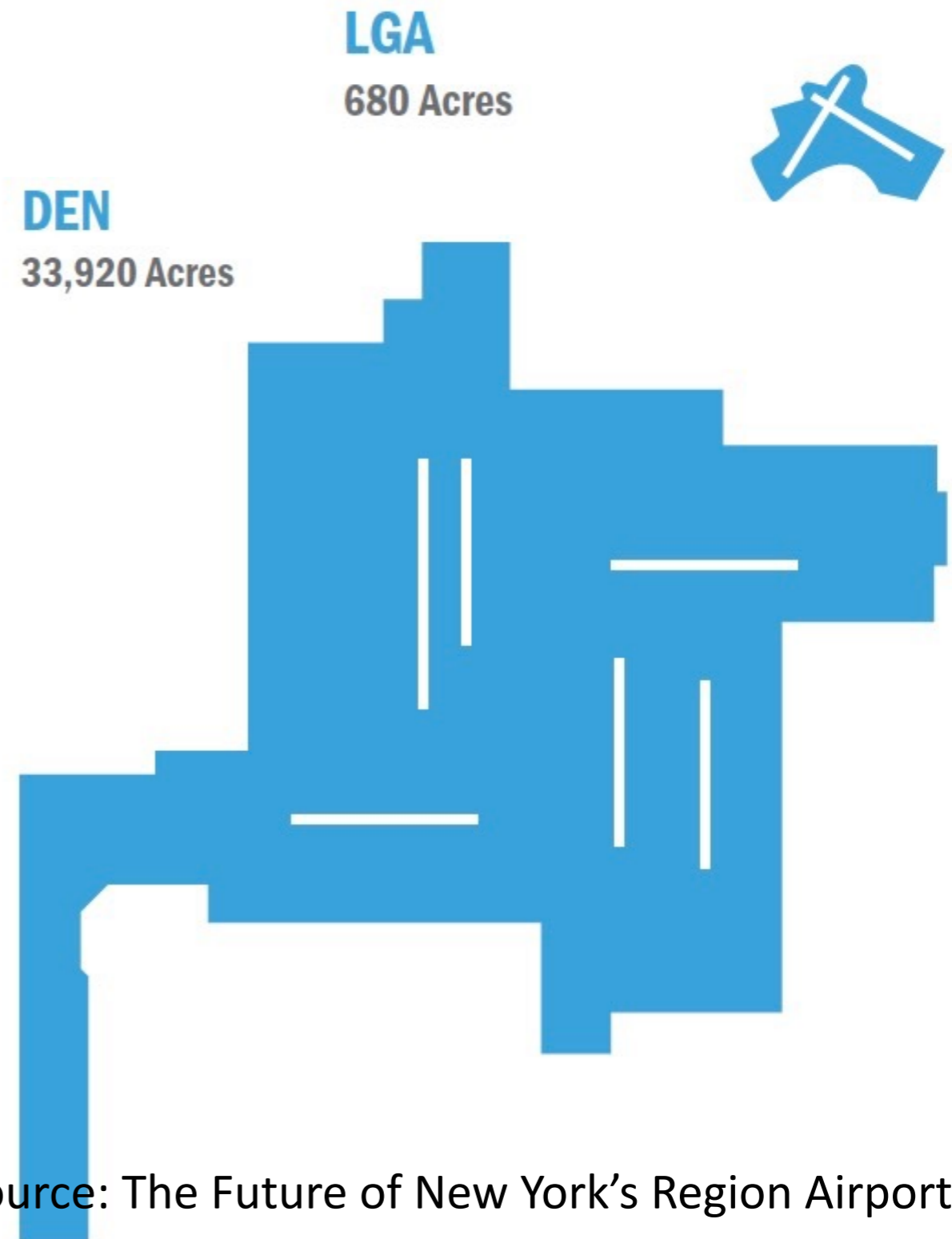
Finishing costs

Equipment costs



Comparative Size of Various Airports

- Old airports were planned around relatively modest land use plans
- Modern airports require large plots of land to accommodate multiple independent runways and the infrastructure to serve very large capacity aircraft





Sample Master Plan



Los Angeles International Airport



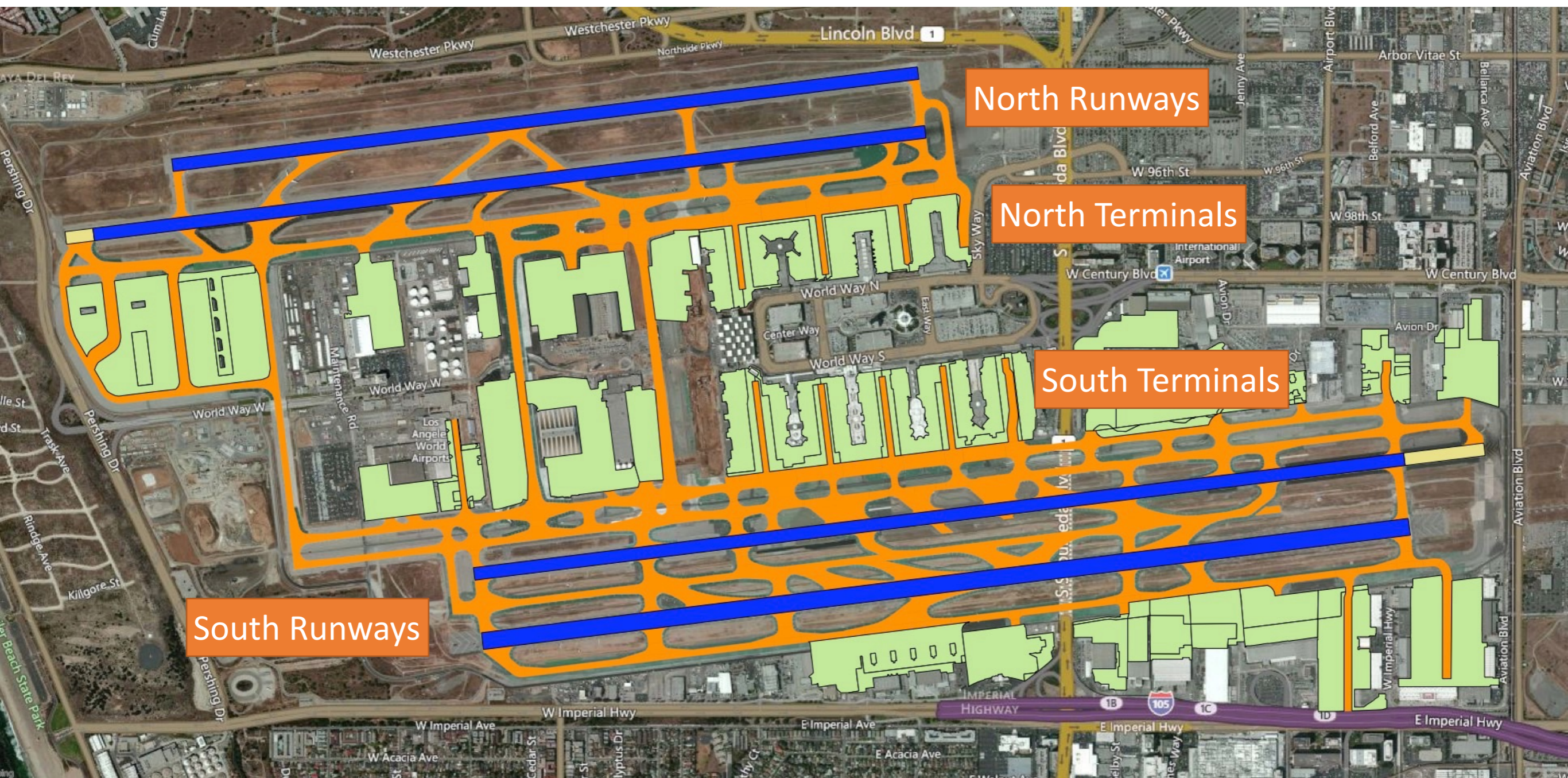


LAX Airport in 1961 (Painting)





Los Angeles International Airport Configuration (2014)



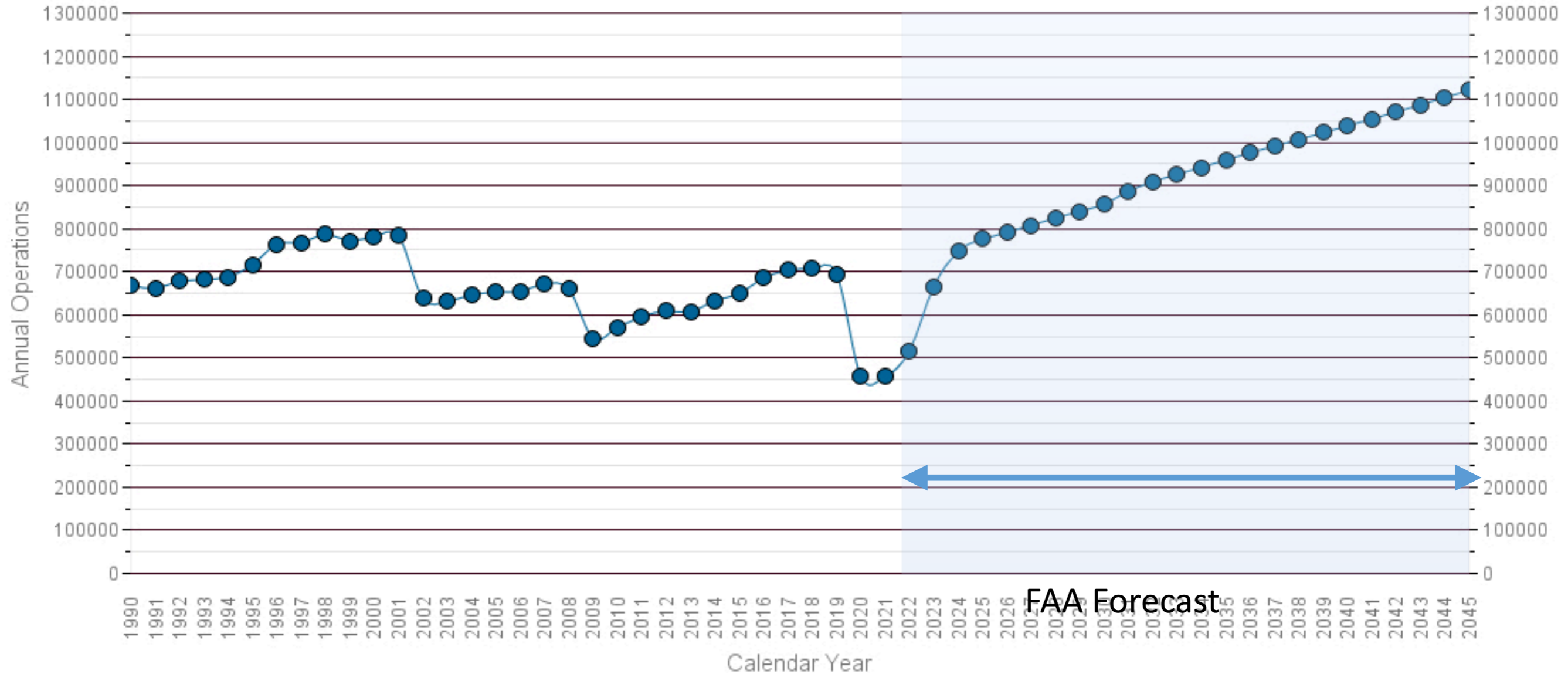


Los Angeles International Airport

- Large hub airport
- Busy ATC tower operations and complex airspace around
- 66.7 million passengers (arrivals and departures) in 2013
- 786,364 aircraft operations in 1998 (peak year) equivalent to an average of 2,154 operations per day
- Four parallel runways (>10,000 ft. long)
- Master plan costs > 10 million (multiple engineering firms involved)



Los Angeles International Airport

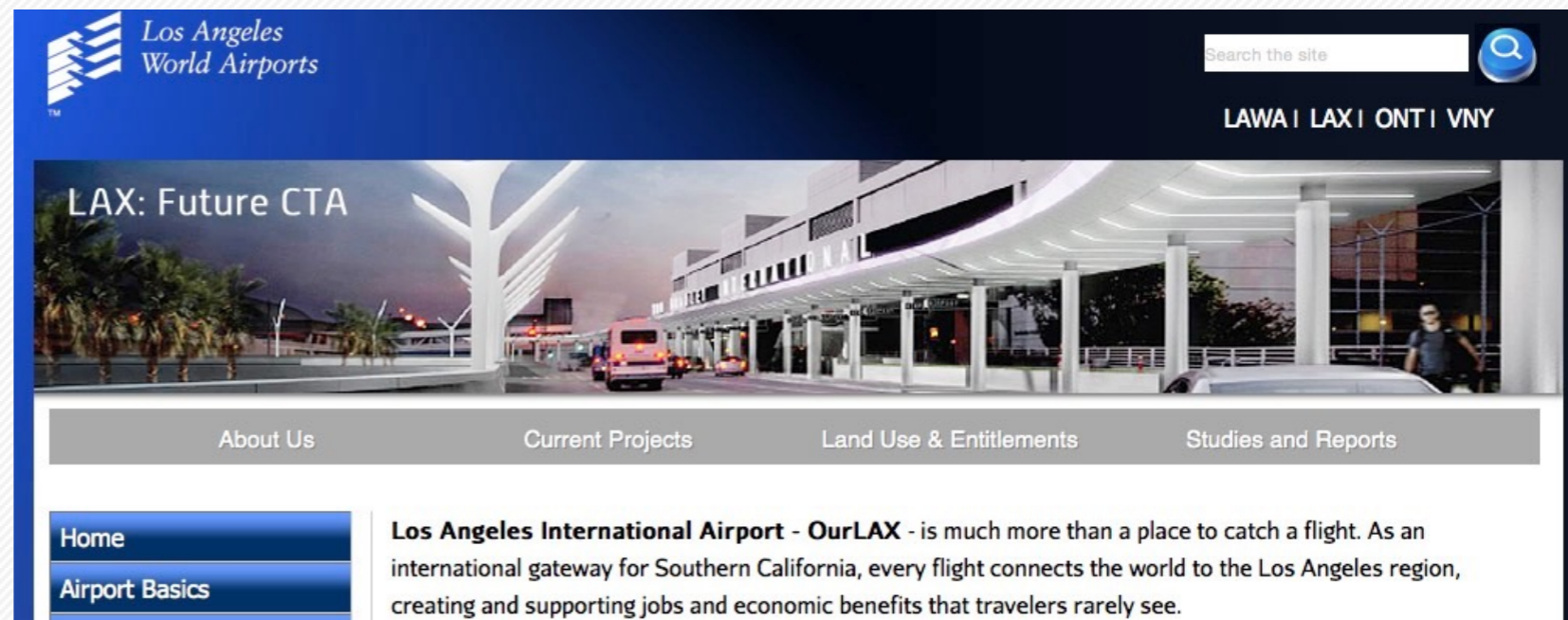


Source: FAA Terminal Area
Forecast (2021)



Los Angeles International Airport

- A good example of how a complex airport master plan is developed
- Shows how the airport authority communicates with the community
- To learn more go to: <https://www.lawa.org/lawa-our-lax/environmental-documents/documents-certified/2004-lax-master-plan-program>





LAX Old Master Plan Timeline

October, 1994 LAX Master Plan is initiated to address long-term issues of airport capacity, ground access and environmental impacts.

Three Phases in the Master planning process:

- **December, 1995** Phase I of the LAX Master Plan is completed. Research phase determines demand for air service by 2015 could reach 98 million annual passengers and 4.1 million annual tons of cargo.
- **February, 1996** Phase II of LAX Master Plan is initiated. Facility requirements are assessed and a total of 30 concepts are developed and reviewed by LAWA
- **December, 1996** Four airport development alternatives are unveiled.



LAX Old Master Plan Timeline

June-July, 1997 LAWA and the FAA issue Notice of Preparation/Notice of Intent to prepare EIS/EIR, followed by a series of public meetings to help define the scope of the EIS/EIR.

August, 1997 - As a result of public input, two of the original four alternatives are eliminated.

October, 1998 Phase III of the Master Plan is underway. A new third alternative is developed in response to issues raised during the initial scoping process and subsequent public input.

June, 1999 - A new four-runway alternative is added to the Master Plan. The new alternative is introduced to better balance the needs of the flying public, the business community, and the airport's neighbors. Under the new plan, LAX would accommodate 8 million fewer passengers annually than the other alternatives under study and 400 fewer daily flights.

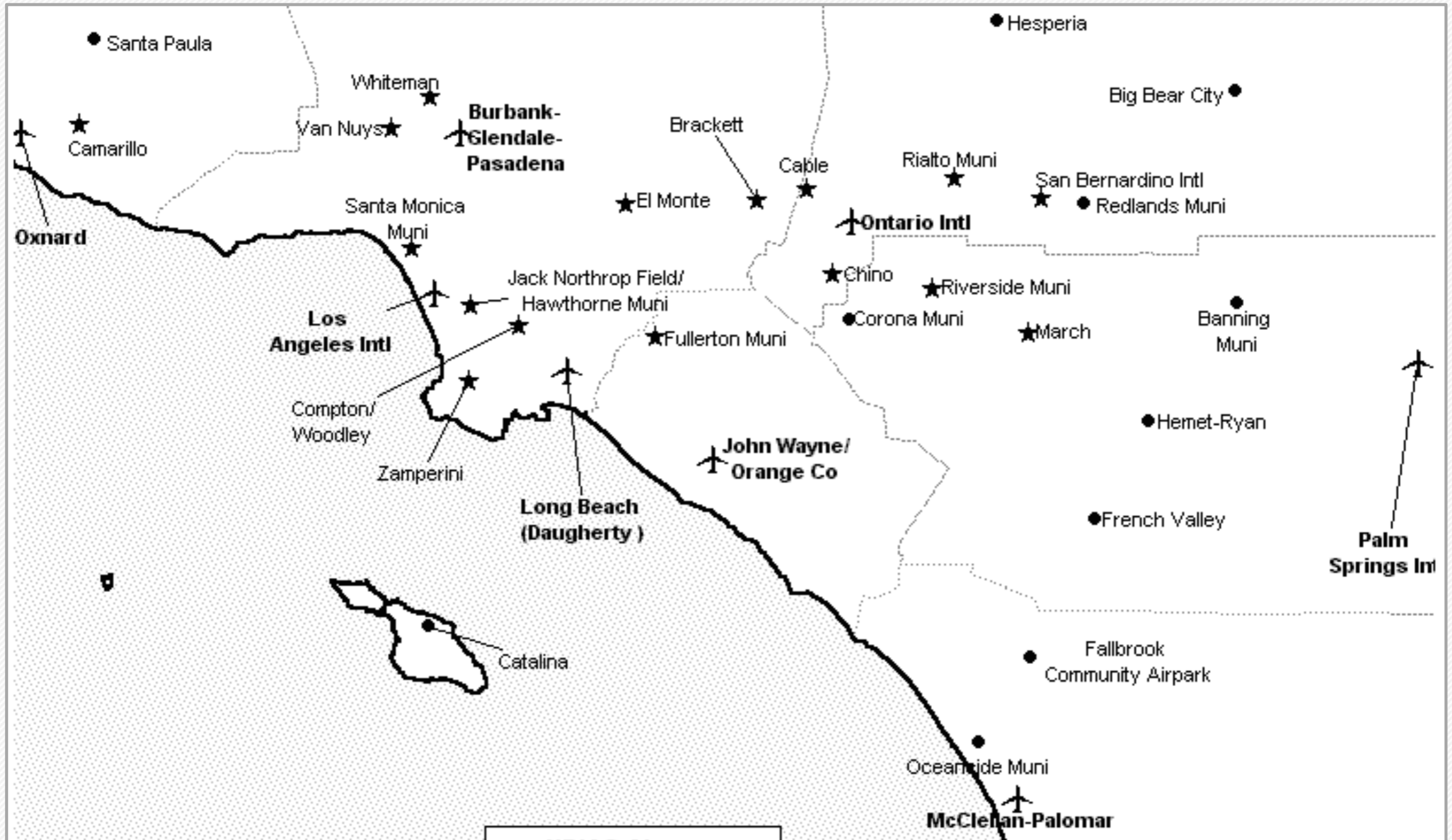


LAX Old Master Plan Timeline

- **1999-2000** - Environmental impact assessments are completed. An Airport Layout Plan and implementation plan for the preferred alternative is developed.
- **January, 2001** - The Draft EIS/EIR and Draft LAX Master Plan are released. An unprecedented 180-day public comment period commences
- **June, 2001** - Public Hearings will be held to provide opportunity for the public to voice their comments on the Draft documents
- **2001 to 2014** - Multiple safety studies (includes RSA improvements and declared distance analysis) and landside improvements to the airport



Airports in the Los Angeles Basin





LAX Alternatives

Do nothing (No action alternative)

Up to 79 million annual passengers (MAP) by 2015.

Alternative A - North Runway + Terminal Mods.

Up to 98 MAP and approximately 2,700 daily operations by 2015.

Alternative B - South Runway + Terminal Mods.

Up to 98 MAP and approximately 2,700 daily operations by 2015.

Alternative C - Terminal and Access Improvements

Up to 89 MAP and 2,300 daily operations by 2015

No Action (2005-2015)





Alternative A - Additional North Runway

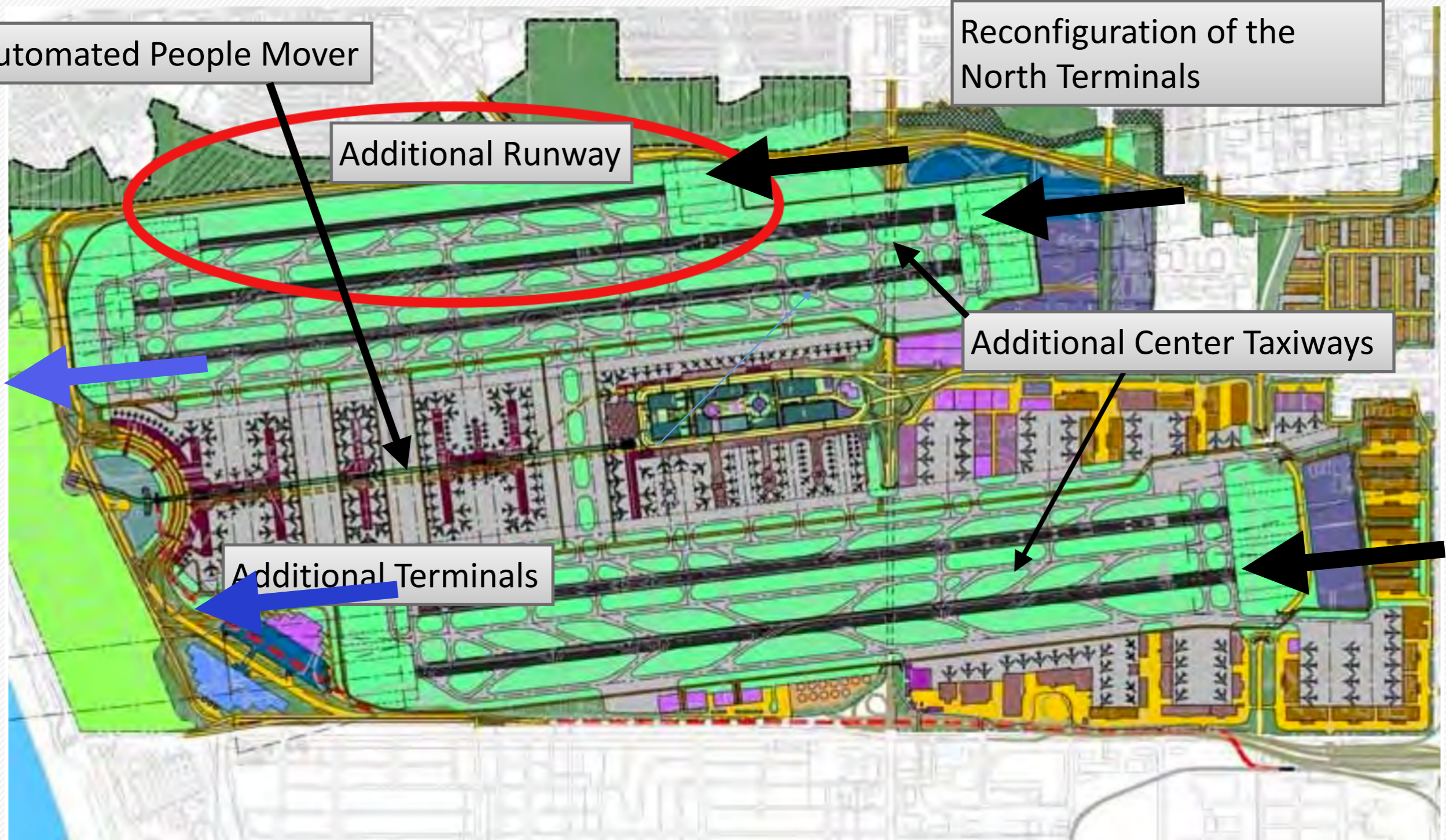
Automated People Mover

Additional Runway

Reconfiguration of the
North Terminals

Additional Center Taxiways

Additional Terminals





Alternative A - Additional North Runway

- This alternative adds a new runway on the north airfield approximately 400 feet north of the existing runways.
- The efficiency and safety of the taxiway/taxilane structures on both the north and south airfields would be improved.
- A new west entrance and terminal with additional aircraft gates, rental car facilities and parking would be added.
- A people mover would provide passenger access from a new parking garage and the west terminal to new concourses west of the Tom Bradley International Terminal and all other terminals.
- Cargo facilities would be expanded in the southeast corner of the airport.



Alternative A - Additional North Runway

- The improvements included in Alternative A would enable LAX to accommodate 98 Million Annual Passengers (MAP), 4.2 Million Annual Tons (MAT) of cargo and approximately 2,700 daily operations by 2015.
- Major vehicle access improvements would include the LAX Expressway, which would draw traffic off of the San Diego (405) Freeway.
- The expressway would connect to an airport ring road to provide direct access to terminals and cargo areas, thus reducing traffic on the freeway and local streets.
- The light rail Green Line would be extended into the airport to provide non-automobile, direct service to LAX.



Alternative B - Additional South Runway

Automated People Mover

Reconfiguration of the South Terminals

Additional Terminals

Additional Runway



Alternative B - Additional South Runway

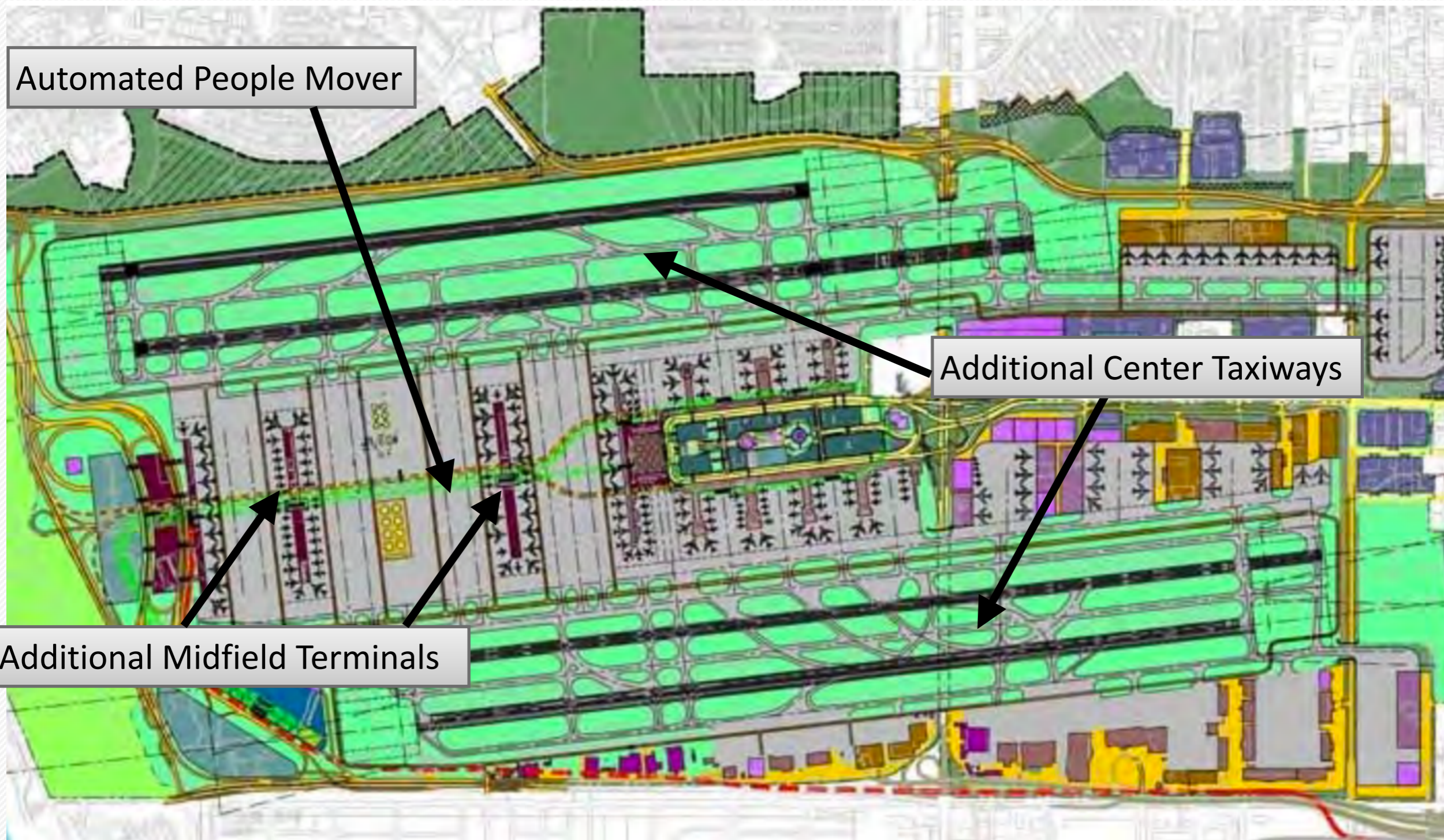
- This alternative adds a new runway to the south. The existing southern runways would be relocated north in order to increase the lateral spacing between all three runways.
- The efficiency and safety of the taxiway/taxilane structures on both the north and south airfields would be improved.
- A new west entrance and terminal with additional aircraft gates, rental car facilities and parking would be added.
- A people mover would provide passenger access from two new parking garages and the west terminal to new concourses west of the Tom Bradley terminal and all other terminals.



Alternative B - Additional South Runway

- Cargo facilities would also be expanded.
- Completion of the improvements included in Alternative B would allow LAX to accommodate 98 MAP, 4.2 MAT of cargo and approximately 2,700 daily operations by 2015.
- Major vehicle access improvements would include the LAX Expressway, which would draw traffic off of the San Diego (405) Freeway.
- The expressway would connect to an airport ring road to provide direct access to terminals and cargo areas, thus reducing traffic on the freeway and local streets.
- The light rail Green Line would be extended into the airport to provide non-automobile, direct service to LAX.

Alternative C - No Additional Runway





Alternative C - No Additional Runway

- No new runways to the airfield at LAX.
- The outboard northern runway would be relocated and the inboard northern runway would be lengthened to accommodate larger aircraft.
- Taxiways/taxilanes would be added to the two northern and southern airfields to improve safety and operational efficiency.
- A new west entrance and terminal with additional aircraft gates, rental car facilities and parking would be added.
- A people mover would provide passenger access from new parking facilities and the west terminal to new concourses west of the Tom Bradley International Terminal and all other terminals.

Alternative C - No Additional Runway

- Cargo facilities would be expanded to meet the needs of LAX through 2015.
- LAX could serve 89 MAP, 4.2 MAT of cargo and approximately 2,300 daily operations by 2015.
- Major vehicle access improvements would include the LAX Expressway.
- The expressway would draw traffic off of the San Diego (405) Freeway and connect to an airport ring road to provide direct access to terminals and cargo areas, thus reducing traffic on the freeway and local streets.
- The light rail Green Line would be extended into the airport to provide non-automobile, direct service to LAX.

Expanding an Airport May Require Significant Changes to Access Roads

Airport Ring Road

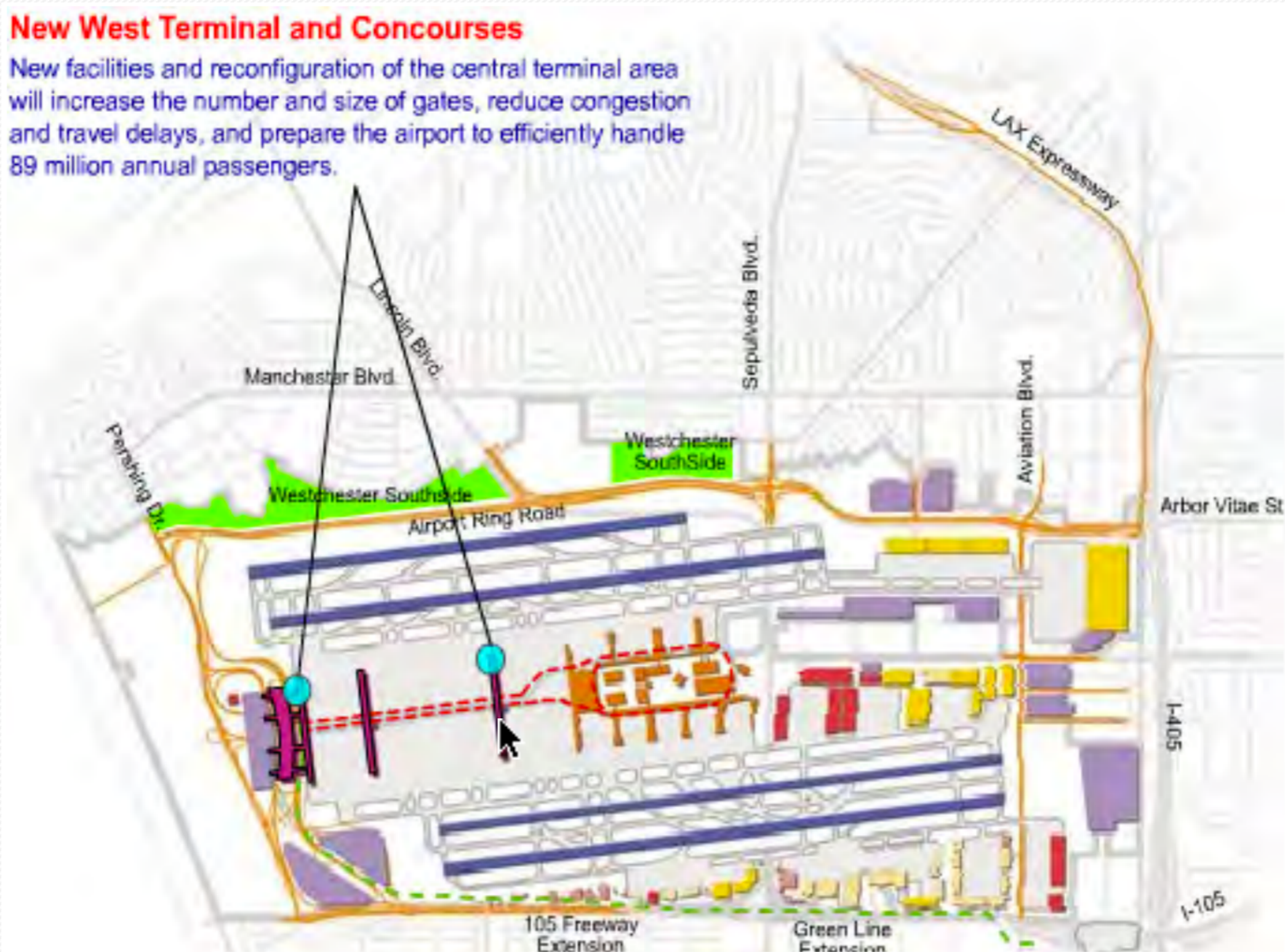
A new airport Ring Road tied by the new LAX Expressway and an extension of the I-105 Freeway will provide direct freeway connections to the airport and sharply reduce airport traffic on neighborhood surface streets, freeways, and terminal areas.



Sample Master Plan (LAX)

New West Terminal and Concourses

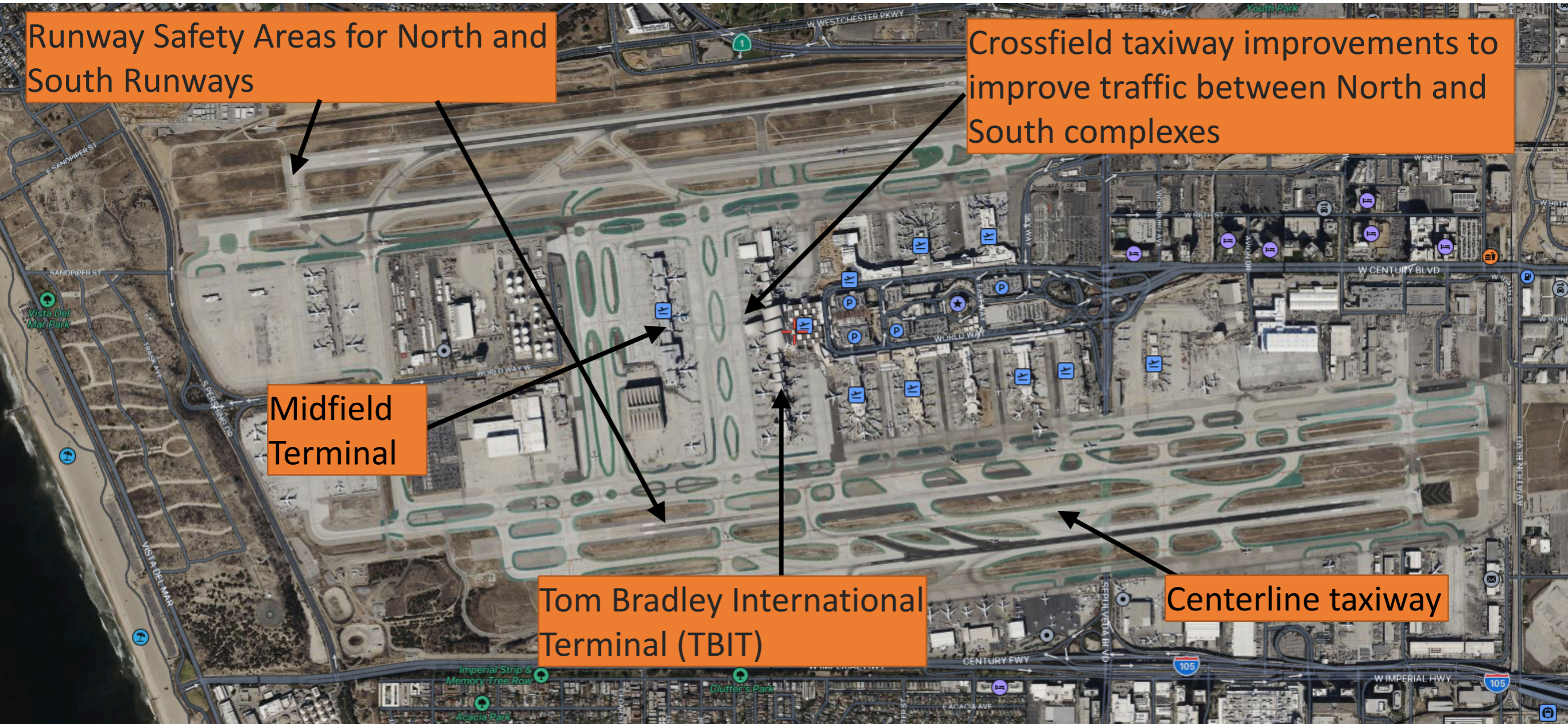
New facilities and reconfiguration of the central terminal area will increase the number and size of gates, reduce congestion and travel delays, and prepare the airport to efficiently handle 89 million annual passengers.





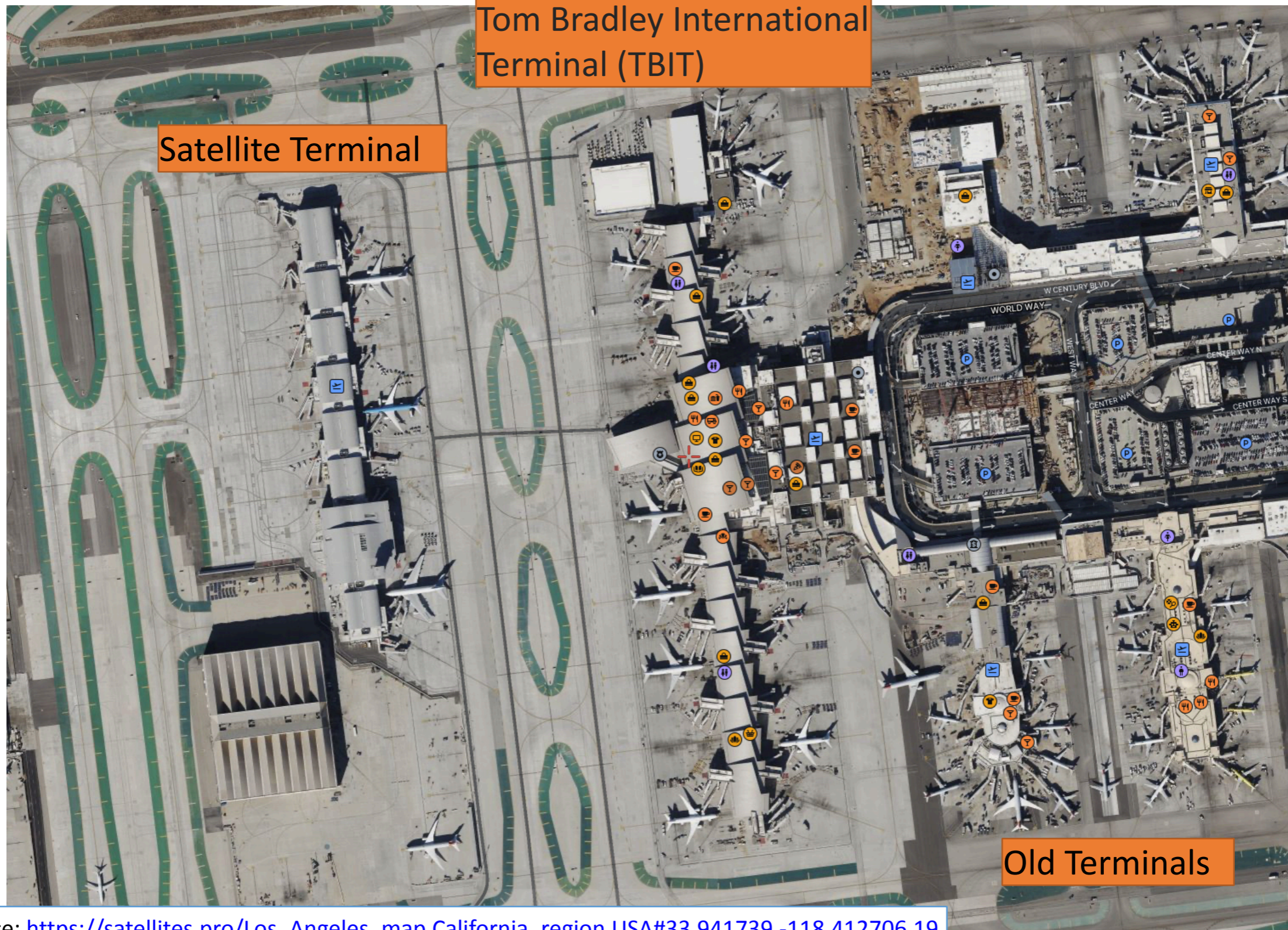
LAX Today

- Over time, a variation of the improvements of Alternative C were adopted over time (no new runway)



Source: https://satellites.pro/Los_Angeles_map.California_region.USA#33.941739,-118.412706,19

Large Investment in New Terminals



Source: https://satellites.pro/Los_Angeles_map.California_region.USA#33.941739,-118.412706,19



Large Investment in New Terminals

Tom Bradley International Terminal (TBIT)

Satellite Terminal

Taxiways sized for ADG VI

Gates
Accomodate
ADG VI Aircraft



Source: https://satellites.pro/Los_Angeles_map.California_region.USA#33.941739,-118.412706,19



LAX Mass Transit Integration

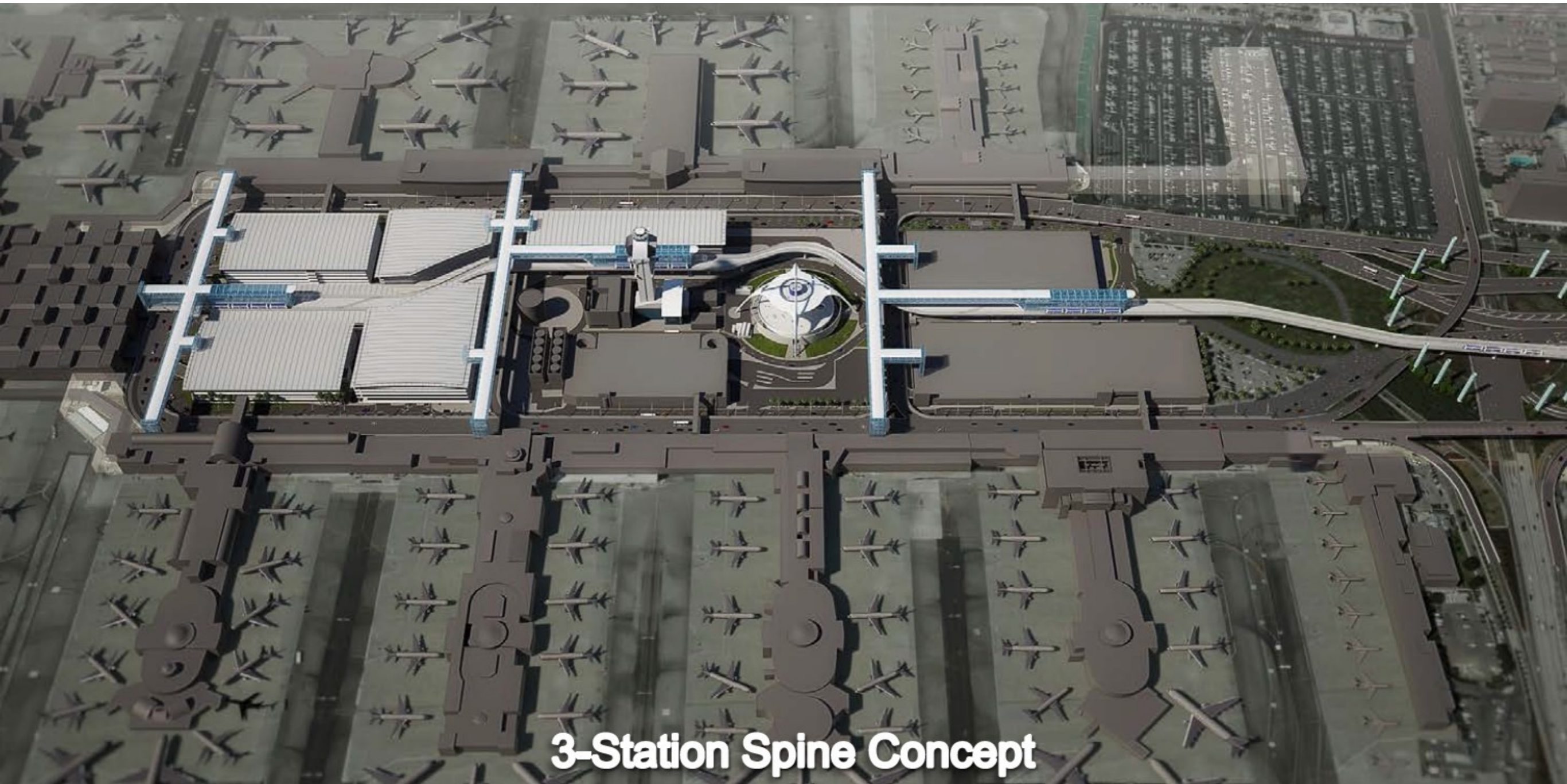
- The Los Angeles World Airports wants to improve the traffic situation for passengers at LAX
- Offer better connectivity to the city mass transit system



Source: LAX Board of Airport Commissioners, 2014



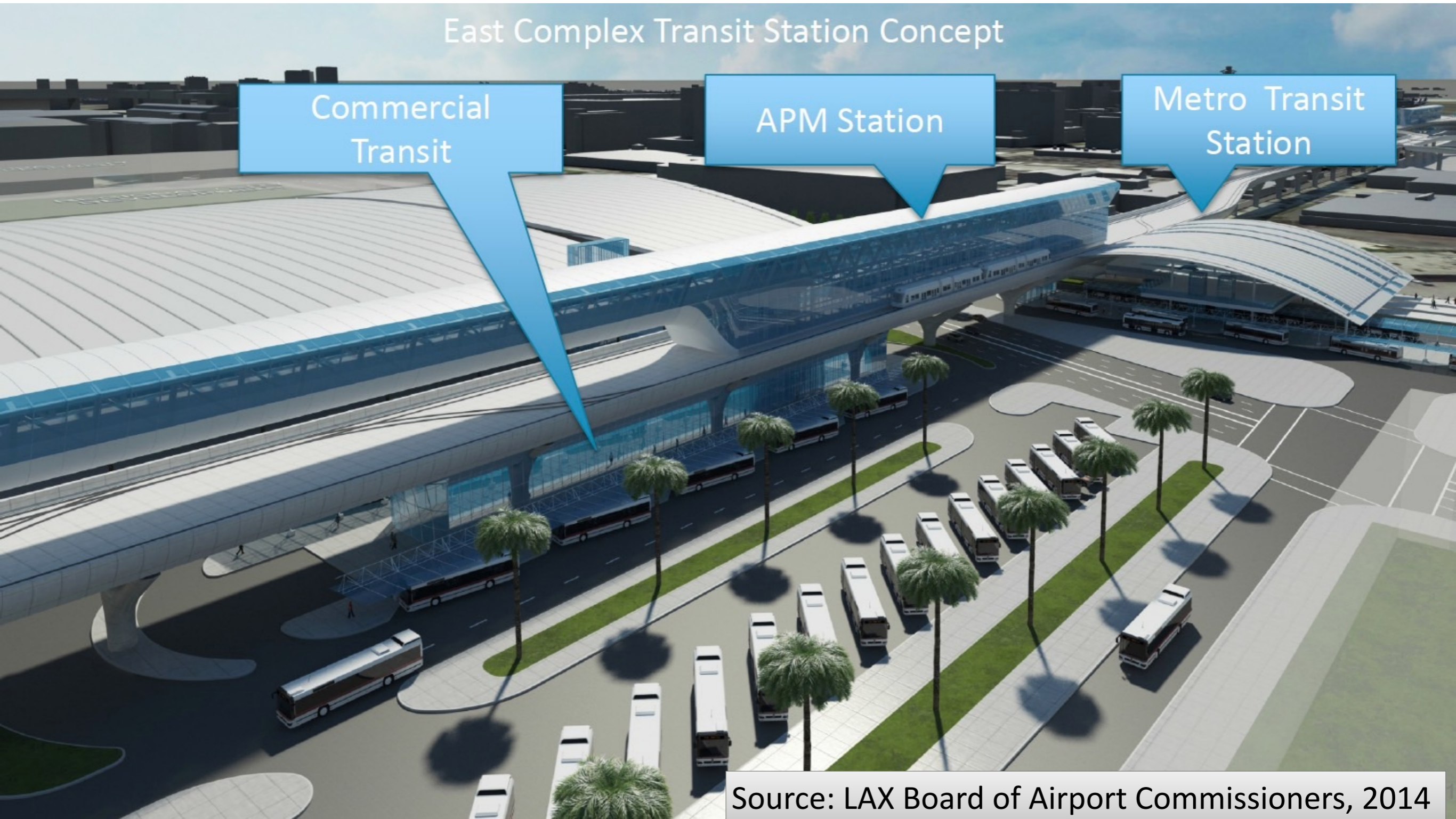
LAX Automated People Mover Concept



Source: LAX Board of Airport Commissioners, 2014



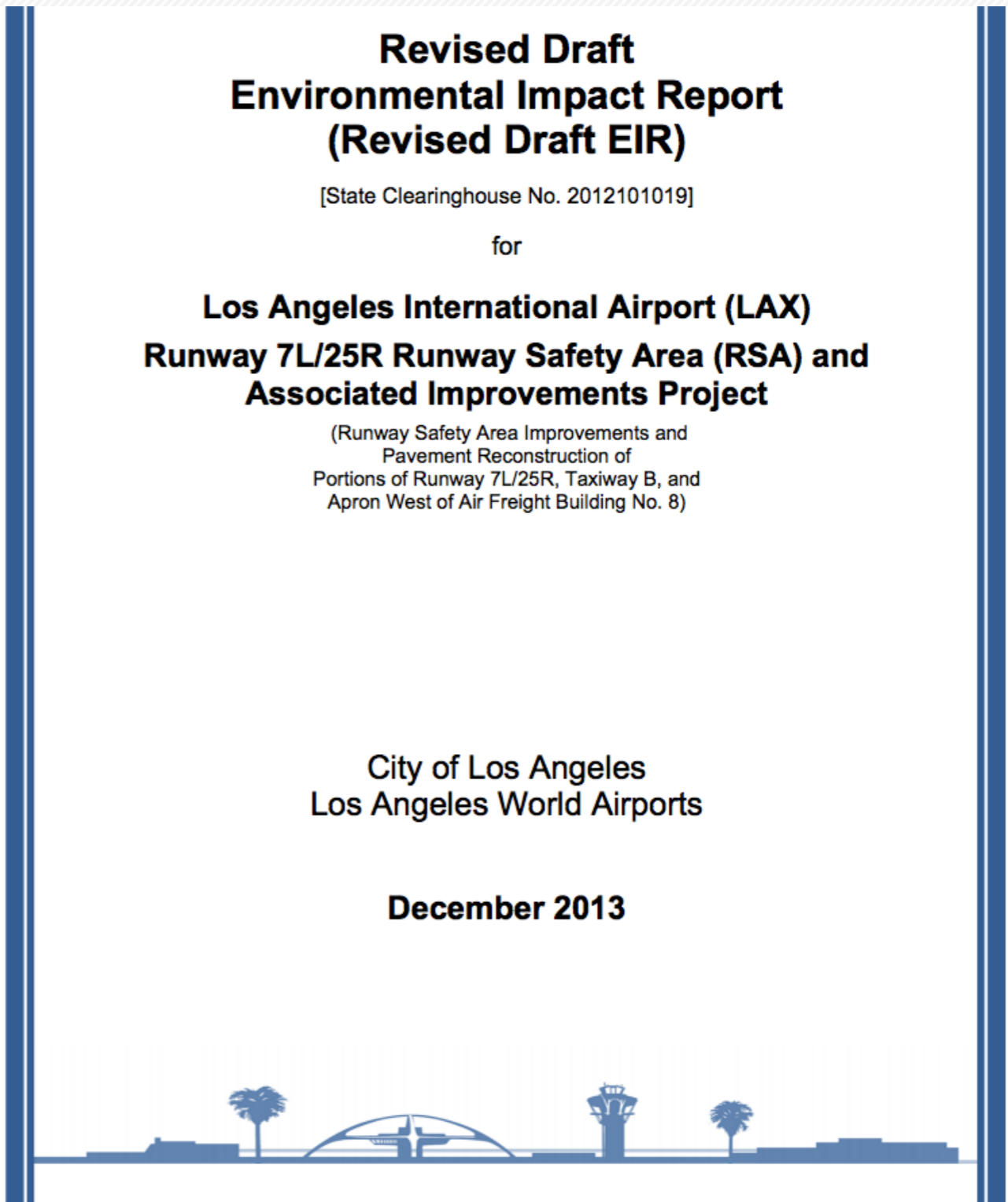
LAX Mass Transit APM Integration



Example Study: Runway 7L/25R Runway Safety Area at LAX

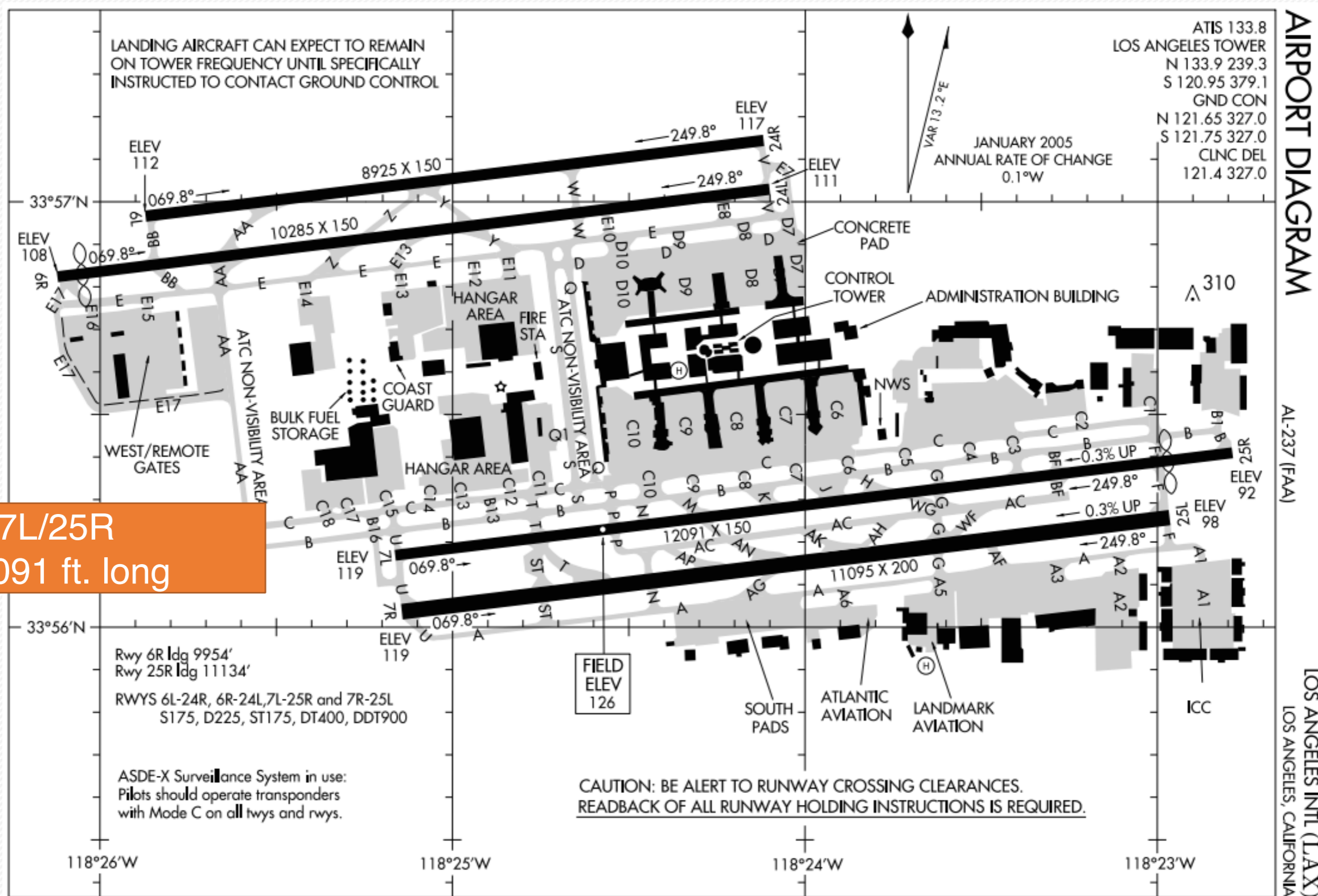
Source: LAWA

[http://ourlax.org/
LAXRunway7L25R.aspx](http://ourlax.org/LAXRunway7L25R.aspx)





Current Runway Lengths and Layout



RWY 7L/25R
is 12,091 ft. long



Runway Safety Area Needs

Table 1-2

Existing LAX Runway 7L/25R RSA Compared to FAA RSA Standards

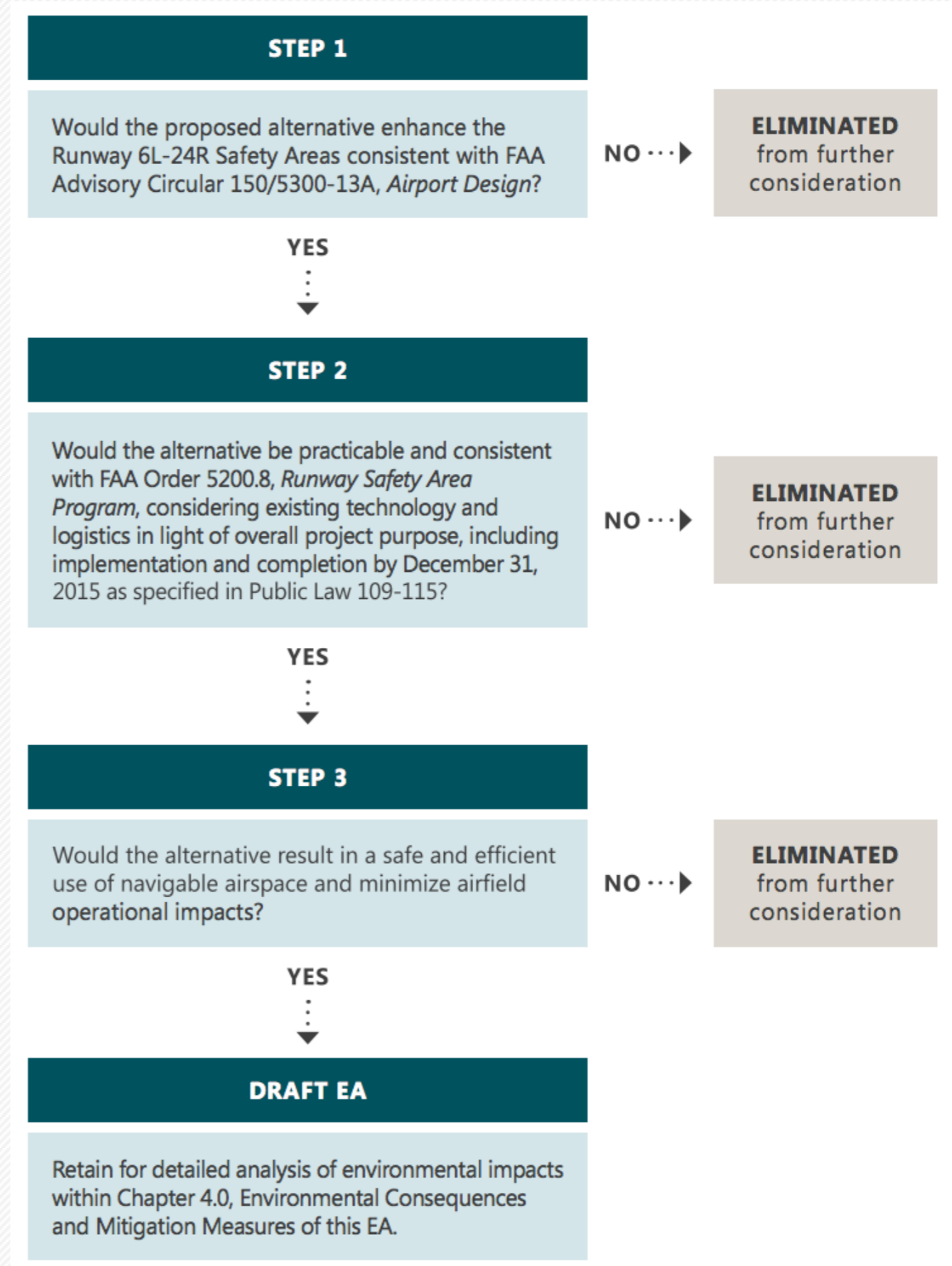
| Runway End | FAA RSA Standards for ARC D-V Runways (feet) | | Existing Runway RSAs (feet) | | | |
|------------|--|--------------------------|-----------------------------|--------------------------|-----------------|------------------|
| | Width | Length Beyond Runway End | Width | Length Beyond Runway End | Deficient Width | Deficient Length |
| 7L | 500 | 1,000 | 500 | 711 | N/A | -289 |
| 25R | 500 | 1,000 | 500 | 168 | N/A | -832 |

Source: Ricondo and Associates, *Runway 7L-25R Safety Area (RSA) Practicability Study for Los Angeles International Airport*, December 2009.

The airport authority wants to comply with RSA dimensions for FAA ARC V



Screening Process and Alternatives





Screening Process and Alternatives

Table 2-2: Runway 6L-24R RSA Alternatives Comparison Matrix

| ALTERNATIVE | RUNWAY END | RUNWAY SHIFT/ EXTENSION (FEET) | DISPLACED THRESHOLD (FEET) | USE OF DECLARED DISTANCES | STANDARD RSA | AVAILABLE DISTANCES (FEET) | | | |
|------------------------|------------|--------------------------------|----------------------------|---------------------------|--------------|-------------------------------|------------------------------------|---|----------------------------------|
| | | | | | | TAKE OFF RUN AVAILABLE (TORA) | TAKE OFF DISTANCE AVAILABLE (TODA) | ACCELERATE-STOP DISTANCE AVAILABLE (ASDA) | LANDING DISTANCE AVAILABLE (LDA) |
| No Action | 6L | | | | | 8,925 | 8,925 | 8,925 | 8,925 |
| | 24R | | | | X | 8,925 | 8,925 | 8,925 | 8,925 |
| Construct Standard RSA | 6L | | | | X | 8,925 | 8,925 | 8,925 | 8,925 |
| | 24R | | | | X | 8,925 | 8,925 | 8,925 | 8,925 |
| Reduced Runway | 6L | | | | X | 7,532 | 7,532 | 7,532 | 7,532 |
| | 24R | | 1,393 | | X | 7,532 | 7,532 | 7,532 | 7,532 |
| Declared Distances | 6L | | | X | X | 8,925 | 8,925 | 8,566 | 8,566 |
| | 24R | | | | X | 8,925 | 8,925 | 8,925 | 8,925 |
| Shift Runway | 6L | 615 (Westward) | | | X | 8,925 | 8,925 | 8,925 | 8,925 |
| | 24R | 615 (Westward) | | | X | 8,925 | 8,925 | 8,925 | 8,925 |
| EMAS | 6L | | | | | 8,925 | 8,925 | 8,925 | 8,925 |
| | 24R | | | | | 8,925 | 8,925 | 8,925 | 8,925 |
| Refinement #1 | 6L | 359 (Westward) | | X | X | 9,284 | 9,284 | 8,925 | 8,566 |
| | 24R | | | | X | 9,284 | 9,284 | 9,284 | 9,284 |
| Refinement #2 | 6L | | | X | X | 8,925 | 8,925 | 8,566 | 8,566 |
| | 24R | | | | X | 8,925 | 8,925 | 8,925 | 8,925 |

NOTES: Numbers in RED indicate different numbers than existing conditions.

X = Alternative satisfies this condition.

SOURCE: Ricondo and Associates, Inc., *Runway 6L-24R & 6R-24L Safety Area (RSA) Practicability Study for Los Angeles International Airport*, April 9, 2010.

PREPARED BY: Ricondo & Associates, Inc., June 2014.



Runway 7L End RSA Area





The Situation on Runway 25R End





RSA Extension on Runway 7L End





Runway 25R ILS Localizer Antenna

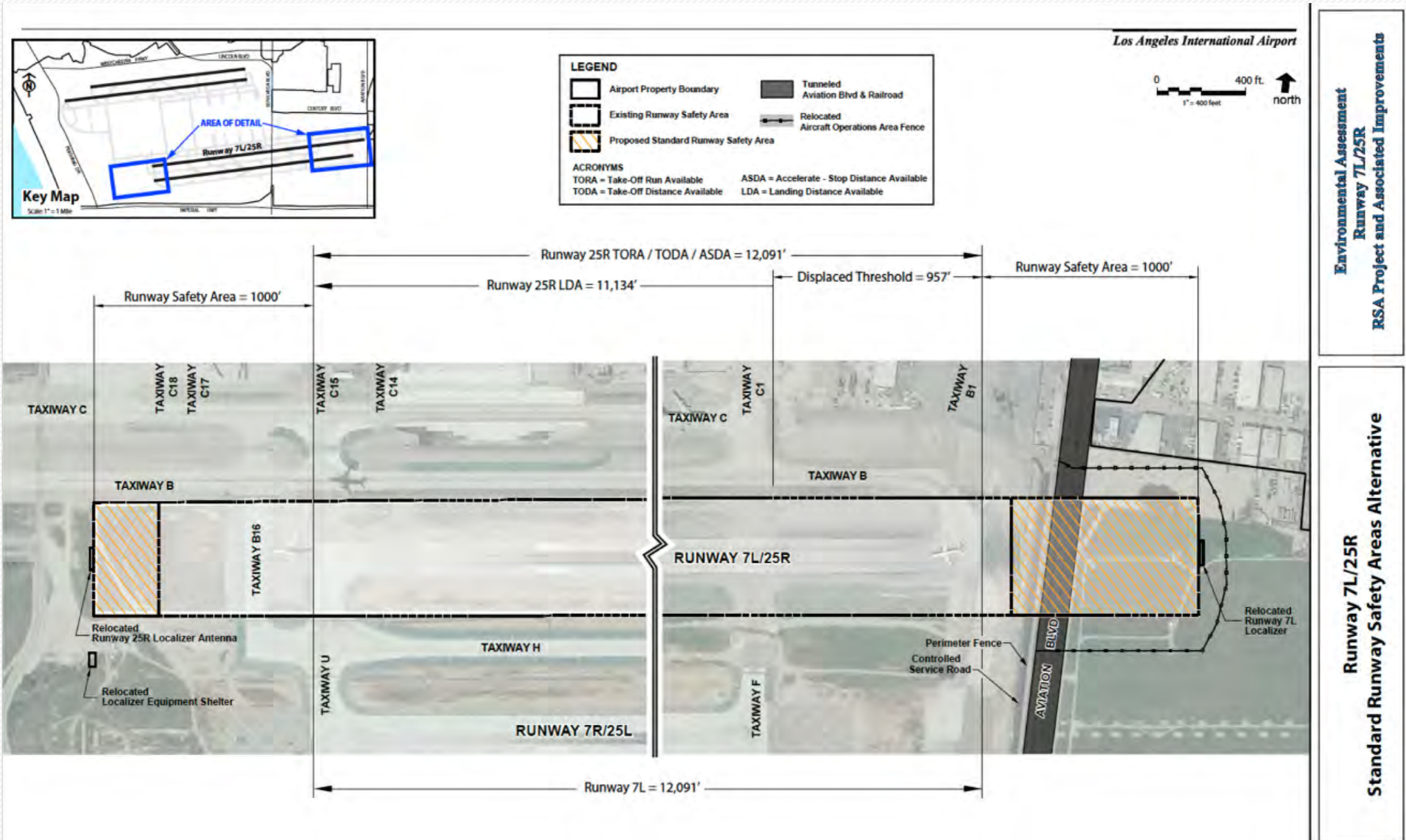
Note that at the location of the localizer a hill is evident
source: LAWA EIS Study



ILS Localizer Antenna

Proposed Solution : Standard RSA

source: LAWA



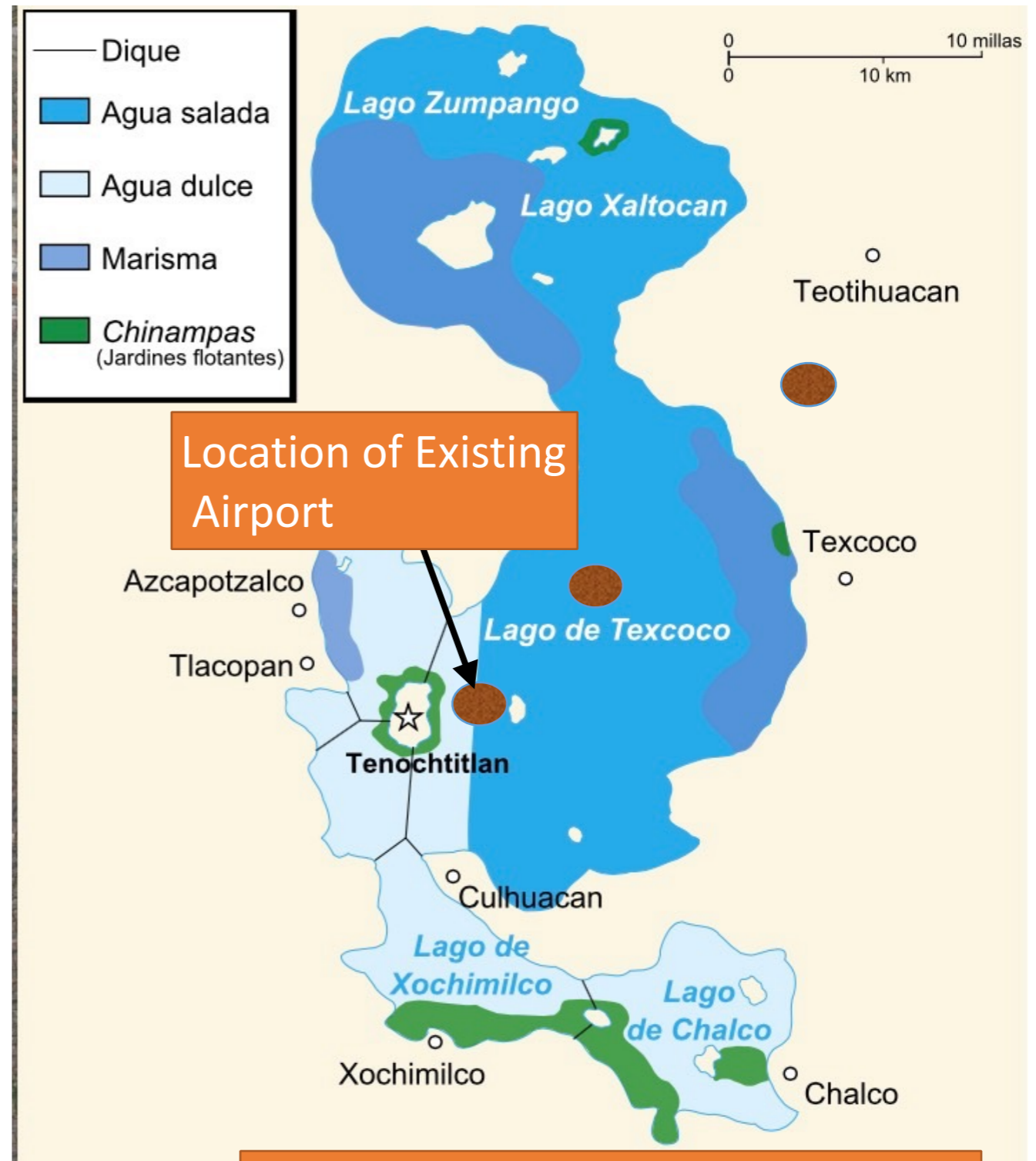


New México City International Airport Example of New Airport Plan



A View of History (circa 1519)

- Mexico City was constructed on a Lake
- City eventually took over the lake and the remains of the lake are located to the East of the



Source: Wikipedia - Spanish version



Mexico City Airport Today



Source: Google Earth Satellite Picture



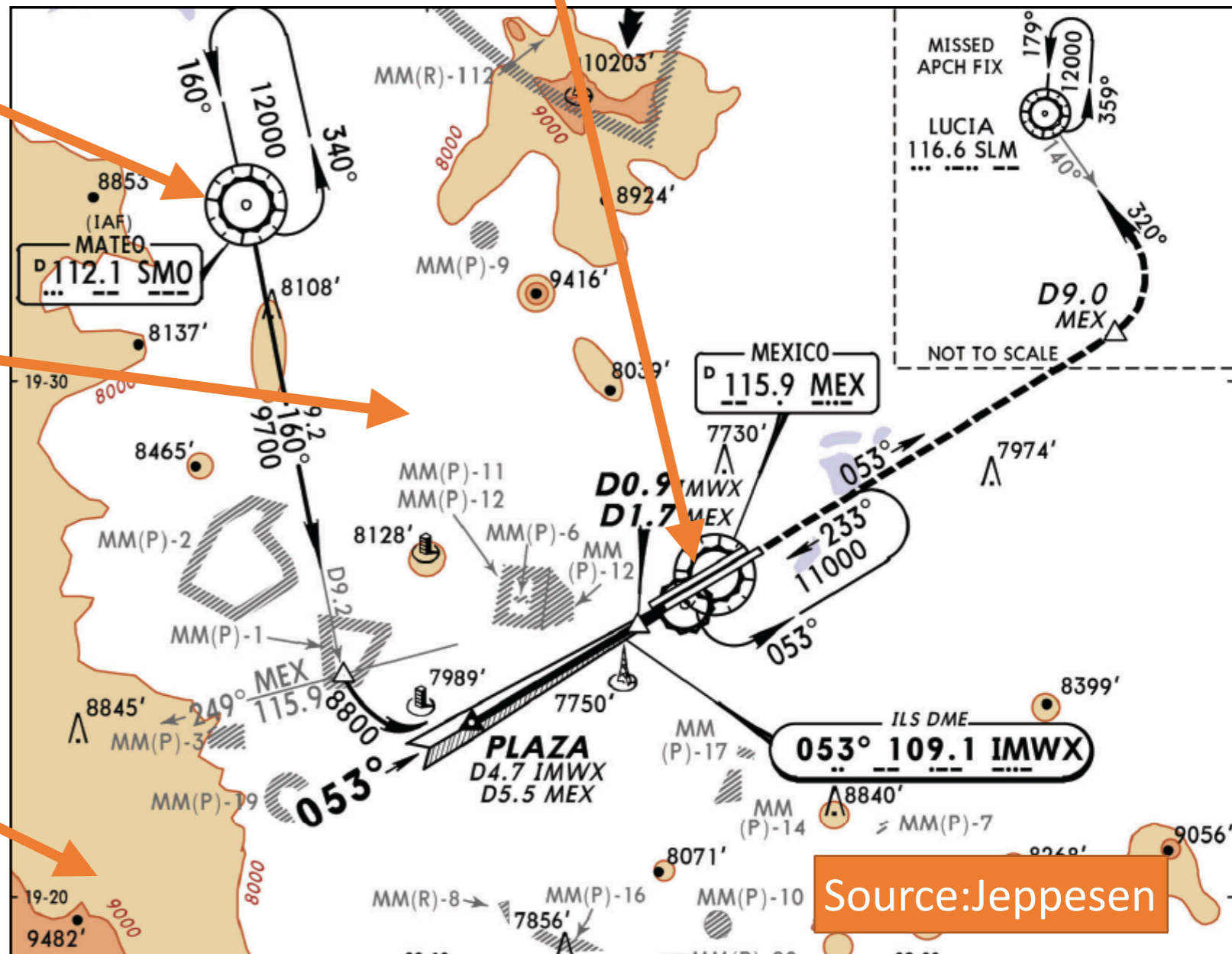
Mexico City Airport Constraints

Single Point Approach Corridor San Mateo VOR

Two Close Parallel Runways spaced 800 feet

Airport is surrounded by population centers

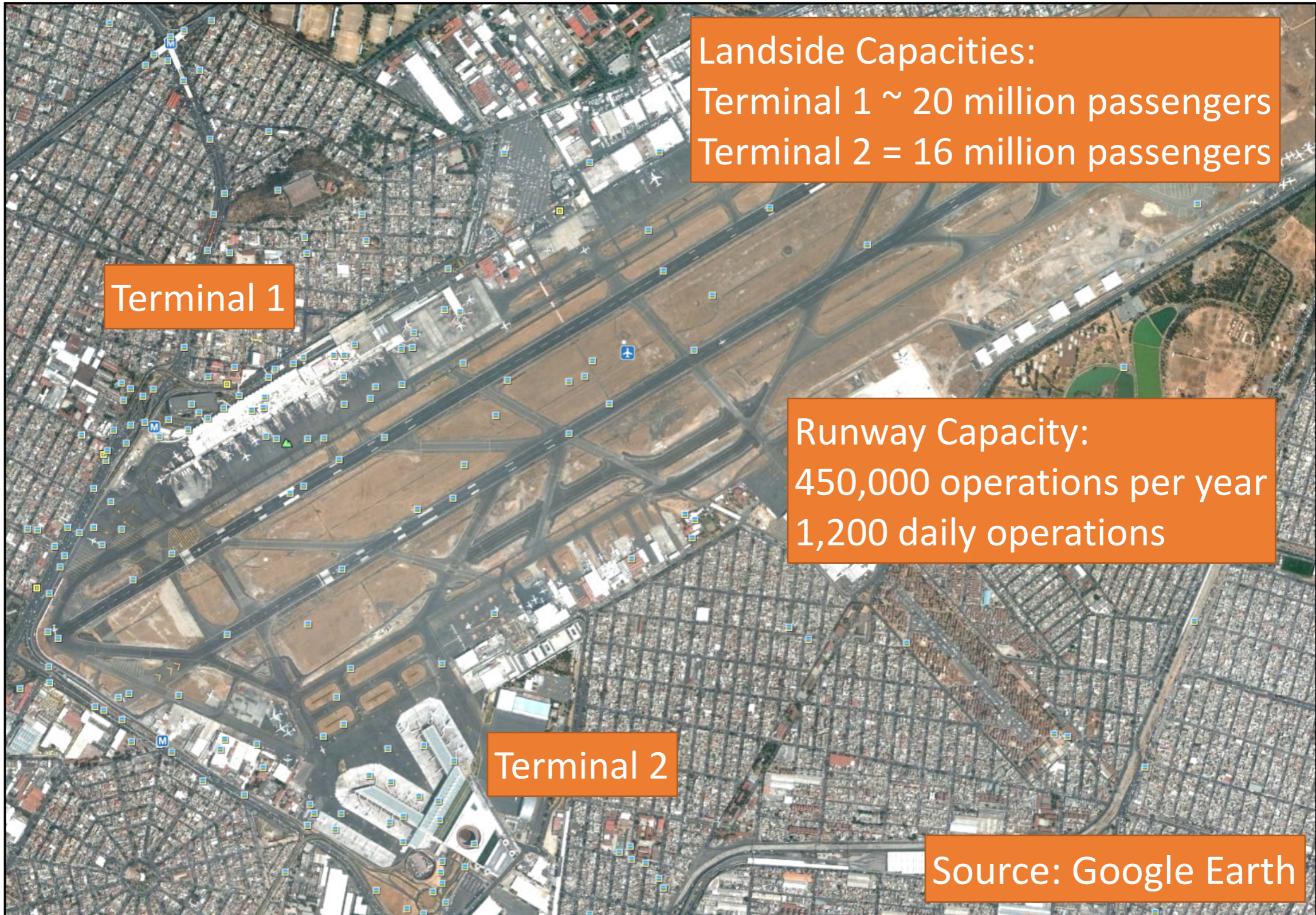
High train to 3 quadrants (W, S and SE)



Source: Jeppesen



Mexico City Airport Constraints

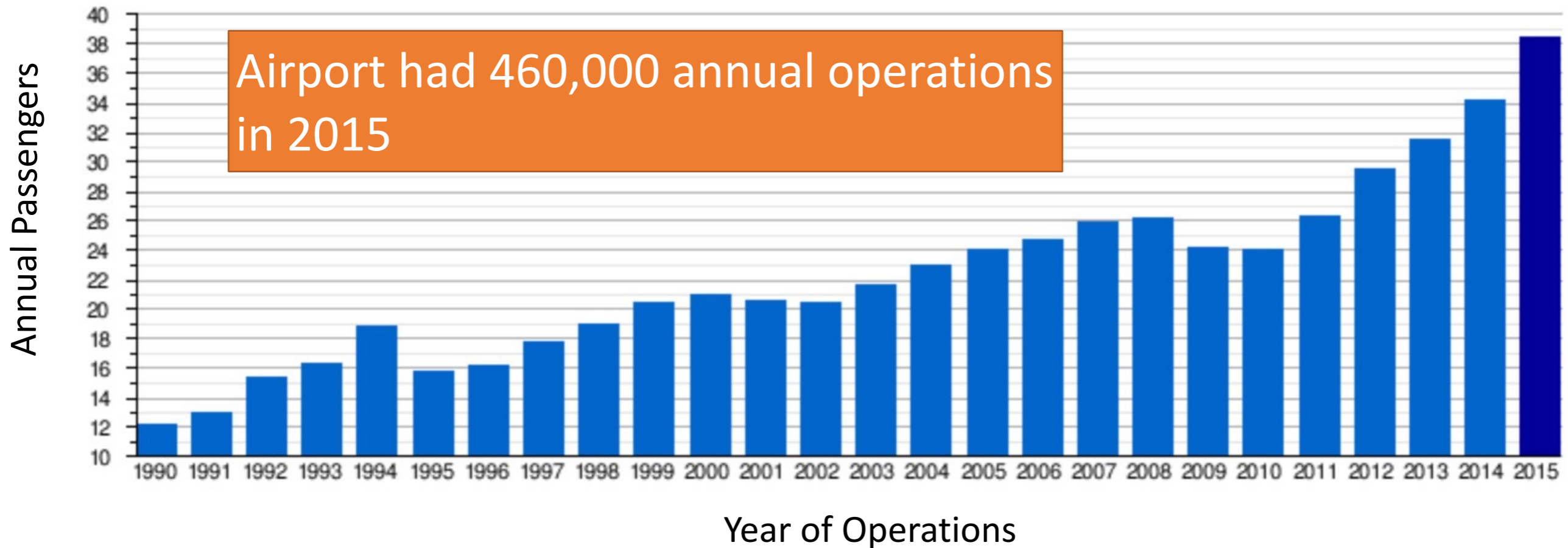




Mexico City Airport Flight Demand

Airport has slot controls to mitigate large delays

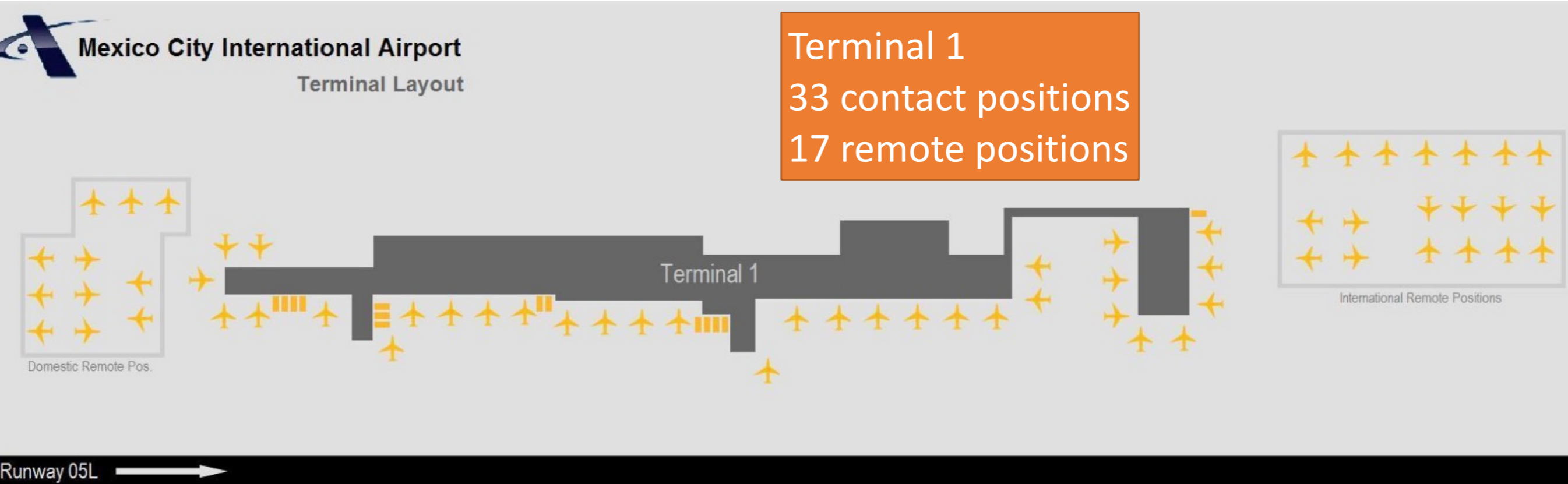
Airport had 50 million passengers in 2019



Source: Wikipedia



Mexico City Airport Terminals





Mexico City Airport Terminals



Aeropuerto Internacional de la Ciudad de México
Posiciones de las Terminales



Pista 05 I →

Source: Wikipedia

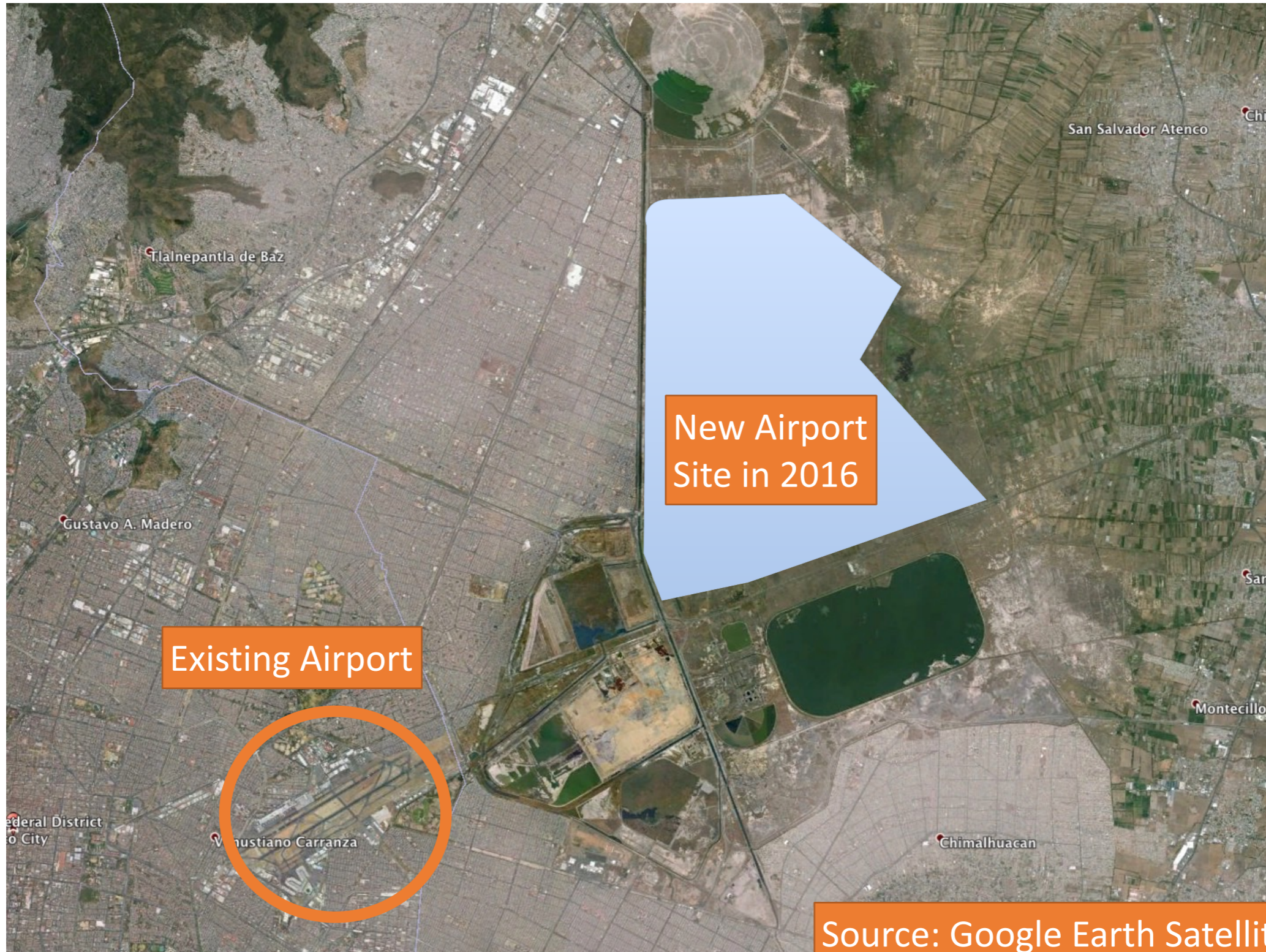
Pista 05 D →



Terminal 2
24 contact positions
8 remote positions



Location of New Airport (circa 2016)

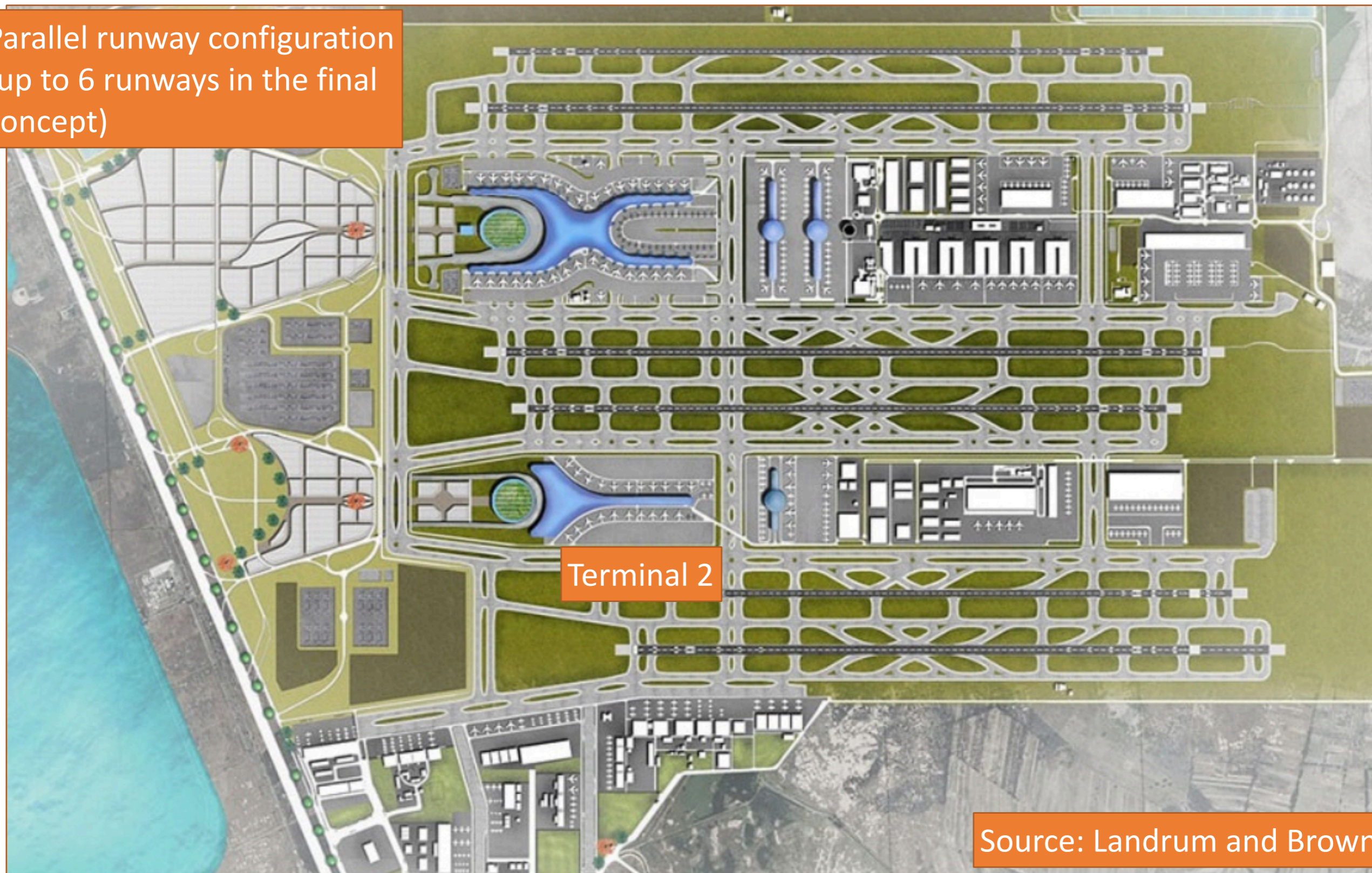


Source: Google Earth Satellite Picture



Proposed Mexico City Airport (Texcoco)

Parallel runway configuration
(up to 6 runways in the final
concept)



Terminal 2

Source: Landrum and Brown



Major Hydraulic Infrastructure Needed

- 3 Regional water treatment plants (1365 l/s capacity)
- 21 local water treatment plants (500 l/s capacity)
- 39 km of tunnels for drainage system
- 145 km of marginal collectors for 9 rivers that feed the Lake Texcoco





New Plan for the Mexico City International Airport

Source: www.architectureanddesign.com.au



Airport Design Concept by Foster, Romero and Netherlands Airport Consultants

Check the video of the New Mexico City Airport (<https://www.youtube.com/watch?v=5NOoKNYinsg>)

New Plan for the Mexico City International Airport



Airport Design Concept by Foster, Romero and Netherlands Airport Consultants



<https://www.youtube.com/watch?v=5NOoKNYinsg>

New Plan for the Mexico City International Airport



Airport Design Concept by Foster, Romero and Netherlands Airport Consultants

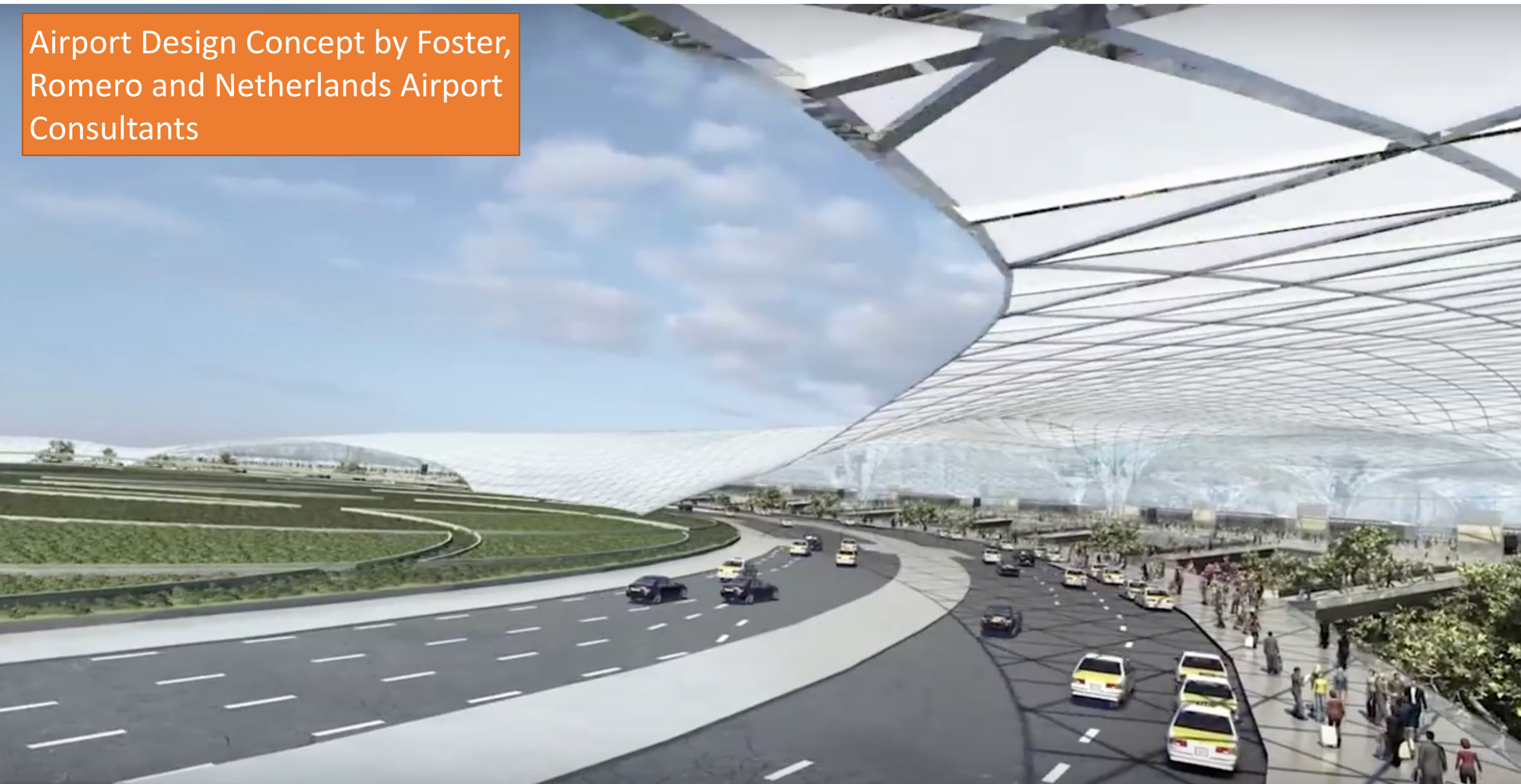


source: <https://www.youtube.com/watch?v=5NOoKNYinsg>



New Mexico City International Airport

Airport Design Concept by Foster, Romero and Netherlands Airport Consultants



source: <https://www.youtube.com/watch?v=5NOoKNYinsg>



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New Mexico City International Airport

Airport Design Concept by Foster, Romero and Netherlands Airport Consultants



source: <https://www.youtube.com/watch?v=5NOoKNYinsg>



October 2018: The Airport Construction is Stopped



One third of the project completed
12,000 billion dollar project
4,000 billion dollars spent/committed



New Government: New Airport

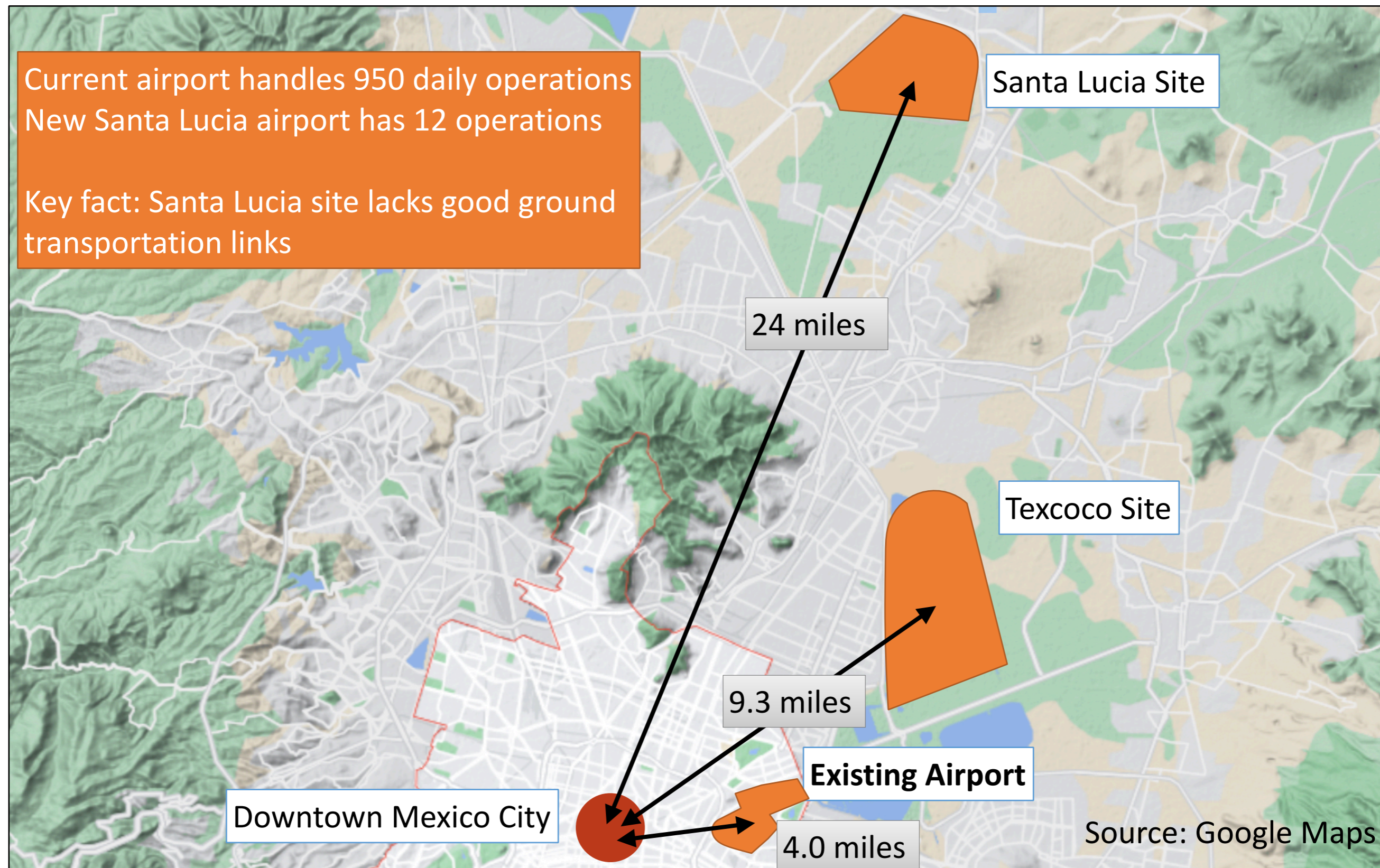
- New government proposed a “cheaper” alternative
- New airport built by expanding an existing military base in Santa Lucia
- New airport is named Felipe Angeles (NLU)
 - Current configuration has:
 - 28 contact gates (narrow-body)
 - 14 gates wide-body aircraft
 - ~6 billion dollars



Location of New Airport

Current airport handles 950 daily operations
New Santa Lucia airport has 12 operations

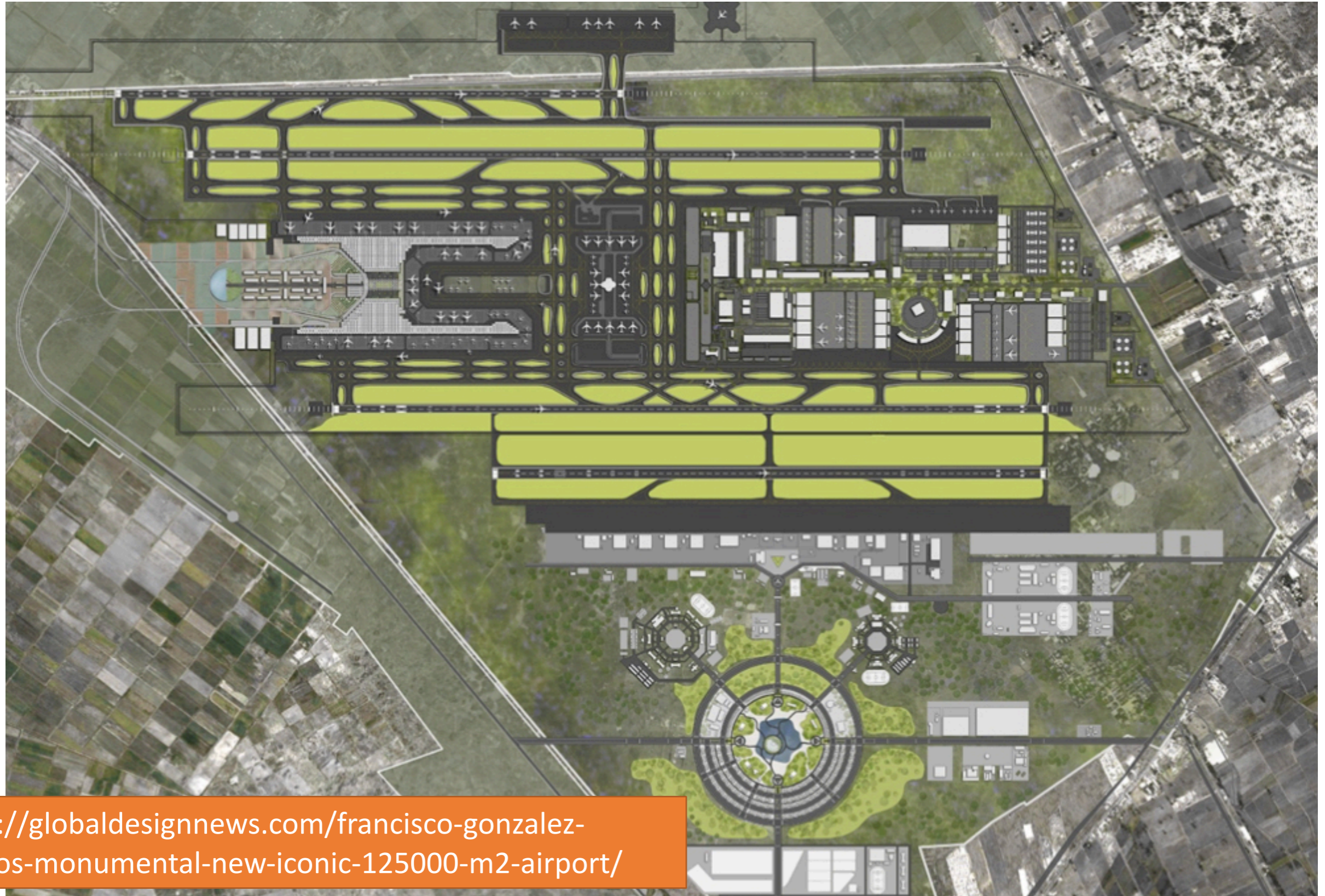
Key fact: Santa Lucia site lacks good ground transportation links



Source: Google Maps



New Airport in Santa Lucia Starts in 2019



<https://globaldesignnews.com/francisco-gonzalez-pulidos-monumental-new-iconic-125000-m2-airport/>



Existing New Airport (2022)



Source: SEDENA



Bottom Line

- Airport needs need to be assessed carefully
- Changing direction in large airport projects can be expensive and counter productive
- Location of the airport is important
- Provide fast ground transportation access to the airport (otherwise its use may not be acceptable to the public)