

Upgrading to World Class

The Future of the Region's Airports Revisited



Acknowledgments

This report highlights key recommendations from RPA's Fourth Regional Plan for the New York-New Jersey-Connecticut metropolitan area.

View the full plan at fourthplan.org

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Executive Summary

New York's airports are its international and long-haul domestic gateways. In 2017 they served almost 133 million passengers or over 360,000 daily air travelers. They make a first and lasting impression on business and leisure travelers, deliver time-sensitive cargo, and make it possible for the New York region to maintain its leadership in finance, media, tourism and other industries. In short, without its airports, New York would be unable to maintain its status as a global city.

Passenger aviation traffic last year at the three airports generated a total of \$33 billion in wages and \$92 billion in sales to the region and supported approximately 624,000 jobs.¹

Today, the region's three major airports rank 1st, 3rd and 4th for having the worst delays in the nation, a product of more flights than the region's constrained airports and airspace can handle. While delays at most airports in the nation average closer to 10 minutes, takeoff and landing delays at each of our airports exceed an average of 15 minutes per flight. This is an improvement over the average delays of 20 minutes reported back in 2011. These averages also mask the wide variability that can make flying times unpredictable and frustrating. Delays result in hours of lost passenger (or employee) time, costing businesses billions of dollars annually. The impacts of delays are not just felt by travelers but also by those dependent on their timely arrival. This is especially the case for business, where timeliness is essential. In response, some businesses now choose to fly out employees earlier, a day or more before, adding additional costs for room and board.

John F. Kennedy International (JFK), Newark Liberty International (EWR) and LaGuardia Airport (LGA), all operated by the Port Authority of New York-New Jersey (PA)² served over 132 million passengers in 2017 and account for most of the scheduled commercial airline operations in the region. JFK and EWR handle some of the largest volumes of air cargo in the world. The region is



also served by Teterboro (TEB), a business jetport, several smaller commercial service airports and dozens of general aviation facilities.

In 2011, Regional Plan Association published its comprehensive study, *Upgrading to World Class: The Future of the Region's Airports*, which recommended adding new runways at both EWR and JFK airports in order to increase their operational capacity to accommodate future demand. Guided by an Airport Stakeholders Group comprised of government agencies, business and civic organizations, the report looked at a wide variety of solutions, including improved technology for managing air space, diverting air passengers to Amtrak by improving intercity rail service, and making greater use of smaller regional airports. While all of these alternatives were shown to provide some incremental improvements in air capacity, taken together they would still not obviate the need for new runways at the region's major airports. The report also recommended better ways to get people to the airport, and provide a better experience when arriving and departing. RPA suggested several landside and ground access improvements, including a one-seat AirTrain ride from JFK to midtown Manhattan and a rethinking the central terminal area at EWR. These improvements were aimed at raising the standards at our airports to a level comparable to its peers, providing improved services for business (e.g. conference centers) and leisure (e.g. play areas for children) travelers.

This report, part of RPA's Fourth Regional Plan, adds to these findings and presents a more comprehensive vision of how the region's airport can build on current plans and transform service for decades to come. New analysis driving this vision includes the following:

- Updated ridership forecasts indicating even more growth than was predicted in 2011
- An analysis of the effects of climate change on the airports

¹ "Airport Traffic Report." The Port Authority of NY&NJ, 2017. http://www.panynj.gov/airports/pdf-traffic/ATR_2017.pdf

² The Port Authority of New York and New Jersey is a bi-state agency with responsibility for airports, ports, interstate water crossings and other transportation facilities within the core of the New York metropolitan area.



Photo: Port Authority of New York and New Jersey

- A new and comprehensive analysis of how both land-side and airside facilities can be redesigned to maximize capacity and customer service
- Ground access plans that provide direct rail transit service to all three major airports

Since 2011, airport traffic has grown even faster than predicted, and RPA's updated projections indicate an even more urgent need for new runway capacity — up to two new runways at JFK and one at EWR. To accommodate growth in traffic and larger aircraft all three airports will require additional landside and airside expansions. This means new and larger terminals, additional gates and apron space to park aircraft and improvements to ground access for public transit and automobiles.

To date, the PA has not indicated any ongoing work or plans to expand airfield capacity. Instead, the PA has begun to reconstruct the terminal facilities at LGA, which will increase airport efficiency so it can accommodate the forecasted growth of 4 million additional annual passengers and help reduce delays. In early 2017 Governor Cuomo released a vision for JFK that focused on terminal and ground access investments and recommended that the need for future runways be evaluated once the implications of the new air traffic control system are fully analyzed. However, the report did not reference earlier findings by RPA and the agency itself that new capacity will be needed even with successful implementation of new traffic control technology. The FAA has also since revised its rules for allocating slots at EWR, loosening restrictions on the number of flights per hour, in order to spur competition at that airport. The FAA has left the slot rules unchanged at JFK and LGA.

In addition to constraints on capacity, sea level rise (SLR) represents a growing threat to the region's airports. According to the New York City Panel on Climate Change, New York Harbor could see at least one foot of sea level rise

(SLR) by 2050, possibly as soon as the 2030s. Three feet could be realized by the end of the century, possibly as soon as the 2080s. Six feet of sea level rise is possible early in the next century.

The region's three major airports, plus its major business jetport (TEB), are impacted by sea level rise in varying degrees. TEB would be partly flooded at one foot and could be fully inundated with three feet of sea level rise. EWR and LGA weather three feet but are vulnerable to six feet. JFK is able to withstand both three and six feet, but — like all of these airports — will need to be hardened for future storm surges. TEB will likely need to be phased out over decades and its operations spread to other smaller general aviation airfields and the larger commercial airports. In the longer-term interventions will be needed to protect EWR and LGA, along with the adjacent seaports and interstate highway I-95. It would be catastrophic to the region's economy, its residents and businesses if our airport's vulnerability to sea level rise and storm surge events is ignored or if planning the planning necessary to protect them in the long-term is not high on the agenda.

RPA is recommending a \$50.8 billion investment to expand and transform both JFK and EWR airports over the next 30-40 years. This equates to a \$1.5 billion annual investment, roughly \$500 million more annually than the \$1 billion the PA is estimated to invest in its airports in 2017 (which is already projected to increase to \$1.17 billion in 2018). This will require new revenue, particularly an increase in the Passenger Facility Charge (PFC) that has not been increased since 2003. It may also require the airports to reinvest more of their revenue that now cross-subsidizes other Port Authority operations. The following summarizes select topline recommendations for each of the region's major commercial air passenger airports:

John F. Kennedy International Airport

Expanded Airside with Improved Terminals and Ground Access

- ▶ Two new runways to serve an anticipated 100 million air passengers by 2060 or sooner plus additional passengers shifted from LGA once TEB phases out operations.
- ▶ Consolidated central terminal area with four to six terminals
- ▶ Improved AirTrain 2.0 to serve public transit demand to the 2040's
- ▶ New one-seat ride service that would connect JFK to the regional transit system and provide capacity for growth beyond 2040 when both runways are constructed

Newark Liberty International Airport

Re-Oriented Airport Layout with Direct Access to Public Transit, Midfield Concourses and a New Runway

- ▶ Northeast Rail Corridor (NEC) terminal headhouse (the frontage of an airport where ground access connections are made, passengers check-in and go through security and baggage is handled), shifting the front door of the airport to the NEC and creating the region's premier intermodal facility that would be served by an extended PATH, RPA's proposed regional rail service connecting to all parts of the region and Amtrak.
- ▶ One additional new runway to serve up to 69 million annual air passengers by 2060, including displaced TEB business jet operations
- ▶ New midfield concourses (up to four) with secure-side AirTrain connection to the NEC headhouse
- ▶ Expanded southern cargo area
- ▶ Start planning on how to harden airport to survive up to six feet of SLR

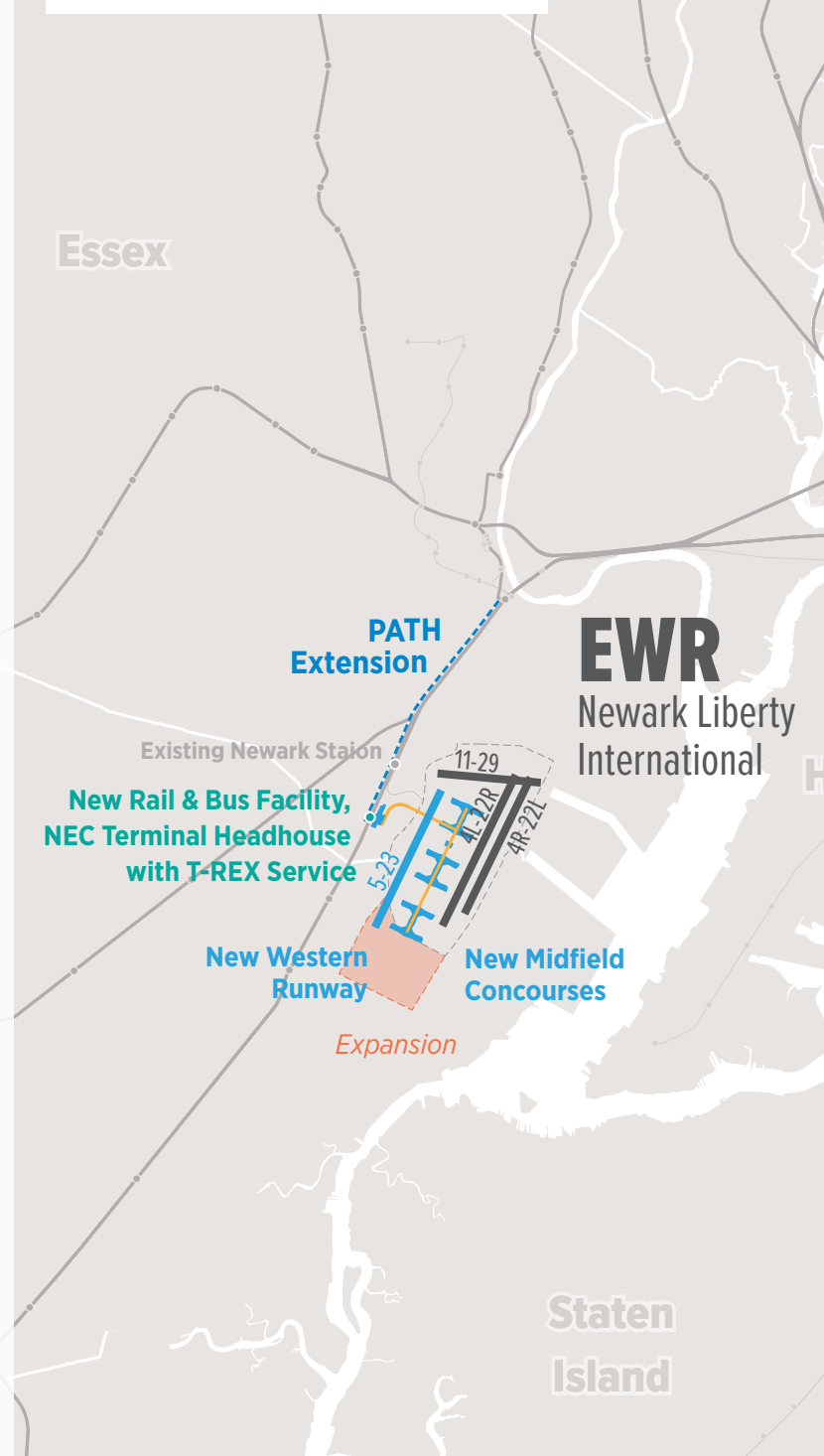
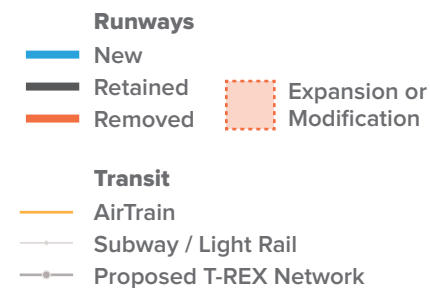
LaGuardia Airport

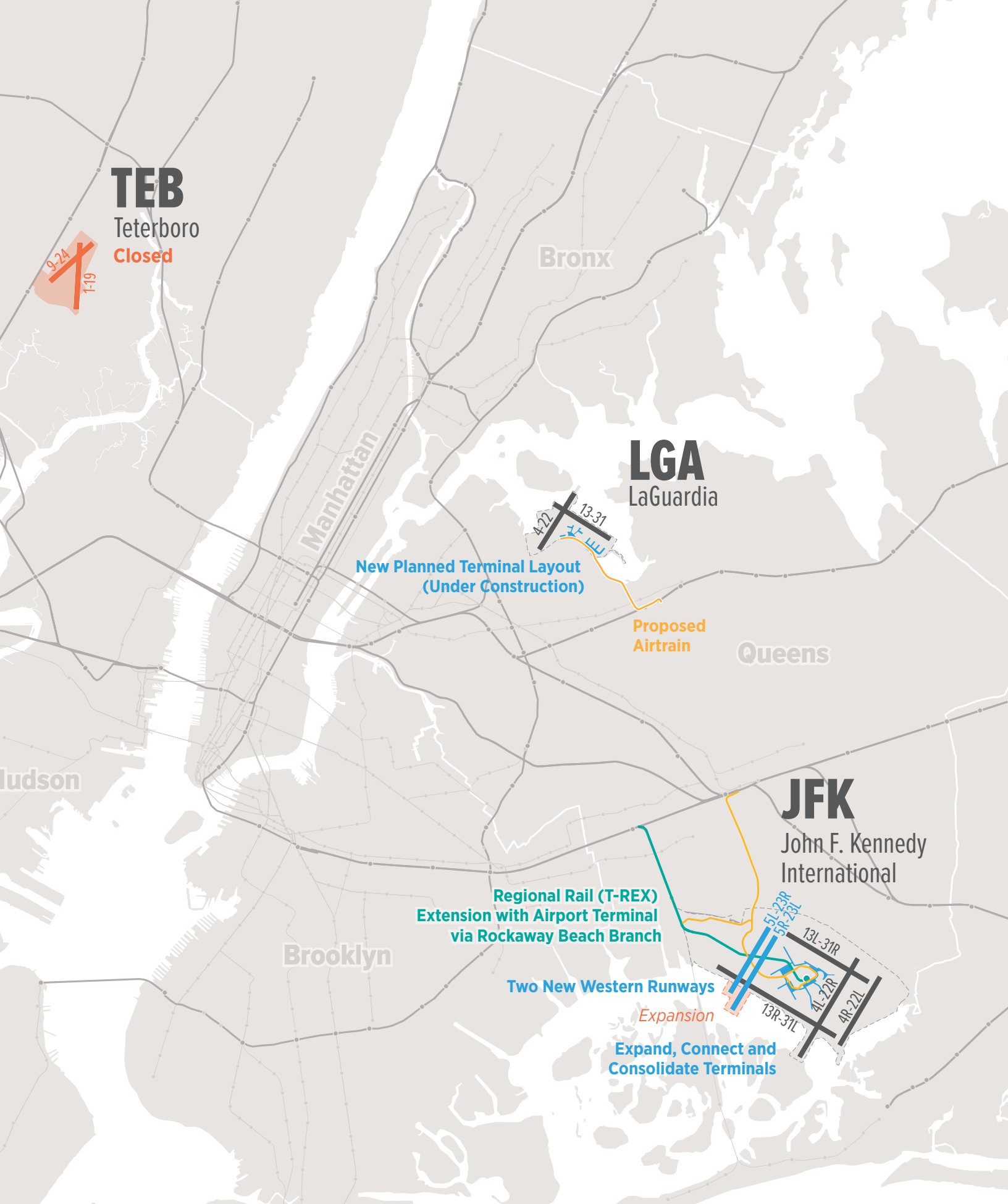
Improve Transit Access and Plan for Future SLR

- ▶ Alignment for new AirTrain connection to Willets Point designed to prioritize transfer with LIRR and future extension to Jamaica Station
- ▶ Monitor SLR developments and continue planning efforts to protect airport for over five feet of SLR and more extreme surge events

Figure 1: Summary of Recommendations

Source: RPA





TEB

Teterboro

Closed

Bronx

LGA

LaGuardia

New Planned Terminal Layout
(Under Construction)

Proposed
Airtrain

Queens

Hudson

JFK

John F. Kennedy
International

Regional Rail (T-REX)
Extension with Airport Terminal
via Rockaway Beach Branch

Brooklyn

Two New Western Runways

Expansion

Expand, Connect and
Consolidate Terminals

Introduction

Intercity travel is at the core of an increasingly interconnected and competitive global economy. Without the ability to efficiently transport business and leisure travelers and time-sensitive cargo, both domestic and international business would grind to a halt. Since virtually all long-distance travel is by air, along with a high proportion of shorter distance travel between cities, metropolitan economies depend on their ability to provide high quality airline service to multiple destinations. This is especially true for world city regions like the New York metropolitan area that are even more dependent on industries with a high propensity for flying. In New York, New Jersey and Connecticut, the leading economic sectors—financial and business services, tourism, pharmaceuticals, media and communications, higher education, research and development—all rely on frequent air travel to multiple destinations. Indeed, the region's status as a nexus for domestic and international air travel is intricately linked to its role as a premier center of global commerce.

In 2011 Regional Plan Association (RPA) published a report *Upgrading to World Class: The Future of the Region's Airports* concerning the future of the airports in the New York region. The impetus for this prior effort was rampant congestion and delays at our three major airports — Kennedy, Newark, and LaGuardia — that ranked them at the bottom among the nation's airports and threatened the region's economic vitality. In addition, the FAA had just imposed slot limits on hourly flights at all three airports. While slots were effective in reducing delays, they also placed a hard cap on air traffic growth and prevented airline competition, meaning fewer flight options and higher fares. Without growth in airport capacity, connectivity will degrade over time and without additional airline competition, prices for air travel will inevitably rise. The 2011 report cited the cost of delays at approximately \$1.7 billion annually for passengers and another \$1 billion cost to the airlines. Many other costs not easily measured also add to the economic impacts.

The objective of RPA's examination was to look at the prospective demand for air travel and how well it could be accommodated by the airports and the airspace system and what might be done in combination to lower demand or increase the ability to service it. At the time the report was issued passenger volumes were just beginning to emerge from the negative impacts of the Great Recession of 2007-

2009. RPA projected air passenger growth, converted it to operations at peak times at the three airports and compared it to runway capacity to determine how much added runway capacity at each of airports was needed to achieve different levels of delay reduction. Various actions were then explored to either reduce peak demand at the airports or expand capacity to narrow the gap between demand and supply. To reduce demand RPA examined a) the potential commercial role of other smaller airports in the region — principally Stewart International in Newburgh and Long Island MacArthur in Islip, b) the possibility of an entirely new airport in the region, c) the ability of improved high speed rail service to shift passenger demand to an alternate transportation mode, and d) pricing or other administrative measures to encourage a shift or travel to off peak times. Implementing technology-based capacity improvements in the air traffic control system—collectively known as NextGen — was also examined as such improvements could lead to more efficient and frequent landing and take-off operations.

The analysis concluded that many of these measures would incrementally help to narrow the gap between supply and demand, but the gap would not close without the addition of runway capacity at the three airports. Further, RPA developed some potential alternatives to develop additional runways at Kennedy and Newark airports and also concluded that there were no practical or feasible additional runway opportunities at LaGuardia.

Subsequent to the release of the report six years ago, the Port Authority of New York and New Jersey (PA), the operator of the three major airports, sought to confirm the results of our work, and if its findings were consistent with ours, investigate in more detail how additional runway capacity could be constructed at JFK and EWR. To date that work has not been completed and no plans to expand capacity have been generated by the agency. Instead, the PA has begun to reconstruct the terminal facilities at LGA. While this will improve service and the customer experience, it will have only a marginal impact on airside capacity. The PA is expected to announce plans soon for JFK that may or may not address the need for additional runways.

Figure 2: Diagram of the Region's Airports
Source: RPA

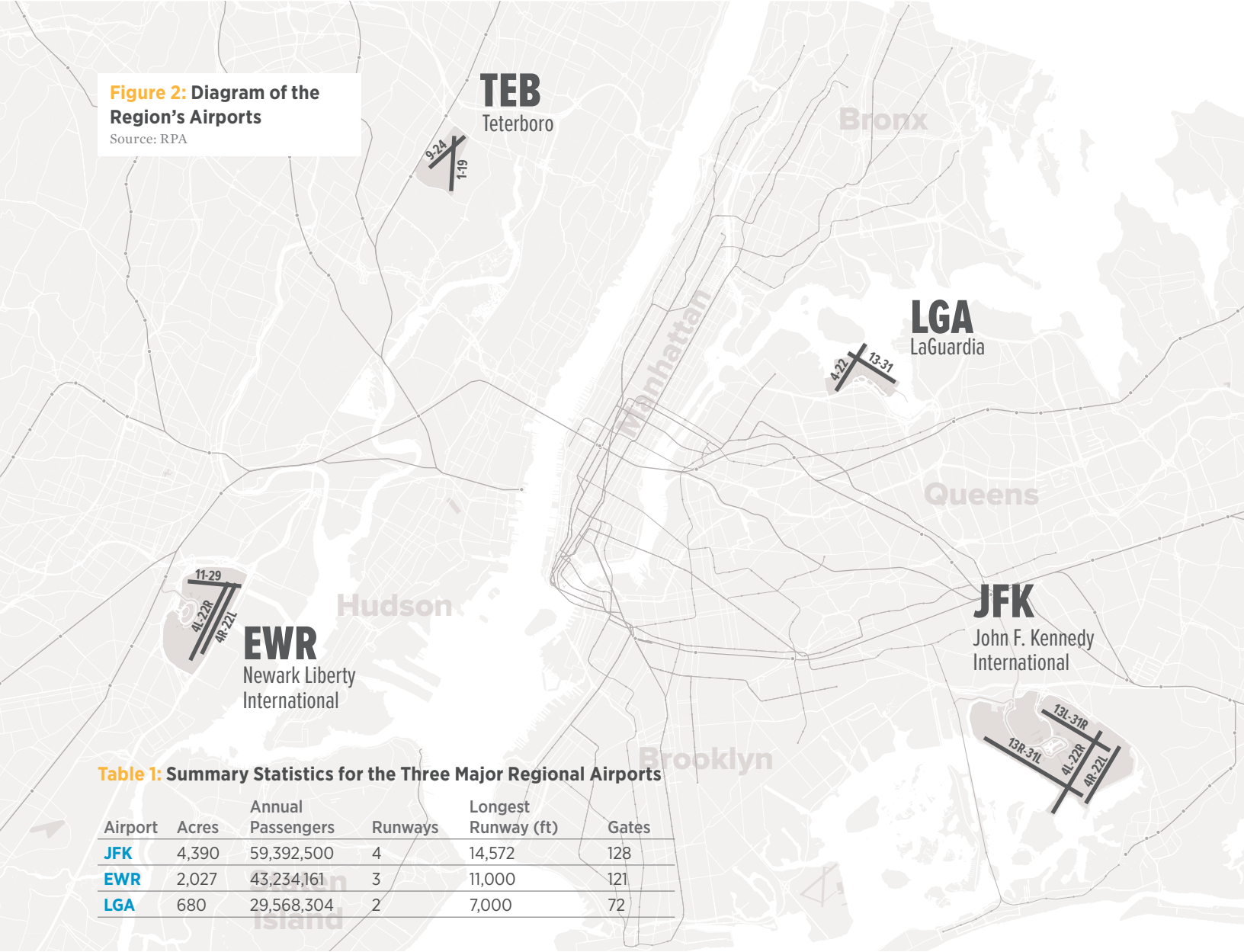


Table 1: Summary Statistics for the Three Major Regional Airports

Airport	Acres	Annual Passengers	Runways	Longest Runway (ft)	Gates
JFK	4,390	59,392,500	4	14,572	128
EWR	2,027	43,234,161	3	11,000	121
LGA	680	29,568,304	2	7,000	72

In light of these developments and as part of its Fourth Regional Plan, RPA has revisited the analysis and findings of its 2011 study, updating it with recent air passenger and operations data and other developments that may have occurred in the interim. This study also takes a fresh look at improvements at all the region's airports with a focus, once again, on the big three commercial air passenger facilities.

Improving New York's connectivity to other cities is essential to maintaining New York's competitive position in today's global economy. The region's airports are the "front door" to New York; they must serve air travelers without inordinate delays and meet the need for anticipated growth. There is increasing concern that without sufficient capacity at the region's commercial airports, FAA slot limits along with other constraints would engender reluctance among existing businesses to remain in the region or grow here, discourage businesses contemplating locating in the

region, and reduce tourism. In addition, existing delays and low levels of air service reliability would continue making air travel even less desirable for residents of the region.

Profiles of the Region's Airports

Most of the New York region's residents and businesses rely on the Port Authority of New York and New Jersey's (PA) three commercial airports — John F. Kennedy International (JFK), Newark Liberty International (EWR) and LaGuardia Airport (LGA).¹ These three airports served over 132 million passengers in 2017 and accounted for most of the scheduled commercial airline operations in the region. The three major airports have only a limited

¹ The Port Authority of New York and New Jersey is a bi-state agency with responsibility for airports, ports, interstate water crossings and other transportation facilities within the core of the New York metropolitan area.

general aviation function; however, John F. Kennedy International and Newark Liberty International airports are among the largest, by volume, air cargo facilities in the world. The region is also served by Teterboro (TEB), a business jetport, several smaller commercial service airports and dozens of general aviation facilities.

John F. Kennedy International Airport (JFK)

At 4,390 acres JFK is the largest airport in the region. It is also the busiest, serving 59 million passengers in 2016. In the past JFK was the primary international gateway to the region, and it still carries almost two-thirds of the region's international passengers, with EWR carrying nearly all of the others. It is also a major domestic hub serving as a dual domestic-international hub for both JetBlue and Delta Air Lines.

The airport has four runways (two sets of parallels aligned perpendicular), including the longest in the region at 14,511 feet, and six terminals, with 133 gates, the most in the region. There are 14,370 parking spaces at the airport. On a typical day in 2015 there were 1,202 flights (arrivals and departures); 94% commercial, 3% cargo and 3% general

aviation. In 2008 the United States Department of Transportation (USDOT) capped scheduled traffic at 81 operations per hour per 16-hour period, in an attempt to limit delays.

Newark Liberty International Airport (EWR)

Newark is the second largest (2,207 acres) airport in the region and predominantly serves air passengers starting or ending their trips west of the Hudson River. In 2017 over 43 million passengers chose Newark, with a growing number of flights destined for international markets. EWR is the domestic hub for United Airlines, which operates Terminal C — the largest terminal at the airport.

The airport has three runways (two closely spaced parallels plus one intersecting) the longest measuring 11,000 feet, and three terminals, 104 gates, and 15,291 parking spaces, the largest number in the region. On a typical day in 2015 there were 1,133 flights (arrivals and departures); 91% commercial, 5% cargo and 3% general aviation². As at JFK, in 2008 the USDOT capped peak-hour scheduled traffic at 81 operations but has since removed the restriction by classifying the airport as a Level 2 facility, effective October 2016. Level 2 airports are not limited by hourly operations, called slots, nor are the slots allocated to specific carriers through an auction process or trading. Under Level 2 status, carriers coordinate flight schedules with the FAA (which must approve them) to limit congestion on the airfield.³ However, the FAA has stated that they will limit flight operations to no more than 231 per three-hour period, which is effectively 77 flights per hour.

LaGuardia Airport (LGA)

LaGuardia opened in 1939 and was the first modern airport in the region. It is the most land constrained airport of the three major airports, with a footprint of only 680 acres. In 2017 LGA served nearly 30 million passengers, most of them on domestic flights; Canada and the Caribbean are the only international destinations served and passengers are pre-cleared. LGA does not have a customs facility. The airport has two intersecting runways that are only 7,000-ft long and four terminals; the Central Terminal Building is the largest containing half of the airport's gates. On a typical day in 2015 there were 1,170 flights (arrivals and departures), 97% commercial and 3% general aviation. In 2008, the USDOT capped peak-hour scheduled traffic was reduced to 74 (71 commercial and up to 3 general aviation slots) flights. Airlines were encouraged, but not required to return unused slots to the FAA, but few did so. LGA had served up to 75 commercial flights per hour during the peak, and still does for much of the day.

Table 1A summarizes the major characteristics of the airports, giving a sense of their scale individually and combined.

² An additional 2% are commuter flights

³ "FAA Orders Voluntary Slot Controls at San Francisco." *Airports Council International — North America*, accessed January 30, 2018. <http://www.aci-na.org/content/faa-orders-voluntary-slot-controls-san-francisco>.

Airports & the Regional Economy

In January 2015, the FAA published *The Economic Impact of Civil Aviation on the U.S. Economy*. According to this study, in 2012, civil aviation generated \$1.9 trillion in sales and wages and supported about 11.8 million jobs throughout the country.¹

RPA's 2011 report noted that passenger aviation traffic (in 2009) at the three commercial airports in our region generated a total of \$16.8 billion in wages and \$48.6 billion in sales to the region and supported nearly 415,000 jobs. Since 2009, the economic impact of the three commercial airports has increased to \$30.7 billion in wages, \$85 billion in sales and over 590,000 jobs.² This economic impact falls in three categories:

- ▶ Operating impact of the aviation industry: on- and off-airport services rendered to passengers.
- ▶ Economic impact of air visitors to the region, including tourists and business travelers.
- ▶ Economic impact from investment in airport infrastructure.

¹ "The Economic Impact of Civil Aviation on the U.S. Economy: Economic Impact of Civil Aviation by State." *Federal Aviation Administration*, January 2015. https://www.faa.gov/air_traffic/publications/media/2015-economic-impact-report.pdf.

² "Airport Traffic Report." *The Port Authority of NY&NJ*, 2015. http://www.panynj.gov/airports/pdf-traffic/ATR_2015.pdf

Figure 3: Map of the Region's Commercial Airports and Teterboro — the Region's Business Jetport

Source: RPA

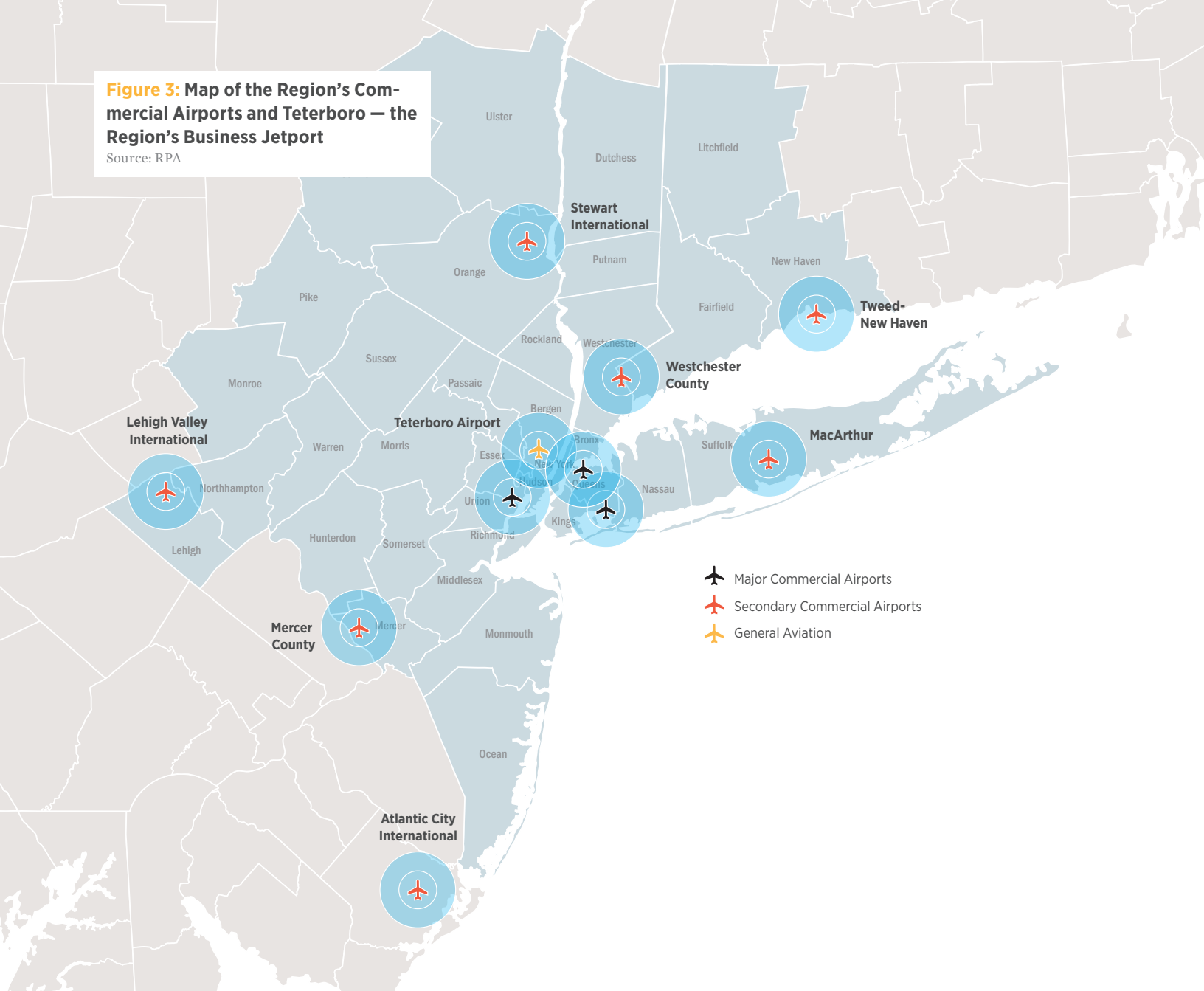


Table 2: Summary Statistics for Teterboro and Smaller Commercial Airports in the Region (2015)

Airport	Acres	Annual Passengers	Runways	Longest Runway (ft)	Gates
Atlantic City International (ACY)	5,000	1,207,273	2	10,000	10
Lehigh Valley – Allentown International (ABE)	2,629	688,505	2	7,599	9
MacArthur – Islip (ISP)	1,311	1,192,000	4	7,006	17
Stewart International (SWF)	2,400	275,431	2	11,817	7
Teterboro (TEB)	827	N/A	2	7,000	N/A
Trenton – Mercer (TTN)	1,345	553,000	2	6,006	2
Tweed – New Haven (HVN)	394	57,000	2	5,600	2
White Plains – Westchester County (HPN)	708	1,506,000	2	6,549	6

Sources: Port Authority, FAA ATADS, Bureau of Transportation Statistics and National Based Aircraft Inventory Program

Smaller Commercial and General Aviation Airports

There are 67 other airports in or near the region with seven — Stewart International (the PA took over Stewart’s lease in 2007), White Plains-Westchester County, MacArthur-Islip, Tweed-New Haven, Atlantic City, Trenton-Mercer and Lehigh Valley-Allentown — having some scheduled passenger airline service. Additionally, Teterboro Airport, the region’s business jetport operates in the same airspace as the three major commercial airports and Teterboro serves much of the business/corporate jet and general aviation traffic for New York City.

Many of the smaller commercial airports have relatively few passengers per year compared to the major commercial airports, which each serve between 27–59 million passengers annually (Table 2). In addition, most of the smaller commercial airports have lost air service and passengers during the past six years, whereas the three major airports have experienced record traffic. The region’s smaller airports have little to no access for travelers arriving at the airport by any other means than driving or taxi services. However, in some cases this is improving. In 2017 Coach USA began running a new express bus service between Stewart International and the Port Authority Bus Terminal, a trip that takes approximately 80 minutes.

Ground Access Today

Most air passengers still access the region’s airports using automobiles — both private and for-hire vehicles. However, since RPA’s 2011 report the number of those who use transit to travel to the airport has been on the rise. The largest increase has been at JFK with its transit share doubling over the past seven years to 32% from 16%. The airport continues to see dividends from its investment in a robust AirTrain solution, which is a popular option for the growing numbers air passengers that have been drawn to the low cost carriers at JFK. LGA saw its transit share (bus) increase by 7%, driven by the introduction of two new Select Bus Service (SBS) routes — the M60 and Q70. Conversely, transit use to EWR decreased, with fewer air passengers using rail to access the airport today than back in 2009 — 10% in 2016 compared to almost 14% seven years ago. This decline is likely the result of infrequent NJT and Amtrak service to the airport’s NEC rail station and EWR’s unreliable and limited capacity AirTrain. Nevertheless, the numbers clearly indicate that investments in transit improvements to better connect the airports have resulted in shifting air passengers out of private automobiles.

Table 3: Ground Access Mode Share of JFK, LGA and EWR, 2016 PANYNJ Survey

	JFK	LGA	EWR
Transit	32%	18%	15%
Rail	30%	-	10%
Bus	2%	18%	5%
Auto	37%	25%	49%
Shuttles/Taxis/TNCs	31%	57%	35%

Source: PANYNJ Passenger Ground Access Survey 2016

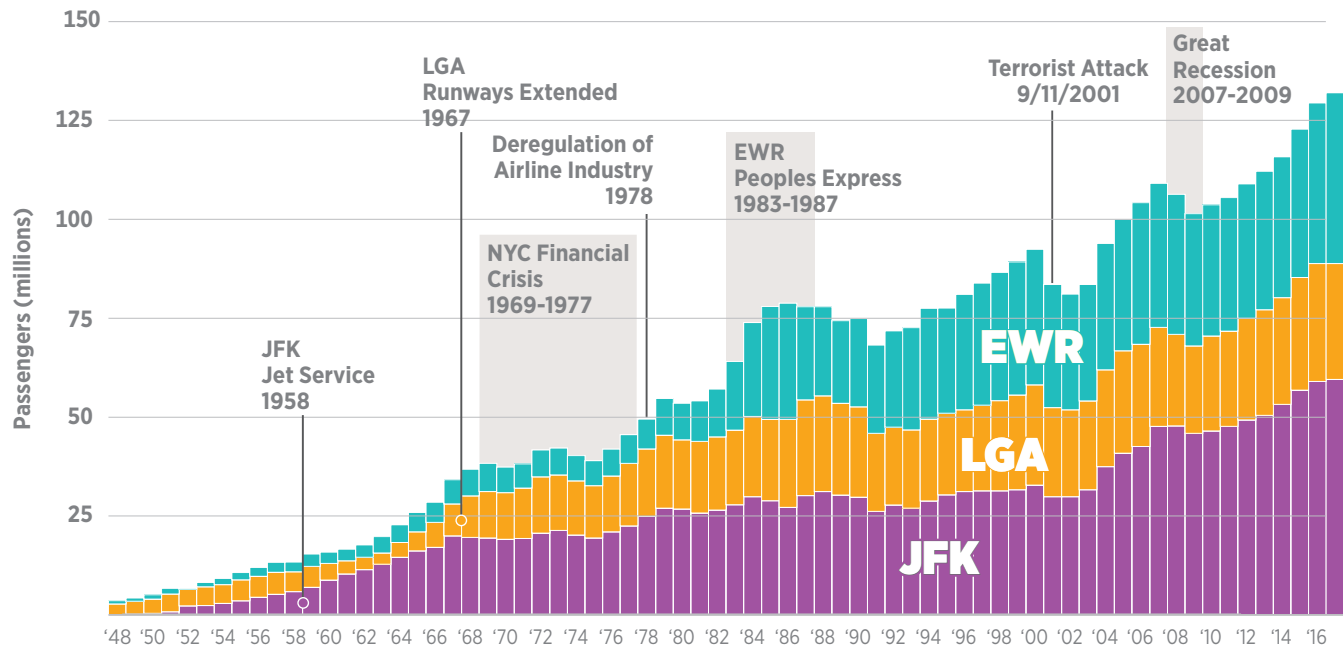
More troubling is the roadway network that serves the three major airports, especially the highways feeding JFK and LGA. The Grand Central Parkway adjacent to LGA and the Van Wyck Expressway that serves as JFK’s highway artery both suffer from chronic congestion. They are unreliable and have little space to grow⁴. NYSDOT is currently planning to widen the Van Wyck, setting aside over \$500 million in the State’s FY18 budget to begin the planning and design process. However, widening the Van Wyck alone will only marginally improve access to the airport due to the induced local area circulation that will consume much of the new capacity. To date, both existing highways, are mostly unmanaged and little has been done (or is planned to be done) to apply modern “Managed Use Lane” techniques to try to reduce congestion. While EWR is in a better position because of the number of roadways — Routes 1/9, I-78 and I-95 — that serve it, the interchanges and segments of the roads adjacent to the airport (and seaport, which bookends I-95) perform poorly and are considered bottlenecks in the larger network.

Highway congestion is problematic for airport passengers, most of whom rely on them to access the airport and also for goods movement. Aside from serving passengers, EWR and JFK are major cargo airports. Increased congestion threatens the ability of these airports to reliably serve the air cargo demand of the New York market. Parcel service at EWR demands reliable and quick access to Fortune 500 companies in midtown Manhattan and air freighter deliveries at JFK require that it has routes that support larger trucks (53-footers) for oversized loads and to lower costs through economies of scale. Managing congestion and creating priority for goods movement is an area that needs to be explored further at all three airports.

⁴ JFK airport is also served by the JFK Expressway a short segment of highway that provides a redundant connection with the Belt Parkway. It was originally planned to extend north to the Clearview Expressway and Throgs Neck Bridge, providing a parallel route to the Van Wyck Expressway.

Accommodating Increasing Demand & Staying Competitive with Global Peers

Figure 4: Air Travel Demand at New York Airports: 1948 to 2017



Source: PANYNJ, RPA

The Demand for Aviation

In 1948, the three major airports in the New York-New Jersey-Connecticut metropolitan region¹ — LaGuardia (originally known as New York Municipal Airport), New York International (commonly known then as Idlewild and now JFK International or JFK), and Newark (now Newark-Liberty International or EWR) carried 3.6 million passengers per year, or about 1,000 a day.² Most of this traffic was at LGA; JFK had opened for commercial service only that July (1948).

In the seventy years that followed, combined traffic at the three airports increased by a factor of 36, a rate far surpassing population growth in either the region or the United States. By 2017, over 132 million passengers, an average of over 360,000 per day traveled through these three airports.

This phenomenal growth has been fueled by many factors:

- ▶ the expansion of incomes that makes air travel more affordable;
- ▶ the development of faster and more comfortable jet aircraft with greater flying range to serve more places;
- ▶ air fares that grew much more slowly than the rate of inflation, owing in part to deregulation of the airline industry starting in 1978;
- ▶ the growing national economy;
- ▶ a growing immigrant population which retains ties to its homelands, and globalization of the world's economy.

¹ The region is defined by Regional Plan Association as the 31-county, three-state, metropolitan area centered in New York City and extending to central Connecticut, all of Long Island, the Hudson Valley to include Dutchess and Ulster counties, and to central and western New Jersey.

² In this report these three airports will be referred to as JFK, LGA and EWR, using the official three-letter airport designations.

Figure 4 depicts the growth of passenger traffic at the three major airports individually and collectively. The growth has been relentless, but uneven.

A History of Delays

This crucial link between air travel and economic prosperity is threatened by a lack of adequate capacity in the region's aviation system, including air space, airports and landside connections. Today, this is manifested in flight delays that exceed those of every other major airport in the United States. These delays cost the region hundreds of millions of dollars each year in lost wages and business income. In the future, without additional capacity the impacts will be far more severe. While delays cost valuable time and can inhibit some from flying, having too few flights to handle demand will prevent millions from flying and cost the region thousands of jobs and billions of dollars.

Strained capacity at the airports is more than a local problem. Delays at the region's three major airports—JFK, EWR and LGA, hubs for all of the “Big 4” U.S. airlines—ripple through the national aviation network causing delays from Washington, D.C., to Los Angeles, CA. Constraining the New York region's capacity for air travel growth would also weaken the nation's ability to compete for global business in finance, media and other industries for which New York is United States' leading international center.

Solutions will require a coordinated strategy by a number of public and private sector participants, including the PA, which operates the three airports, the Federal Aviation Administration (FAA), which regulates and controls the nation's airspace, the private airlines that operate terminals and schedule flights, and the city and state agencies responsible for the roads and transit network connecting to the airports.

Today, the region's major airports rank 1st, 3rd and 4th for *worst* delays in the nation, a product of more flights than the region's constrained airports and airspace can handle. In 2014 Memphis International Airport ranked 2nd for airport delays at the nation's major airports, overtaking Newark and JFK airports.³ While delays at most airports in the nation averaged closer to 10 minutes, takeoff and landing delays at each of our airports exceeded an average of 15 minutes per flight. These averages mask the wide variability that can make flying times unpredictable and frustrating. To limit the delays created by the excessive flights scheduled during peak times, the FAA placed a cap on hourly flights at all three major airports in 2008⁴, but earlier this year removed the caps at EWR, for the prime reason noted by most industry experts, to spur competi-

³ “FAA Operations & Performance Data.” *Federal Aviation Administration*, accessed January 30, 2018. <https://aspm.faa.gov/>. 35 major airports delayed as per flight plan.

⁴ Peak hour flight caps were in place at LGA since 1968

tion at that airport. This continuation of caps limits the ability of the remaining two airports to meet current or projected growth. To date, planned and proposed investments have focused solely on terminal, apron and taxiway improvements which only marginally reduce delays, but have increased the ability of the airports to service some additional passengers. Substantial delay reduction will require improving how the airspace is managed (Next Gen) and new airside capacity (runways).

Seven Years of Rising Demand: Many More Passengers but Not More Aircraft

Since RPA's 2011 report, delays have actually declined from an average of 20 minutes to closer to 15 minutes, except at EWR which experienced higher delays since its cap was lifted as described above. There are several reasons for this decline in delays including on-airport improvements (Delay Task Force) and introduction of NextGen technologies/techniques, but by far the biggest factor is better load factors and the deployment of larger aircraft by key airlines. The airlines have only added a few more flights to their schedules but they are carrying many more passengers; flights are up only 4% since 2009 while passenger volumes increased by 19%. Partially in response to the limited runway capacity⁵; the airlines are seeking to extract more passenger capacity from a limited number of flights.

It is reasonable to assume that the number of passengers per flight will increase at a lesser pace in the future than it has over the last five years. Two of the three factors behind the recent trend are not repeatable. First, airlines reconfigured aircraft seating to increase the number of seats on many aircraft. Second, the airlines improved their revenue management software to increase the percentage of seats sold and filled on each flight. The only remaining tool the airlines have to increase passenger capacity is to fly larger aircraft on each flight. Buying and flying larger aircraft is a far more expensive solution than adding seats or upgrading software⁶.

Using larger aircraft does not work in smaller markets, where there is insufficient demand to fill them. With limited capacity, these smaller markets will tend to, first, experience a loss in air service frequency and then lose all of their air service to New York, as airlines use larger aircraft to serve the growing demand from larger markets. Over time, the total number of non-stop markets served

⁵ Airlines have also put more seats on aircraft and increased load factors in order to reduce unit costs.

⁶ Airlines could also reallocate larger aircraft from other hubs, but only at the cost of providing capacity at these other stations, which presumably are also growing. At best, this is only a short-term strategy.

from the region's airports and/or daily frequency of flights in markets will decline, leading to a decline the region's connectivity will decline. Further, the continuation of slot regulations at the airports will inhibit the entry of new airlines into the New York market, and prices for air travel will inevitably rise. Both of these trends will erode the region's competitive stature with other world economic centers that have chosen to invest in expanding the capacity of their air transportation infrastructure.

The implications of slowing the trend towards having more passengers per flight for the New York metropolitan region are profound. The region's leaders and its major airport operator, the Port Authority, must confront the choice between increasing airport capacity or accepting a future with less economic growth.

Projecting Future Demand for Air Travel in the Region

Since 2009 in the nadir of the Great Recession, air passenger traffic volumes at the three major airports have grown rapidly; between 2009 and 2016 traffic has risen by 27 million passengers, an annual average growth rate of 3.4%. These spurts of growth following periods of stagnation are not new, with similar patterns observed in the late 1970s,

the late 1980s and after 2001, as Figure 5 shows. In the long run, however, these dips and spurts tend to even out and a pattern of consistent growth becomes the norm.

These trends are used for projecting growth by isolating domestic and international travel of air passenger growth for two time periods, the 39 year history from 1977 to 2016 and a shorter period from 1996 to 2016. This was done by tracking the trends for both domestic and international travel for the two periods. The results are shown overlaid on Figure 5. The slopes in the equations of best fit represent the average annual increase in passengers. These four charts are used to estimate the domestic and international annual volume of passengers in 2020, 2030, 2040, 2050 and 2060 shown in Table 4 using the two sets of trends. Also, shown for comparison is the range of estimates used in the 2011 RPA report.

The shorter 20-year period for the projection yields a higher increment of growth of 985,000 domestic passengers and 1,066,000 international passengers, while the longer 39-year period produces 812,000 more domestic and 856,000 more international passengers. Each of these long term trends were projected forward to 2020, 2030, 2040, and 2050 and the results are presented in Table 5. With the higher 20-year relationship by 2030 the three airports

Figure 5: Total Air Passengers All Three Airports, 1977 to 2016 and Projected to 2020 to 2060

Source: PANYNJ, RPA Analysis

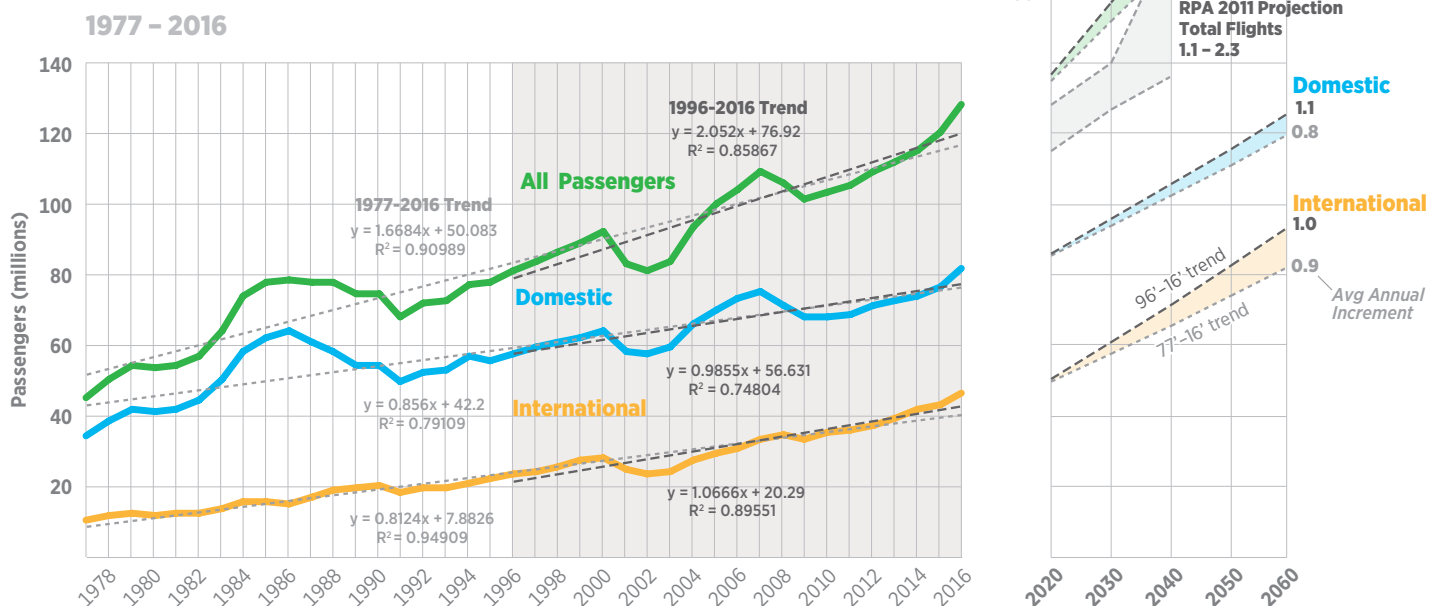


Table 4: Trends and Projections — Domestic and International MAP Passengers

	1977 to 2016			1996 to 2016			2011 RPA Report
	Domestic	International	Total	Domestic	International	Total	
Annual Increment	0.9	0.8	1.7	1.0	1.1	2.1	1.1–2.3
2020	85.4	49.5	134.8	85.9	50.5	136.4	115–128
2030	93.9	57.6	151.5	95.7	61.2	156.9	127–140
2040	102.5	65.7	168.3	105.6	71.8	177.4	136–175
2050	111.1	73.8	185.0	115.4	82.5	197.9	NA
2060	119.7	82.0	201.7	125.3	93.2	218.4	NA

Source: RPA

Table 5: Projections of Passengers (MAP): RPA Low, RPA High and PANYNJ

		EW R	JFK	LGA	Total
RPA Low	2030	48.3	70.0	33.2	151.5
	2040	53.6	78.3	36.4	168.3
	2050	58.9	86.5	39.5	185.0
	2060	64.2	94.8	42.6	201.7
RPA High	2030	50.0	72.9	33.9	156.9
	2040	56.5	83.3	37.6	177.4
	2050	63.0	93.7	41.3	197.9
	2060	69.4	104.1	44.9	218.4
PANYNJ	2033	58.0	82.5	34.1	174.6

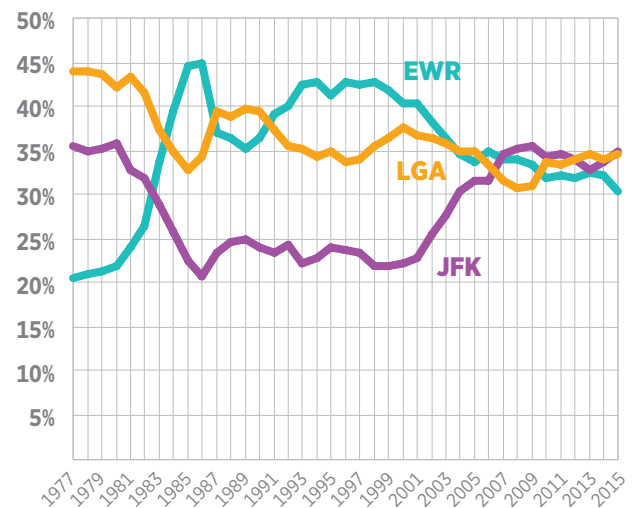
Source: RPA and Port Authority

Note: The PANYNJ projections for 2033 tend to be somewhat higher than RPA's high estimates. For EWR their 2033 projection is higher than RPA's 2040; for JFK the PANYNJ projection for 2033 falls later in the decade of RPA's projection. The LGA projection by the PANYNJ lands just about right in the RPA range for the 2030s.

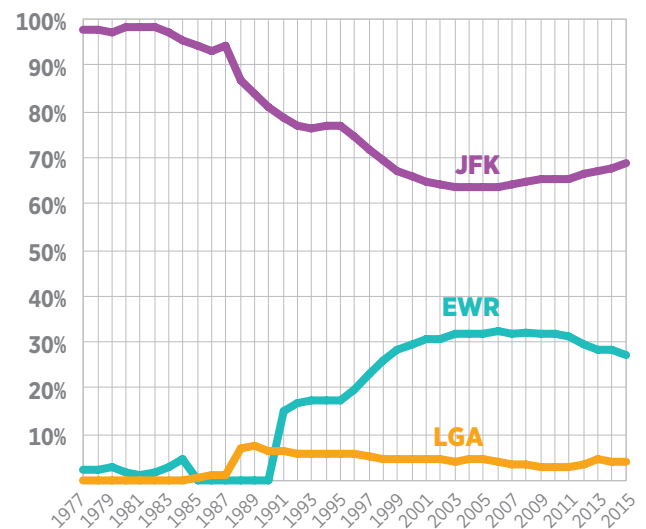
will serve about 157 million annual passengers (MAP) and by 2040, 177 MAP. The 39-year trend produces somewhat lower estimates, 152 MAP and 168 MAP. If these trends prevail, about 185 to 198 MAP would be reached by 2050, and over 200 MAP or more would be reached by 2060. The estimates in the 2011 report were somewhat lower than the current projections in the short term, not having included the extraordinary rapid rise that has occurred in the last few years. However, by 2040 at the high end of the range they produce and estimate similar to the 1996 to 2016 trend.

The next step is to determine how the projected growth might be shared among the three airports. Past trends of these shares for domestic and international travel are shown separately in Figures 6 and 7.

Domestic shares among the three airports have stayed relatively even in the last few years with a slight upturn for EWR. It is reasonable to assume that the average splits for the last ten years for domestic and international trips will remain in the future. For domestic passengers the split is 0.328/0.341/0.331 for EWR/JFK/LGA, respectively. The international traffic divides 0.305/0.659/0.035. In absence of rule changes regarding distance restrictions at LGA, the assumption is made here that these splits will hold. Table 5 shows the projected number of passengers at each airport assuming these splits. The Port Authority's 2015 passenger

Figure 6: Historic Shares of Domestic Passengers by Airport — 1977 to 2015

Source: PANYNJ and RPA

Figure 7: Historic Share of International Passengers by Airport — 1977 to 2015

Source: PANYNJ and RPA

projections⁷ for each airport for each year to 2033 are also shown in Table 5, for comparison purposes with RPA's projections.

To be useful for analysis of the adequacy of runway capacity, these projected passenger volumes must be converted to annual operations (flights) using the assumed ratios of passengers per aircraft for each airport for the projection years. Several developments involving airline fleet planning inform the following projections of passengers per flight. After consulting with aviation experts and reviewing press releases of aircraft procurements and other publically available material, it's clear that the trend to greater seats per aircraft will continue in the short-term, but cannot continue indefinitely. Several airline fleet management changes were identified as examples of decisions that will impact the long-term mix of aircraft, many of these suppressing the growth of passenger to aircraft ratios:

- ▶ American has retired their smaller 140-seat MD-80 aircraft and replaced them with B-737 or A320 series aircraft with 160-187 seats each.
- ▶ Delta is likely to continue deploying a large portion of its newly-acquired 110-seat B717 fleet to short and medium haul, high-density routes, many of which originate in the New York/New Jersey region. Longer term, Delta has ordered Bombardier CS100 series aircraft as more fuel efficient, similar sized aircraft to the B-717. These aircraft will be deployed on routes currently served by large (70-90 seat) RJ aircraft such as the ERJ-175 or the C900.
- ▶ Delta has indicated that it will retain B757 aircraft for "hot and high" markets and long-haul markets served from airports with shorter runways such as LGA. Such aircraft will be especially useful if the LGA Perimeter Rule is eliminated or relaxed and airlines are able to operate nonstop from LGA to the West Coast or deep into the Caribbean.
- ▶ American will retire the majority of its B757s, but has orders for 100 similarly-sized A321neo with similar range and improved fuel efficiency.
- ▶ Low cost carriers such as Southwest, JetBlue, Frontier, and Spirit are adapting their future fleet plans to higher-capacity variants of their fleet families in an effort to reduce per-seat unit cost. Southwest is increasing the ratio of 175-seat 737-800 aircraft over 143-seat 737-700s. Similarly, JetBlue has focused its future Airbus delivery plan on 190-200-seat A321s rather than their mainstay, the 150-162-seat A320.
- ▶ Airlines plan to retire their 35 to 50 seat RJ aircraft over the next ten years. That said, Delta has indicated that there will always be a few markets where a 50 seat

aircraft will be needed. These 35 to 50 seat aircraft will mostly be replaced by larger 2-class RJ aircraft such as the CRJ-700/900 and the ERJ-170/175.

These fleet plan announcements were supplemented with aircraft order information from aircraft manufacturers to gauge which aircraft will be entering the fleet with each airline⁸. Currently, the majority of the aircraft fleet serving the three major airports is FAA classified "large" aircraft, Boeing classes smaller than the Boeing 757 and Airbus classes smaller than the A380. At EWR 76% of the aircraft served is classified as large aircraft, 93% at LGA and 63% at JFK.⁹

Partially offsetting these trends of retiring/replacing smaller aircraft, the existing fleet is expected to increase due to rising seat density by refitting aircraft with "slim-line" seat. Delta, United, American and JetBlue indicate that per aircraft seating capacity will increase by 5% to 10% due to "slim line" seats, depending on the aircraft type.

Beyond ten years, the phase-out of 35-50 seat aircraft and the deployment of thin seat technology will be largely complete. At this point, the increases in seating capacity will revert to the trend established solely by using larger aircraft.

Based on our analysis, it is assumed here that the trend of using greater capacity aircraft will persist for about another next decade, tapering off by 2025. The assumed passengers per flight for the three airports for domestic and international flights at the three airports are shown in Table 6.

With the estimate of passenger shares at each airport applied to domestic and international passengers, the demand can be converted to operations by projecting the ratio of passengers per operation. This ratio is, once again, determined by the average seating capacity of the aircraft flown by the airlines and the percent of the seats filled, i.e. load factors. The scarcity of runway capacity will cause the airlines to implement policies and services that will influence these two factors. If there is limited runway capacity the airlines will tend to purchase and operate larger aircraft and will market them to fill every seat possible. This is not to the advantage of the flying public and to the economy of the region because it limits departure choices. Moreover, as noted earlier, some smaller markets would see far less frequent service or be squeezed out altogether in favor of larger more lucrative destinations, resulting in fewer destinations served directly with non-stop service. The markets sacrificed will likely be the mid-sized ones in the USA and overseas.

⁷ "Port Authority of NY and NJ, 14 Code of Federal Regulations (CFR) Part 150 Airport Noise Compatibility Planning Studies." *The Port Authority of New York & New Jersey*, accessed January 31, 2018. <http://panynjpart150.com>. Appendix F for each airport (LGA & JFK).

⁸ Ibid.

⁹ "Airport Capacity Profiles." 2014. *Federal Aviation Administration*, accessed January 30, 2018. www.faa.gov/airports/planning_capacity.

Table 6: Average Domestic and International Passengers per Flight by Airport — Past and Projected

	EWR		JFK		LGA	
	Domestic	International	Domestic	International	Domestic	International
1993	61	118	60	160	62	66
2007	83	126	92	170	57	58
2015	75	128	106	173	82	65
2030	86	130	116	178	93	75
2040	93	132	124	182	100	82
2050	100	134	131	186	107	89
2060	107	136	138	189	115	96

Source: RPA

Table 7: RPA Projected Annual Operations (Passenger) at Three Airports — 2030 to 2060 (in thousands)

		RPA Moderate			RPA High		
		Domestic	International	Total	Domestic	International	Total
JFK	2015	254	174	427	254	174	427
	2030	275	213	488	280	226	506
	2040	283	238	521	291	260	551
	2050	290	262	552	301	293	594
	2060	296	285	581	310	324	634
EWR	2015	311	92	403	311	92	403
	2030	359	135	494	366	143	509
	2040	362	152	513	373	166	538
	2050	364	168	532	378	188	566
	2060	366	184	550	383	209	592
LGA	2015	324	27	351	324	27	351
	2030	334	28	362	341	30	370
	2040	339	29	368	349	32	381
	2050	343	30	373	356	34	390
	2060	346	31	377	362	35	398

Source: RPA

Table 8: Peak Hour Operations (Passengers) and Runway Capacity Gaps at Three Airports in 2030, 2040, 2050, and 2060

		Capacity Required				Capacity Gap			
		No Delay		10 Minute Delay		No Delay		10 Minute Delay	
		RPA Low	RPA High	RPA Low	RPA High	RPA Low	RPA High	RPA Low	RPA High
JFK	2030	129	133	109	113	43	47	23	27
	2040	137	146	117	124	51	60	31	38
	2050	146	157	124	133	60	71	38	47
	2060	155	170	132	144	69	84	46	58
EWR	2030	121	125	103	106	38	42	20	23
	2040	127	133	108	113	44	50	25	30
	2050	131	140	112	119	48	57	29	36
	2060	136	147	116	125	53	64	33	42
LGA	2030	86	88	73	75	10	12	(3)	(1)
	2040	88	91	75	77	12	15	(1)	1
	2050	89	93	76	79	13	17	(0)	3
	2060	90	95	77	81	14	19	1	5

Source: RPA

Table 6 compares the passengers per operation for 2030, 2040, 2050 and 2060 assuming that the average number of passengers per flight will grow more modestly than in the recent past. These ratios are then applied to the projected passenger volumes for each airport to estimate the annual airline passenger operations shown in Table 7.

By 2030 EWR can be expected to add about 25% more passenger aircraft operations, growing from 400,000 to 500,000 annually. The increase would be 32% to 40% by 2040. JFK's growth rate in operations would be somewhat slower, adding 12 to 18% by 2030 and as much as 29% by 2040. LGA flight volume growth would be much lower because of the higher rates of growth in passengers per flight.

These estimates of annual passenger operations must be converted to peak hour operations. A series of factors, all of which are temporally stable, was used to convert annual to monthly, monthly to daily and then daily to peak hour. The peak month amounts to 9.3% of the year and the peak day is 3.4% of the month. These factors are essentially the same for all three airports. The peak hour factor is somewhat different for each of the airports — 7.6% at EWR, 8.1% at JFK and 7.5% at LGA. The application of these factors to annual operations yields the peak hour flights that would have to be provided to prevent any delay at each of the airports shown in the first two columns of Table 8. However, the total absence of delay is unrealistic; these estimates are adjusted downward to reflect the actual runway throughput that would be achieved ¹⁰ assuming average delays 10 minutes, lowering the required capacity by 15%. EWR would require capacity of 103 to 106 flights per hour by 2030 and six more each decade thereafter. Today, the capacity is pegged at 83 flights per hour, suggesting a shortfall of over 20 by 2030, upwards of 30 by 2040.¹¹

JFK's requires a capacity of 130 by 2030 and about 150 by 2050 if no delay is assumed, but only about 110 by 2030 and 120 by 2040 with a 10 minute delay target. Based on the current capacity of 86 per hour, the gaps are about 40 flights per hour with no delays by 2030, growing to as much as 70 by 2050. Accepting 10 minute delays leaves still leaves a considerable gap, approaching 30 in 2030, 40 in 2040 and 50 in 2050 and 60 in 2060.

The capacity picture at LGA is much better. Its current capacity of 76 per hour is adequate if one accepts delays of 10 minutes.

¹⁰ "Airport Capacity and Delay." *Federal Aviation Administration*, September 23, 1983. Appendix 2, p. 150-5060-5. http://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5060_5.pdf. Extrapolated from advisory circular.
¹¹ RPA developed its existing capacity estimates, cited here, by reviewing publically available data/reporting and in consultation with various airport/airspace experts.

The Port Authority Forecasts

The PA estimates passenger operations each year, but only as far as 2033. Their approach is summarized numerically in Table 9. Their projection of passengers at the three airports in 2033 anticipate 165 MAP at the three airports, 55 MAP at EWR, 76 MAP at JFK and 34 MAP at LGA. The levels are somewhat higher for EWR, slightly higher for JFK and very close to LGA. For 2030 the RPA estimates range from 48 to 50 MAP at EWR, 70 to 73 MAP at JFK and 33 to 34 MAP at LGA. The PA analysis estimated a fleet mix and load factor that produces an estimate of passenger operations for each airport. For EWR and JFK the estimated passengers were then constrained based on the passenger per operation ratio believed to be likely by 2033. As expected, this analysis indicates a much smaller gap for EWR and JFK, a result of the higher assumptions for the passenger to operations ratios. The 2033 gap at EWR and JFK, while small will grow in future years. The PA approach assumes that there will be 10% to 13% fewer operations: 1.22 million in contrast to the RPA projections of 1.34 to 1.39. The PA projections are based on a rapid increase of the passenger per aircraft ratio, continuing the short term trend in the last few years, built on a foundation of continuing capacity constraints that drives the ratio ever upward.

The practical effects of the Port Authority approach are problematic for a number for reasons:

- ▶ The passengers per aircraft ratios assumed would not be achieved given the airlines' historical commitment to a narrow bodied hull structure for domestic operations. There are no discernable indications that airlines will change their historical practices. .
- ▶ The assumed upgauging (increasing the size of aircraft) may require the reconstruction of terminals and gate areas to allow maneuvering of larger aircraft.
- ▶ An expanded load factor will limit the growth of flight options — fewer, larger sized flights to predominantly larger markets and the phasing out of flights to many intermediate and small markets to the detriment of both the destinations and the New York region.

Table 9: Capacity Gap in 2033 Using PA Projections

	EWR	JFK	LGA
Passengers Unconstrained (MAP)	58	76/82.5	34.1
Passengers Constrained (MAP)	54.9	77.7	34.1
Passengers per Operation	141.2	174.3	89.5
Annual Operations	389.2	445.5	381
Hourly Operations	96.5	117.8	90.4
Current Hourly Capacity (Flights per Hour)	83	86	76
Capacity Gap (Flights per Hour)	13.5	31.8	14.4

Source: PANYNJ

Other Factors Impacting Demand for Air Travel

These estimates must account for factors that may affect both demand and capacity. On the demand side four are potentially relevant — two that add flights (general aviation and cargo) and two that subtract flights (diversion to other airports and diversion of passengers to improved higher speed intercity rail service).

General Aviation Flights

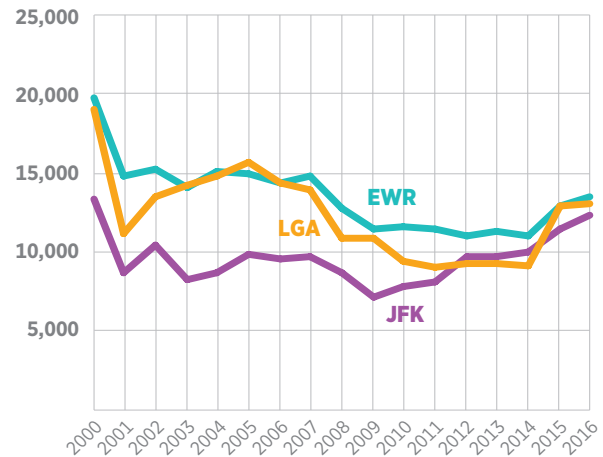
General aviation flights have remained static or declined at the three airports as depicted in Figure 8. From 2000-2009 the trend was generally downward before leveling off with signs of some growth in the last year.¹² Growth of population and employment in the region will tend to push these annual levels upward to perhaps 15,000 each at JFK and EWR and 12,000 at LGA. Current volumes during peak hours at the three airports are very low — not more than one per hour at EWR, three at JFK and two at LGA. With overall volumes of general aviation remaining flat, future peak hour flights are assumed to remain the same, since growing congestion at the airports is likely to dampen growth in general aviation flights since they will be less attractive and expensive for the general aviation user. Thus, it is assumed that the current diurnal patterns will hold and that there would remain in future years only one such flight in the peak hour at JFK, two at LGA and one at EWR. The wild card is the impact of sea level rise, discussed elsewhere in this report. If Teterboro Jetport is phased out over time because of sea-level rise, its general aviation flights would need to be accommodated by other airfields in the region. Proximity to New York's central business district is highly valued by business jet passengers (a major user of TEB) and the only close-in airfields are the three major commercial airports. It is likely that one or more of these airports would absorb some of this traffic, putting added pressure at JFK and EWR for additional runway capacity.

Cargo

Cargo operations had been trending downward, but they are now leveling off as shown in Figure 9. With growing cargo demand in the region, a prudent estimate might have them growing to about 30,000 operations at EWR and 20,000 at JFK annually, although a growing share of cargo carried in passenger aircraft as aircraft get larger would reduce the number of all-cargo (freighter) flights. The vast majority of these flights do not occur in peak, as many occur during the off-peak overnight period. At EWR, the average number of cargo flights in that airport's peak hour is two. Allowing for growth, it is reasonable to assume no more than three flights in any peak hour. Similar reasoning puts the peak hour cargo flights for future years at JFK

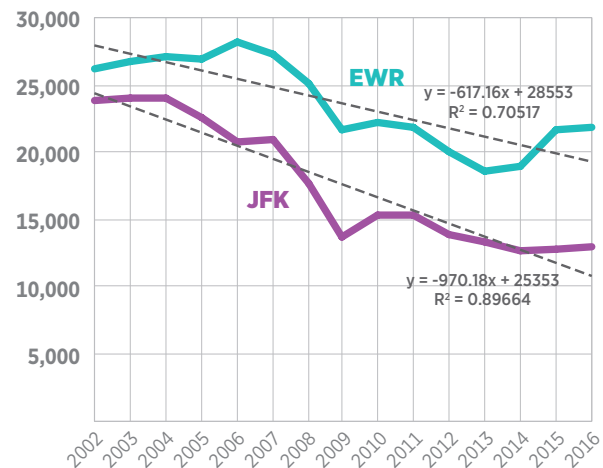
¹² Efforts underway to rebuild that airport's roadways and terminal will likely dampen the growth of traffic at LGA.

Figure 8: General Aviation Operations at Three Airports: 2000 to 2016 GA Operations



Source: PANYNJ

Figure 9: Cargo Operations



Source: PANYNJ

at two. However, recent developments point to a possible resurgence in freight, especially if the trend of instant deliveries persists and expands over time. Companies, such as Amazon, are even investing in their own freighter fleets to increase their ability to control the supply chain and the reliability of their deliveries. With this in mind, it's essential that the region's airports have the space to allow for scaling up of their cargo handling facilities. Similar to off-hour deliveries in other modes, if the number freighters calling the region's airports were to substantially increase many of these operations could be handled during periods of reduced demand, as they are today.

Diversion to Outlying Airports

In the 2011 report RPA estimated the number of passengers at each of the airports that might logically shift to other airports located in or near the 31-county region. Based

on the relative distance that current air passengers at the three major airports begin or end their trips and the magnitude of relative air service offered, estimates were made that approximately 6.6 million passengers could be diverted when the three airports reached 150 MAP¹³. Almost all would be concentrated at five airports: Monmouth County, Islip, Stewart, Tweed New Haven, and Mercer County airports. Westchester County Airport (HPN) is a sixth possibility, but it is capped at 2.24 MAP the result of an agreement with local communities. Any natural growth that led to exceeding that level would rebound to the existing airports, and possibly to some of the outlying ones. At present Monmouth County does not have air carrier service and would require extensive upgrading, and Tweed New Haven airport has runway constraints that are not easily remedied given surrounding residential land uses. The net effect is that only Stewart and Islip can be counted on to receive significant numbers of diverted passengers. At 150 MAP for the three majors, this diversion is estimated to amount to about 2.7 MAP, less than a million at each at EWR, JFK and LGA. The conversion to peak hour flights in 2030 would amount to about two each at EWR and JFK and about two-and-a-half at LGA. At HPN airport passenger demand would not even reach the cap by 2050 if it grows by a 42,000 per year increment. Thus, it would not be handling any of diversion from the existing airports even if the cap were lifted.

Faster Intercity Rail Service

The diversion to improved intercity service was also examined in the 2011 report, concluding that high speed rail service could divert 4.4 MAP if fully implemented when the three airports reached 150 MAP¹⁴. This relatively small number reflects the realities of the market. A large share of air passengers using the three major airports are not traveling to or from places where rail service exists or is likely to be an attractive option. They are travelling internationally or beyond a reasonable distance for even high speed service to compete. For markets within the sweet spot of high speed rail — 100 to 350 miles — many of those markets already have significant rail share. Further, those using our airports to connect to other places will not find the rail-to-air option attractive given the downtown terminals.

To estimate the number of flights that would be diverted in the peak, the estimates in the 2011 report were updated assuming the high speed option would be in place by 2030 in the Northeast Corridor south of New York City south as far as Washington, DC, and in all other markets the “enhanced” rail service would be in place, as RPA recom-

mends in its fourth regional plan. This recommendation is similar to the NEC FUTURE study’s preferred high-speed rail alternative for which a record of decision was issued in 2017 on the corridor-wide tier 1 FEIS. The diverted passengers from each of the three major airports (Table 8.8 of the 2011 report) were then factored to account for the projected passengers in 2030, 2040 and 2050. These were converted to operations using the ratios of passengers to operations for domestic flights described earlier and then converted to hourly volume using monthly, daily and hourly factors. As Table 6 shows the largest impact would be at LGA since that airport serves a larger share of passengers making short trips.

Table 10: Flights Diverted in Peak Hour by Higher Speed Rail

		RPA Low Scenario	RPA High Scenario
JFK	2030	1.8	2.0
	2040	2.2	2.5
	2050	2.4	2.8
EWR	2030	1.7	1.8
	2040	2.0	2.2
	2050	2.2	2.5
LGA	2030	6.0	6.3
	2040	6.0	6.3
	2050	6.0	6.4

Source: RPA Analysis

The net effect of the puts and takes — added demand less diversions are shown in Table 11. Other than LGA they do not amount to a significant diversion of passengers and do not blunt the need for additional airport capacity.

Table 11: Net Impact on Airport Demand of Four Factors

		General Aviation	Cargo	Other Airports	Higher Speed Rail	Net Peak Hour Flight Diversions
JFK	2030	3	2	-1.9	-2.0	1.1
	2040	3	2	-2.0	-2.5	0.6
	2050	3	2	-2.1	-2.8	0.2
EWR	2030	1	3	-1.9	-1.8	0.3
	2040	1	3	-2.0	-2.2	-0.2
	2050	1	3	-2.1	-2.5	-0.5
LGA	2030	2	0	-2.4	-6.3	-6.7
	2040	2	0	-2.4	-6.3	-6.8
	2050	2	0	-2.4	-6.4	-6.8

Source: RPA Analysis

¹³ For more detailed methodology for calculating the diversion of air traffic to outlying airports please see Chapter 6 and Appendix C of RPA’s previous aviation report. “Upgrading to World Class: The Future of the New York Region’s Airports.” *Regional Plan Association*, January 2011. <http://library.rpa.org/pdf/RPA-Upgrading-to-World-Class.pdf>.

¹⁴ For more detailed methodology for calculating diversion if air passengers to rail please see Chapter 8 of RPA’s previous aviation report. “Upgrading to World Class: The Future of the New York Region’s Airports.” *Regional Plan Association*, January 2011. <http://library.rpa.org/pdf/RPA-Upgrading-to-World-Class.pdf>.

The Region's Airports and the Environment

The region's commercial airports, like any major transportation system, impact the environment in numerous ways. Whether it's the concentrated emissions generated by surface vehicles that serve the airports or the noise of the aircraft on the surrounding communities, airports can have an adverse effect on the health of the natural environment and the public. Conversely, in recent years it has also been shown that the environment can seriously impact the ability of airports to operate reliably and can also be a threat to their long-term viability. While bad weather and bird strikes have always been a factor in aviation operations, extreme weather events and sea-level rise are rapidly changing prior assumptions about the vulnerability of these critical assets. The following section highlights four major environmental challenges identified by RPA that must be addressed directly by government and the public if the region is to have a robust, equitable and resilient airport system.

Greenhouse Gases and Other Noxious Emissions

The global aviation industry accounts for 2-3% of global carbon emissions. The FAA anticipates aviation's share of global GHG emissions will rise over time as demand for travel increases unless new fuel saving technology or renewable fuels are introduced. In the New York region the PANYNJ estimates that in 2014 its aviation operations, tenants and customers generated 3.4 million metric tons of carbon emissions. These emissions are generated in three primary ways, by aircraft (1.8 million metric tons), by customer travel/ground access to and from the airports (1.1 million metric tons), and by energy use and fuel combustion for operations at the airports (149,260 metric tons).¹ Overall emissions from the aviation industry in the New York region have decreased by 4% over the 2006 base year, when the PANYNJ established a goal of reducing greenhouse gas emission by 80% by 2050.²

¹ "Scopes 1, 2, 3 Greenhouse Gas and Criteria Air Pollutant Emissions Inventory for the Port Authority of New York and New Jersey." *Southern Research Institute and E.H. Pechan & Associates, Inc.*, September 2016. <http://www.panynj.gov/about/pdf/2014-Scope-1-3-Report.pdf>.

² "Greenhouse Gas Emission Inventory for The Port Authority of New York & New Jersey." *Southern Research Institute and E.H. Pechan & Associates, Inc.* February 2009. [https://www.panynj.gov/about/pdf/PANYNJ-GHG-Emissions-](https://www.panynj.gov/about/pdf/PANYNJ-GHG-Emissions-Inventory-2006.pdf)

In addition to greenhouse gas emissions, aircraft emit criteria air pollutants such as nitrogen oxides ((NO_x) and particulate matter of 2.5 microns in size or smaller (PM_{2.5}).³ Much of the research on air pollution in the region has found that high concentrations of PM_{2.5} and NO_x occur due to traffic emissions from ground access vehicles such as buses, shuttles, taxicabs and private cars. On-road vehicles account for 30% of NO_x emissions in New York City. Additionally, diesel trucks that serve the cargo operations on airports can contribute significantly to black carbon emissions, which make up 75% of the particulate matter from diesel exhaust.⁴ Using EPA air quality data and data provided by the New York City Department of Health we have mapped the relative concentrations of NO_x and PM_{2.5} levels adjacent to the region's airports. It is clear that non-aircraft sources account for the bulk of noxious emissions, actions to divert air passengers to "greener" ground access options and to reduce the emission generated by on-airport facilities must be pursued.

Noise

Excessive noise is the most common complaint from communities surrounding the Region's airports, largely due to an aircraft's engine and the displacement of air over its surfaces (aerodynamics) during landing and take-off. The FAA regulates aircraft noise through various standards and sets requirements for aircraft to not exceed certain levels of noise during operation. As of 2014, all civil aircraft operating in the United States must meet Stage 3 or 4 noise exposure classification.⁵ Stage 3 noise contours, the distance based decay of noise from take-off or landing aircraft, is roughly equivalent to a maximum of 95 sound exposure level (SEL) noise within 2-3 miles. Decreasing to noise levels less than 80 SEL beyond 6 miles from take-off or land-

[Inventory-2006.pdf](http://www.faa.gov/about/officeorg/headquarters/offices/apl/noise-emissions/airport-aircraft-noise-issues/).

³ Stratton, Russel W., Hsin Min Wong, James I. Hileman. "Life cycle greenhouse gas emissions from alternative jet fuels." *MIT Laboratory for Aviation and the Environment*, June 2010. http://nehalem001.mit.edu/uploads/LAE_report_series/2010/LAE-2010-007-R.pdf.

⁴ Matte, Thomas D, Zev Ross, Iyad Kheirbek, Holger Eisl, Sarah Johnson, John E. Gorczynski, Daniel Kass, Steven Markowitz, Grant Pezeshki, and Jane E. Clougherty. "Monitoring Intraurban Spatial Patterns of Multiple Combustion Air Pollutants in New York City: Design and Implementation." *Journal of Exposure Science And Environmental Epidemiology* 23 (January 16, 2013): 223.

⁵ "Aircraft Noise Issues." Federal Aviation Administration, 2018. <https://www.faa.gov/about/officeorg/headquarters/offices/apl/noise-emissions/airport-aircraft-noise-issues/>.

ing. SEL is a weighted metric of decibels (dB) of noise that is used to generate an average of day and night time noise level.⁶ RPA evaluated noise levels at or above the 65 dB noise contours for aircraft at the region's airports in its 2011 report. A sustained daily average of 65 dB can disturb sleep patterns and can also create significant annoyance that disturbs typical activity during school or work. Exposure of average noise levels in excess of 70-75 dB within a 24 hour period can lead to hearing impairment and damage.⁷ For context, standing 50 feet from a busy freeway is roughly equivalent to 85 dB, and sustaining that level of exposure over extended periods of time leads to hearing loss.⁸ In the region, nearly 272,500 people live within areas of significant aircraft noise, of 65 dB or more, surrounding EWR, LGA and JFK airports.

To mitigate noise exposure a number of different techniques are employed; 1) aircraft fleets shift to newer and quieter engines; 2) soundproofing is installed on airport and on buildings adjacent to airports; 3) buyouts of property in areas significantly impacted by aircraft noise above safe levels; 4) airport compatible land uses surrounding airports to decrease the immediately adjacent residential population size; 5) operational changes to flight paths and procedures that reduce use of aircraft engines for thrust during take-offs and landings. Given these mitigation measures the FAA has found that the overall population affected by aircraft noise has decreased by 6.7 million people since the 1970s even during an era of increasing travel with over 700 million annual passengers at airports nationwide.⁹ These strategies and others to mitigate noise will need to be adopted by the region's airports as the volume of flights increase.

The Port Authority has established a noise office to manage Part 150 noise compatibility studies at LGA, JFK, EWR and TEB. This office is also responsible for establishing airport community roundtables to maintain an open line of communication between local communities impacted by noise, the PA and FAA. The first roundtable was established in 1987 for TEB airport.

Natural and Protected Lands

Adjacent to the three major airports are substantial open spaces and parkland. Gateway National Park and Jamaica Bay is on the edge of JFK's airfield. Flushing Bay, Bowery Bay and Rikers Island Channel surround LaGuardia Airport. Weequahic Park is to the east of Newark Airport.

Gateway National Recreation Area (Gateway or GNRA) is spread across over 26,000 acres, four counties, three New York City boroughs, and two states; it is comprised of Great Kills on Staten Island, Sandy Hook in New Jersey and Jamaica Bay in Queens. Jamaica Bay alone sees an average of 4 million visitors each year, of which 100,000 visit the wildlife refuge southeast of the JFK airfield. Gateway's mandate is to provide a great national park experience for the diverse communities of the New York City region, while also protecting and evoking the area's rich history and serving as a "gateway" to the national park system. Of particular concern is preserving the Gateway Wildlife Refuge and the erosion of the fresh and salt marshes. Current losses of roughly 45 acres per year, are on top of the over 12,000 acres of the original 16,000 acres of wetlands that have been lost during the past century due to filling operations.¹⁰ In 2012, Hurricane Sandy created breaches in the brackish water ponds, East and West Ponds that support migratory bird populations, introducing salt water and invasive plant species to the habitat.¹¹ Restoration of the West Pond by the National Parks Service has been slow with the breach filled in early 2017¹² and the next phase focuses on building a new fresh water source, either from municipal water sources or a groundwater well.¹³ Ongoing debate exists as to whether preserving these manmade brackish ponds should continue rather than letting them return to saltwater marshes.¹⁴ As federally protected areas, any changes to Jamaica Bay and its Wildlife Refuge require approval from the National Parks Service.

LaGuardia Airport is surrounded on all but one side by the tidal waterways of the Long Island Sound and the East River. To the west is Bowery Bay and Rikers Island Channel and to the east of the airfield is Flushing Bay. Bowery Bay Wastewater Treatment Plant (WTP) built in 1939 drains a 15,203 acre area of northeastern Queens and serves nearly 1 million people to clean wastewater from homes and

⁶ "Comparison of Stage 3 and 4 Noise Benefits for Takeoff vs. Landing." *Boward County, Florida*, September 10, 2012. <https://www.broward.org/Airport/Community/Documents/Stage3and4presentation.pdf>.

⁷ Heinrich, Janel. "Potential Health Effects of Noise Exposure." *Public Health Madison & Dane County*, June 7, 2013. <http://www.publichealthmdc.com/publications/documents/noisehealtheffectsreport.pdf>.

⁸ Chepesiuk, Ron. "Decibel Hell: The Effects of Living in a Noisy World." *Environmental Health Perspectives* 113, no. 1 (2005): A34-A41. <http://www.publichealthmdc.com/publications/documents/noisehealtheffectsreport.pdf>.

⁹ "Aircraft Noise Issues." *Federal Aviation Administration*, accessed January 31, 2018. https://www.faa.gov/about/office_org/headquarters_offices/apl/noise_emissions/airport_aircraft_noise_issues/.

¹⁰ "The Path Forward: Public Input on the Future of Gateway National Recreation Area." *Regional Plan Association*, 2009. <http://library.rpa.org/pdf/RPA-GNRA-The-Path-Forward.pdf>.

¹¹ "Gateway." *National Park Service*, accessed January 31, 2018. <https://www.nps.gov/gate/learn/news/jamaica-sandy-6.htm>.

¹² "Jamaica Bay Wildlife Refuge Update." *The Linnaean Society of New York*, February 3, 2017. <http://linnaeannewyork.org/conservation/20170203-Jamaica%20Bay-WR-Update.html>.

¹³ O'Reilly, Anthony. "NPS proposes to fix West Pond breach." *Queens Chronicle*, October 8, 2015. <http://www.qchron.com/editions/queenswide/nps-proposes-to-fix-west-pond-breach/article.75811eff-2e88-597f-b04c-5f913bedb8a2.html>.

¹⁴ Foderaro, Lisa W. "Environmental Group Proposes Options for Breached Pond at Jamaica Bay in Queens." *The New York Times*, February 10, 2014. <https://www.nytimes.com/2014/02/11/nyregion/environmental-group-proposes-options-for-breached-pond-at-jamaica-bay.html>.

business before draining into Bowery Bay.¹⁵, ¹⁶ Between the Bowery Bay WTP and LGA's Marine Terminal is a small waterfront park, the remainder of a large beach and amusement park from the late 19th century, a portion of which became part the airport's expansion under Mayor LaGuardia in the late 1930s.¹⁷ North of the park is Rikers Island, the home of the city's largest correctional facility that was built on landfill in the 1920's. Rikers Island Channel is the waterway between the eastern side of the island and the piers of LGA runways 13 and 22. The channel is the inlet for tidal waters into Bowery Bay from the Western Narrows of Long Island Sound. On the eastern side of the LGA airfield is Flushing Bay, which is undergoing environmental remediation. The NYC Department of Environmental Protection has begun dredging the bay to remove contaminated soils from combined sewer outfalls and the World's Fair Marina. Over \$34 million is being spent in 2017 to restore wetland habitat, removing decaying timber piles and piers and invasive trees.

Weequahic Park is an Essex County park located in the south ward of Newark, New Jersey. The park includes a public golf course, playgrounds, ball fields, picnic areas and recreational trails that serve the adjacent communities of Greater Dayton, Weequahic and Hillside. The park spans 311 acres and was designed by the Olmsted Brothers firm.¹⁸ Created from over 265 acres of saltwater wetlands the park includes the manmade Weequahic Lake. Several historical streams that were branches of the Passaic River and tidal flats drain into Weequahic Lake, which formed with the construction of a dam in the early 1900s as part of the effort to convert the wetlands into parkland.¹⁹ In addition to the streams that feed into Weequahic Lake, other tidal creeks were diverted into the Peddie Street Ditch beginning in 1883. These historical streams are now underground in culverts and pipes as part of the City of Newark's combined sewer system.²⁰ The water from these streams mixes with stormwater runoff from Newark's streets before reaching the Peddie Street combined sewer outfall. The Peddie Street outfall in turn drains into the Peripheral Ditch surrounding Newark Airport and then out into Newark Bay.²¹ As part of the Port Authority's ongoing sustainability

efforts best management practices are being explored to reduce sediments and stormwater runoff from the airfield into the Peripheral Ditch, with particular focus on reducing deicing fluid runoff.²²

Sea-Level Rise and Extreme Weather

The developed coastal areas of the tri state metropolitan region, where our major commercial airports are sited, are at significant risk from sea level rise (SLR). According to the New York City on Panel on Climate Change, sea levels in New York City have already risen more than a foot since 1900 and are on pace to accelerate faster than global averages²³, as global greenhouse gas emissions continue to trap heat and warm the planet. The projections done by the panel indicate that the region could see at least one foot of sea level rise by 2050, possibly as soon as the 2030s. Three feet could be realized by the end of the century, possibly as soon as the 2080s. Six feet of sea level rise is possible early in the next century. A rise in sea levels of 3 to 6 feet could mean the permanent flooding of one or more of our major commercial airfields. The options for addressing the threat are relatively few: 1) Do nothing and hope that the projections are wrong or that future technology will provide an easy solution; 2) Work with existing tools to try and engineer solutions, building higher sea walls or dikes around infrastructure and installing pumps to keep the water out; 3) Find ways to live with the water, elevating structures and infrastructure and adjusting to a new life on less dry ground; or 4) Begin to phase out infrastructure in at-risk places and phase in retreat from them over the next few decades. All of these options present significant obstacles, raise tough questions and would require significant investment and political leadership. RPA took a closer look at these issues in its 2016 report *Under Water: How Sea Level Rise Threatens the Tri-State Region*.

The region's three major airports, plus its major business jetport, are affected by SLR by varying degrees, and all are affected by storm surge. Teterboro faces potential inundation with as little as three feet of SLR. EWR and LGA withstand three feet but are vulnerable to six feet. JFK is able to withstand both threes and six feet, but will need to be hardened for future storm surges.

The following sections detail the impacts of SLR and storm surge at each of the airports and present some preliminary mitigation strategies:

¹⁵ "New York City's Wastewater Treatment System." *NYC Environmental Protection*, accessed January 31, 2018. <http://www.nyc.gov/html/dep/html/wastewater/wwsystem-plants.shtml>.

¹⁶ "\$3 Million Upgrade to the Bowery Bay Wastewater Treatment Plant to Substantially Reduce Nuisance Odors in Astoria and Nearby Communities." *NYC Environmental Protection*, February 19, 2016. http://www.nyc.gov/html/dep/html/press_releases/16-008pr.shtml#WMWAam8rL_U.

¹⁷ "Bowery Bay Beach or North Beach." *The William Steinway Diary, Smithsonian Institute*, accessed January 31, 2018. <http://americanhistory.si.edu/steinwaydiary/annotations/?id=955>.

¹⁸ "Weequahic Park." *Essex County Parks*, accessed January 31, 2018. <https://www.essexcountyparks.org/parks/weequahic-park>.

¹⁹ "Phase I Diagnostic-Feasibility Study of Weequahic Lake prepared for Department of Parks, Recreation and Cultural Affairs, Essex, NJ." *F.X. Browne Associates, Inc.*, June 1983. <https://rucore.libraries.rutgers.edu/rutgers-lib/51528/PDF/1/>.

²⁰ "The History of the Newark Sewer System." *Old Newark*, accessed January 31, 2018. <http://www.virtualnewarknj.com/histories/sewersystem.php>.

²¹ Correspondence re: Compliance Evaluation Inspection of Newark International Airport. *New Jersey Department of Environmental Protection*, 1964-1989. <http://www.nj.gov/dep/passaicdocs/docs/3rd-PartyComplaintNexusPackages/3rd-PartyComplaintANexus/NewarkAirport-Site.pdf>

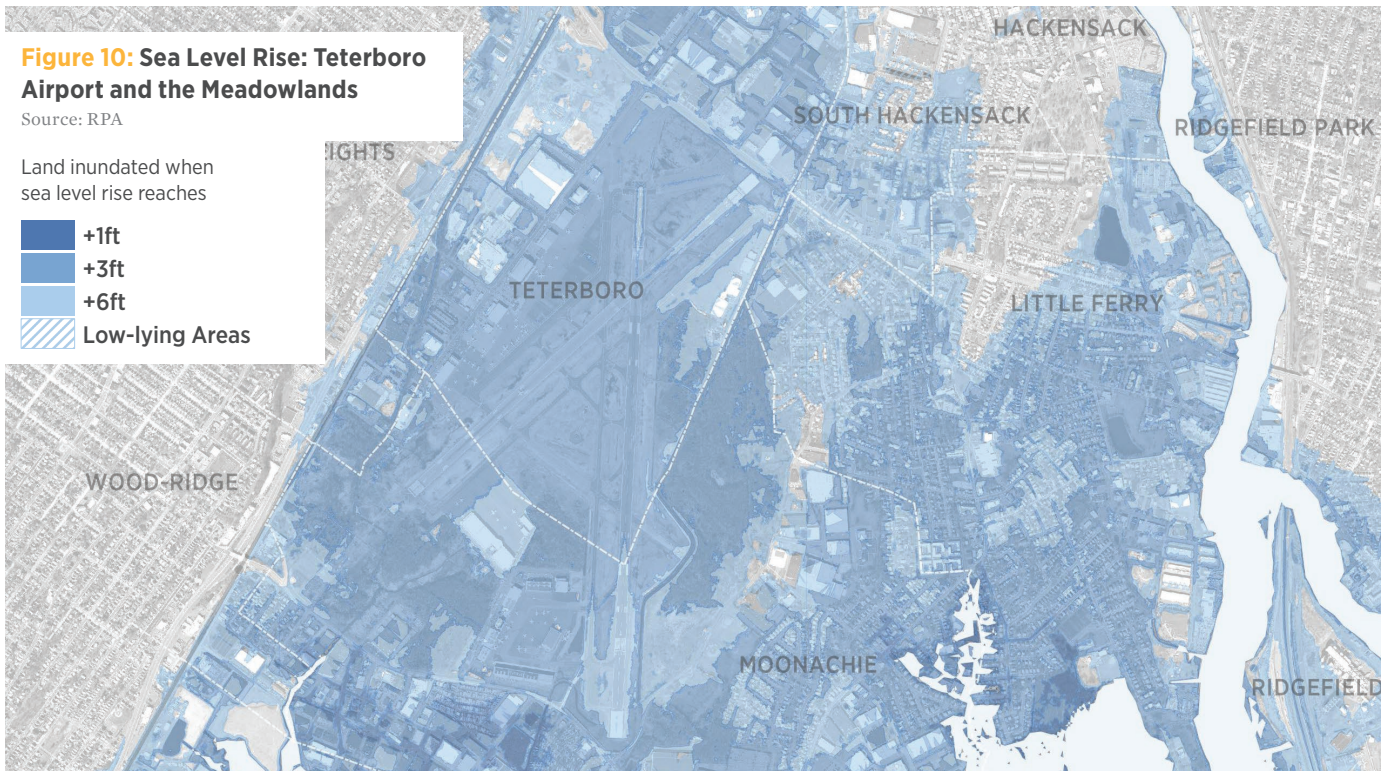
²² "Newark Liberty International Airport: Sustainable Management Plan." *Port Authority of NY&NJ*, October 2012. <http://www.panynj.gov/about/pdf/newark-liberty-sustainable-management-plan.pdf>.

²³ The Atlantic coast experiences different degrees of sea-level rise due to gravity and how the movement of the ocean distributes water differently across the globe. Also, the region's land is sinking (subsidence) from the withdrawal of groundwater and from a centuries-long rebalancing of land from the loss of the weight of glaciers.

Figure 10: Sea Level Rise: Teterboro Airport and the Meadowlands

Source: RPA

Land inundated when sea level rise reaches



Teterboro Business Jetport

Teterboro Airport faces near complete inundation at three feet of SLR, and many of the roadways and communities around it face inundation at three and six feet.

In its role as the New York region's primary reliever and business jetport, TEB served over 167,000 aircraft in 2016. TEB is a success story, one that dates back to the 1960's when RPA recommended that the PANYNJ shift all non-commercial aircraft traffic out of the big three airports to another facility to make room for commercial air carrier growth. This strategy worked and the loss of TEB could unravel much of the benefits that have accrued over its existence, putting even more pressure on the region's three commercial airports. If TEB is to be abandoned, an alternate site(s) would need to be found.

A new business jetport would need to be within a 45 minute drive to the Manhattan Central Business District. RPA's 2011 analysis examined several general aviation facilities in NJ, LI and Westchester that might be converted to commercial passenger service, but all were deemed insufficient based on a critical criterion for that analysis. In addition, existing general aviation facilities in Morristown, Republic and White Plains are all possible receivers of a portion of TEB's air traffic.

A comprehensive climate adaptation vision is needed for the communities and infrastructure of the New Jersey Meadowlands where Teterboro is located. With the significant amount of population and employment centers in the Meadowlands, and the critical energy, wastewater treat-

ment road and rail infrastructure passing through, difficult decisions will need to be made about what can be protected and what should be phased out. It could be difficult to justify significant investments in elevating or walling off the 827 acre airport and its connecting roadways. Protecting the airport alone would only worsen conditions in surrounding communities by displacing flood waters. Closing TEB results in some efficiency improvements to the airspace due to its proximity to EWR and LGA. TEB serves as a pivot point, at times connecting the airspace west of the Hudson to the east of the Hudson. Its decommissioning would further decouple the region's largest commercial airports — EWR and JFK. Additionally, TEB's proximity to EWR creates an airspace problem (due to the different runway orientations at the two airports) that would be corrected if it was decommissioned. Its closing would free up airspace around EWR, which would improve the reliability, flexibility in operating that airport. The closure of the airport would also mean that reduction of noise that inflicts the dense communities that surround it, such as Lodi and Rutherford.

The Port Authority and other stakeholders are currently engaged with the effort to consider alternatives for protection from storm surge and precipitation flooding of the boroughs of Little Ferry, Moonachie, Carlstadt and Teterboro (including the airport) as well as the township of South Hackensack through the implementation of the Rebuild by Design-Meadowlands project. Currently, \$150 million in federal funding has been awarded towards the design and construction of a flooding risk reduction strategy and an EIS is underway that considers three alternatives: 1)

Figure 11: Sea Level Rise: JFK Airport and Jamaica Bay

Source: RPA

Land inundated when sea level rise reaches



structural flood reduction (levees, berms, barriers, drainage structures, pump stations, floodgates and/or other hard and soft infrastructure); 2) storm water drainage improvement (drainage ditches, pipes and pump stations, roadway elevations, green infrastructure, water storage areas, water control structures, cleaning and de-snagging of waterways, and increasing and enhancing public open space); and 3) an integrated hybrid of the two. All three alternatives focus primarily on flooding from surge and precipitation versus permanent flooding from sea level rise. The Port Authority should expand the scope of this effort to look at the impacts of SLR on Teterboro and develop its own series of actions to ameliorate its loss.

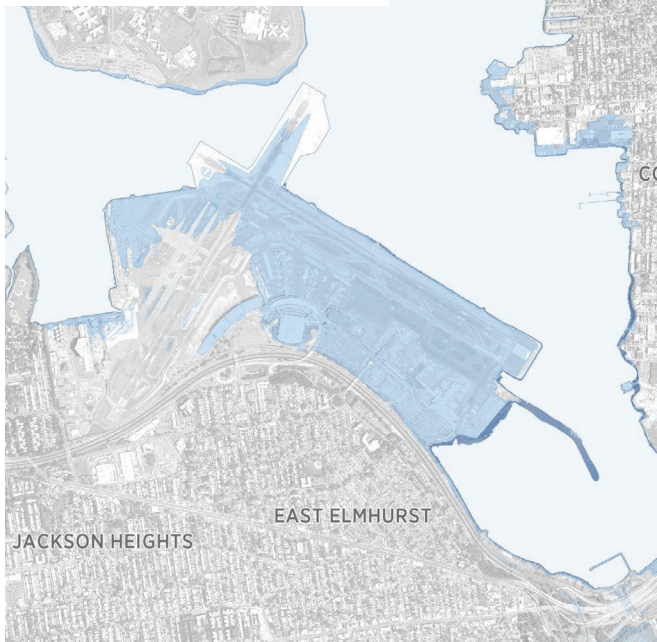
John F. Kennedy International Airport

JFK is not affected by three feet of SLR and six feet only impacts its edge along the bay, though it is at risk of storm surge from a 100-year flood. Thus, the airport is well positioned to cope with SLR but will need to be hardened to increase its ability to cope with more frequent storm surges.

Over time, it is possible that SLR impacts at Broad Channel and the Rockaways will reduce the adjacent population affected by future increases in air traffic — the airport will eventually be operating at the edge of the Atlantic with only recreational/parkland uses along its southwestern border.

Figure 12: Sea Level Rise: LGA Airport and Flushing Bay

Source: RPA



LaGuardia Airport

LGA has a perimeter barrier system that protects the airport up to 4-5 feet of SLR. However, its 13/31 runway will be completely inundated at six feet along with the most of the taxiways and apron around the main terminals. The entirety of the airport is already impacted by a 100-year storm.

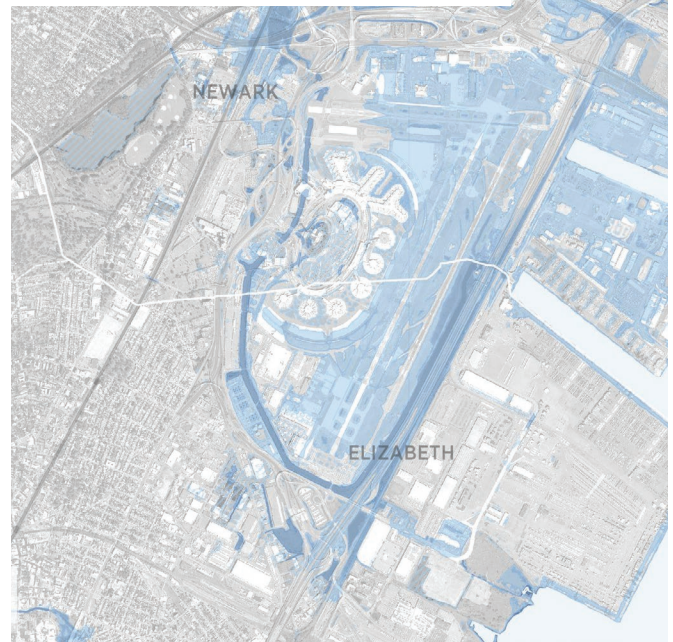
If no action is taken most of the 680 acre airport site will need to be abandoned sometime in the next 100 years. In 2015, LGA served 28.4 million passengers, handling more passengers per acre per year than any other airport in the world¹. The expansion of EWR and JFK would be insufficient to accommodate projected demand and the lost capacity at LGA — another airfield would be required. In 2011 RPA completed an exhaustive survey of possible new greenfield or expansion of general aviation facilities and found no new opportunities with a 45 minute drive-shed from New York City that could accommodate larger commercial aircraft.

Work must begin within the next decade to protect this critical part of the region's airport network from the effects of six feet of sea level rise and beyond. This should be done in conjunction New York City's efforts to protect the coastline. To date, the Port Authority has completed a flood study for LGA and has a program of improvements to harden the airport for future SLR and surge events. Some of these actions should start preparing it for six feet of SLR.

¹ "Airport Traffic Report." *The Port Authority of NY&NJ*, 2015. http://www.panynj.gov/airports/pdf-traffic/ATR_2015.pdf.

Figure 13: Sea Level Rise: EWR Airport and Port of New York and New Jersey

Source: RPA



Newark Liberty International Airport

EWR is only marginally impacted by three feet of SLR, but could be completely inundated by six feet. Abandoning this 2,207-acre airport is not a viable option. It serves over 37 million passengers annually and is the region's express air cargo hub. EWR is also critical to the mobility of New Jersey residents, which make up 80% of the passengers it serves. Finding a site of this size with the proximity to the region's core is no longer possible. Protecting this airport must also be seen in combination with preserving adjacent critical infrastructure — both the I-95 corridor and the region's major container port will be underwater with six feet of SLR.

Actions to Meet Future Demand and Transform the Region's Airports

Little has changed over the past seven years since Regional Plan Association (RPA) recommended adding new runways at EWR and JFK airports. Recent efforts to improve our airports have been focused on rebuilding LGA's outmoded central terminal area and completing a series of targeted state-of-good-repair and relatively minor upgrades to the JFK and EWR airfields. New runways, terminals and improved ground access have not materially progressed at JFK and EWR even as passenger traffic has surged. The PA does have plans to invest \$2 billion at EWR to replace the existing Terminal A with a modern facility, which should be completed over the next few years, and multiple proposals are currently being evaluated by the agency for the renovation/reconstruction of many of the terminals and roadways at JFK.

As discussed earlier, RPA anticipates demand to increase significantly in the coming decades and has yet again reached the conclusion that the only way to accommodate this future growth will be by constructing new runways. We cannot divert all these future air passengers to high-speed rail or the region's outlying airports. Demand management options are impractical and will undermine economic growth. Furthermore, the promise of the Next Generation air traffic control has not yet fully materialized and is unlikely to deliver the performance that many had originally hoped for. For the region to grow and maintain its competitive position among other global cities it will need new runway capacity.

Actions that Impact All Airports

There are actions that will impact all three airports, some of which should be taken in the short-term. First, the region needs to continue the roll-out of NextGen air traffic control which will allow for some additional capacity but more importantly help with delay reduction. The airports also need to adapt to the increasingly popular on-demand auto services and prepare for the arrival of autonomous vehicles over the next decade or so. These two topics will be discussed further in the following section along with the viability of adding a new large international airport.

What Can NextGen Do?

Since 2011 the roll-out of NextGen has been slower than anticipated and much of its benefits have not yet materialized. Limited federal funding, roll-out delays at the national and local level, concerns of air traffic controllers, and slower adoption of the new technologies by aircraft manufacturers have delayed its implementation. At the New York Terminal Radar Approach Control (TRACON) facilities, which includes all three major commercial airports in the region, few programs have been fully rolled-out (Table 12). Key improvements like closely spaced parallel runway operations have been approved for JFK, but the program has not been implemented because alternative landing approach and departure flight procedures are still being developed by the FAA. Other NextGen improvements are in development or in the process of being approved for implementation at the three major airports. Many of the programs including RNAV/RNP, GBAS, and ADS-B are in early implantation phases.¹ WAKE ReCAT aircraft separation standards were implemented the New York region in 2015. The frequency of use for these technologies and programs are dictated by weather conditions, the adoption of the technology by aircraft manufacturers and their airline carrier partners, as well as program implementation within the National Airspace System.

Implementation of NextGen programs has been limited due to the lack of technology adoption by airlines and decisions made by air traffic control professionals. For example, the RNAV/RNP navigation systems improvements implemented in recent years have affected aircraft approaches and departures very little. The departure paths and tighter approaches enabled by RNAV/RNP are being used infrequently at the three major airports (Table 13). These precision based navigation approaches and departures require avionics upgrades in aircraft and could allow for more closely spaced aircraft movements in the region, increasing airspace capacity. If a lack of direct investments by airlines to make the equipment upgrades continues there will be limited implementation of the new approaches and departure paths.

¹ "NextGen Implementation Plan." *Federal Aviation Administration*, June 2016. https://www.faa.gov/nextgen/media/NextGen_Implementation_Plan-2016.pdf.

Table 12: NextGen Improvement and Program Status at EWR, LGA and JFK

NextGen Improvement	Improves	EWR	LGA	JFK	NYTRACON
RNAV/RNP Overlays of Existing Procedures	Improves navigation along existing routes	Implemented Frequency of use depends on aircraft and carrier	Implemented Frequency of use depends on aircraft and carrier and runway configuration in use	Implemented Frequency of use depends on aircraft and carrier and runway configuration in use	
New RNAV/RNP Procedures	Provides ability to navigate along a new route	In Development	In Development	In Development	
Advanced Electronic Flight Strips	Air Traffic Monitoring and data communications	Implemented	Implemented	Implemented	
Airport Surface Detection Equipment-Model	Air Traffic Monitoring	Implemented	Implemented	Implemented	
Surface Surveillance Capability	Air Traffic Monitoring				
GBAS	Runway Utilization	Implemented Frequency of use depends on aircraft and carrier	Implemented Frequency of use depends on aircraft and carrier	Implemented Frequency of use depends on aircraft and carrier	
Wake RECAT	Runway Utilization by reducing aircraft separations	Implemented	Implemented	Implemented	
Closely Spaced Parallel Ops	Runway Utilization	Implemented	Not relevant	Not relevant	
Simultaneous Dual Approaches	Runway Utilization	Not relevant	Not relevant	Not relevant	
Dependent Stagger for CSPRs greater than 2,500 feet & less than 3,600 feet	Runway Utilization	Not relevant	Not relevant	Implemented	
Simultaneous Dual Approaches with Offset	Runway Utilization	Airspace N. A.	Not relevant	Not relevant	
ADS-B	Air Traffic Monitoring	Implemented Frequency of use dependent on NAS wide adoption	Implemented Frequency of use dependent on NAS wide adoption	Implemented Frequency of use dependent on NAS wide adoption	Initial Operating Capability (IOC) ADS-B has been added with limited implementation
Time Based Flow Management	Air Traffic Control	Implemented	Implemented	Implemented	
Data Comm	Communications	dependent on NAS wide adoption	dependent on NAS wide adoption	dependent on NAS wide adoption	
SWIM	Air Traffic Control	dependent on NAS wide adoption	dependent on NAS wide adoption	dependent on NAS wide adoption	
ICF	Air Traffic Control	-	-	-	Delayed and Underfunded

Source: "NextGen Implementation Plan." *Federal Aviation Administration*, June 2016. https://www.faa.gov/nextgen/media/NextGen_Implementation_Plan-2016.pdf; "Performance Based Navigation (PBN) Implementation and Usage." *Federal Aviation Administration*, accessed January 31, 2018. <https://www.faa.gov/nextgen/pbn/dashboard/>.

Table 13: NextGen RNAV/RNP Utilization of Candidate Flights (Calendar Year 2015) reported to FAA

Airport	RNAV SID Departures	Average Daily Flights	RNAV STAR Arrivals	Average Daily Flights	RNP AR Approaches	Average Daily Flights
LGA	0%	0	-	-	0.3%	N/A
EWR	1.0%	5.7	25.2%	143	0.8%	N/A
JFK	1.7%	10	12.7%	78.2	1.6%	N/A

Source: "Performance Based Navigation (PBN) Implementation and Usage." *Federal Aviation Administration*, accessed January 31, 2018. <https://www.faa.gov/nextgen/pbn/dashboard/>.

Given the slow adoption of NextGen technology and policies, minor improvements to aircraft operational capacity are anticipated at the three major airports. The FAA's FACT 3 report estimated hourly operations at each airport and the FAA has also developed a more in-depth model integrating airline industry trends into its System-Wide Administration Analysis Capability (SWAC) model. For the purpose of RPA's analysis, a conservative implementation scenario based on the two models as well as key conditions at the region's airports was developed. Table 14 summarizes the estimated hourly operations capacity at the region's three major airports once NextGen is fully implemented over the next decade. These estimates were used to evaluate the capacity gap with a slower implementation of NextGen in the next decades.

Table 14: Maximum Hourly Operations Existing and with NextGen Improvements

Airport	Existing	FACT 3 ^a	SWAC Base Case (IMC/VMC) ^b	Conservative Implementation Scenario
JFK	86	90	80/92	90
EWR	83	85	Not evaluated	85
LGA	75	84 ^c	62/70	76

^a FACT 3 2030 capacity estimates with midterm NextGen Improvements. "Fact 3: Airport Capacity Needs in the National Airspace System." Federal Aviation Administration, January 2015. https://www.faa.gov/airports/planning_capacity/media/FACT3-Airport-Capacity-Needs-in-the-NAS.pdf.

^b 2020 capacity estimates. "NextGen benefits evaluation: Air carrier perspective." Federal Aviation Administration, February 13, 2015. http://www.nextor.org/Conferences/201502_NEXTOR_Workshop/Post-Asilomar-2015.pdf.

^c This estimate assumes that operations are on the 13-22 runways — with runway crossings of the 4-22s there are less average operations per hour.

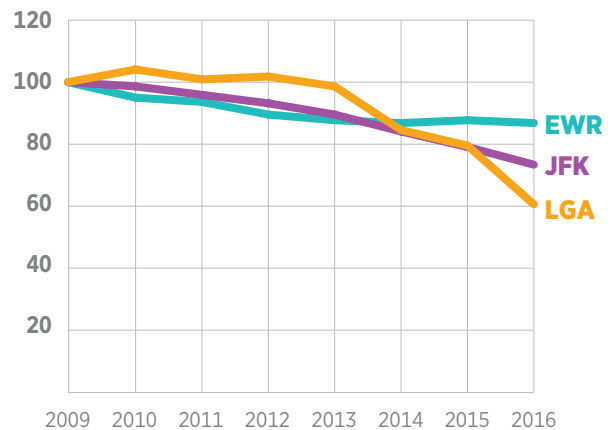
At EWR an estimated hourly maximum of 85 operations is anticipated. The FACT 3 modeling reflects added hourly operations due to improvements in Wake RECAT and greater use of the 11-29 runway than is currently achieved. At LaGuardia the hourly operations estimate provided by FACT 3 assumes a greater use of the highest capacity runway configuration than is currently achieved. This maximum throughput of 84 operations per hour is only possible when Runway 22 is used for arrivals and Runway 13 for departures and the airspace allows use of multiple climb-out corridors from Runway 13. However, given wind conditions at both JFK and LGA, this is only achievable 30-35% of the time the airport operates. Given the frequent use of other runway configurations, 76 operations per hour at LGA is a better representation of a consistently achievable maximum capacity. This is higher than the SWAC estimates but lower than FACT 3 estimates. For JFK an hourly capacity of 90 operations is assumed given that there is an operational dependency between decoupled runways during instrument meteorological conditions (IMC), which is reflected in the SWAC model's lower hourly operations for IMC. The estimates for JFK and EWR assume that many of the NextGen investments, including Wake RECAT and enhanced flow metering, have been fully implemented. The

capability of future phases of Next Gen technologies and procedures are far too uncertain to credibly estimate their impact on airport capacity.

Universal Ground Access Actions

Since RPA's 2011 report there have been several major developments in mobility — the most significant has been the introduction of on-demand car services in the New York region and rapid advancements in autonomous vehicles (AV). Both have the potential to radically alter the ground access dynamics and reshape the design of future landside facilities. Already on-demand or Transportation Network Companies (TNC) are having an impact on the airports by providing more affordable and attractive alternatives to driving and parking private automobiles. As shown as an index in Figure 14, parking utilization at all three airports has fallen since 2009.

Figure 14: Index of Annual Parking Use at EWR, JFK and LGA, 2009 to 2016



While the drop in parking at JFK was relatively steeper than EWR's, in absolute terms the decline at EWR was larger — 13% reduction versus JFK's 7%. LGA had the highest drop, but this is mostly the result of the closure of four parking lots with a combined loss of 4,497 spaces or more than half of the airport's parking capacity due to ongoing construction activities to rebuild the central terminal area. The ability of the PANYNJ to operate the airport with such a dramatic reduction in parking along with the decline in parking at EWR and JFK point to availability of surface alternatives that do not require storage — TNC and transit. Transit has grown at JFK and LGA, but as noted earlier, not at EWR. The Port Authority's annual air passenger customer surveys have shown that TNC now eclipse limousine services and are competing with conventional taxis. Those who actually drive their own cars and park at the airport are a very low share of the total passengers surveyed, ranging from 1-10%. This comports with the decline in long-term parking lot utilization at both EWR and JFK. At EWR the reduction has been steep with a 26% decline at P6 and 39% decline at its valet lot from 2009 to

Table 15: Net Effect on Peak Hour Operations Demand, Diversion and NextGen Improvements to 2030

		General Aviation	Cargo	Other Airports	Higher Speed Rail	NextGen Implementation (Conservative Scenario)	Net Peak Hour Flight Diversions
JFK	2030	3	2	-1.9	-2	-1	0.1
EWB	2030	1	3	-1.9	-1.8	-2	-1.7
LGA	2030	2	0	-2.4	-6.3	-4	-10.7

Source: RPA

2016. Short-term parking has declined as well, even as the duration of stay has increased. This is likely explained by the relatively large number of passengers that are dropped off by personal cars (family or friend), roughly 20-30% of respondents in the annual customer survey stated that this was how they arrived at the three airports².

If these trends persist the demand for parking will continue to erode, which will ultimately impact the PA's bottom line. Parking typically accounts for 11% of aviation revenues — generating \$264 million in 2015. To date the agency has not seen a decline in revenue due to actions taken to increase parking fees (in 2009, 2013 and 2016) over the intervening seven years. However, raising the price of parking will put additional pressure on air travelers to seek out cheaper alternatives. This combined with the aforementioned developments in autonomous vehicles, will necessitate a change in how parking structures are used, vehicles are charged and the curb is managed.

Toll Airport Roads. RPA's 2013 study *Extending PATH to EWR* recommended tolling the airport roadways at EWR to pay for the extension of the railroad, with the advent of TNC and AV this idea should be extended to all three facilities. More than half of the passengers at the three airports are dropped off or picked up by private automobiles, taxis or liveries. While transit riders and people parking in the lots pay a fee, these other passengers are not helping pay for the infrastructure to access the airport. Charging a fee to use the airport access roads — as Dallas-Fort Worth and Dulles International Airport are doing — would help fill the eventual decline in parking revenues and also generate funding for infrastructure maintenance and improvements. Instituting tolls to access our airports by automobile would also have the benefit of further encouraging air travelers who could use transit to switch modes and the price could be adjusted to respond to congestion or other policy considerations. Instituting airport tolling systems could involve installing gantry systems at both the airport entrances and exits, and would not create chokepoints or slow traffic on the internal roadways. It could use EZ-Pass transponders and/or License Plate Recognition (LPR) cameras to bill motorists. Eventually this system could be replaced by Vehicle Miles Tolling — as covered in RPA's 2012 report *Mileage-Based User Fees: Prospects and Challenges* — reducing its operating costs to maintain the gantries.³

² In recent years there has been an increase on off-airport (non-Port Authority) long-term parking facilities at EWR

³ Zupan, Jeffrey M., Richard E. Barone, and Jackson Whitmore. "Mileage-Based User Fees: Prospects and Challenges." RPA, June 2012. <https://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and>

Repurpose Excess Parking Capacity for Vehicle Staging. To reduce congestion and VMT the airports should further designate underutilized parking capacity for staging areas for taxis, TNC and eventually AV. JFK Airport employed a similar practice for TNC in 2015, using the excess capacity at its existing "cell phone" and limousine waiting lots. The lots employ a virtual queue to move vehicles efficiently through the lot with a first-in, first-out policy.⁴ This would enable these vehicles to be proximate to air passengers and be able to respond quickly to their e-hails, while at the same time not adding to traffic or taking up precious curb space.

Increase and/or Dynamically Manage Curb Space. The PA should be monitoring and reevaluating the demand for drop-offs to determine whether existing frontage is sufficient. In the near-term the agency should continue and build on its program to incentivize TNC and taxi drivers to change their behavior, but in the longer run other physical actions will be required. One of these could include extending the curb by taking adjacent travel lanes, which might be possible once AV technologies are implemented increasing lane capacity. However, it will be critical that the agency pilot technologies to dynamically provision the curb in real-time — sharing information on occupancy and designating the users allowed to dwell based on demand and/or time of day. These technologies, which have been used for curb side parking/metering, would also help in enforcement and lower the agency's costs and possibly eliminate the need to physically expand available frontage.

What about a New Airport?

RPA explored this possibility in its earlier study and was unable to identify any parcels in the region (within a reasonable distance of the core) that would accommodate a new commercial air passenger facility. There have been no measurable changes since this survey was completed in 2011. Another option explored was to reclaim land, constructing an airport island on either the Atlantic side (off the coast of the Rockaways) or in the lower harbor (in Raritan Bay), an alternative left open in RPA's earlier study. However, the catastrophic extreme weather event that the region experienced in 2012 (Super Storm Sandy) and RPA's more recent research into sea-level rise have since eliminated these options. The risk to these facilities would be enormous as would the cost to harden them to

d-repository/C-10-22-21144%20Mileage%20Based%20User%20Fees%20Final%20Report%2029June12.pdf.

⁴ "John F. Kennedy International Airport (JFK)." Uber, accessed January 31, 2018. <https://www.uber.com/drive/new-york/airports/jfk-international-airport/>

survive extreme weather. Recent trends continue to support expanding the region's existing airports. The growth in employment and population has further concentrated in the region's core, with a resurgence of new development in New York City and surrounding urban areas. RPA's fourth plan forecasts that this trend will continue with as many as another 1.9 million jobs and 3.7 million residents added to the region by 2040, with almost half of this growth occurring in the core.

Actions to Expand and Improve Our Existing Airports

As RPA determined in its earlier study, expansion of the region's existing airports is the only means of delivering the aviation capacity needed to serve anticipated future demand. The recommendations presented for each of the three airports build off research completed for RPA's 2011 report and subsequent developments that have taken place over the past seven years, including RPA's involvement in supplemental efforts to plan for airport improvements with the Port Authority, its own independent research, and collaborations with various aviation experts at several leading airport planning and financial firms. The expansion of the airports must adhere to a set of rational principles while also improving how the region's airspace functions along with accounting for the loss of Teterboro airport.

Reorienting to a 4-22 Airspace

This report will not address the intricacies of the region's airspace. For a greater in-depth discussion of these issues see Chapters 2 and 10 in *Upgrading to World Class: The Future of the New York Region's Airports*. However, it is important to briefly discuss the changes RPA is proposing to the operation of the region's exiting airspace in order to set the stage for RPA's runway recommendations. To simplify the operation and improve the reliability of the airspace it was determined in the 2011 report that a single primary orientation would be the preferred alternative. The analysis keyed off the two runway orientations at JFK and LGA, which are the airports most adversely affected by conflicting orientations due to their extremely close proximity of less than ten miles. The two orientations at the airports are 13-31 (or 130 degrees and 310 degrees) and 4-22 (or 40 degrees and 220 degrees). The east/west operation of the 13-31 runways were deemed to be more complicated due to the fact that the obstruction of the Manhattan skyline has to be avoided on takeoff and landing by turning either north or south, a similar constraint exists at EWR with its 11-29 crosswind runway. The more straightforward and simple solution is to operate JFK, LGA and EWR in the 4-22 or northeast/southwest direction. This would act as the default operating configuration and would allow all the

Airport Expansion Principles

The expansion options for each of the airports should adhere to the following seven principles:

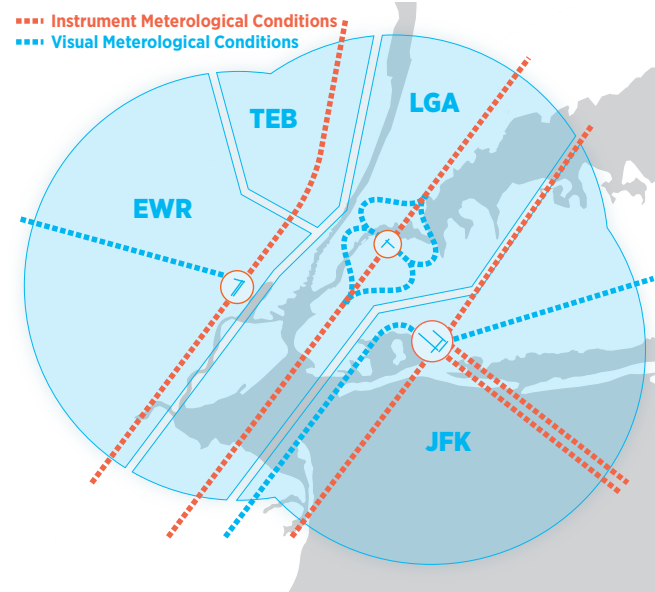
1. The region's airport must have the capacity to serve projected demand to support the region's economy and sustain its global competitiveness
2. Delays at the region's airports should align with the national average of ten minutes of airside delay
3. Public transit should have equal access to the curb as automobiles, this includes rail and bus
4. Public transit should absorb much of the growth in ground access
5. Sufficient roadway capacity must be provided to serve remaining auto share and trucks
6. Surrounding centers should be seen as commercial extensions of the airport and economic development opportunities should be oriented to support these synergies
7. The airports must be hardened to cope with storm surges and adapt to sea-level rise

airports to operate in parallel without conflicts. The other runways would still be retained and used to serve aircraft during high-demand periods and when weather conditions make operating in the default orientation unusable due to aircraft performance. Unlike in the 2011 report, all the new runway recommendations by RPA are oriented in the 4-22 direction. This is due to a better understanding of the limits of NextGen and other developments since the release of the earlier study.

Planning for the Loss of Teterboro

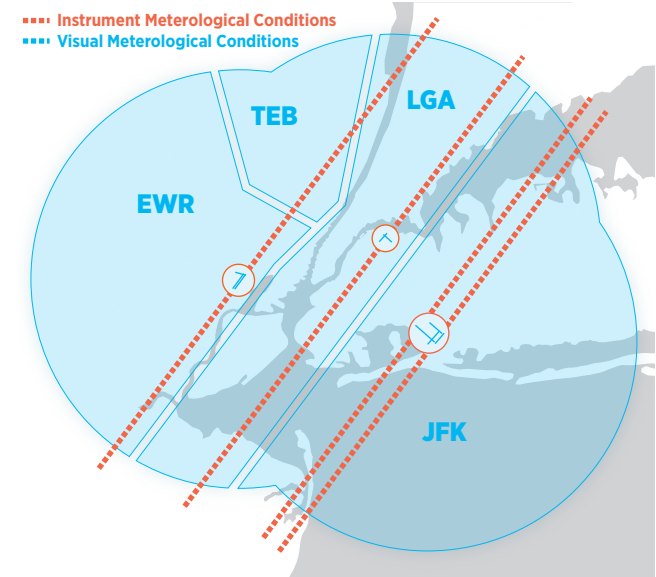
The cost of maintaining Teterboro, both financially and environmentally, will be increasingly hard to justify with rising sea levels, and should eventually result in closing the airport. Over the next 20 to 30 years the airport will slowly start to lose its battle with sea-level rise and will need to be replaced. Almost all of TEB operations are itinerant flights that originate from other airports. The airport can handle, and does at certain times of the day, 64 operations per hour on its two runways. Also, over 70% of the aircraft that operate out of the airport are higher performing private jets that require longer runways for take-offs. It was clear from our review in 2011 of the outlying commercial and GA airports that there is no equivalent facility that can alone absorb TEB's 167,000 annual aircraft operations. While these smaller airfields could take a portion of these flights — such as Morristown, Stewart, White Plains and

Figure 15: Existing Airspace Orientation for the Region's Major Airports



Source: RPA

Figure 16: New Conventional Approach Airspace Orientation (4-22) for the Region's Major Airports



Source: RPA

Republic — many of the larger private business jets will search for closer-in airfields with better access to New York City. The two obvious places will be LGA and EWR due to their excellent highway connections and close proximity to the central business district, JFK's distance and congested highways will make it a distant third choice — with only “special” GA service traffic (Air Force One and UN flights) calling at that airport. To ensure that the loss of TEB does not jeopardize the ability of the three major airports to serve anticipated demand or further worsen delays, additional slack capacity will be required at one of the major airfields to allow for absorption of approximately three-quarters of the traffic⁵. This assumption is incorporated into the supply side analysis that was completed for each of the airports.

⁵ The remaining traffic would be absorbed into other more distant regional airports.

John F. Kennedy International Airport



Photo: Port Authority of New York and New Jersey

At 4,390 acres, JFK International Airport is the largest airport in the region. It is also the busiest, serving nearly 59 million passengers in 2016. In the past JFK was the primary international gateway to the region, and it still carries almost two-thirds of the region's international passengers, with EWR carrying most of the others. It is a major domestic hub too. In the last few years its domestic volumes have grown rapidly, serving as the domestic hub for JetBlue and Delta Air Lines. The growth in air traffic at JFK and the region has been phenomenal over the past five years, outpacing RPA's 2011 demand projections.

Demand for air travel at JFK is projected to increase 60% by 2060. The size of aircraft is also anticipated to further increase, as airlines continue to take advantage of economies of scale. JFK is ill equipped to handle these additional aircraft on its four existing runways, of which no more than three ever operate simultaneously. Its fragmented central terminal area — six terminals with a combined 125 gates — will also not have the capacity to serve projected air passenger volumes that will be connecting at the landside.

JFK lacks adequate ground access capacity to transport these air passengers — by transit or automobile. The overwhelming majority of the travelers today arrive using private automobiles or a for-hire vehicle, straining the already congested roadways that serve the airport, such as a Van Wyck Expressway that has a level of service of D or worse on some segments¹. These same roadways are also used by trucks that move goods from JFK where most of

the region's air-freighter traffic is destined. An increase in automobile and truck volumes on these roadways will be untenable.

The AirTrain, a resounding success, has absorbed much of ground access demand over the past two decades, yet still only accounts for about 20% of travel to the airport. The service on the AirTrain is infrequent, the line has several slow zones and trains are capacity constrained (short). It also requires a transfer at Jamaica Station to the Long Island Rail Road or New York City Subway to reach the Central Business District in Manhattan (or at Howard Beach to the New York City Subway to reach Downtown Brooklyn or Lower Manhattan). Additionally, the railroad and the subway are not oriented to serve the needs of air travelers — hard to navigate stations without elevators and escalators are abound in the system and there is no luggage storage on any of the vehicles.

Vision and Elements

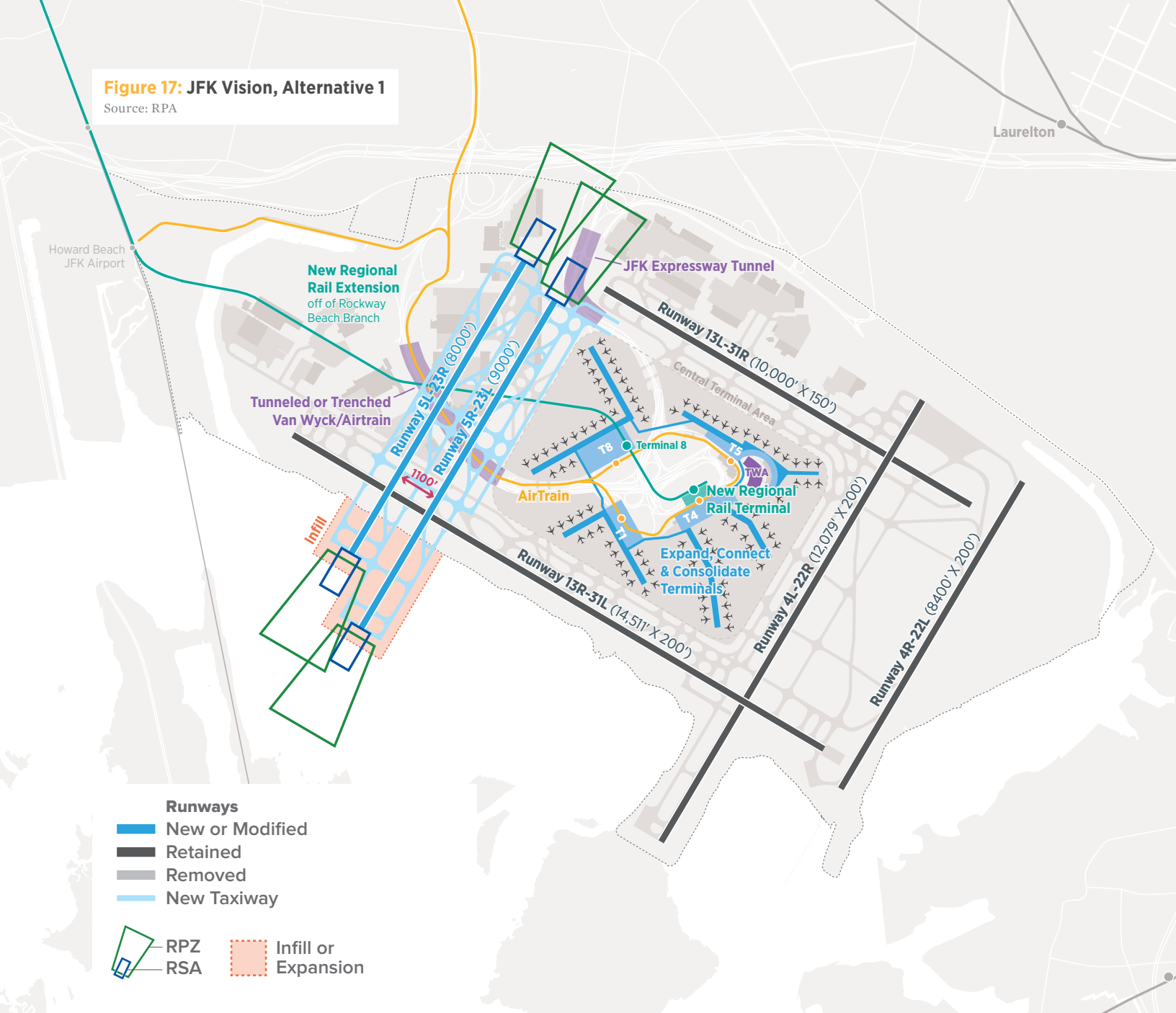
Out of the two New York airports, JFK is the best positioned for expansion. The airport is the region's largest with surplus space (acreage) and is located at an elevation that protects it from the risk of sea-level rise. JFK is also close to the region's core and connected to its vast commuter rail and subway networks.

Two new runways will be needed to accommodate forecasted growth. The second runway would provide additional capacity for diverted LGA traffic so that airport would be able to absorb the business jet traffic diverted from a shuttered TEB.

¹ Service level E is when a roadway is essentially operating close to capacity and the flow of traffic is becoming unstable.

Figure 17: JFK Vision, Alternative 1

Source: RPA



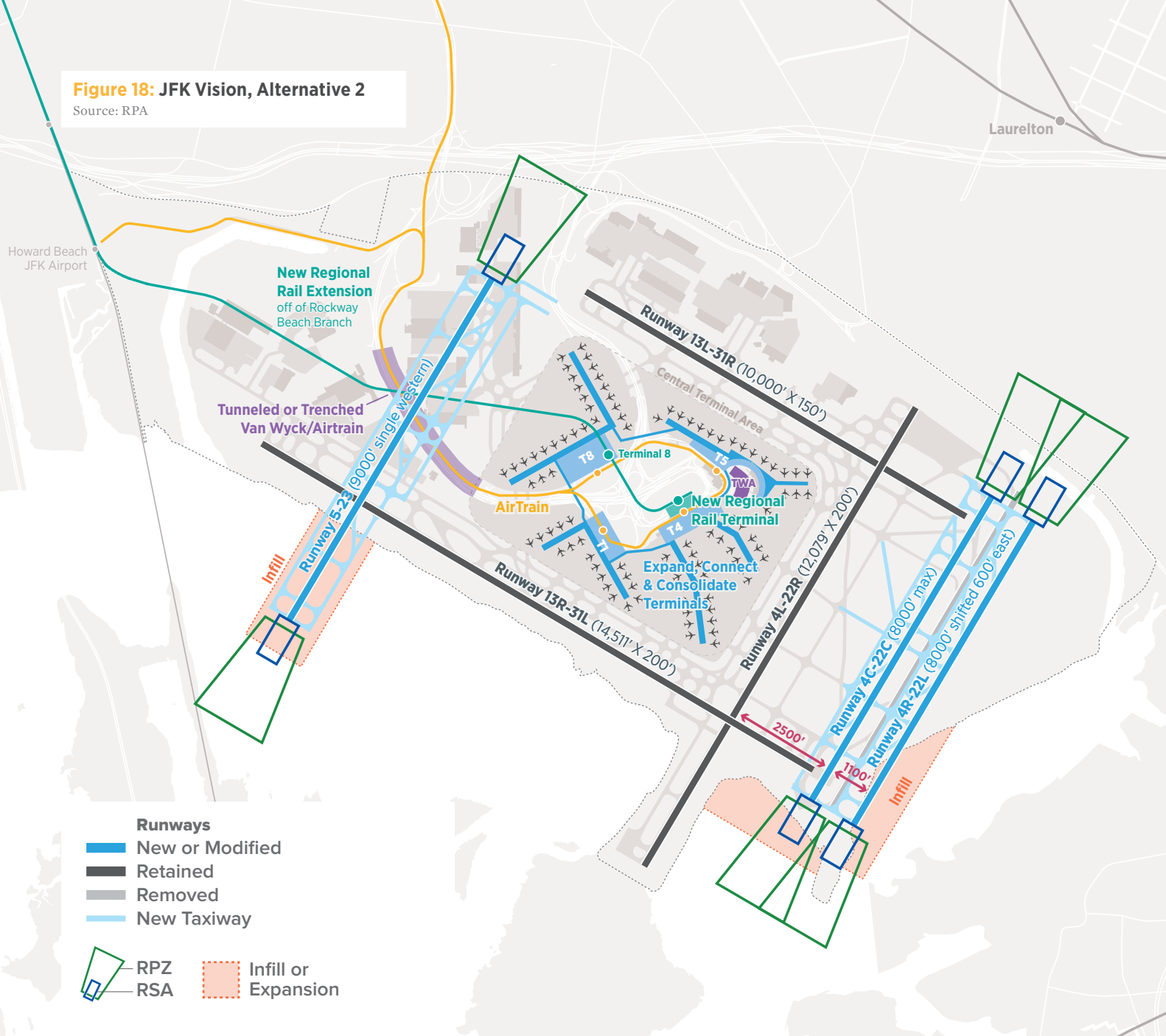
JFK's terminal area would be consolidated to fewer, larger facilities with common use gates — as outlined in Governor Cuomo's vision plan for JFK released during the winter of 2017. The four remaining terminals would be served by a much improved AirTrain along with a new one-seat ride regional transit service that would provide added capacity for growth, connect the airport directly to the Manhattan CBD and allow for quick and easy access from markets in northern New Jersey, the lower Hudson Valley and southwestern Connecticut. JFK would become a mega-airport — similar in size, transit access and amenity — to London Heathrow and able to serve over 100MAP annually with average delays of 10 minutes or less. The following details the seven major elements that make-up the vision for JFK.

Construct Two More Runways

To accommodate forecasted demand two new runways oriented in the 4-22 direction will be required, increasing the airport's capacity by over 50%. RPA is recommending the construction of a new 9,000 foot runway west of the terminal area — 5R-23L — that would serve as both a departure and arrival runway. The new runway would increase JFK's capacity by another 48 in bad weather or instrument meteorological conditions (IMC) to 50 in good weather or visual meteorological conditions (VMC) operations per hour. A second 7,000-8,000ft arrivals runway would be constructed either adjacent to the western runway or in between the two eastern 4-22 runways, 5L-23R or 4C-22C. This runway would support another 22 operations per hour and allow for the diversion of additional commercial traffic from LGA so that airport could absorb GA jet traffic from

Figure 18: JFK Vision, Alternative 2

Source: RPA



the decommissioned TEB. The AirTrain and Van Wyck Expressway would need to be placed in trenches as they would pass below the new western runway(s). The 5R-23L and 4C-22C runways would require reclaiming land/fill or constructing a deck into Jamaica Bay. However, RPA has reduced its estimate of the amount of fill required compared to its earlier 2011 report by eliminating one of the taxiways and shifting the runway slightly to the north. The current estimate is that between 49 to 222 acres would need to be decked over or filled, depending on the runway configuration. The decked solution would cost between 2.5 to 3.5 times more than fill, but could preserve the hydrological environment (shadowing the water could still be an issue). It would still result in pushing the perimeter zone further west, a concern of the communities surrounding

the airport. The new runways would also disrupt several communities just northeast of the airport, potentially requiring buy-outs or other forms of noise mitigation.

Consolidate Landside Facilities, Larger Terminals And Gates

The JFK Vision Plan presented earlier this year by Governor Cuomo features fewer expanded and interconnected terminals surrounding a redeveloped ring road and parking at the heart of JFK's Central Terminal Area (CTA). Long concourses of aircraft gates would radiate out from each of the expanded terminals towards the airport's taxiway network. All landside vehicular traffic would flow into and out of the terminals and garages of the CTA via the Van Wyck Expressway and the ring road. RPA's vision mostly aligns with this current plan, with only a few minor changes to

accommodate the new runways. The six existing terminals would be consolidated into three or four larger common-use facilities, and all gates would be available to all airlines. The actions could include the expansions of the new Terminals 4, 5, and 8 and the following additional actions:

- ▶ Terminals 1 & 2 (T1 & T2) would be demolished and their sites used for aircraft parking until a fourth terminal might be required
- ▶ The headhouse of Terminal 4 would be expanded, both existing concourses extended to full-length, and a third concourse developed on the site once occupied by Terminal 3
- ▶ Terminal 5 would be fully extended to the Terminal 6 site, and possible further onto the Terminal 7 site if and when the nearly 50 year old T7 is vacated and demolished
- ▶ T7 would be demolished and the site used to expand T5 or Terminal 8 (T8) OR T8 and T7 could be completely eliminated and the entire western side of the CTA reoriented and redeveloped to align with the new 5-23 runway(s) with a new headhouse and much larger mid-field concourse. This option would require the trenching and covering of the adjacent sections of the Van Wyck and JFK Expressways.

Create World Class Facilities And Amenities

The reconfiguration of the central terminal area provides an opportunity to correct the airport's poor service and apply best practices — open and spacious terminals with business centers, customer amenities, and effective management — competing with world class terminal experiences at airports in Singapore, Amsterdam, Madrid, London, Dubai, and other global cities.

AirTrain 2.0 — Improve Service, Amenities And Accessibility

In the near-term JFK AirTrain service needs to be improved, including a limited number of extensive physical interventions. Over the longer-term AirTrain could be directly connected the region's transit system to create a one-seat ride from the airport to the CBD or, as explored later, a new one-seat ride alternative could be constructed. RPA's evaluation of AirTrain's future ridership demand found that the system would reach its maximum capacity between 2040 and 2050 — making the connection to the mainline less desirable than a new service that would not only provide improved one-seat access but needed additional public transit capacity.

- ▶ **Increase Service Frequency:** from every 10–15 minutes today to every 5–6 minutes².

² Frequency of the AirTrain at its termini (Howard Beach and Jamaica Station) is limited by the shared right-of-way that both services must use in the central terminal area.

- ▶ **Increase Train Capacity:** by doubling the number of train cars on the AirTrain from two to four.
- ▶ **Integrate AirTrain Fares With Public Transit:** The AirTrain should be upgraded to the same “open loop” fare payment system that the MTA will be installing over the next five years. This should allow for a seamless transfer between public transit and the airports, which might be free or for an additional surcharge to be determined between the MTA and PANYNJ.
- ▶ **Rebuild Archer Avenue Subway Station At Jamaica:** The subway station at Jamaica Station should be completely stripped down to its bones (similar to the 63rd Street station platform levels for the Second Avenue Subway project) and rebuilt. The new station should match the design of the modern Jamaica/AirTrain complex and include an expanded mezzanine with additional elevator and escalator drops to both platforms. These improvements would also benefit local users of the subway and LIRR. The MTA should use this opportunity to install more accessible fare gates, similar to the gates the PANYNJ has installed at the AirTrain entrance, making the transfer easier between the AirTrain and subway/LIRR.
- ▶ **Rebuild & Expand On-Airport AirTrain Stations:** Portions of the existing AirTrain alignment should be rebuilt in the central terminal area so that it better integrates the stations with the existing or new terminals — giving transit better or equal access to the check-in hall as the curbside (i.e. T4). The rebuilt station would be designed to accommodate longer trainsets.

Create A New One-Seat Ride Express Transit Service To Midtown Manhattan

Almost all of New York's peers have one-seat rides from their major commercial passenger airports to their central business districts. RPA proposes to construct a new line on the airport to provide an express one-seat ride to Manhattan instead of extending the existing AirTrain. An analysis of AirTrain ridership demand indicated that over 1,000 air passengers per hour would be “left behind” by the 2050's with capacity falling short as soon as 2040 at Howard Beach. A new one-seat service would allow the airport to accommodate these air passengers and help to decongest a crowded AirTrain. The new airport service would be an outgrowth of RPA's Fourth Plan proposal for transforming the region's commuter rails into an integrated Trans-Regional Express. The Rockaway Beach Branch would be reactivated for passenger service from Atlantic Avenue, where it would connect to the new regional rail line³, to Howard Beach with two dedicated tracks for the airport service. There would be up two stops on the airport — at Terminals 8 and 4. The new airport express service would

³ The Regional Rail scheme proposes to extend the Atlantic Branch to Lower Manhattan via a pair of new tunnels, then up the 2nd/3rd Avenue corridor to Midtown East and over to New Jersey under the Hudson River at 57th Street.

provide a quick one-seat ride from Midtown Manhattan, Lower Manhattan and possibly Downtown Brooklyn to JFK utilizing a new East River crossing. There would be at least four trains per hour or one train every fifteen minutes with an average wait time of seven minutes.

Harden JFK For Storm Surge

While not impacted by three feet of sea level rise and only marginally by six feet, JFK Airport is still vulnerable to flooding from what are expected to be more frequent and higher intensity storms. Investments in storm surge mitigation solutions should be employed as part of the airport's redevelopment.

Strengthen Connections Between JFK & Downtown Jamaica

Downtown Jamaica, especially the area surrounding the AirTrain terminal, is both an underutilized asset for airport passengers and businesses and an emerging business center that can provide jobs and services for residents of southeast Queens. Redevelopment strategies for the airport and downtown Jamaica should be coordinated and complementary to strengthen synergies between the two.

Phasing

10 years: Begin the construction of the first runway, demolish T7 and extend T8 or T5 onto the T7 site — reconfiguring AirTrain in this part of the CTA.

20 years: Runway and one-seat ride are operational (between 10-20), remaining terminals demolished and consolidated with AirTrain completely reconfigured in CTA (aside from T4). Opening of phase one of the new one-seat ride express service that would terminate in Downtown Brooklyn at Atlantic Terminal.

30 years: Second runway is constructed, additional apron space and facilities are created for diverted LGA traffic to free up capacity at that airport to handle diverted GA traffic from the decommissioned TEB. Extension of one-seat ride express service to Manhattan via the 3rd Avenue corridor, enabling regional through running to JFK from New Jersey, Connecticut and the Mid-Hudson Valley.

Costs

The cost of expanding JFK were estimated for Alternatives 1 and 2 described above, with both options including the base costs of Governor Cuomo's recent vision that estimated an \$8 billion in landside investments to transform the central terminal area and improve AirTrain. Alternative 1, the preferred option, was estimated to cost \$22.6 billion — \$4 billion for airside expansion, \$14 billion for landside improvements (\$5 billion more than the current plan) and \$4.4 billion for additional AirTrain improvements and for a new on-airport rail corridor that would create a one-seat ride to JFK. Alternative 2 was estimated to cost slightly more (\$22.8 billion), with most of the added

cost attributed to the airfield expansion that would require more fill and be a more disruptive reconstruction of the airfield.

These estimates include civil works (all construction and demolition) and soft costs such as engineering, design, construction management, project administration, insurance/bonding and permits/surveys (other). However, they do not specifically include the mitigation costs to address the environmental, noise and wetland impacts of expansion. There will most likely be the need to buyout some residential properties north of the runways 5/23. The fill in Jamaica Bay will require offsets and the noise impacts to surrounding communities will need to be addressed either through relocation or residential soundproofing. A 20% contingency was also applied to the estimates to account for variability and these added costs.⁴

⁴ The accuracy range of this estimate, developed using Association for the Advancement of Cost Engineering (AACE) best practices, has been determined to be -20% and +50%. The accuracy range is a gauge of likely bid prices if the project was issued to tender at this current stage.

Design Reference: London Heathrow — Supersized Public Transit and Terminals

Heathrow Airport served 75 million annual passengers, operated 474,000 flights in 2015 and is the primary connection for international travel to the UK. Heathrow Airport serves more than 25 million passengers each year than JFK Airport does currently and Heathrow serves as many passengers today as RPA projects JFK will by 2040. London has continually made investments to improve its main commercial airport and in the process has created a series of robust ground access improvements — including an extension of the Piccadilly tube line to the airport (in 1977) and a dedicated higher-speed train service between the airport and Paddington rail station called Heathrow Express. The Heathrow Express has been a big success since its introduction in 1998, reducing a 45 minute tube ride from the airport to central London to just 15 minutes. Two cabin classes are offered, but both are considerably more expensive than the tube or buses. However, by creating a range of transit options, London Heathrow is able to meet the needs of all different types of air travelers, from young tourists to business people. There are plans to take this a step further by connecting the airport to Crossrail (now called the Elizabeth Line), London's new express regional rail service that would take air passengers through the center of London connecting them to many of the major transit hubs and destinations in the city, including providing a one-seat to the major Canary Wharf business district.

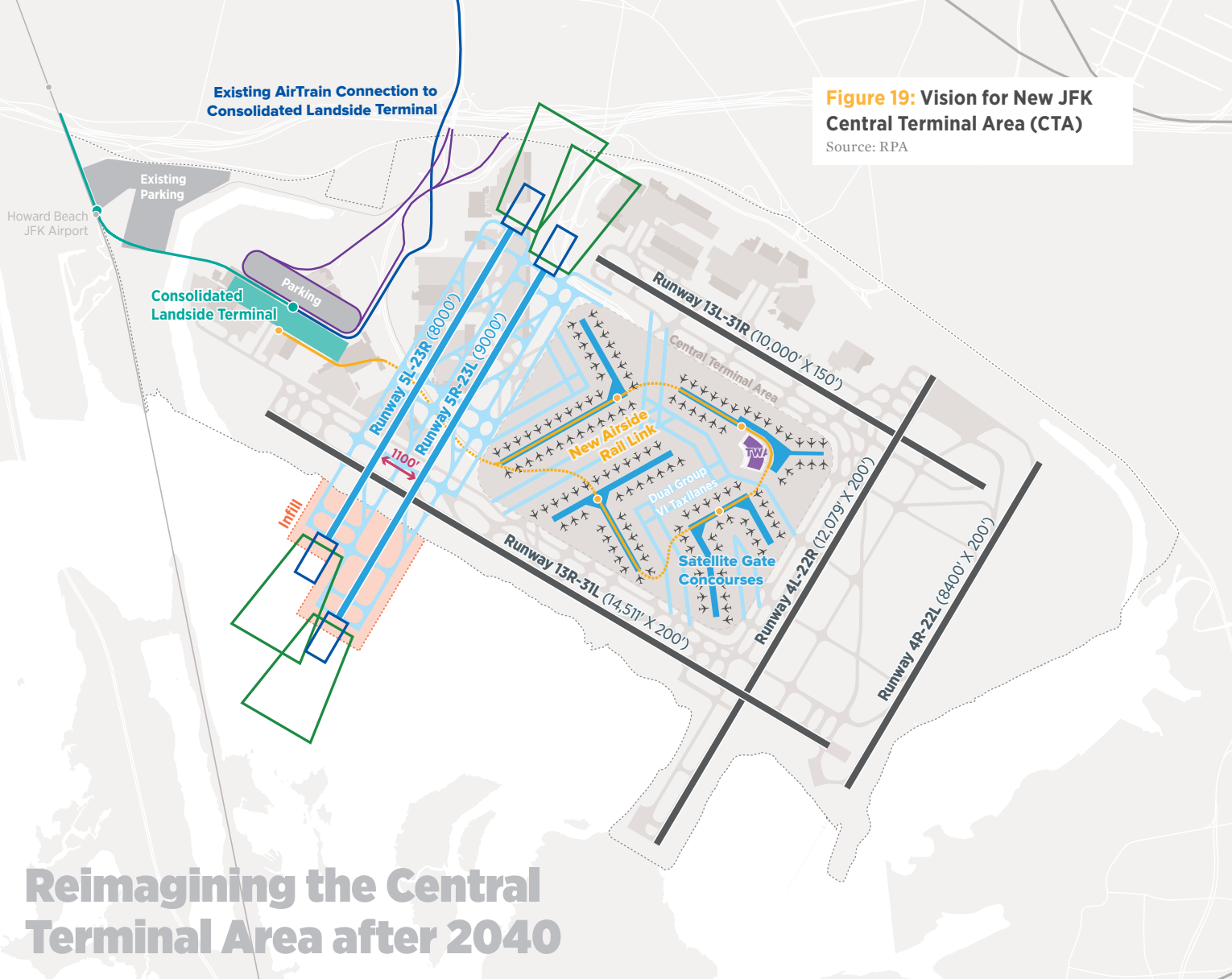
However, additional airfield capacity at Heathrow Airport has been needed for over a decade. A third runway at Heathrow Airport was first proposed in 2007 though plans were halted in 2010 due to local opposition. Over the years additional terminals and concourses have been built to expand landside capacity, yet the limitations of two runways have continued to constrain flight movements at Heathrow Airport. Capacity at London's regional airports,

Heathrow and Gatwick both began to see strain as Heathrow reached 99.2% of its capacity in 2011 and Gatwick began approaching its capacity limits. Plans for expansion were revived in 2012 when the Airports Commission was formed by the UK Government to address air travel constraints. In fact, RPA testified in front of this Commission and our 2011 report was used as reference for their efforts. After three years of study and public input the Airports Commission proposed a third runway at Heathrow to provide greater long-haul connections and expansion of Gatwick to serve intra-European travel in 2015.

The expansion plan for Heathrow-London Airport is ambitious. The plan includes a third runway, increasing flight capacity to 740,000, alongside development of two main terminals and several satellite concourses in the airfield located between runways. And the plans for Heathrow build upon the UK's existing and future investments in rail connections to the airport, including Crossrail, southern and western rail access plans, and the UK's second high-speed intercity rail line or HS2. It is anticipated that over 12 million people will live within 60 minutes of Heathrow by 2019. Additionally, Heathrow will operate with performance based navigation (PBN) requirements, improving flight paths, increasing the operating capacity of the runways and minimizing noise, which has been the primary reason for those opposed to Heathrow's expansion. PBN is anticipated to be operational in the UK by the mid-2020s. In July 2016, Heathrow Airport Holdings (owner and operator of Heathrow-London International) selected a design concept for the airport and it was approved by the government. Approvals by parliament are still required and are anticipated by 2018. The airport hopes to commence construction in 2021 and have the runway operational by 2025. The expansion is anticipated to cost \$21.4 billion.

Figure 19: Vision for New JFK Central Terminal Area (CTA)

Source: RPA



Reimagining the Central Terminal Area after 2040

The Governor’s JFK Vision Plan clings to the same “Terminal City” concept that was the foundation of JFK’s 1950s-era master plan — a island of disconnected terminals oriented around the automobile. Current best practices in airport master planning tend towards a large consolidated landside terminal headhouse, where outbound passengers first enter the terminal, connected to a series of satellite gate concourses by an underground Automated People Mover (APM) system. The landside terminal headhouse contains passenger processing (e.g. check-in, security screening, immigration), baggage processing and claim, ground transportation, and parking. The satellite concourses are typically located in the airport’s midfield between widely spaced parallel runways and with a high-efficiency taxiway system. Denver International (DEN), Atlanta’s Hartsfield Jackson International (ATL), and Washington’s Dulles (IAD) are examples of airports that feature this modern configuration. The RPA’s long-term vision for EWR, discussed later in this report, would also feature this layout.

RPA has examined whether the enhanced “Terminal City” concept put forth in the Governor’s Vision Plan has the flexibility to evolve into a layout featuring a consolidated landside terminal plus satellite midfield concourses in the long run and when or if it would be needed.

The current proposed Vision Plan might suffice over the next two decades assuming that trends persist or accelerate towards a greater shift towards public transit and use of on-demand car services, both of which would place less demand for expanded parking and roadway capacity. However, if demand for surface vehicular access does not abate, volume on the ring roadway network would limit the airport’s landside capacity and ability to serve forecasted demand of 104 MAP by 2060. Furthermore, as air passenger demand increases and air carriers are no longer able to increase the size of aircraft, JFK might require additional gates beyond the 250 narrow body equivalent gates provided in the Governor’s Vision Plan. A prudent course of action would be to examine additional terminal and land-

side capacity improvements, possibly outside of the CTA, that could be undertaken to ensure that near-term investments do not impede long term capacity solutions.

It is likely that the Vision Plan would be implemented over the next 10-15 years, so evolution to a consolidated landside terminal plus midfield concourses layout would be expected in 40-50 years when the next cycle of JFK terminal redevelopment would be required. Our preliminary concept study concludes that the Vision Plan does include the flexibility to adapt to a more efficient and higher-capacity midfield layout, as described below.

Consolidated Landside Terminal (CLT)

The genesis of the long term concept plan is to develop a large Consolidated Landside Terminal (CLT) to entirely replace the CTA's expanded and interconnected terminals proposed in the Vision Plan. As shown in the conceptual plan drawings the CLT would be developed on the current Cargo Area A site just southwest of Federal Circle, replacing antiquated facilities such as the former Pan Am Jet Center and Hangars 14 and 17. The advantage of the Cargo Area A location is its proximity to 1) the Rockaway Beach rail line (for rail connectivity), 2) the Belt Parkway, the Nassau Expressway, and the off-airport Van Wyck Expressway (the CLT would be located one mile closer to Manhattan than the existing CTA), and 3) JFK's existing Long Term Parking Lot between Lefferts Boulevard and Howard Beach.

Like RPA's proposed EWR NEC headhouse, the CLT would be a world-class intermodal facility bringing the ultimate JFK Express / Trans-Regional Express system directly into JFK's sole terminal. A high capacity highway spur would branch off the Van Wyck near Federal Circle to provide vehicular access to the CLT, its new short-term parking garages, and the existing Long-Term lot just to the west.

Upon arriving at the CLT by vehicle or train, departing passengers would go through a transformed passenger processing experience, checking-in and dropping bags with their airline, passing through high-tech and consolidated security screening, and then boarding an APM train for a ride out to one of multiple satellite gate concourses in the rectangular midfield between JFK's runways.

Satellite Gate Concourses

With the CLT, its roadways and parking will replace all existing terminals, roadways and parking in the CTA. A significant amount of CTA acreage could be converted from landside to airside. It is estimated that converting the existing landside portion of the CTA to apron airside would create an expansive 750 acre rectangular midfield area, larger than the 680 acre LaGuardia airport. The added apron would allow for additional contact gate positions, remote hardstand positions, and a high-efficiency delay-reducing apron configuration that would eliminate alleyways and provide dual taxilanes.

While there are many possible configurations of the APM-connected satellite gate concourses, the conceptual plan drawing puts forth a specific layout for illustrative purposes. The configuration shown features satellite concourses that have evolved from a potential Vision Plan layout, specifically with the Vision Plan's terminals, roadways and parking eliminated and replaced with apron and concourse extensions. This configuration may be advantageous from a capital cost, timeline, and construction phasing perspective.

Of note, the landmark TWA Flight Center — currently being developed into a hotel — is included in this long term concept plan. Access to the hotel could be provided by a dedicated non-secure express APM run (on the assumption that the hotel is to remain non-secure landside), or via a secure APM station in the adjacent and connected Terminal 5 (on the assumption that the hotel would be on the airport's secure side). A service roadway dedicated to hotel access could also be provided if deemed advantageous.

Summary of Benefits

While an evolution of the Vision Plan into the CLT plus satellite gate concourse configuration proposed here is possible in the long term, it is recommended that this concept undergo further study. There may even be merit, from a capital, operational and construction standpoint, to bypassing the enhanced CTA concept put forth in the Vision Plan and instead developing the CLT plus satellite gate concourses plan over the next 10-15 years.

Advantages of the plan include:

- ▶ Replaces expanded but legacy existing JFK terminals with a brand new world-class, efficient, consolidated landside headhouse terminal that would act as the airport's intermodal gateway. The consolidated terminal would embrace NextGen and common-use technology and practices and be used by all airlines, resulting in greater capital efficiency.
- ▶ Concerns about potential landside roadway constraints in a redeveloped CTA ring road would be ameliorated by developing an efficient, linear, and high-capacity landside frontage for the consolidated landside terminal.
- ▶ Converting the significant landside acreage of the existing CTA to apron airside acreage would allow for an expansive rectangular midfield apron area with more gates, more hardstands and an efficient dual taxilane configuration supporting additional aircraft operations and reducing delays.
- ▶ APM access to the satellite gate concourses and multiple stops in each satellite would minimize to/from-gate walking distances for passengers, a common complaint of JFK passengers destined for the Delta concourse at T-4 and the AirTrain/parking facilities at T-5 and T-8.

Recommendations

Newark Liberty International Airport



Photo: Port Authority of New York and New Jersey

Newark is the second largest (2,207 acres) airport in the region and today predominantly serves air passengers starting or ending their trips west of the Hudson River. In 2016 over 40 million passengers chose Newark, with a growing number of flights destined for international markets. EWR is one of seven domestic hubs for United Airlines, which operates Terminal C — the largest terminal at the airport. In addition, United uses Terminal B for some international arriving flights and Terminal A for flights by regional jet aircraft.

As at JFK, in 2008 the USDOT capped scheduled traffic at EWR at up to 81 operations per hour. In October 2016, the FAA reclassified EWR as a Level 2 Schedule Coordinated facility. As a Level 2 Schedule Coordinated facility, the FAA caps demand at 237 operations per three hour period, but does not formally grant airlines slots. Rather, the FAA will consider requests for new service, and either grant the request, suggest an alternate time, or deny the request.

The terminals at EWR were initially designed in an era that did not have modern aviation security requirements. Thus, they are frequently congested. Further, their designs are difficult to modify. The roadway and parking areas use space inefficiently with large areas devoted to surface parking. Terminal A and its concourses have reached the ends of their useful lives. Terminal B is in a better condition but its concourses do not have a sufficient number of larger gates. Terminal B has about a decade of service left. Terminal C, the newest and largest facility, has benefited from significant investments by United Airlines and will continue to service the airport for another 10-20 years.

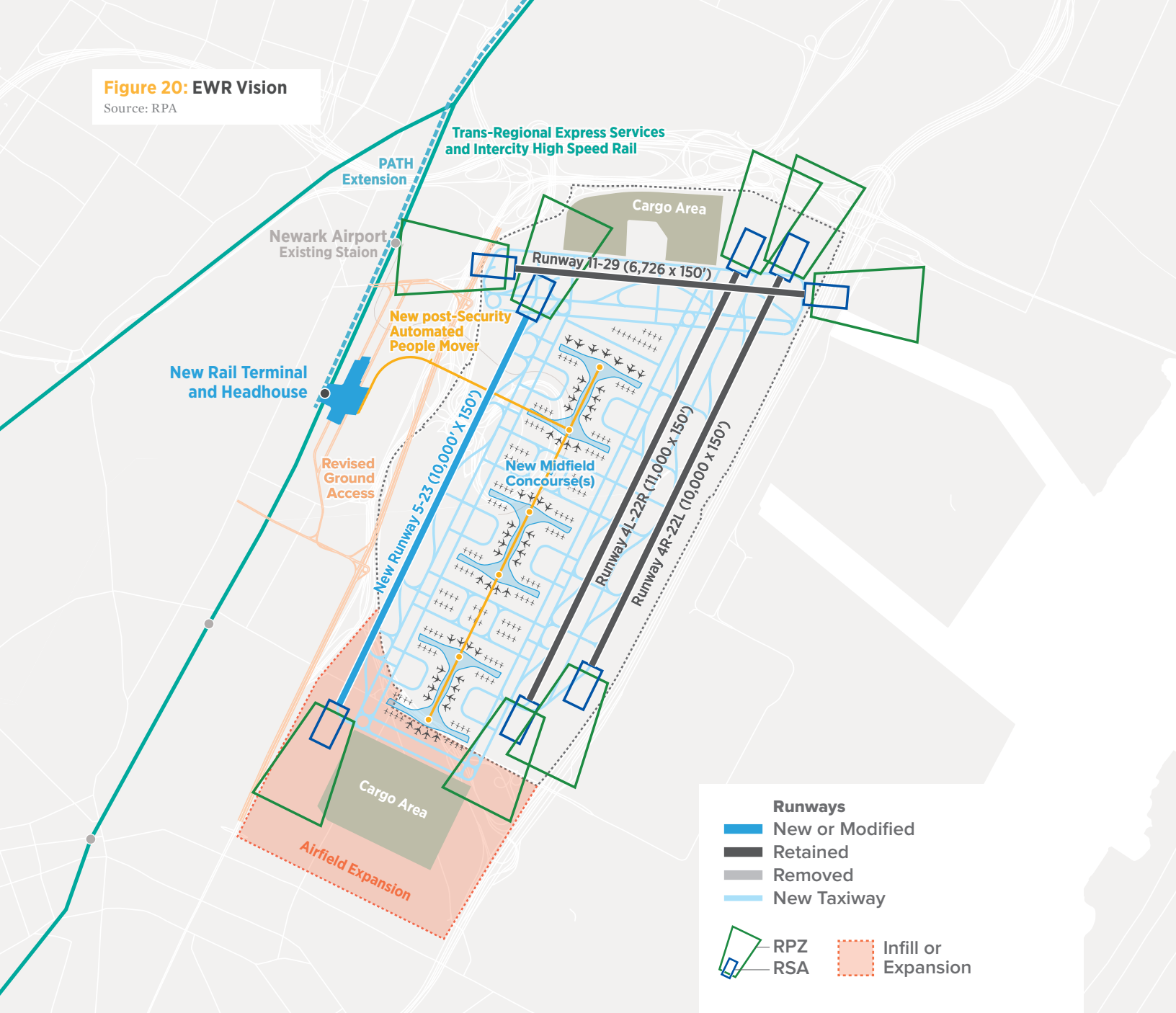
EWR is served by a rail station on the Northeast Corridor and its connecting Air Train that serves the terminals and several parking garages. NJ Transit and Amtrak both stop at the station. However, the service operates at uneven headways with trains arriving as frequently as 5 minutes or as long as 30 minutes with little thought to how an airport operates.¹ The most frequent service to the airport is 4-5 trains per hour operated by NJT between the hours of 3PM to 6PM. This service aligns more to a conventional PM peak commutation schedule than EWR's peak which is between 4AM to 6AM in the morning. The airport also has the demand for a more frequent service throughout most of the day and evening until about 11PM. The more expensive Amtrak intercity services that arrive just once an hour during the same time period and the lowest fares to New York City are typically \$25-30 one way.² Connecting between these infrequent rail services is further complicated by EWR's aging Airtrain. The Airtrain is scheduled to run trains every three minutes. However, the trains often run less frequently in poor weather conditions, when wet or icy tracks can slow train speeds or suspend service altogether. Additionally, the design and circulation for automobiles within the central terminal area is circuitous. Coupled with this is the insufficient curb frontage space for the uptick in passenger drop-offs and pick-ups since the introduction of on-demand app services like Uber and Lyft. The roadway design in the oval complicates ground access to EWR's terminals.

¹ "Northeast Corridor Schedule." *NJT*, accessed January 31, 2018. <http://www.njtransit.com/pdf/rail/R0070.pdf>.

² "Amtrak System Timetable." *Amtrak*, January 2018. <https://www.amtrak.com/content/dam/projects/dotcom/english/public/documents/timetables/Amtrak-System-Timetable-0118.pdf>

Figure 20: EWR Vision

Source: RPA



Physical design of the airfield has been modified slightly since 2011 with the completion of high-speed cross taxiways for the parallel runway and ground sensors have been installed that are being incorporated with ground-based augmentation systems (GBAS) for Next-Gen improvements. Even with changes made since 2011, airside capacity at Newark Liberty International Airport is virtually unchanged — hampered by physical and regulatory constraints. The most pressing of these is the current airfield footprint which limits runway operations and has insufficient parking for wide-body aircraft. There are aircraft circulation conflicts between the large, wide-bodied aircraft capable 4-22 runways, and the shorter, intersecting runway 11-29. This results in little use of the 11-29 runway unless one of the parallel 4-22 runways is closed. FAA approval for simultaneous operations on the 4-22 runways

is also not projected at this stage.³ This is due to close proximity of the two runways, limiting their capacity and making them insufficient to handle projected future growth.

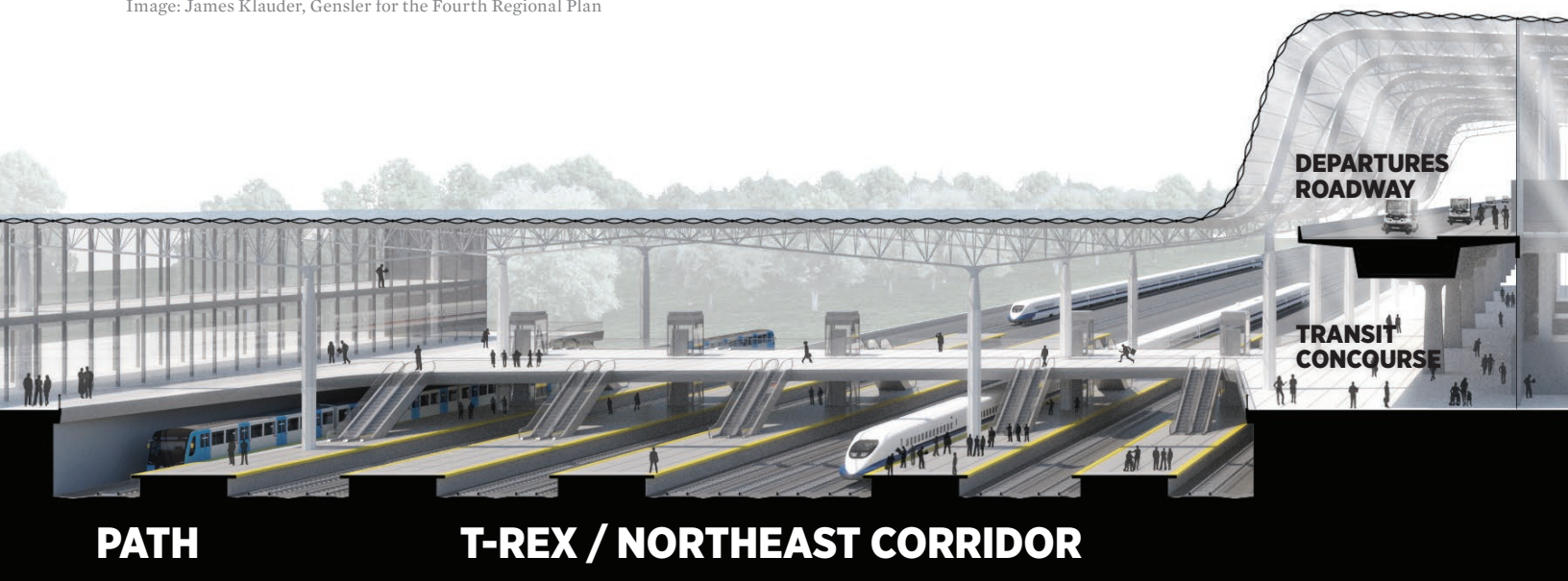
Vision and Elements

The vision for EWR is transformative and will take several decades to be fully realized. In the past, planners have proposed bringing transit directly onto the airport. RPA's vision for EWR would instead bring the airport to transit by constructing a new main terminal headhouse — the

³ "NextGen Implementation Plan." *Federal Aviation Administration*, June 2016. https://www.faa.gov/nextgen/media/NextGen_Implementation_Plan-2016.pdf.

Figure 21: Section of NEC Terminal

Image: James Klauder, Gensler for the Fourth Regional Plan



primary interface between the landside and airside with ground transportation services, check-in counters, passenger security screening, and baggage claim — directly on the Northeast Corridor. This would be coupled with an extension of PATH to EWR (and then Elizabeth) and introduction of more frequent regional and high-speed intercity rail services. A long-term land assemblage and phasing plan would slowly lay the ground work for a new (fourth) western runway and midfield concourse. The airport would also be extended south to accommodate the airfield expansion and make more space for aircraft parking and to create a more modern and accessible air cargo area. The following eight elements, in order of phasing, would transform EWR into the region's premier intermodal facility.

Build Terminal A

Construct the new Terminal A to operate for the next 30 years or more. This terminal would serve as bridge between the airport as it is today and RPA's proposed masterplan and would be operated concurrently as the airport is rebuilt, including the initial phases of the mid-field concourse. It would eventually need to be razed to make way for the construction of the new western (fourth) runway.

Implement Short-Term Airtrain Replacement Solution

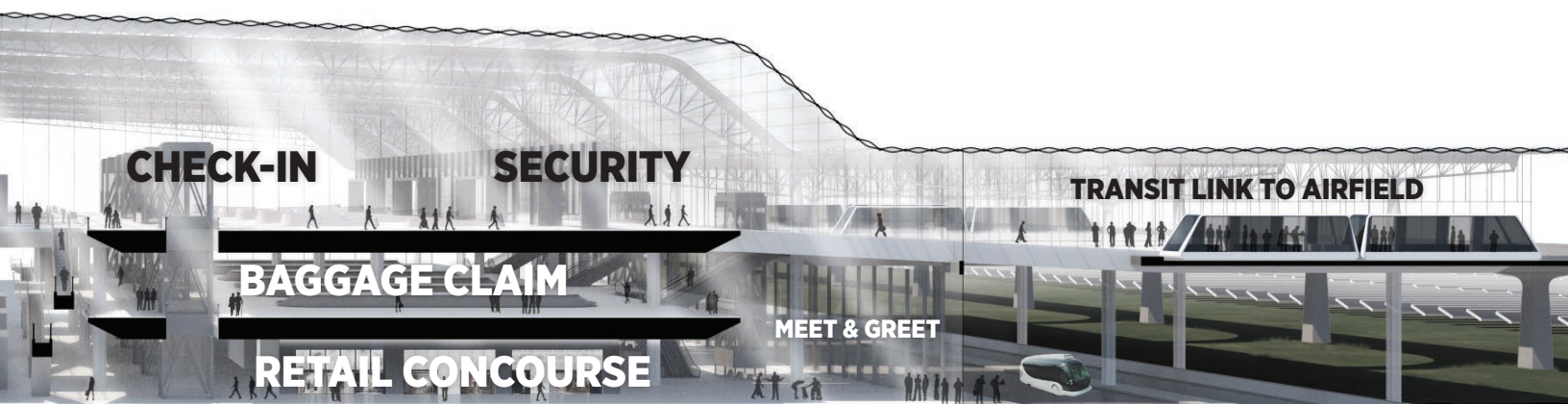
The AirTrain is failing and has less than a decade of operation left. It will need to be replaced long before the full vision for EWR is realized. To this end, it is important that that its replacement be considered as an interim and not a final solution. If it's another automated people mover (APM) then it should have a design life of no more than 25-50 years, since it would likely need to be removed to make way for the runway in less than 30 years. RPA would also recommend that the Port Authority consider an on-airport APM and the use of a more flexible and less costly

option for the Rail Link station, which might include a bus shuttle service similar to the one operating at Los Angeles International Airport.

Build The Nec Terminal Headhouse With New Rail And Bus Facilities

EWR suffers from two major constraints, a limited amount of space for airside operations and poor connectivity to public transit. A solution to both is to shift the airport further to west and placing its main headhouse directly on the Northeast Rail Corridor (NEC), putting transit at the airport's front door. The new headhouse would consolidate all airport ground access, security and baggage handling in one large facility. Its position located between the rail corridor and Routes 1 and 9 gives it direct access to all ground modes. The new terminal headhouse program would also include short-term parking garages, a bus facility (~72-100 bus bays) for commuter and intercity service, and curb access lanes for private and on-demand vehicles. A new railroad station would be constructed with 10 tracks and 5 platforms (plus two express bypass tracks) to accommodate PATH, regional rail and intercity trains. The structure would span the NEC, making a bold architectural statement, while also linking the new airport and station to the communities on the western side of the corridor. Unused land on the western and eastern side of the corridor could be redeveloped as hotels and other complementary airport uses, buildings on the eastern side of the NEC (south and outside of the threshold for 11-29, mostly the Brewery site) would have a height limit of 16 floors based on their proximity to the new runway⁴. Secure side people-movers would connect the NEC terminal headhouse to one or more midfield concourse(s) that would be located between the new runway and two existing parallel 4-22 runways.

⁴ Calculation is $DFR - 500 / 7 = ABH$, where DFR is distance from runway and ABH is allowable building height. Assumption of the height per floor was 14 feet.



ARRIVALS ROADWAY

BREWERY DEVELOPMENT ►

Phase-Out Existing Terminal Area And Replace With Midfield Concourse

Over the next three decades the central terminal area would be deconstructed as each of the terminals reach the end of their useful life. This would include removal of the oval roadway system, and its surface parking lots, relocation of the air traffic control tower and on-airport hotel. Starting with demolition of Terminal B, the replacement facilities would be reconfigured as remote midfield concourses with their other functions moved to the NEC headhouse — including check-in, security, baggage claim and ground access.

Extend Path To EWR And Then Elizabeth

Extend the PATH less than 2 miles south from Newark Penn Station to the existing airport rail link station. This modest project is currently in the PA ten-year capital plan and would open up access to the airport for residents and workers in Newark, Harrison, Jersey City and Lower Manhattan. Furthermore, the new WTC transit hub seamlessly connects PATH to seven subway lines — almost all ADA accessible. From WTC to the existing NEC rail link station trains could run every 2.5 minutes during peak periods. The extension would also serve to improve the operation of PATH by constructing a proper terminal and yards for the transit service. These new facilities would also allow PATH to extend its uptown service (which currently terminates at Journal Square) from 33rd Street to EWR.

To reach the new NEC headhouse PATH will need to be extended a half-mile further south along the corridor from the existing rail link station, which will be eventually be decommissioned. This will place PATH at the entrance to the airport, dramatically reducing the distance transit users would need to traverse before checking-in. A future extension further south to Elizabeth should also be explored, which could help open access the airport for

those that live in the surrounding communities for travel and employment. The FAA is exploring amendments to the Passenger Facility Charge (PFC) policy that would allow for funding of rail extensions like PATH to EWR, with a PFC increase at the airport⁵.

Extend Airport South To Create New Cargo Area

EWR's airfield area is constrained — at only half the size of JFK's. While there is much wasted space within the CTA, reconfiguring this area alone will be insufficient. As aircraft continue to grow in size more space will be required to park and operate them. EWR is also the main express parcel facility in the region, acting as a hub for both FedEx and UPS. The projected increase in employment and residential population will also increase the demand for cargo. To accommodate aircraft and cargo operations the airport will need to expand its footprint. The logical place for this expansion is to the south of the existing airfield and fuel farm in a 600 acre industrial/commercial area that sits between the airport and the old Central New Jersey rail line, which today is used for freight.

Construct A New Western 4-22 Runway

EWR will need a runway by the 2050's, but finding a place to construct one that does not disrupt one of the nation's most critical interstate routes, displace the second busiest port in the nation, or level entire communities while still remaining operable without airspace obstructions has proven to be a significant challenge. RPA's 2011 report recommended a closely-spaced triple parallel solution that would have kept the expansion within the borders of the airport but still would have resulted in the reconstruction of the central terminal area. Since the study was released

⁵ "Passenger Facility Charge (PFC) Program: Eligibility of Ground Access Projects Meeting Certain Criteria." Notice by the Federal Aviation Administration, *Federal Register*, May 3, 2016. <https://www.federalregister.gov/documents/2016/05/03/2016-10334/passenger-facility-charge-pfc-program-eligibility-of-ground-access-projects-meeting-certain-criteria>.

Figure 22: Aerial Rendering of EWR 2040 Vision

Image: James Klauder, Gensler for the Fourth Regional Plan





the Port Authority and FAA have taken a closer look at that option and have eliminated it due to operational constraints. The FAA has stated that this new runway would only marginally increase capacity because controllers would not operate aircraft independently on the outboard runways and would rarely use the center runway for arrivals. RPA had originally assumed that the Next Gen air traffic control system would have given air traffic controllers the precision required to allow this type of operation⁶. However, the delay (and confidence) in delivering the new ATC along with other operational challenges and complexities has negated the capacity benefits of this option, requiring the PA and RPA to go back to the drawing board to assess other viable options⁷. To that end RPA logically looked further east and west of the existing runways. Three options were initially evaluated and eliminated — the port, I-95 and Brewery runways:

Port: This option would place a runway on the western end of the berths. This would require the relocation of large part of the container port, which accounts for 80% of the region's containers. Making this even less feasible is the \$1.3 billion dollar investment that has been made to raise the Bayonne Bridge and the billions of dollars expended by the Army Corp to dredge the Kill van Kull and berths to a depth of 50 feet to accommodate modern larger vessels. All of this has been done to prepare the ports for larger container ships. On top of this investment the PA has spent almost \$600 million⁸ to construct on-dock rail facilities (ExpressRail) and make other ground access improvements at the ports. These sunk costs, combined with costs of having to build a port someplace else and connect it to region's rail freight and roadway system, likely makes this option infeasible.

I-95: A runway would be built over or on the I-95 highway segment that runs adjacent to the airport. The highway would either be trenched and shift to east (impacting port) or west (impacting the airfield) or placed in a tunnel. This option would require demolishing and reconstructing two major interchanges that serve the port and airport. It would also require rerouting one of the nation's busiest and most critical highway corridors. The construction impacts to interstate and intrastate goods and passenger movement would be massive. Part of the seaport (and its operations) would also be impacted (and possibly displaced to created space for tunnel portals and ancillary facilities) by this option, due the centerline of the new runway being less than 1,000 feet from the nearest ship berth. This option would also impact the adjacent freight railroad that connects the ports to the hinterland, this surface railroad might also need to be placed in the tunnel as well due to its

proximity to the runway. This option would be very complex, have high costs and operational impacts, across many modes, making it a difficult proposition.

Brewery: This third option would center a new runway on the site of the existing Budweiser Brewery, adjacent to the Northeast Corridor. This site would allow the existing airfield to remain relatively intact and limit operational impacts to the existing airport by essentially constructing a satellite runway. Route 1 would be trenched in places to allow for the construction of jet bridges that would connect the runway to the main airfield and CTA. The NEC headhouse would need to be downsized under this option since most of the space between Route 1 and the NEC would be used for the new runway. To safely clear (on one engine) the existing 374 foot high Prudential Tower in downtown Newark the runway would need to be shifted further south. This airspace constraint would force the intrusion of the runway into adjacent communities in Elizabeth and based on its required length of 9,000ft (~ 11,000ft with RSAs) these impacts would be severe. It's hard to estimate the exact number of property takings, but based on RPA's crude geospatial analysis, overlaying the profile of the new runway in this location would impact thousands of properties and displace hundreds of households. Furthermore, developers in downtown Newark are currently planning even taller buildings that would force the runway even deeper the community, increasing the number of residents that would be displaced. The magnitude of the community impacts makes this option undesirable.

The issues associated with each alternative led RPA to search for a solution that would allow the runway to stay more within the boundaries of the existing airport to reduce its impact on surrounding residential communities and adjacent transportation facilities. To this end, RPA experimented with various runway alignments — shifting the western runway further east while keeping the required 3,600 feet between the new runway (for independent arrivals, 2,500ft for independent departures) and the existing 4-22s to enable independent parallel aircraft operations. It was also critical that the runway have few airspace obstructions to the north, moving it far enough away from downtown Newark to eliminate existing and future conflicts was an important factor.

Central Terminal Area Runway: The best alignment was found to be within the existing central terminal area, just east of Route 1. The appeal of this option was further buttressed by the industrial area located just south of the airport at this location, allowing the southern extension of the runway to almost entirely bypass residential communities. The runway orientation and location also does not directly align with any existing or future airspace obstructions since the communities to the north, Ironbound and Harrison, are both mixed-use districts with a built-form of around six stories. However, building heights would be restricted west of Newark Penn Station to Broad Street

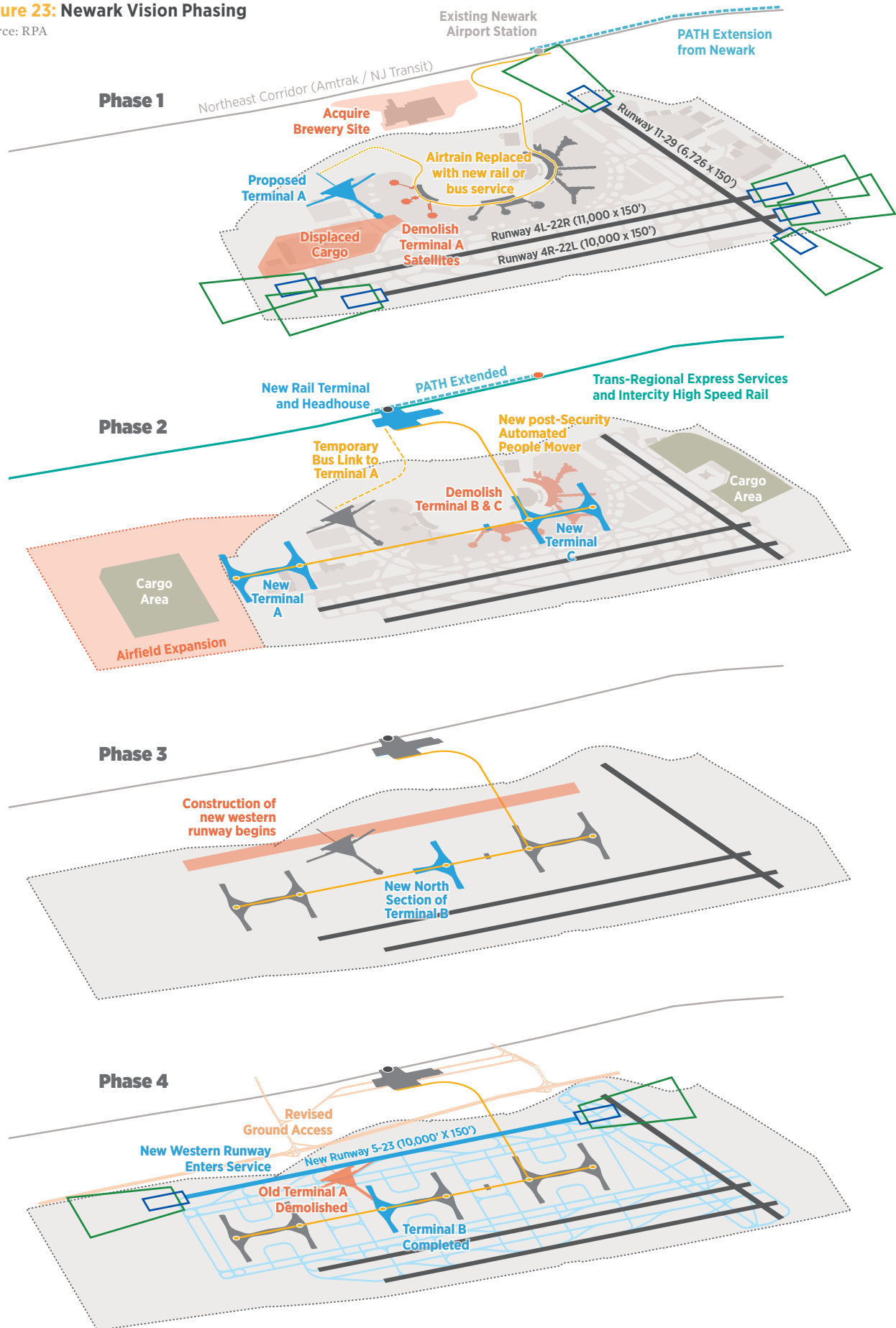
⁶ RPA also evaluated numerous other alternatives for EWR as part of its 2011 study of the region's airports; all but the additional 4-22 alternative were eliminated due to insufficient capacity.

⁷ Tamburro, Ralph. "Interview with Port Authority Program Manager, Delay Reduction." Personal interview. 17 Mar. 2017.

⁸ "Port Capital Improvements." *The Port Authority of NY & NJ*, accessed January 31, 2018. <http://www.panynj.gov/about/port-improvements.html?tabnum=0>.

Figure 23: Newark Vision Phasing

Source: RPA



— with buildings closer to Broad Street limited to 1,000ft (~83-70 stories), a building height much taller than existing structures in downtown Newark. Current planning in downtown Newark conforms to these restrictions, with buildings adjacent to Penn Station likely to be at most 20 stories or 280ft in height. This virtually eliminates long-term airspace conflicts. However, the impact of this option on existing operations will be significant. It will require the complete demolition and reconstruction of the central terminal area, shifting the headhouse function to the NEC terminal and building new midfield concourses. It is a radical change that will take decades to piece together and will need to occur simultaneously with operating the airport and serving tens-of-millions of customers a year.

Leverage Development Opportunities On Underused Land West And East Of NEC

The expansion of EWR offers the opportunity to better connect it to adjacent communities and take advantage of adjacent properties that are underused to develop complementary amenities. These would be attractive to air passengers and provide greater economic opportunity for the surrounding communities. Within its 2012 Master Plan, the City of Newark's Airport Support Zone encourages synergistic land uses surrounding Newark Airport. With particular focus on the NEC station, the city supports the extension of PATH and a multimodal hub at the station linking into transit oriented development. These include general commercial uses, airport logistics offices, and hospitality nearby. Allowable building height on the western side of the NEC would be roughly 30 stories for structures across from the headhouse, south of the 11-29 runway. The recently implemented zoning from Newark's 2012 Master Plan supports the development of new hotels, conference centers, office space and residential developments both to the west of and south of the NEC station.⁹ And local plans for Dayton Street¹⁰ and the Greater Dayton Neighborhood¹¹ support local job creation opportunities that come with greater commercial development of infill sites. Of particular focus for these communities is reducing the off-airport parking that abounds east of the NEC and creating greater transit access for residents to downtown Newark through the extension of PATH. Transforming vacant land and soft sites, where land is primarily used for surface parking, into transit oriented developments with residential and airport supportive commercial uses would grow the local economy and result in substantial community benefits.

Phasing

10 years: Construct the new Terminal A as planned by the Port Authority, replace AirTrain with an interim rail system or a shuttle bus solution for the Central Terminal Area (CTA), acquire the brewery site and expand the Northeast

Corridor (NEC) station (phase 1 of NEC terminal) as part of the PATH to EWR extension. Continue to assemble land for airport expansion.

20 years: Construct the NEC Terminal Headhouse, acquire remaining commercial parcels and extend the airport south, demolish Terminals B & C and replace with midfield concourses A (southernmost) and C (northernmost) served by post-security Automated People Mover (APM) from/to the NEC Terminal. Operate Terminal A separately with bus link to NEC station. Regional rail arrives at the airport via completed Gateway project with through regional service to geographic Long Island and New England.

30 years: Final properties (residential) acquired and construction of the new western runway begins along with the northern half of concourse B, which would not impact Terminal A.

40 years: Terminal A is demolished, the western runway is completed and enters service, and the remaining portions of concourse B are constructed.

Costs

The cost of this 40-year plan to transform EWR was estimated at \$28 billion — \$13 billion for airside expansion and construction of the new midfield concourses and taxiway network, \$8 billion for landside improvements that includes the new NEC terminal headhouse and reconfigured roadway network and \$7 billion for a new secure-side people mover to connect the NEC terminal headhouse to the midfield concourses and a short half-mile extension of the PATH to the new headhouse station.

These estimates include civil works (all construction and demolition) and soft costs such as engineering, design, construction management, project administration, insurance/bonding and permits/surveys (other). However, they do not specifically include the mitigation costs to address noise and community impacts of expansion. There will be the need to buyout commercial and some residential properties as part of extending the airport south to accommodate the new runway, air cargo operations and one of the midfield concourses — this is detailed more in the mitigation section below. These needs may be addressed with future federal Airport Improvement Funding (AIP) and other state/local grants in aid. A 20% contingency was also applied to the estimates to account for variability and these added costs.¹²

⁹ Office of Planning, Zoning and Sustainability, *Newark Zoning and Land Use Regulations Quick Reference: EWR & EWR-S*, (City of Newark, 2015), accessed December 10, 2015, <http://planning.ci.newark.nj.us/zoning-information/#EWR>

¹⁰ "Dayton Street Transformation Plan." *Newark Housing Authority*, April 2014. [http://www.newarkha.org/cni/CNIDOCs/CNI%20TRANSFORMATION%20PLAN/Draft_Dayton_Street_TP_-_Narrative_Only_04-09-14\[1\].pdf](http://www.newarkha.org/cni/CNIDOCs/CNI%20TRANSFORMATION%20PLAN/Draft_Dayton_Street_TP_-_Narrative_Only_04-09-14[1].pdf).

¹¹ Greater Dayton Neighborhood Revitalization Plan, forthcoming

¹² The accuracy range of this estimate, developed using Association for the Advancement of Cost Engineering (AACE) best practices, has been determined to be -20% and +50%. The accuracy range is a gauge of likely bid prices if the project was issued to tender at this current stage.



Design Reference: Shanghai Hongqiao International Transportation Hub – Integrated Rail and Airport Complex

Hongqiao Airport was Shanghai's first international and domestic hub and served as critical gateway for the country. To satisfy growing demand for air travel, due to Shanghai's rising status as the financial hub of China, a new airport, Pudong International, was built in 1999 in the eastern part of the city.

However, traffic continued to increase at Hongqiao, exceeding the airport's capacity of 9.6 million passengers to more than 10 million annual passengers by 2006. Expansion of the airport was approved by the National Development and Reform Commission in February 2007. Unlike most airport expansions, it was not focused solely on airfield improvements and new terminal infrastructure for air passengers, but also on transforming the airport's landside into one of the largest integrated rail, bus and airport terminals in the world. A site on the western side of the airport was selected for a new intermodal facility that would contain the first high-speed rail hub in Shanghai along with a bus facility, which would be directly adjacent to a new terminal.

In 2010, the Hongqiao Transportation Hub opened alongside a second terminal, providing an integrated air service, high-speed rail and long-distance bus facility. Moving between these various modes of travel is seamless, with a vast multi-story corridor spanning the ground and air transportation facilities.

The transportation hub connects air travelers to the Beijing via Shanghai High-Speed Railway, the Shanghai–Hangzhou High-Speed Railway and the Shanghai–Nanjing Intercity High-Speed Railway as well as two of Shanghai's metro rail lines. Terminal 2 opened simultaneously and serves over 90% of all flights at the airport, all of which are domestic and short-haul regional/international travel (Japan, South Korea, Singapore, etc.).

The \$2.2 billion expansion took five years to complete and also included a third runway that quadrupled the airport's capacity to over 40 million annual passengers (and one million tons of additional cargo annually). As of 2015, Hongqiao Airport served 38 million annual passengers.

Recommendations

LaGuardia Airport



Photo: Port Authority of New York and New Jersey

LaGuardia opened in 1939 and was the first modern jet airport in the region. It is the most land constrained airport of the three major airports, with a footprint of only 680 acres. In 2016 LGA served almost 30 million passengers, most of them on domestic flights; with the only international destinations served in Canada and the Caribbean. The airport has two intersecting runways that are only 7,000-ft long and four terminals; the Central Terminal Building is the largest with half of the 74 gates. On a typical day in 2015 there were 987 operations (arrivals and departures), 97% commercial and 3% general aviation. In 2008, the USDOT capped peak-hour scheduled traffic to 74 (71 commercial and up to 3 general aviation slots) operations. LGA had served 75 scheduled flights and up to three general aviation flights per hour during the peak, and still does for much of the day. However, when USDOT reduced the cap, they did not mandate that airlines cut flights. Some voluntarily did so, and daily activity by the scheduled airlines fell by approximately 50 flights per day.

As part of the Governor of New York's vision plan for LaGuardia a new unified terminal area is being built for LGA. The \$4 billion construction project is led by a public-private partnership and a joint venture will manage the terminal after its construction as part of a lease and concession agreement with the PA.¹ LaGuardia's Central Terminal Building (Terminal B) and its concourses are being rebuilt as a central terminal. The new central terminal is anticipated to be completed in 2022. The central terminal will be expanded to a 1.3 million square foot single terminal, containing 35 gates and will handle 17.5 MAP, increasing

the terminal handling capacity by almost 4 million over current demand.^{2,3} Currently, Delta, the lease holder and operator of Terminals C and D, is linking the two terminals and revamping them into a combined 37 gate facility.⁴ The new airport vision plan from the Governor of New York also includes a proposal to serve the terminals by an AirTrain connecting to LIRR and Flushing Line at Willets Point. Once East Side Access to Grand Central Terminal opens in 2022 (est), the anticipated travel time to midtown Manhattan will be 30 minutes.⁵ The Delta terminals and AirTrain projects are separate from the initial CTA redevelopment and are anticipated to require an additional \$4 billion in public and private funds to complete.

Even with the complete reconstruction of the terminals, the airfield will be unable to handle most of the larger Group V wide-body aircraft. The shorter runways and closely spaced taxiways are not suitable for the Boeing 747 or 777 or Airbus' A330 and A350 series, aircraft typically used for longer haul flights. Even the newer Boeing 787 that can operate on the 7,000 foot runways in a lighter configuration cannot navigate LGA's closely spaced taxiways without its broad wingspan conflicting with other ground movements⁶.

¹ "Governor Cuomo Unveils Vision for Transformative Redesign of LaGuardia Airport." *New York State*, July 27, 2015. <https://www.governor.ny.gov/news/governor-cuomo-unveils-vision-transformative-redesign-laguardia-airport>.

² "LaGuardia Central Terminal." *LaGuardia Gateway Partners*, accessed January 31, 2018. <http://laguardiagatewaypartners.com/project/>.

³ Braun, Martin Z. "Skanska Team Picked for \$3.6 Billion LaGuardia Terminal Work." *Bloomberg*, May 28, 2015. <http://www.bloomberg.com/news/articles/2015-05-28/skanska-consortium-picked-for-laguardia-central-terminal-work>.

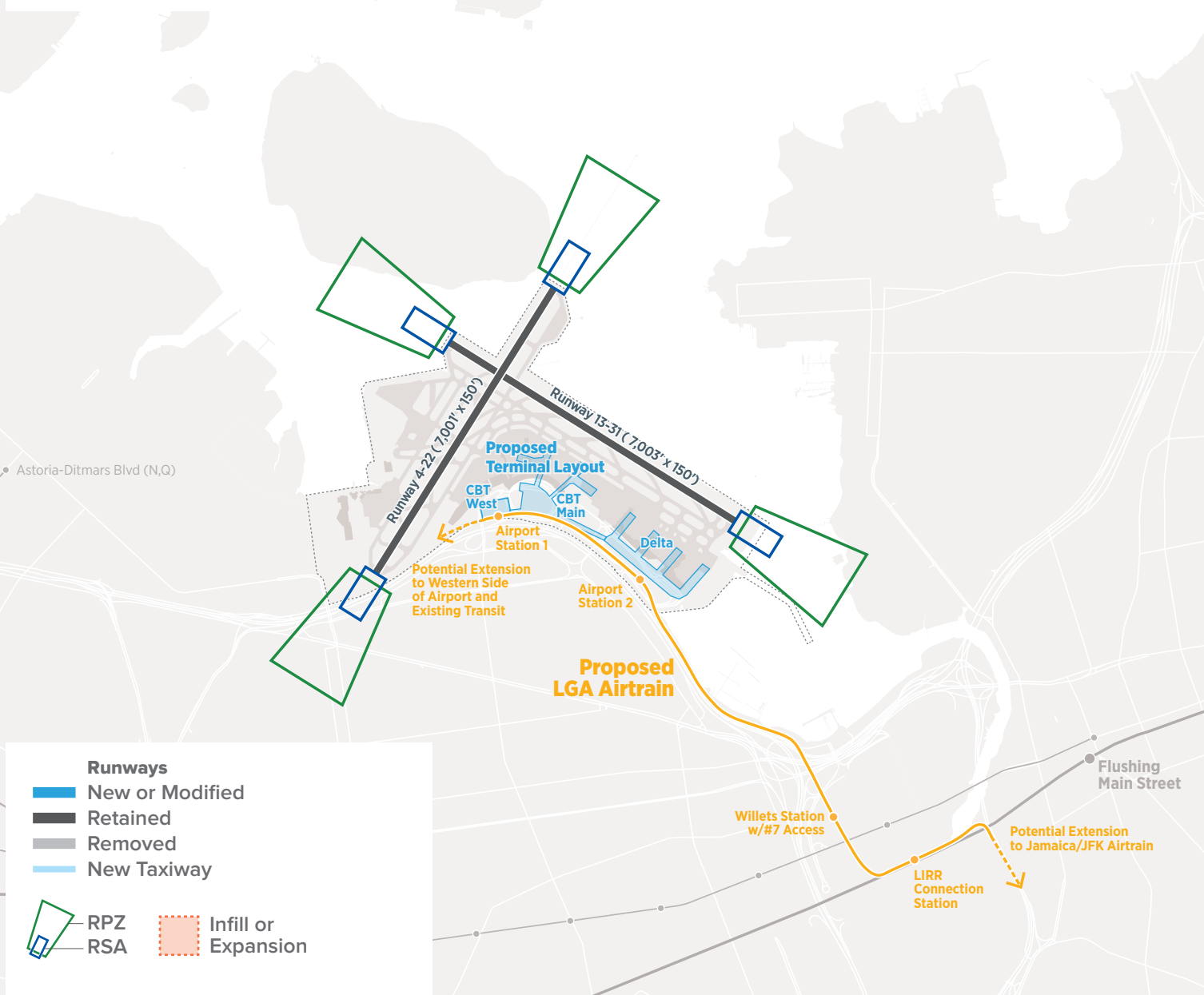
⁴ Bachman, Justin. "New York's \$8 Billion Airport Still Won't Get You to L.A." *Bloomberg*, July 20, 2016. <https://www.bloomberg.com/news/articles/2016-07-20/new-york-s-8-billion-airport-still-won-t-get-you-to-l-a>.

⁵ "Background: Transport To and From NY's Airports." *Port Authority of NY & NJ*, October 24, 2014. https://www.panynj.gov/airports/pdf/MTA_Background_on_Airport_Access.pdf.

⁶ The 787-9 can operate on a 7,000ft runway with a payload of 490-430,000 lbs. The max design weight is much lower than 777 (or 747) whereas a787-9 is

Figure 24: LGA Vision

Source: RPA



Vision and Elements

LaGuardia airport is projected to serve up to 45 MAP by 2060. While LGA's perimeter barrier will protect it from four to five feet of sea level rise, it will eventually require additional hardening for six feet and more intense storm surges. RPA's recommendations are that the PANYNJ begin efforts to strengthen the perimeter barrier over the next decade and continue to evaluate the pace of SLR to ensure sufficient lead time to protect the airport for eventual higher sea levels. The vision also supports the full build-out of the central terminal area, currently under-way, and the plan to construct a new AirTrain that would connect LGA to the LIRR and #7 subway at Willets Point. However, it is critical that the AirTrain have two stops, one that serves the new development area (and also providing a reasonable connection to #7) and the other that creates an easy and seamless connection between the AirTrain and LIRR. The alignment (detailed below) should also position the AirTrain for a future southern extension to the Jamaica station complex. The following details the three major elements that make-up the vision for LGA.

Complete Full Reconstruction Of Central Terminal Area

The first phase of terminal reconstruction is underway. Funding for the central terminal building (Terminal B) has been secured and public funds to support Delta's redevelopment of Terminals C and D are in the Port Authority's 10 year capital plan for 2017-2026. RPA supports the expansion of the terminal facilities to increase gate sizes and gate capacity as these investments will reduce delays and bring modern amenities to passengers at LGA. The preliminary proposals by Delta for Terminals C and D require long walking distances between gates, concourses and terminals. The final design solution should facilitate more rapid connections and a seamless experience for passengers.

Construct New Airtrain From LGA To Willets Point

RPA's 2011 report recommended a series of ground access improvements, including new SBS bus services and an AirTrain to Woodside station (LIRR and #7). Since that report many of the bus improvements have been made to great success resulting in the transit share (buses) at LGA increasing from 10 to 18% in the past six years. While RPA still believes that the Woodside alignment is the most direct alternative that provides the best connection between the LIRR (all 11 lines vs. 1) and the #7 (further west), the recent proposal of an AirTrain to Willets Point could still dramatically improve access to LGA if done properly and at a lower cost than the Woodside alternative⁷.

560,000 lbs, which results in reduced range or # of passengers and/or cargo. "787 Airplane Characteristics for Airport Planning." BOEING, December 2015. <http://www.boeing.com/assets/pdf/commercial/airports/acaps/787.pdf>.

⁷ Woodside station is farther from the airport than Willets with a much more complicated alignment along the GCP and BQE. The station would also likely need to be constructed under the Woodside complex due to the existing site constraints. See pages 141-143 of *Upgrading to World Class* for additional details.

What is the perimeter rule and what does its elimination mean?

LaGuardia Airport's "perimeter rule" restricts non-stop flights to specific lengths and destinations; the rule has been in place informally since the late 1950s to encourage greater use of JFK, with a roughly defined flight radius of 2,000 miles articulated in PA's early policies. The PA's policy since late 1970s has been to preserve LGA's capacity for short and medium-haul domestic flights with the exception of international services to Montreal and Toronto, which were "grandfathered" under the policy at that time. The lack of clarity on the flight radius came under scrutiny with Air Canada's request to inaugurate flights from LGA to Calgary, Alberta in 1984, believed to be in violation of the PA's policy on non-stop flights from LGA. In response the PA studied the application of a defined flight radius and formally imposed LGA's perimeter rule in 1984. The perimeter rule restricts non-stop flights from LGA to serve destinations within a 1,500 mile radius for domestic and pre-cleared international markets. The perimeter rule does not apply to flights to and from Denver, which are "grandfathered" into the current policy as part of the PA's 1984 decision.

In 2015 the PA began a process to evaluate the possibility of eliminating the perimeter rule. If this action were taken it would likely result in the reduction of service to smaller domestic and upstate markets as high demand domestic and international locations supplant these routes. For example, West Coast domestic destinations like Los Angeles and San Francisco and preclearance for popular international destinations like London, Amsterdam and Rome (all beginning preclearance processes with Homeland Security)¹ are likely to take over slots at LGA. Two mitigating situations might make these market changes of lesser concern. First, if NextGen improvements and an increase in operational capacities (a new runway) at JFK are implemented the lack of slot availability for small markets diminishes at JFK and EWR. These airports can potentially serve more markets as their operational capacities are increased. Additionally, changes within the fleet mix as airlines purchase larger aircraft, which are unlikely to be filled by serving small domestic markets, will drive airlines towards limiting service to these markets regardless of the perimeter rule.

¹ "DHS Announces 11 New Airports Selected For Possible Preclearance Expansion Following Second Open Season." *Homeland Security*, November 4, 2016. <https://www.dhs.gov/news/2016/11/04/dhs-announces-11-new-airports-selected-possible-precleanance-expansion-following>.

The Governor of New York's proposal for an AirTrain connection from LGA to Willets Point will link the new terminals at the airport to the Long Island Railroad (LIRR) and the 7 subway line. This connection will provide easier access to the airport for residents to the east and could leverage the substantial public investment in East Side Access by connecting passengers to Midtown Manhattan in 30 minutes or less via LIRR. The proposed alignment is shown in Figure 19. The estimated cost is \$2 billion, with the MTA spending \$125 million in its amended 2015-2019 capital plan to make upgrades to accommodate the AirTrain connection to the LIRR commuter rail station at Willets Point.

The AirTrain could also allow the airport to expand its footprint, making space for airport back office and supportive uses such as rental car service, hotels, business/conference centers and other amenities for air passengers. In the long-term, there might also be the potential to redevelop the space over the Flushing Line subway yards — expanding the footprint of the site.

To ensure that the new AirTrain is positioned to be competitive with other alternatives (primarily automobiles, the dominate mode) it should be constructed with the following elements, which are also illustrated in Figure 18:

- ▶ Integration of AirTrain and the new terminal complex must be seamless. The PA should explore constructing two stations to shorten the walking distance to both ends of the complex. The stations should be positioned similar to T-4's at JFK — sandwiched between the arrivals (check-in) and departures (baggage claim) levels. A provision should also be made to allow the AirTrain to extend further west to support future facility expansion and additional connections to existing public transportation.
- ▶ There should be two off-airport stations, one to serve the Willets Point development site and the other to allow direct transfers to the existing Willets Point LIRR station
- ▶ The station at the development site should be placed to provide good access for riders that might use the #7 for local Queens-based destinations.
- ▶ The station connecting to the LIRR should be parallel to and centered above the existing rail station. The AirTrain station would be constructed with an island platform with direct access to the LIRR (non-event) island platform below. The vertical circulation elements should be predominantly mechanical, with several large elevators (e.g. Howard Beach) and escalators.
- ▶ LIRR service should be frequent, with at least four trains per hour throughout the day.
- ▶ Fare control must not impede the ease of transfer between the AirTrain and LIRR.

- ▶ An AirTrain alignment directly above the LIRR station should orient the line to allow the future extension of the AirTrain further east (1,500ft) to the Van Wyck Expressway where it then could be extended south to Jamaica, connecting with the existing AirTrain. The chosen solution (technology, power requirements and rolling stock) for LGA AirTrain should not preclude this connection with the JFK AirTrain.

Monitor And Ensure Sufficient Planning And Construction Time To Project LGA From Rising Seas

LaGuardia Airport is not at risk of frequent inundation due to sea level rise in the near term. However, the PA should closely monitor the pace of sea level rise and take steps to further protect the airport to ensure its continued operation



Design Reference: Singapore — Adapting for Climate Change

In 2014, Changi served a record 55.4 million annual passengers with 30,621 aircraft movements, and processed over 1.8 million tons of cargo. With over \$2 billion in retail sales within the airport alone and as the only international airport for the populous island nation, Changi is crucial to Singapore's economy, supporting nearly half a million jobs in related industries in the city (tourism, finance and retail). Changi is a world class gateway for international travelers to the city state, receiving numerous awards for design and customer experience annually. Passenger growth at Changi Airport has continually outpaced expectations as Singapore continue to grow as a major hub for international air travel in Southeast Asia, while also serving as a shipping hub for the nation, Southeast Asia, and Australia.

To serve growing demand the airport began expansion plans in 2011 to include a new terminal T4, increased apron space, a mixed use hub called the “Jewel” which includes retail, an integrated rail hub and a large indoor garden all of which will be completed next year. Following on the tails of the current airport expansion, the Government of Singapore and Changi Airport Group (CAG), the private corporation that operates and manages the airport, announced they would be expanding the airport footprint into a 1000-hectare site just to the east of the airport in 2013. Called Changi East, this expansion will include a third runway, a fifth terminal (T5), an expanded industrial zone for seaport and

air cargo operations, and an integrated passenger ferry terminal to be completed in the mid-2020s. Both T4 and T5 will include additional apron space for aircraft and will enable the airport to serve the 135 million annual passengers expected to travel through Changi Airport by 2030.

As an island nation, Singapore is highly vulnerable to sea level rise due to climate change. The city-state has taken an aggressive approach preparing for 4 meters of sea level rise (12 feet), shoring up key infrastructure assets throughout the city and Changi Airport is no exception. The expansion area that includes the third runway, T5, cargo facilities and ferry terminal will be raised by 5.5 meters, over 18 feet, to protect against sea level rise. In addition to raising the airport, the site will be designed with green infrastructure and canals to divert floodwaters from storm surges. Also, CCTV monitoring and sensor systems will be installed to actively measure water levels in the canals and shoreline adjacent to the airport. The expansion is anticipated to cost tens of billions of dollars and the CAG and the Government of Singapore will share in the costs.

Summary of Impacts and Mitigation Strategies

Noise

As part of the Environmental Impact Study (EIS) process for airport expansion, a noise analysis is completed using the FAA's Integrated Noise Model (INM) or Noise Integrated Routing System (NIRS) when impacts to the surrounding areas increase by 1.5dB or more or are above 65dB. This study does not adhere to the stringent regulatory framework of a formal EIS, but it is important to gain an understanding of the order of magnitude of the noise impacts for each of the proposed expansion options. RPA used this methodology to analyze the noise impacts of its proposals. This was accomplished through a spatial analysis using the existing 65dB+ noise contour profile for each airport and then overlaying these shapes with current and projected population estimates. Existing 65dB+ "block" buffers, first developed by Landrum and Brown as part of RPA's World Class Airports study, were used as part of a spatial query. The existing and projected populations within each buffer were summarized for each option. The specific geographies (or properties) where noise impacts would be the greatest were not documented. Only the incremental increase in the "existing" and "projected" populations impacted between the base noise condition that exists today and individual expansion options was calculated and then summarized in Table 16. Roughly a quarter million residents would experience noise impacts if JFK and EWR were expanded, with EWR's expansion impacting the greatest number of residents. The difference between the existing and the projected 2040 populations that would be impacted is relatively small, estimated to be less than 20,000 additional people.

The close proximity of the New York airports makes it difficult to modify flight path to avoid populated areas while also maintaining or increasing capacity. However, reorientation to a 4-22 airspace and the use of continuous descent/ascent flight approaches during non-peak hours could reduce noise levels for affected populations. Recent research has shown that continuous descent approaches can reduce noise by 3 to 12 decibels, reducing the size of the 65 dB+ noise contour by 8 to 36% in size. For continuous ascent departures the reductions are as much as 9 dB in noise and 42% of the size of the 65dB+ contour area. Additionally the reduction in thrust required for the continuous

Table 16: Increase in Existing and Projected Populations within 65dB+ buffers for Expansion Options

Airport	4RP Design Option	Existing Population (2015)	Projected Population (2040)
JFK	Modified 4/22s & New 5/23 Single Western Runway - Three Parallels	96,940	102,976
JFK	Triple 4/22s & Western 5/23 - Four Parallels	44,171	47,211
EWR	New 5-23 runway on-site aligned with new NEC head house	124,226	136,209
Total of Preferred Alternatives	Western 5/23 parallels at JFK, new 5-23 at EWR and LGA Hardening	253,417	272,832

Source: Regional Plan Association

descent approaches reduces fuel consumption by as much as 1,000lbs of fuel per landing and leading to as much as 35% reduction on CO2 and NOx emissions. For departures the continuous ascent flight paths can reduce greenhouse gas emissions by as much as 630 kg and save up to 440 lbs of fuel per flight.¹ Continuous approaches require increased spacing between aircraft reducing airport capacity,² however, when used during off-peak hours (early morning and nighttime) they can reduce noise impacts during the times when aircraft noise is most disruptive to local residents.

Private Property Buyouts

Expansion of JFK airport would not require the purchasing of private property. However, the taking of private property would be needed to expand EWR. The airport's existing property line would need to be extended south to accommodate a new runway and larger cargo area. This would predominately impact vacant and industrial properties located in the township of Elizabeth. Table 17 lists the total number of parcels in the expansion area, the acreage

¹ <http://www.icao.int/environmental-protection/Documents/ReviewNAD-RD.pdf>
² https://www.klm.com/corporate/en/images/008524%20Factsheet%20operational%20measures_tcm729-342205.pdf

and land use of these parcels. Nearly 40% of the expansion area would be industrial land, 25% vacant land and just 12% residential.

Table 17: Parcels and Land Uses within potential EWR Expansion Area

Land Use Type	Parcels	Acreage
Industrial	25	196
Vacant	36	137
Residential	31	68
Commercial	34	60
Unspecified	11	19
Institutional	6	8
Mixed Use	1	5
Parks and Recreation	1	2
Transportation	2	1
Total	147	496

Source: RPA 4RP Existing Land Use Analysis

Open Water Fill and Decking

Any expansion of JFK’s airfield requires fill or decking due to their proximity to open water. The two runway alternatives for JFK would require as much as 133 acres of fill or decking for Alternative 1 (two western runways) or 222 acres of fill or decking for Alternative 2 (one western and three eastern runways). Table 18 summarizes the fill and decking options at JFK.

Table 18: Fill and / or Decking Alternatives for JFK Expansion and LGA Resilience

Airport	Runway Alternative	Fill or Deck (acres)	Deck (acres)
JFK	Alternative 1: Parallel Western 5-23 Runways	133	49
JFK	Alternative 2: Western 5-23 and Eastern Triple 4-22 Runways	222	57

Source: RPA and ARUP Analysis

While the reduction in area is substantial, when comparing decking and fill options the cost of decking was estimated to be 2.4 to 3.5 more expensive than fill. For example, to the two western runways alone in Alternative 1 were estimated to cost \$580 million if placed on fill and over \$2 billion if extended over the Bay on a deck.

Environmental Mitigation in and around Jamaica Bay

Given the environmental impact of constructing one or two new runways into Jamaica Bay, various mitigation measures should be implemented by the Port Authority. First, every acre of habitat impacted by construction of runways should be restored elsewhere throughout the bay. For example, if two runways are built, impacting 133 acres of habitat, the Port Authority should fund the restoration of a minimum of 133 acres of habitat elsewhere in the bay. Emphasis should be placed on restoring the salt marshes and maritime forests, as well as filling the holes made by the excavations to fill the bay, and restoring other bird sanctuaries away from flight paths. Further, the Port Authority should establish and invest annually into a Jamaica Bay Restoration & Resilience Mitigation Fund that will serve to fund research, restoration and adaptation efforts (living shorelines, buyouts, etc.) to make Jamaica Bay and its communities more resilient. The fund could be managed in cooperation with a group such as the Science and Resilience Institute at Jamaica Bay or the NY-NJ Harbor Estuary Program. Raising funds could be achieved in a number of ways, including the institution of a per-flight user fee or a new line item in the Port Authority’s budget for JFK. Further, the Port Authority should ensure that an expanded JFK is “green”, taking steps to make the airport the most sustainable in the world, from site level improvements including green infrastructure and buildings to carbon offsetting programs. These steps will demonstrate the balance in ensuring a world class airport with a healthy and resilient ecosystem.

Setting Priorities and Phasing

Limited resources combined with the infeasibility of undertaking expansion projects at all three airports simultaneously without crippling air travel dictate that improvements be phased strategically for the three airports as a single aviation market. LGA is currently undergoing an estimated \$8 billion expansion of its central terminal area that will take much of the coming decade to complete. After this work is done financial capacity will be available to address the capacity needs at the other airports. In the meantime, the Port Authority has much to do to prepare both JFK and EWR for runway expansion.

JFK will need new capacity sooner, and work should commence on the federally mandate environmental review as soon as possible. This process, combined with extensive community outreach and consultation, will take years and the PANYNJ and other stakeholders will also need to work with Congress to amend the 1972 law that created the Gateway National Recreational Area to allow for the expansion of the airport into Jamaica Bay. Construction of the two runways should start no later than 2024 so that the airport system will have the capacity to absorb TEB’s traffic once it’s decommissioned. Over the next decade the PA should start laying the groundwork for a reconfiguration of the CTA and one-seat ride service. These improvements could be phased in between 2025-2040 when AirTrain is anticipated to hit its capacity ceiling.

EWR’s expansion is on the longest path because of its complexity, and demand forecasts indicate EWR will not require a runway as soon as JFK. However, the reconstruction of EWR will be akin to assembling a puzzle. The PANYNJ will need to prepare the airport for the new runway over a period of decades and some changes to the airport’s layout will materialize much sooner than others. The Port Authority should formalize the vision for EWR and complete a public engagement process. This might include an MIS to generate a firm long-term masterplan to transform the airport. Over the next two decades the agency must begin assembling the “pieces of the puzzle” and begin construction of the new runway at EWR by the 2030’s with a service entry date by the 2040’s.

Table 19: Airport Capacity (Supply) Summary — Existing, w/NextGen and RPA Proposals

Airport	Airfield Capacity (Operations per Hour)			Increase over Existing
	Existing	w/NextGen	Proposed	
JFK	86	90	135	57%
EWR	83	85	120	44%
LGA	75	84	84	12%
All	244	259	339	39%

Source: RPA Analysis

When all three airports are redeveloped, EWR’s ground access and headhouse will be completely reoriented around the northeast rail corridor with three 4-22 runways and a new midfield concourse. JFK will have two new runways, a reconfigured CTA and new one-seat regional express service to midtown Manhattan. LGA will be reconstructed with a new terminal area and a new transit connection. The result will be an airport system that will have the capacity to serve the region’s growing economy and number of air travellers and join the club of other world class facilities.



Regional Plan Association

Regional Plan Association is an independent, not-for-profit civic organization that develops and promotes ideas to improve the economic health, environmental resiliency and quality of life of the New York metropolitan area. We conduct research on transportation, land use, housing, good governance and the environment. We advise cities, communities and public agencies. And we advocate for change that will contribute to the prosperity of all residents of the region. Since the 1920s, RPA has produced four landmark plans for the region, the most recent was released in November 2017. For more information, please visit www.rpa.org or fourthplan.org.

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