ENVIRONMENTAL STUDIES BOARD

JAMAICA BAY AND KENNEDY AIRPORT

A MULTIDISCIPLINARY ENVIRONMENTAL STUDY

Volume II

A REPORT OF THE
JAMAICA BAY ENVIRONMENTAL STUDY GROUP

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Dr. Philip Handler, President, National Academy of Sciences
Mr. Clarence H. Linder, President, National Academy of Engineering
Washington, D.C.

Gentlemen:

I am pleased to forward to you Volume II of the report, *Jamaica Bay and Kennedy Airport: A Multidisciplinary Environmental Study,* prepared by the Jamaica Bay Environmental Study Group. This group was appointed by the Environmental Studies Board to evaluate the potential impacts of expansions of Kennedy Airport upon Jamaica Bay and its environs, pursuant to a request from the Port of New York Authority to the Board.

The Port of New York Authority, without in any way intruding upon the conduct of the study, provided indispensable data, time, resources, and personal energies in response to the needs of the Study Group. For these exceptional considerations, the Board is deeply grateful.

Volume II is the Study Group's report to the Environmental Studies Board. It has been reviewed, and the board recommends publication in view of its broad public interest and with the hope that it will prove valuable in the critical decisions to which it relates.

Sincerely yours,

DAVID M. GATES
Chairman, Environmental Studies Board

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PREFACE

In December of 1969, the Port of New York Authority approached the Environmental Studies Board (a joint board of the National Academy of Sciences and the National Academy of Engineering) about possible Board interest in undertaking a study of the environmental impact an extension of the runways at Kennedy International Airport into Jamaica Bay would have on the Bay and its surrounding communities. The Board was urged to undertake the project by Secretary of Transportation John Volpe, who stated that the "Department is extremely interested in this study because of its potential relevance not only to the immediate New York situation, but to the Nation as a whole." Walter J. Hickel, Secretary of the Interior, noted his Department's interest in the study and "any detrimental effect the proposed expansion of Kennedy Airport might have on the environmental qualities of the Bay." The Executive Director of the Port of New York Authority, Austin J. Tobin, expressed his judgment that it would be impossible to proceed with any expansion into the Bay without first knowing what effects such an action would have on the viability of the Bay and on the people who live in its environs. He also wished to know whether such an expansion could somehow be made compatible with other plans for development of the Bay by the City of New York and the federal government, and could be designed in such a way as to upgrade the quality of the Bay's environment. (Letters of Messrs. Tobin, Volpe, and Hickel are presented in full following this preface.)

In many ways Jamaica Bay presents as complex a set of environmental issues as can be found in our nation today. It is the object of competing demands for its use to serve many diverse, incompatible, and perhaps equally justifiable public and private needs. It is a seriously damaged environmental resource in the midst of a heavily populated urban area, where the quality of human life for most is seriously deteriorating. We are committed as a nation to the restoration and maintenance of a healthy and viable natural environment. The future of Jamaica Bay will symbolize the depth of the commitment and help to set a pattern for dealing with similar environmental issues throughout the country.

On the other hand, Kennedy Airport is a vital component of the economic and social patterns of New York City and its environs. The City is a center of commerce, finance, and communication. All these require convenient and reliable air transportation, and Kennedy Airport is now, and probably will be for some time to come, indispensable to the life of the City.

In view of these considerations, it is evident that the problems are very complex and that their solution may eventually turn on a Solomon's choice. The members of

the Study Group are, however, not decision-makers; they serve only in an advisory role. The decision as to the disposition of the Bay is necessarily in the hands of others. Scientists alone cannot make the choices concerning alternative solutions to problems of this kind, which must ultimately depend on competing values and the weight governments assign to them in arriving at decisions. Scientists can, however, isolate and consider objectively the issues involved, lay out and evaluate the effects on the physical and human ecology that may be expected to follow particular actions, and suggest and examine the various alternatives and their implications. However, we recognize that scientists are not value-free and that their concerns and predispositions will have some effect on their own conclusions and recommendations. But, whatever decision is ultimately arrived at, it will be a public one made by people whose actions must be acceptable to their constituencies.

Jamaica Bay is not only a local problem for New Yorkers; it also exemplifies many problems of environmental management, conservation, control, and improvement that face this nation. Many urban centers in the United States are now considering expansion of airport facilities. Although it is highly probable that such expansions will pose significant problems for the environment, it is difficult to argue against the contention that, in order to maintain a dynamic and viable economy in our cities, fast, safe, and convenient travel must be readily available. At present, that implies air travel. Electric power-generating plants, solid-waste-disposal sites, sewage-treatment facilities, incinerators, and many other necessary, though environmentally taxing, installations are also required to support a rapidly growing technology-dependent society. In this sense, the Jamaica Bay problem is a national one, and the lessons learned from this study, both substantive and methodological, may well have implications for and applicability to the way we assess the problems posed by expanding needs of an expanding population and their impact on the physical environment and the quality of life. It was for these reasons that the Environmental Studies Board undertook this environmental study of Jamaica Bay.

The Jamaica Bay Environmental Study was designed as a multidisciplinary study involving some twenty-five people from the physical and biological sciences, engineering, the social and behavioral sciences, and the law. Considerable interest in the study will be, we believe, in the methodology employed and the broad range of competency brought to bear on the complex environmental problem, which relates in so many ways to the human as well as the physical ecology of Jamaica Bay and its environs.

JAMES A. FAY
Chairman, Jamaica Bay Environmental Study Group

ACKNOWLEDGMENTS

Outstanding contributions were made to the work of the Study Group by its Steering Committee. Originally, the Steering Committee gave assistance in the organization of the Study Group itself, and provided seminal ideas and insights relating to definition of the problem. In late August, it intensively reviewed the initial draft report, which was of great value in the fashioning of the final report.

The Study Group was assisted extensively during the course of its work by the Port of New York Authority and its staff. We sincerely appreciate the many forms of this assistance—technical, informational, and logistical—which effectively expedited our task.

The Study Group wishes to acknowledge indispensable administrative support from the staff of the National Academy of Sciences. Also, it is especially appreciative of the extraordinary contributions in the design and illustration of this report by Mr. George Lilly and Mr. Don Joyce of the Academy's Printing and Publishing Office. Under the circumstance of the extraordinarily demanding requirements of putting this report in its final form, Harriet Hudson, Joan Kirchner-Dean, and Jeannette Lindsay, also of the Printing and Publishing Office, made indispensable editorial contributions.

Particular thanks are due Anne Greene Keatley and Denise Emery of the Environmental Studies Board staff, and to Donna Bishop, Olivia Kredel, and Joan Shaffer for their unstinted efforts on behalf of the Jamaica Bay Study.

Many other organizations and individuals made contributions to the study. These are listed separately at the end of this report (pages 149–150).

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SUMMARY

IMPROVING THE ENVIRONMENT IN THE FACE OF COMPETING NEEDS

Over the years, Jamaica Bay and its peripheral land areas have served the needs of New York City residents and visitors in many ways. Some land for housing and other purposes was created by filling marshes with solid refuse. Other land was formed by dredging sand from the bottom of the Bay to fill marsh or water areas. In this manner, two large airports (Kennedy and Floyd Bennett) were created, serving both civilian and military air transport needs. While raw sanitary sewage is no longer discharged into the Bay, except in periods of excessive storm drainage flow, treated effluent from a large population is continuously emitted into Bay waters. A road and rail line bisecting the Bay, and a bridge at its mouth, provide vehicular access to the Rockaway peninsula. Construction of a parkway along the Bay's northern periphery created a ground transportation artery for southern Brooklyn and Queens. Distribution of oil and gasoline in the Bay region originates in part at shoreside terminals supplied by barges that move through the Bay channels. In the summertime, fishermen line the few accessible shore sites, and pleasure boats ply the Bay's waters. Visitors and schoolchildren explore the wildlife sanctuary the year round.

In its bird refuge and hospitable but imperfect marine environment, the Bay is an ecological unit productive of natural life of many forms. To the extent that man as a natural species inhabiting a biosphere depends upon an abundance and diversity of other living species, Jamaica Bay also helps to sustain human life in an indirect way. By providing both a quality and quantity of recreational and educational experience not normally found in urban environments, this natural ecological unit serves human needs that would remain unfulfilled if it were much less accessible to the large urban population in the surrounding communities.

As long as the demands upon the Bay for simultaneous multiple use were moderate, they were easily accommodated within its great area. But as the demands intensified, strains appeared. Increased raw sewage flow forced health officials to outlaw bathing and shellfishing. Solid-waste landfill operations lessened the pleasure of boating and fishing. The deep dredging of Grassy Bay to supply landfill for Kennedy Airport left a stagnant pool devoid of marine life. Dredging, filling, and oil spills took their toll of finfish populations. The construction of the Shore Parkway without adequate provision for foot or motor access to shorefront areas hindered the use of the few shoreside areas that were not covered with rubble or litter. Most of this environmental degradation could have been prevented by planning and regulatory activities of public authorities.

All these strains were minor compared with the environmental impact of Kennedy Airport. The last two decades have seen a multiplying of air traffic and the advent of screaming jet planes. Concurrently, large areas of vacant land near the aircraft flight paths have become densely packed with housing. Through simultaneous construction of the airport on City-owned land and official approval for housing use of adjacent areas,

New York City autorities unwittingly set in motion incompatible developments that now threaten a confrontation of citizen against citizen and citizen against his government. Urban-renewal projects being constructed to relieve the pressure for more and better housing will expose even more residents to intense aircraft noise. Nor is aircraft noise the only irritant, for the fear of an aircraft crash and the sight and smell of aircraft pollution add to the anxiety and discomfort of nearby residents. Ground traffic congestion induced by air passenger and freight movements spills over into nearby communities. For the nearest neighbors there is the additional apprehension over land condemnation for airport expansion or invasion by commercial development attracted by the airport. So severe is this impact that one must ask whether, under present circumstances, the airport is totally incompatible with surrounding urban life.

Despite these many serious failures to plan ahead, there are a few counter-examples of successful measures to reverse this environmental disruption. In the mid-1950's, the Parks Department created a wildlife refuge in the midst of the Bay by artificial means such as filling and planting. In the ensuing years, the numbers and variety of wild fowl using this refuge have grown to approach those formerly frequenting the Bay in its undegraded state. Through technological means and wise management and planning, a component of the ecological unit was repaired at a very minor cost to the public treasury. Because of its size and location, this refuge was not affected by, nor did it imperil through bird strikes, the use of the airport.

In more recent years, a program has been planned and started for upgrading the sewage-treatment procedures and terminating the discharge of untreated sanitary sewage accompanying storm-water overflow. When successfully completed, the new treatment facilities very likely will reduce the bacterial content and biochemical oxygen demand of treated waters to safe and nonpolluting levels. This publicly financed program, through use of recent technological developments or other alternatives, will so improve water quality that recreational use of the Bay can be greatly enlarged.

The difference between improvement and degradation of the environment of Jamaica Bay lies in the creation of alternatives, in part through technological and scientific advance, and in the wise selection from among them of a compatible set of actions to meet as completely as possible a variety of human needs.

Where competing needs are very pressing, and the alternatives for meeting them are clearly incompatible, decisions must be based on the values attached to the costs and benefits of alternative uses, both present and future. In these circumstances, greater weight should be given to the course of action that is less irreversible or that holds open the greater number of options for future choice.

The alteration of the environment through use of public resources to satisfy legitimate human needs is a central problem of the modern world. Many scientists believe that the physical environment, in which all life evolved and now flourishes, is being irreversibly changed in ways that may limit the opportunities of future generations. To the urban dweller this may appear in the form of a public swimming beach closed because of pollution, a neighborhood park taken for construction of a freeway, or rising levels of air pollution or noise generated by a nearby public facility. Increasing public awareness of the changing environment is a necessary precursor of the inevitable adjustment society must make between escalating demands and the limited capacity for their fulfillment.

Because the environment is a public resource, decisions to control or prevent its degradation must be public decisions, openly arrived at after informed discussion. Individuals, local communities, and public and private agencies at the local, regional, and national level must all declare their interests and assess the consequences of various possible actions. In large measure, the current high intensity of controversy over environmental issues is a consequence of past and present failures of public officials to incorporate adequate and continuing participation of all affected parties, especially local communities, in the decision-making process. This will assume even more importance in the future as it becomes more difficult to find and more costly to use new technological means of simultaneously satisfying different human needs competing for the same limited environmental resources.

AIR AND GROUND TRANSPORTATION

The Need for Air Transportation

It should not be supposed that air transportation affects the quality of life of only a small proportion of Americans. In 1970, the mode of life of almost all Americans depends upon air transportation, whether or not they ever travel on airplanes.

A great many Americans do, in fact, travel on airplanes. Thirty-four million did so in 1969. Even though commercial air transportation in this country is hardly 50 years of age, it has superseded every other means of

long-distance travel except the private automobile. Not only is it the fastest and most comfortable way to travel over distances greater than several hundred miles, it is also one of the cheapest ways. For public travel to many cities and towns in the country, it is almost the only way, since there is no longer rail passenger service to many places, and bus travel is often inadequate. Even where railroad trains or passenger ships are still available, they are few. If all the Americans who now travel by air to Hawaii, or Alaska, or Europe, or even Chicago, were suddenly to seek other ways to get there, the remaining ships and trains would be unable to accommodate them.

Large numbers of those who travel by air, some of them quite poor, do so for personal reasons; but a great many air travelers are managerial, technical, professional, and sales people, at all levels, who are engaged in commercial, governmental, scientific, professional, and technical activities of many sorts. During the last few decades, American business, government, science, and technology have come to rely upon rapid air travel, direct inspection and supervision, and face-to-face meetings of key people in order to carry out their functions. The major human activities that are dependent upon air travel today are far more than those that are directly or indirectly related to the aircraft industry and to air travel; they include almost all the major human activities of our time. It is not just people who travel by air. Goods of all sorts also travel by air, especially critical items: mail, reports and publications, bank checks, video-tapes, the plates to print magazines and newspapers, and replacement parts for all sorts of machinery. Many other less critical and relatively light items such as new clothing, baby chicks, and cut flowers travel by air as well.

Every major human society has modes of transportation upon which its patterns of life depend. During the past half century, air transportation has moved into such a role in American society. To whatever extent the high productivity of our present economy and the high standard of living of many Americans are dependent upon rapid transportation, they are in part dependent upon air transportation. As ours has become a nation of automobiles, highways, television, telephones, and teletypes, it has also become a nation of airports and airplanes—a society based upon rapid communication and rapid access, widespread and very rapid distribution of information, goods, and services, and the close integration of widely separated activities that this makes possible. American society could hardly exist as it does in 1970 without air transportation.

Many of the activities of New York City in particular depend upon rapid access and distribution. To a very large extent this means that they depend upon air transportation. Prominent among these are the "center functions" of the city—as an international center for banking and finance; as a national center for corporate headquarters, for publishing, for communications, for entertainment, for the arts, and for many industries; and, of course, as the site of the United Nations. The City has its own industries also, some of which, like the garment industry, depend for competitive advantage on their ability to ship their goods by air. Probably New York is more dependent upon air transport than most other cities in the world.

Current estimates of future need for air transportation are based on projections of demand for air travel. This demand forecast is based on extrapolation into the future of existing relationships between air travel and such indicators as personal income and age, including projections of temporal changes in these indicators. It is assumed that future demand expresses the need of the metropolitan area for air service. Future requirements for airport and airline expansion are based on these demand forecasts.

The existence of a public need for a service such as air transportation does not automatically pre-empt scarce public resources for its satisfaction, especially in view of other competing essential needs. The travel need must be seen in its true dimensions and in relation to others that are equally pressing. In every case, the use of public resources to satisfy a need must meet the test of good stewardship, namely, that these scarce resources are used efficiently and economically rather than wastefully.

The Benefits and Costs of Providing Air Transportation

It is difficult to quantify all the economic benefits of air transportation to New York City. Other than the compilation of statistics on employment in airport- and airline-related activities and the spending habits of tourists and other visitors who travel by air, there has been no substantive study of the impact of air travel on the regional economy. Although it is universally claimed by public and private officials that convenient air transportation is essential to the maintenance and growth of the "national center" complex in Manhattan, the same would also be true for the communications system, which links it to the nation and the world; the mass transportation system, which carries its employees

to one of the most intensively utilized pieces of real estate on earth; and the building complex, which provides housing, heat, light, and other amenities for all this human activity. Air transportation is but one of many essential services required for the functioning of a modern industrial society. This society must determine how much of each of these essential services it needs and can afford to purchase. What is immediately at issue is not the benefits of air transportation, but its social cost to the community as distinct from the economic cost to the traveler.

The benefits of air travel to the individual are related to the quality of the service. Safety, reliability, punctuality, flight frequency and duration, comfort, absence of delays on the ground as well as in the air, and ability to secure reservations at preferred times are some of the desired attributes. Attempts to increase the quantity of air travel by scheduling more flights than can be handled by the airport may degrade the quality through a decrease in safety and reliability and an increase in flight delays and discomfort. The total benefits to the community, which depend upon both the quantity and the quality of air transportation, may be decreased through such ill-considered attempts to expand service.

To the extent that air service is supplied by a private airline, a share of the cost of air travel is paid by the traveler, who purchases its benefits in an open market in which other services (including competing forms of travel) are sold. But the air-traffic-control and regulatory system, as well as most airports, are publicly owned and not entirely supported by user fees, so that part of the travel cost is carried by the general public. Some of this cost may fall on the local community in the form of loss of tax income from land taken for airport use. Presumably, these costs are justified by the benefits of air transportation to the entire community. Difficult as it may be to measure precisely these economic benefits and costs, the public decision to build airports and subsidize airlines where necessary expresses the public judgment that the community benefits outweigh the social costs.

But there are community costs other than the economic ones. Modern air transportation has brought nearly unbearable noise to millions of Americans who live or work near airports. This environmental hazard must be suffered by some part of the community—often that part that scarcely benefits either directly or indirectly from air travel itself. Under present law, few of those impacted individuals can seek recompense for or relief from this damage to their lives from either the airport owner or the airline. As a consequence, this environmental cost is not "internalized" and is not paid by either the traveler or the whole community that benefits from the provision of air service; nor has there been, except for those directly affected by it, any public or private incentive or initiative to abate the environmental nuisance. As a consequence, the "cost" of aircraft noise has been incorporated into the political process and is manifested as adamant opposition by many communities to airport construction or expansion.

There are other social costs that are not paid by the air traveler. The ground transportation of air travelers is not considered part of the air transportation system, but must be provided by the local community as a part of its public transportation system in the form of highways and, in rare instances, mass transportation links. Since the number of air passengers to an urban area is but a small percentage of the total number of daily travelers into the area, mass transportation links exclusively serving airports are very uneconomical. Ground access to airports is mostly by automobile or bus, causing added congestion on highways and resulting in ground travel delays for both the air passenger and the local commuter. Congestion and delay for the air traveler increases the premium for locating airports closer to urban centers, and thereby also increases both the direct economic costs to the community of land-taking and the social costs of operating noisy planes near areas that are, or soon will be, densely occupied by homes. This unhappy spiral of social and other community costs is a consequence of failure to plan an integrated ground/air transportation system that properly allocates the direct and social costs to both the traveler and the community, both of which benefit from the provision of this service.

In the case of a Kennedy Airport expansion, another social cost would be involved—namely, the opportunity cost of that area of Jamaica Bay needed for runway extensions that might otherwise be used for recreation and conservation. (This, of course, applied also to the present airport site, which is located on what was once a marsh area of the Bay.) To the extent that use of some Bay area for runways reduces the recreational potential of the Bay, the future opportunity for recreation of some New York City residents will be lost so that others may have the benefits of air travel. But because both the airport land and Jamaica Bay are owned by the City, there will be no direct charge to the air traveler for his use of this Bay land if the airport is expanded, as there would be no charge to recreational users if the airport is not expanded. The public decision to use the Bay for one or the other of these purposes will involve a transfer of the corresponding social cost from one segment of the community to another without any compensation from the users who benefit directly.

Technological Factors and Remedies in Air Transport Capacity

The capacity of an airport—that is, the sustainable rate of movement of passengers or freight—is limited by technological features of aircraft and their control systems. Simply put, the passenger capacity is determined by the maximum number of scheduled aircraft movements under adverse weather conditions and the average seating capacity of the aircraft in use.

To avoid collisions, aircraft approach or leave an airport under the guidance of an air-traffic-control system. Air-traffic controllers direct pilots to maintain safe distances between aircraft and prevent aircraft from approaching or leaving the airport more frequently than can be accommodated safely by the runway system. It is possible to handle more aircraft in fair weather than in poor weather. In poor weather, when aircraft follow instrument flight rules, the landing rate is limited by the number of runways equipped with instrument-landing systems. The capacity of an airport like Kennedy to sustain scheduled flights under all weather conditions is determined by the flight characteristics of the aircraft being used and the electronic instruments that guide them, both on the ground and in the air. For any given level of technology, this capacity is limited by the paramount requirement that aircraft operation be safe. The judgment of aircraft pilots and ground-based air-traffic controllers is a factor in determining safe operations.

The land area needed for runway construction is determined by the aircraft performance characteristics and the air-traffic-control system. Runways must be sufficiently long to permit a heavily loaded aircraft to take off safely. When parallel runways are used, such as at Kennedy Airport, their lateral separation is determined by air-traffic-control capability of preventing collision of aircraft using both runways simultaneously. Runways must face the principal wind directions, since aircraft cannot land safely in strong crosswinds. Moreover, taxiways are needed to keep runways clear for use of aircraft landing or taking off.

The number of runways equipped with instrument-landing systems and the characteristics of the air-traffic-control system are major determinants of aircraft-handling capacity. This capacity cannot be increased marginally, but can grow only in steps through construction of more instrumented runways or development of more advanced air-traffic-control systems for existing runways.

The other factor in passenger-handling capacity is the average number of seats per aircraft. As more long-haul and medium-haul jumbo jets (747, 1011, etc.) replace smaller jet aircraft in the commercial fleet in the next five to ten years, it will be possible to handle more air travelers without requiring more aircraft-handling capacity. One projection for airline aircraft movements for Kennedy Airport shows that in 1980 there will be no need for an increase in such movements over the 1967 volume despite a doubling of air passenger movements.

An offsetting factor in the expected growth in average seating capacity is the continued use of scarce instrument-flight-rule runway capacity by general-aviation aircraft. Whether these are the aerial equivalent of taxis or private automobiles, they carry substantially fewer passengers per aircraft movement than do the commercial aircraft. This disparity will increase in the future. These aircraft are clearly inefficient and heavily subsidized users of a scarce public resource.

The present air-traffic-control system is outdated. The technology for an improved system already exists. Its development into a national and international system can occur only through action by Congress and federal authorities. While the cost of this new system would ultimately be shared by the air traveler and the general public, it would bring great benefits to local communities by increasing the utilization of existing facilities and decreasing the demand for additional land for airport expansion. Without improved air-traffic-control, the air space will be underutilized while airports proliferate, pre-empting land that might better serve other purposes.

Our study has evaluated several suggested runway configurations for Kennedy Airport that would increase instrument-flight-rule plane-movement rates (see Chapter 4, Volume II). Each configuration is associated with a different degree of improvement in the air-traffic-control system. As control capability increases, the land area needed for runway extensions decreases, as does the environmental impact of the corresponding airport expansion.

The development and widespread use of STOL (short takeoff and landing) and VTOL (vertical takeoff and landing) aircraft and their corresponding air-traffic-control systems would very likely decrease the need for expanding conventional airport facilities. These aircraft would attract many interurban and short-haul passengers from conventional aircraft by delivering them more quickly to in-town V/STOL airport sites. However, there are serious technological and financial obstacles to deployment of such systems in the immediate future. As in the development of high-speed ground transportation systems, which could also meet part of the demand for rapid intercity travel, the cost of development and subsequent construction of a system of sufficient size

to be economically viable, compared with the smaller cost of marginal increase in the conventional air transportation system, is a major deterrent. Nevertheless, a continuing effort to develop such systems is warranted.

Administrative Factors and Remedies

While technological features limit what can be done by an air transport system, administrative practices of the airport operators, the airlines, and the relevant federal agencies determine what will be done. Inefficient and inconsistent practices may cause the quality and quantity of air travel to fall far below what is technologically possible. Just as the technological system may underutilize the land and air space it controls, the management system may underutilize the technological system it owns and controls.

The New York metropolitan air transportation needs are met principally by the three regional airports, Kennedy, Newark, and La Guardia (Figure 1). Because of their close proximity, these three airports form an integrated metropolitan air transport system. While Kennedy handles all international flights and La Guardia cannot land the largest jet planes, the remaining traffic can be reallocated where capacity permits, if necessary. The proposed expansion of Kennedy Airport must be viewed as an enlargement of the instrument-flight-rule capacity of the metropolitan system.

A study of the existing usage of the present system during peak hours under instrument-flight-rule conditions shows that congestion and attendant airside delays are caused by scheduling of too many airline flights and overusage by general-aviation aircraft attracted in part by an uneconomic schedule of landing fees. As the number of aircraft using an airport approaches the airport's capacity, the delay time in the air becomes excessive. It is therefore very wasteful to permit or encourage use at a rate that is close to (or even worse, exceeds) airport capacity. Not only does this situation exist at the present time, but there are prospects that it would continue into the future even if Kennedy Airport were expanded.

It has been estimated that the use of peak-hour instrument-flight-rule capacity by a general-aviation aircraft imposes a delay cost on airline users of $1,200 to $3,800 per flight. This contrasts with the average landing fee of only $10 for a general-aviation aircraft. Raising the landing fee to $100 would reduce this usage and thus reduce the delay penalty to scheduled airlines. Increases in the capacity of Kennedy Airport by runway extensions in order to accommodate more general-aviation users cannot be economically justified on the basis of existing landing fees.

Even if the demand placed upon scarce instrument-flight-rule capacity by general aviation were reduced through levying of higher landing fees, this capacity would probably still be overused by commercial airlines because of the wasteful overscheduling of airline flights in some city-pair markets. Since air fares are identical for all airlines, increased patronage is sought by scheduling more frequent flights, especially at the more desirable hours. For any one airline, the increased patronage may more than offset the cost of additional flights. On the other hand, the consequent increase in congestion and delay to all other airlines may exact a cost to the entire system that is much higher than the benefit to the aggressive airline. Clearly, what is good for XYZ Airlines can be bad for the air transportation system.

A brief study of existing peak-hour schedules serving New York indicates considerable scope for reducing flight frequency in several markets. More efficient scheduling could free openings for other uses (including possible future expansion of service) without reducing the quality of service offered to the traveler. A hypothetical study indicates that, using existing aircraft, 34 flights (out of 155) could be eliminated during the busiest peak hour, still maintaining hourly service to all markets and for all passengers now served during that hour. Use of the air bus would permit a further reduction of 22 peak-hour flights, but only if the frequency of service is reduced. It is likely that a more exhaustive study of the passenger usage of the present flight schedule would identify additional potential gains.

The scheduling of air service is regulated by the Civil Aeronautics Board (CAB), and the maintenance of safe flight practices is supervised by the Federal Aviation Administration (FAA), yet neither agency is concerned with efficient use of the airways. When airport airside capacity is being strained, as it is today in the New York metropolitan region, the most efficient utilization of the existing air space and facilities cannot be achieved under the present circumstances, in which the FAA, the CAB, the commercial airlines, the general-aviation aircraft owners and the airport operators (the Port of New York Authority) are able to act almost independently of each other. The practices of each are designed to maximize the gain to each rather than to minimize the cost to the system. As a consequence, the system becomes needlessly overloaded, resulting in congestion and delays and further demands to expand runway capacity. This inefficient operation of the air transport system is translated into premature demands for more land for airport use.

Among the economic or administrative measures for increasing the efficiency of airport usage are:

- Higher landing fees scaled to discourage general-aviation use during peak hours and excessive schedule frequency by air carriers. Fees should be set at the level that equates airport capacity with use. Income from fees in excess of operating costs can be used to alleviate adverse environmental effects of the airport.
- Airline scheduling that eliminates wasteful duplication among competing airlines simultaneously serving the same markets.
- Air-fare differentials that will encourage a shift of patronage to off-peak hours.

While we cannot guarantee that these measures, if adopted, would make the expansion of aircraft capacity at Kennedy Airport unnecessary before 1980, there is a high probability that the current estimates of the degree of expansion of the metropolitan system, including the necessity of a fourth jetport, would be greatly modified by their adoption. We are unable to justify the magnitude of the demands upon land use that are presently contemplated, for the Kennedy Airport expansion as well as a possible fourth jetport, on the basis of an inconsiderate expansion of the present inefficient system, especially in the face of alternate uses of this land for equally demanding social purposes. Given the possibility, although by no means the certainty, that further land-taking in Jamaica Bay for Kennedy Airport might not be necessary if the existing system were operated efficiently, and that the long-term needs of the metropolitan area may be met in part through a new regional airport, the immediate authorization of runway construction in the Bay would be a most unwise and precipitous choice of action at this time.

Ground Facilities and Transportation

The typical air traveler to Kennedy Airport experiences as much delay on the ground as in the air. Whether access to the airport is by private automobile, taxi, or airport bus or limousine, congestion inside the confines of the airport is as bad as that on the approaching highways, which the traveler shares with multitudes of commuters. Since air freight movement by truck is prohibited on the Belt Parkway, truck congestion on the side streets of Queens is particularly severe.

A proposed Metropolitan Transportation Authority link from Manhattan and Jamaica to Kennedy Airport via the Long Island Railroad would probably carry but a small fraction of the air passengers, mostly those traveling on business to Manhattan. At an estimated construction cost of $100 million, this link would be publicly subsidized as a part of the railroad commuter system although it would not carry any commuters. Because most of the air passengers would still travel to the airport on rubber tires, it is uncertain whether the elaborate terminal required to distribute the train passengers to the airline gate would be economically justified.

Airport owners seek to minimize the costs to them of providing ground access to the aircraft. The passenger is urged to travel to the front door of the terminal by private auto or taxi, for which the airport provides a minimal roadway connection to the nearest congested interstate highway or municipal freeway. The capital and operating costs to the airport are least for this system, but the land requirements for internal roadways and parking lots are maximum. Kennedy is no exception to the rule that groundside airport transportation is even less well planned than airside.

The Port of New York Authority (PONYA) has plans for development of ground transportation within the airport limits to handle the expected doubling of the number of air passengers at Kennedy Airport by 1980. Except for the commuter railroad link, these plans make no provision for decreasing the congestion problem outside the airport. Unless alternate means of transportation, such as bus travel from outlying terminals (especially in suburban areas), are employed, and private automobile travel directly to the airport is discouraged, ground congestion and delay will continue to make travel via Kennedy Airport a harrowing experience.

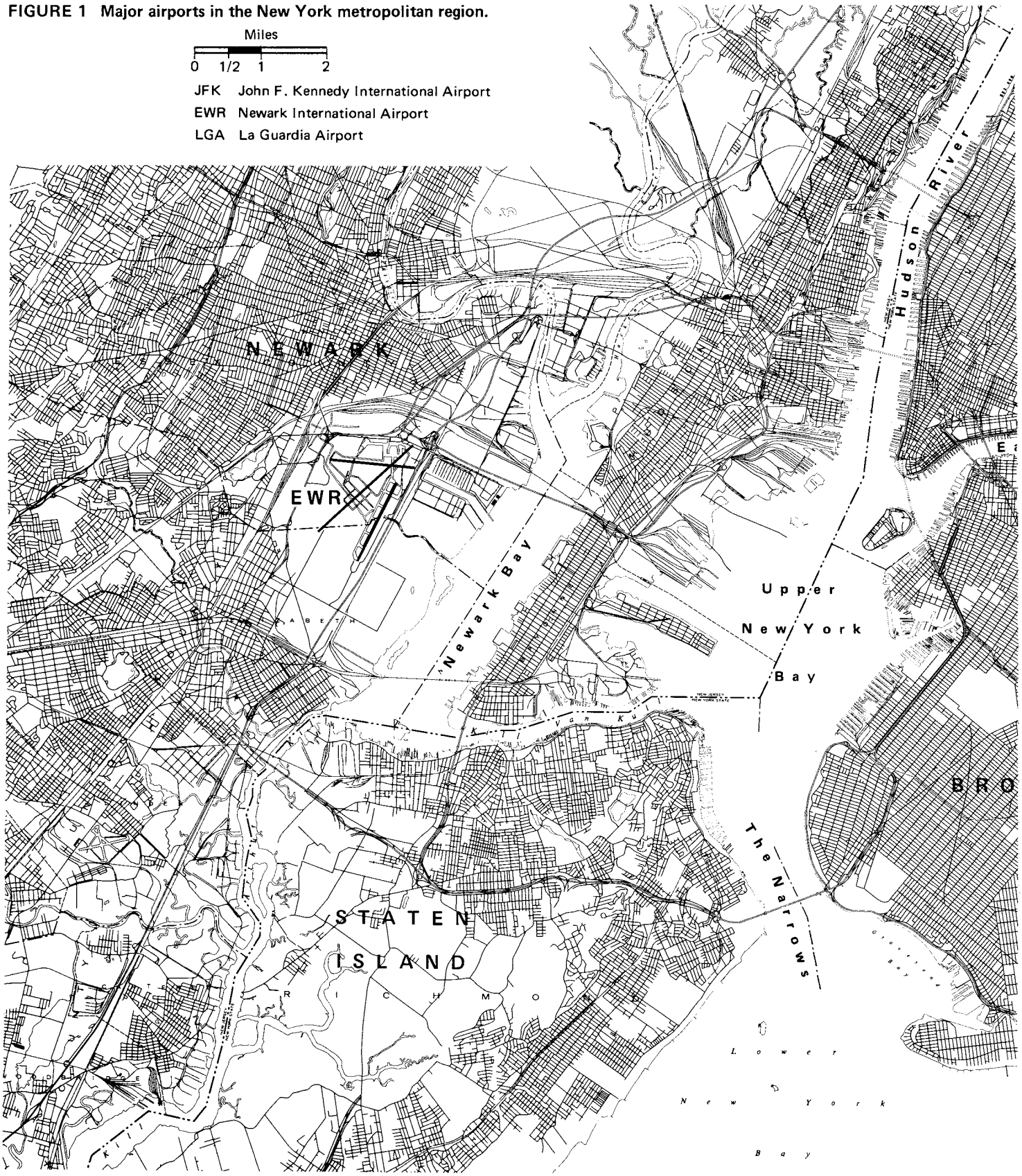
THE FUTURE OF JAMAICA BAY

An Undeveloped Resource

Although the present size of Jamaica Bay (about 13,000 acres) is only half its original primitive extent, the Bay is by far the largest open area within New York City. Within walking distance or a short ride by automobile or public transportation live several million City residents. Still a functioning estuarine area, albeit a severely impaired one, the Bay is an irreplaceable asset in its size, its ready accessibility, and its ecological viability. Nothing similar to it is to be found in any other major city of the world.

The draining and filling of the marshy borders of the Bay provided open land for housing around its periphery. The availability of public transportation to downtown City areas made the housing accessible, and the open vistas and fresh ocean breezes made it very desirable. Except for the airports, very little of the Bay's border is used for commercial or industrial

FIGURE 1 Major airports in the New York metropolitan region.




LGA
JFK
QUEENS
Jamaica Bay
ROCKAWAYS
Rockaway Inlet
HEMPSTEAD
NORTH HILLS
East River
Little Neck Bay
Sheepshead Bay

purposes, which enhances its value for housing. Most of the nearby housing is of low density, consisting of single-family dwellings.

Recreational use of the Bay is confined to boating and shoreside fishing at a few locations, notably Canarsie Pier, and some swimming. While water pollution has made swimming unhealthy in parts of the Bay, a major obstacle to increased recreational use is its lack of shoreside facilities and the difficulty of access across the Belt Parkway to the northern shoreside. The existence of a fine beach on the ocean side of the Rockaways has undoubtedly served to remove pressure for recreational development of the Bay, especially from those who travel by automobile to Riis Park or the Rockaways on summer afternoons. While a million bathers may use this ocean beach on a weekend day, and another million will travel by subway to Coney Island, only several thousand will be able to reach the inner borders of the Bay.

Jamaica Bay is crucially situated at the confluence of two principal flyways of migrating waterfowl. As smaller estuaries along the nearby coast were eliminated by draining and filling, the Bay became more important as a resting and feeding area for migrating birds. Only its vast size (as estuaries go) protected it from annihilation. The large marshy areas in the center of the Bay have been made into a very productive wildlife refuge by the Park Department's artful development of areas for freshwater storage and growth of food.

Polluted as parts of the Bay may be, it is still a major breeding ground of marine life in the New York Harbor region, especially since it is less polluted than the Hudson and other rivers tributary to the harbor. Even now, recreational fishing in the Bay and lower harbor is better than can be found in most major American ports. Abatement of water pollution in the New York area would undoubtedly greatly enhance the quality and quantity of fishing.

In the past, much of Jamaica Bay was developed for commercial or industrial purposes or used for waste disposal. The airports and peripheral highways were constructed on landfill dredged from the bottom of the Bay. Channels were dredged to permit barge transportation of oil to shoreside depots, and liquid waste, treated or not, was dumped into the deepened channels. Solid-waste landfill obliterated marshy areas. While these uses are compatible with each other, they seriously interfere with the present and potential use of the Bay and its environs for housing, recreation, and conservation. Although the prosaic needs of transportation and waste disposal are as pressing as the others, this preferential development of the Bay's resources for commercial purposes reflects an older policy regarding the most beneficial use of the Bay, which is currently being questioned.

We believe that the time has come for a reassessment of these unexamined developmental policies. We attempt to show here how the possible future development of the Bay for housing, recreation, and conservation could meet important unfulfilled needs of the people of New York, and how the potential for this development would be impaired by further commercial use of the Bay for airports, waste disposal, dredging, and other similar purposes. Any alternative development plan that placed first priority on the latter uses would be so inconsistent with existing national, state, and city environmental goals and so incompatible with the expected evolution of existing Bay communities as to be of only hypothetical interest.

Development of the Bay for Housing, Recreation, and Conservation

While the problem of land use along the Bay periphery is treated at greater length below, we wish to emphasize here that the quality of the Bay environment could be its most attractive feature to nearby dwellers. Fresh clean air, open spaces, and the esthetic appeal of a shorefront and open water enhance the environment of neighboring communities. A properly developed shorefront can be a focal point for community recreational and educational facilities and a neighborhood center. In large measure, the value of the Bay to nearby residents is intimately connected with its carefully planned development for recreational use, especially for the inhabitants of peripheral communities.

People of all ages, especially city dwellers, need a variety of recreational experiences. They need them daily, on weekends, and during annual vacations. Children need playgrounds, adolescents need game fields, parents need a park to stroll in and a beach for swimming with their children, fathers and sons need a place to fish, and the elderly need a quiet place in the sun. A recreational area must be easily accessible by walking or public transportation if it is to be used by the many who need it but do not have ready use of private automobiles. If the tension of city life is to be eased and its quality improved, inexpensive and accessible recreation must be made available to all city dwellers.

Jamaica Bay has an unrecognized potential for development as a sorely needed recreational area. Shoreside parks and playgrounds would obviously be used year round by local residents and would certainly be desirable to the inner-city resident looking for more open

spaces than he could find in his corner park (if one exists). Provision of beaches with contiguous areas for picnicking and athletics would open up an untapped recreational use of the Bay. We estimate that beaches along the northeastern sector of the Bay, which could be developed for about $7 million, would provide uncrowded swimming facilities for 200,000 people a day. If suitable additions and rerouting of proposed subway extensions in southern Brooklyn were also provided (at an estimated cost of $40 million), these beaches would be easily accessible by mass transportation to a population of several million residents of Brooklyn and Queens. Swimming in the warmer, calmer Bay waters would undoubtedly be an attractive alternative to use of the less accessible ocean beaches in the Rockaways.

By any measure, the per capita recreational resources of New York City rate very low compared with those of other major American cities. Given its great size and population, only development of major open areas adjacent to mass transportation can significantly add to the recreational potential of the City. Jamaica Bay alone can meet these qualifications. While it obviously would be inconvenient to residents of the Bronx, Jamaica Bay could serve as the major recreational resource for two to three million people, principally in Brooklyn and Queens. Substantial benefits could be gained at a very modest cost.

In the contest for the City budget dollar, recreation invariably fares badly. Upkeep of inner-city parks and playgrounds is very expensive because they are so overused. It is very likely that the per capita first cost and upkeep of Jamaica Bay park land would be lower than the average for other City parks and playgrounds.

The Parks, Recreation and Cultural Affairs Administration has overlooked a promising opportunity to provide more and better recreation at less cost by developing Jamaica Bay for this purpose. While public officials and private groups squabble over the use of an acre or two of Central Park, thousands of acres of prime recreational land along the shores of Jamaica Bay lie fallow.

The Jamaica Bay Wildlife Refuge is protected by its relative isolation in the center of the Bay. Its productivity will be increased as water-pollution abatement programs advance and can undoubtedly be helped by extension of the management practices now employed near the Broad Channel area. In our opinion, the continued viability of this area would not be threatened by the expansion of recreational usage of the Bay. But the greatest improvement would come from the construction there of an educational center, which would make available to City schoolchildren, as well as to the general public, an open ecological laboratory and natural wildlife habitat that is only palely reflected in the cramped quarters of New York City's zoos. The educational benefits would far outweigh the moderate costs of providing facilities for numbers of visitors considerably in excess of the 50,000 or so per annum who now visit the refuge.

Both the use of the Bay for swimming and its expanded use for fishing and conservation critically depend upon the completion of New York City's sewage-treatment program in the Jamaica Bay area. Upgrading of existing treatment plants and the installation of a storm-water/sanitary-sewage overflow-control system, of which the Spring Creek plant is the first unit, will be necessary to ensure bathing-water quality in the Bay and to bring the entire Bay ecological system back to a healthy state. We believe that the completion of the contemplated program will achieve these objectives.

The Incompatibilities of Commercial Development of Jamaica Bay

It is beyond contention that the construction and operation of Kennedy Airport has adversely affected the ecological viability of the Bay and the environment of millions of people within earshot of its air traffic. The taking of 4,500 acres of marshland and the dredging of Grassy Bay for airport fill destroyed one sixth of the original Bay area. Air pollution from aircraft and airport-generated ground traffic, as well as oil pollution from airport activities, has affected all forms of life both above and below sea level. Above all, the whine and roar of jet planes has cast a noisy pall over areas far removed from the Bay, and they are certainly nearly unbearable in the communities close by. Any steps that could alleviate any of these ill effects should certainly be taken.

The total effect of the airport on Bay community growth and improvement is discussed at greater length below. Here we are concerned with its effect on use of the Bay for recreation and conservation.

There is no doubt that aircraft noise will lessen the value of the recreational experience. Present noise levels in the Canarsie Pier area are sufficient to impair conversation and the rest and relaxation that should be normal experiences in afternoons at the beach. But so great is the need for recreation in New York City that new playgrounds, parks, and beaches along the Bay would be filled to capacity regardless of the degree of aircraft noise. For nearly all the prospective recreationers, there would be no comparable alternative.

Wildlife, being less intelligent than human beings, adapts even more readily to aircraft noise. Bird and

marine species that can maintain their instinctive patterns of survival in the presence of a man-altered environment will persist in Jamaica Bay as long as a supply of oxygen and unpoisoned food and a benign habitat for reproduction are available. As the natural environment deteriorates, the number of viable species declines, until only pigeons, rats, and sea gulls are left to remind the city dweller of his natural contemporaries. While Jamaica Bay is far from such a sorry state, a filling of major areas of the remaining marsh would be a giant step in that direction.

Water quality in the Bay is degraded by dumping into it organic matter, which consumes dissolved oxygen needed by marine species as well as introducing nutrients that stimulate the unbalanced growth of lower forms of marine life. (The discharge of inadequately treated sewage carries the additional hazard of organisms dangerous to human health.) Oil and industrial wastes, whether they reach the Bay via the sewage-treatment system or directly from uncontrolled surface drainage, are generally poisonous to marine species. When the background of biochemical oxygen demand and nutrient inputs to the Bay are minimized through the sewage-treatment programs, the pollution by oil and chemical wastes may become more noticeable. Steps to control and abate this pollution should be taken now.

Were it not mostly for the tidal inflow of cleaner seawater from the ocean, Jamaica Bay would fit the exaggerated description now inaccurately given it, namely, an open sewer. It is a common misconception that dredging the bay floor will aid the flushing action of the tidal motion, helping to clean out the pollutants dumped into the Bay. Both dredging for landfill, which increases the water volume in the Bay, and filling of marshy and shallow-water areas, which decreases the volume of tidal flow, increase the retention time, i.e., the time that a pollutant particle remains in the Bay before being flushed out to sea. Either dredging or filling, for whatever purposes, increases the damage caused by any given degree of pollution inflow. Filling parts of the Bay for airport runways will certainly intensify the problem of reducing water pollution. Dredging the bay for this or other fill would only compound the difficulty. As a matter of fact, a case can be made for the necessity of restoring the anaerobic stagnant areas, such as Grassy Bay, to their original shallow depths with fill transported into the Bay from offshore areas. Dredging or filling for any but the most exigent purpose should be forbidden.

Air pollution from Kennedy Airport does not appear to be more severe than that from surrounding areas, although the New York City authorities have made no recent adequate study of the matter. There is some suspicion that marshy plant damage in the Bay is caused by aircraft exhaust or by raw fuel regularly dumped from aircraft near takeoff. Unless aircraft pollution is abated through adoption of aircraft engine emission regulations by the cognizant federal agency, the air pollution from Kennedy Airport will only worsen, both absolutely and in relation to the other sources that are being brought under control.

The City's filling of marshy areas with solid waste has nearly reached an end, although strong pressures remain to continue this practice. If the Bay is to be protected against further loss of water or marsh area, expansion of the official landfill operation must be prevented, and the entire waterfront must be protected assiduously against wildcat refuse disposal and landfill operations, which are now common on the Bay periphery.

As long as oil is transported by barge through the Bay, whether to the airport or to other oil terminals, such as at Head of Bay, there will be oil spills. Certainly, growth of this commercial activity should be discouraged, and delivery of oil products by pipeline, as is now done for jet fuel at Kennedy Airport, should eventually be sought. Alternatively, these oil-handling facilities should be phased out and the land used for purposes more compatible with maintaining high environmental quality.

Federal Programs for Jamaica Bay

The Army Corps of Engineers has under study a hurricane flood-control barrier, which would be erected across the mouth of Jamaica Bay and along the beachfront of the Rockaway peninsula. This barrier is designed to prevent flooding damage to populated areas bordering the Bay under hurricane conditions so severe as to be only remotely likely to occur. Thus far, the study, as restricted by Congress, has ignored the programs for improving water quality in the Bay and the possible recreational development of the Bay, as well as existing recreational use of the Rockaway beaches. We recommend that no such barrier be constructed until its effects upon the entire plan for the development of the Bay have been evaluated and found to be supportive rather than destructive.

The National Park Service's plan for a Gateway National Recreation Area, which would geographically include the water areas of Jamaica Bay, is concerned with the recreational development of the ocean beaches of Breezy Point and Sandy Hook. Ignoring the recreational potential of the inner Bay beaches and shore-

front areas and their potential accessibility to large populations via extended mass transit, the plan tries unsuccessfully to cope with the formidable difficulties of transporting large numbers of inner-city residents to the most remote oceanfront regions of the metropolitan area. We are concerned that the implementation of this plan would prevent the City from making more immediate and more effective use by large numbers of City residents of recreational areas in the Bay, which would otherwise be locked up in a federal park beyond the control or influence of City residents. Direct federal aid to New York City for expansion of its own park facilities in Jamaica Bay would be more beneficial to City residents than would inclusion of the Bay in a national park.

KENNEDY AIRPORT AND COMMUNITY DEVELOPMENT

Characteristics of the Bay Communities

Three fourths of the Bay periphery lies in Queens, a borough in which the population is still increasing, even though that of New York City is declining. In the Bay communities, this growth is reaching its limit, as vacant land has nearly disappeared. About two thirds of the residents own their homes, giving these communities a stability and sense of identity more nearly like those of a suburb than those of a city area. Like the suburbs, many of these communities are predominantly white. City Hall, and even the borough hall, seem remote to many of the residents.

This growth has brought many problems in its wake. Public mass transportation is inadequate, subway service never having reached the extent and capacity found in neighboring Brooklyn. Schools are overcrowded, and more than two thirds of them are over 25 years old. Recreational facilities are very limited. Because much of the land near the Bay has little elevation above sea level, storm drainage is inadequate, and flooding of streets and homes is not uncommon. Street paving and maintenance are poor. In short, the population growth, much of which occurred during the 1930's and 1940's when public funds were scarce, has outrun the ability of the City to provide adequate public services. In the view of the local residents, the City administration has placed a higher priority on providing air transportation for the City and metropolitan region than on the provision of schools, subways, and sewers for the Bay communities.

Despite the growth in numbers of new homes, there are areas of deteriorating housing, very often built to substandard specifications. Urban-renewal programs are presently in progress in South Jamaica and Arverne, both within the present high-noise zone of Kennedy Airport. Other communities, such as Hamilton Beach and Broad Channel, would qualify as renewal areas. Communities such as South Ozone Park and Springfield Gardens are experiencing increasing housing pressures as inner-city minority groups move outward, seeking more adequate housing. It seems inevitable that the population of the Bay communities will continue to grow as higher density replacement housing is constructed and the few remaining open areas become likely prospects for more public housing. Growth of the airport and its related activities, by increasing the demand for and speculation in nearby land for commercial use, will so raise land values that higher density housing, whether public or private, is certain to increase.

Aircraft Noise and Other Effects of the Airport

Scientific studies of the reactions of people to aircraft noise have led to a quantitative scale for measuring its annoyance, called the Noise Exposure Forecast (NEF). This scale accounts for the loudness of the noise, its quality (screech or roar), its duration, the frequency of its occurrence, and the time of day when it occurs. At each level on this scale, the average response of people to aircraft noise can be predicted. For example, at NEF 30, conversation will be repeatedly interrupted for a cumulative duration of about one half hour per day, and about 50 percent of the people will experience an interruption of sleep (with a much higher percentage among elderly people). There will be organized efforts to seek noise abatement in communities subjected to this level. For the purposes of our study, we have selected a value of NEF 30 or higher to define the noise-impacted areas surrounding Kennedy Airport, although we recognize that a lower value should be used as an acceptable standard for residential usage.

At the present time, about 700,000 people live in areas near Kennedy Airport that are subject to a noise exposure greater than NEF 30. About 120,000 of them live in homes subject to an exposure exceeding NEF 40, which should be considered tolerable only for commercial usage in which noise-proofed buildings are used. These large numbers of noise-impacted residents are a result of two factors, both of which have increased with time: the increasing population density in areas surrounding the airport, resulting from housing construction, and the increasing area subject to NEF 30 or greater, caused by more and noisier aircraft operations. Unless circumstances change, both of these trends forecast increasing numbers of people exposed to greater aircraft noise.

Within the present impacted area (NEF 30 or

greater) there are 220 schools attended by 280,000 pupils. With normal schoolroom usage, this implies about an hour's interruption of classroom teaching each day and the development by the teachers of the "jet pause" teaching technique to accommodate the impossibility of communicating with pupils as an aircraft passes overhead. The noise interference with the teaching process goes beyond the periods of enforced noncommunication, for it destroys the spontaneity of the educational process and subjects it to the rhythm of the aeronautical control system. Given the advanced age of many of these schools, noise-proofing (where possible) would cost an appreciable fraction of their replacement cost.

A significant improvement in the noise environment around Kennedy Airport can be produced only by equipping aircraft with less noisy engines. If engine noise were reduced to levels consistent with the projections of the National Aeronautics and Space Administration "quiet engine" development program, which is estimated to be 10 EPNdb (effective perceived noise level) below present FAA standards for new engines, the number of people exposed to NEF 30 would be reduced dramatically from about 700,000 to 60,000, even if present runways were used. While the use of quieter engines would not eliminate the noise problem in communities surrounding Kennedy Airport, it would so reduce its severity as to permit the implementation of a long-range plan for completely compatible land use in the environs of the airport. Until aircraft are equipped with quiet engines, compatible land use is not a realistic possibility within the foreseeable future.

While noise is an overriding consideration, other airport-induced nuisances are felt in surrounding communities. The oft-expressed fear of an aircraft disaster, perhaps engendered by the constant sight and sound of aircraft overhead, is reinforced about once a year by an airliner accident near the airport. The sight of aircraft smoke trails and the smell of jet fuel downwind of the airport may cause exaggerated claims of excessive air pollution, but these cannot be discounted in the absence of clear scientific evidence to the contrary. Oil slicks in Bergen Basin and adjacent Bay waters are perceived as a fire hazard as well as a water pollutant. The ground traffic attracted by the airport, especially the rapidly growing truck traffic transporting air freight, appears to place extra burdens on the inadequate roads in nearby communities. The fear of the taking of homes, either by eminent domain or by purchase for commerical usage related to airport activities, destabilizes neighborhoods near the airport. Altogether, these effects make the airport an undesirable and even threatening neighbor.

Community Response to Environmental Effects

Seen from the view of Bay area residents, there is no government agency, local, state, or federal, that has been able to protect them from the inexorable encroachment of the airport and the deteriorated environment it brings. An ordinance of the Town of Hempstead to limit aircraft noise has been invalidated by the courts. The City and State environmental-protection agencies can control neither aircraft noise nor air pollution. City agencies approve housing renewal projects located in high-noise zones directly under flight paths. The FAA, while proposing engine-noise standards for new aircraft (which have not yet been met by new 747's), vacillates on more stringent but feasible standards for existing aircraft and defers the adoption of air-pollution emission standards.

It is an anomaly in this sorry record that PONYA, which in the eyes of many area residents is the villain of this "conspiracy," is the sole agency to have taken steps to control excessive aircraft noise. Within the limitations imposed upon it by FAA safety regulations and against the objections of aircraft pilots and airline managers, PONYA has specified and monitored takeoff procedures that will lessen noise relative to that associated with uncontrolled flights. While it is claimed that these procedures are evaded, they constitute the sole ameliorative measures undertaken by anyone, however limited in effect they may be. The fact that no improvement noticeable to nearby inhabitants has ensued from the implementation of these measures is direct evidence that manipulating aircraft flight patterns and procedures has only a negligible perceived effect on the noise impact on surrounding communities.

In the absence of any public agency able to cope with this problem, residents have organized citizens' groups to protest airport noise and to press for remedial measures. These groups have been joined by others concerned with broader environmental issues. They have enlisted the support of elected officials, particularly in the legislature, at all levels of government. In some instances, these citizens have been moved to adopt near-violent tactics to press for consideration of their grievances. Considering that many of these activists are respectable middle-class, middle-aged solid citizens, extreme provocation must exist to account for their impassioned response. That no remedy to their distress is in sight and no official redress of their grievances has occurred can only promise an escalation of their discontent and an exacerbation of the conflict between the citizen and his government.

Viewed realistically, only the federal government can initiate remedies that would significantly reduce the environmental impact of Kennedy Airport on the Jamaica

Bay communities. Only the setting of stringent noise and air-pollution emission standards by FAA (or the federal Environmental Protection Agency) will result in any appreciable reduction in airport noise and pollution. Only improvement of FAA air-traffic-control systems will permit the intensification of airport land usage and a consequent decrease in demand for more land for runways. Nevertheless, local and state governmental agencies should press for such measures on behalf of local citizens, who are otherwise poorly equipped to deal with the technicalities involved. Failure to do so will force local agencies to cope with a problem that is insoluble at their level.

Community Planning for Airport Needs

The expansion of the air transport industry and the change in aircraft technology have occurred so rapidly that the planners of Kennedy Airport could not have foreseen in 1947 the impact of these developments on the environment. Yet in the intervening years, as the expanding airport and the growing residential communities surrounding it headed on a collision course, no limits to either expansion were even proposed, much less enforced. The present situation is a result of improvident actions of City officials, airport authorities, and land speculators, and it exacts from nearly a million people a daily penance for the sins of oversight of public and private planners.

There are prospects of considerable alleviation of the plight of nearby residents through improvements in technology that would reduce noise and air pollution and restrict demands for more land for runways. Such improvements would not, however, remove the necessity for developing and implementing a compatible land-use plan for Kennedy Airport and the Bay area. Both the airport and the surrounding communities must recognize the limits on their usage of the land and must be prevented from encroaching on each other. This planning cannot be effective unless the airport's long-range development plans are incorporated into the planning process of New York City and Nassau County.

Some of the hazards to humans of aircraft noise can be alleviated by sound-insulation in buildings. Design and construction standards for buildings in noise-exposed areas should be set and rigorously enforced by local officials. These standards should be applied with equal force to public construction, whether schools or housing. An agreement by a state or federal agency to waive or ignore its own rules against financing substandard housing in noise-exposed areas can be checked at the local level by requiring strict adherence to noise-reducing standards of construction. The ability to maintain compatible land usage in the vicinity of airports also depends in part on the economic disincentives, such as increased construction costs, of alleviating the effects of incompatible uses.

The commitment of the City of New York to the creation and continuance of Kennedy Airport has not been matched by a corresponding commitment to protect the surrounding communities from the adverse environmental effects of the airport. Difficult as it may have been to forecast the extent and severity of this problem, and difficult as it may now be for the City, through its own efforts, to alleviate it in any significant way, there can be no further excuse for continuing the present disastrous policy of permitting and even encouraging marginal increases in size of impacted areas or numbers of people affected by them. That neither state nor federal agencies, nor the air transport industry, nor even the Congress or the national administration, has in any significant way helped the City to cope with its problem, cannot excuse the City from taking all measures within its command to alleviate an environmental hazard it has helped to create. At the very least, the City must avoid expedient actions that will intensify the conflict between the airport and the surrounding communities.

Environmental Evaluation of Some Runway Configurations for an Expanded Kennedy Airport

Increasing the aircraft-movement capacity of Kennedy Airport by improving the air-traffic-control system, by extending existing runways or constructing new ones, or by any combination of these, will have environmental effects on the surrounding communities and on Jamaica Bay. We have found that the noise effects are strongly dependent upon the technology of aircraft engines, while the other environmental damage is related primarily to the amount and location of land or water area needed for the new or extended runways. In turn, the latter is closely related to the characteristics of technologically improved air-traffic-control systems. In order to better understand the environmental costs associated with increasing aircraft-handling capacity and the technological methods for reducing them, we have evaluated the effects of four runway configurations, each of which is premised on different assumptions as to air-traffic-control capability. We believe these typify, but do not exhaust, the realistic possibilities for the near future.

The improvements in air-traffic control that we have considered would make possible a reduction in separation between parallel runways being operated inde-

pendently to as little as 2,500 feet (compared with the present requirements of 5,000 feet) or the operation of dual runways spaced 1,000 feet apart for takeoff and landing operations. For the various configurations considered, the computed capacity lies between the present value of 35 landings per hour and a maximum of 100 per hour, the latter being well in excess of the estimated 1980 demand of 45.

Reduction in aircraft-engine noise is possible through two recent technological developments. The first involves replacing (called retrofitting) existing engine nacelles with acoustically treated ones that reduce noise to levels closer to the Department of Transportation standards now in force for new aircraft. The nacelle treatment, costing about $500,000 per plane, could be fully implemented by 1975 if it were required. The second approach involves redesign of engines in the manner exemplified in the National Aeronautics and Space Administration's quiet-engine program. It is estimated that the quiet-engine noise level would lie 10 EPNdb below the present Transportation Department rule. Such engines, which could be available by 1975, would cost about $4,000,000 to install on existing four-engine aircraft, but could be used on new aircraft at only a 10 percent cost penalty.

The noise effects of aircraft in the surrounding communities depend upon the noise characteristics of the aircraft being used, the number of aircraft operations (both day and night), and the location and relative usage of the runway system under consideration. Since engine technology can be advanced independent of airport operations, we have examined the effects of the former for each runway configuration and the level of usage predicted for Kennedy Airport in 1980. The most significant reductions in number of people exposed to excessive noise (above NEF 30) are the result of use of retrofitted aircraft or those equipped with quiet engines, while much less improvement can be achieved by building new runways farther out into the Bay (see Table 4-5, Chapter 4, Volume II). Of course, additional runways would permit increased aircraft usage, tending to offset some of the gains from moving the traffic away from residential areas. Detailed calculations of NEF contours show that the reduction in number of people exposed to NEF 30 or greater that would ensue from the proposed extensions would never exceed about 100,000. The reduction would be much greater if quieter engines were used. In any event, no great reduction in noise impact can be achieved by runway extensions alone.

Construction of runways in Jamaica Bay will require dredging and filling operations that will have direct effects on the Bay's water quality and ecological system. Among these effects will be a reduction in water-surface area and marsh area, a reduction in tidal volume, a possible increase in retention time, and an interference with existing patterns of surface drainage and water circulation within the Bay. In addition, there will be a major problem in acquisition and disposal of fill material. There will also be numerous indirect effects attendant upon increased airport usage, among which are increased danger of oil spills from larger aircraft-fuel demands, increased demand on sewage-treatment facilities, interference with potential recreational usage of adjacent waters, greater air pollution, and a markedly increased danger of birds striking aircraft.

The various configurations considered will require the taking of between 5 and 28 percent of the Bay water area and from 1 to 26 percent of the present marshland. The filling of the greater areas would certainly endanger the viability of the marsh and marine ecosystems and seriously degrade water quality in the eastern end of the Bay. The relocation of treated sewage outfalls may be required.

Fill requirements of 20 to 175 million cubic yards would have to be obtained outside the Bay, as would disposal of up to 18 million cubic yards of spoil. The effects of the required filling and dredging on circulation patterns of the Bay cannot be ascertained without further study.

The more extensive runway configurations raise questions concerning a possible increase in bird strikes and the consequent danger to aircraft safety that they pose. At present there are more bird strikes at Kennedy than at any other U.S. airport. The number and size of birds being hit will increase as the runways intrude farther into the heart of the Bay. For this reason, extensive filling of water and marsh areas near and between runways will be required.

In summary, the environmental defects generated by extending runways into Jamaica Bay increase with the amount of area taken for such construction. Some ameliorative measures may be taken to reduce these adverse effects, but some degree of permanent degradation of the Bay environment seems inescapable.

NATIONAL AIR TRANSPORTATION POLICY

Implications of the Kennedy Study

While the proposed expansion of Kennedy Airport into Jamaica Bay appears to be a local issue to be resolved by local agencies, both the impetus for the expansion and the effective remedies for preventing environmental degradation lie at the national level. Federal and regional indecision has thrown an insoluble problem into

the lap of harried local officials powerless to cope with it. While the concern for environmental effects has called forth, for the time being, some coordinated interest on the part of local, state, and federal officials, this cannot properly serve as a substitute for a rational, coordinated plan to develop a national air transportation system that efficiently serves the needs of the nation without disrupting the environment of millions of people. In the absence of such a plan, disputes as virulent as those now surrounding the Kennedy Airport expansion proposal will erupt in other major U.S. cities as local citizens resist bearing the brunt of environmental costs evaded by the air transport industry and ignored by public officials.

Air travel to and from the New York metropolitan region in part serves regional needs, but it also helps to sustain the national and international business and financial center in New York City. To a great extent, Kennedy Airport therefore serves a national interest, especially since it is our largest international airport. But the planning for this airport and its possible expansion has proceeded on a local and regional basis, and the burden of land-taking and environmental disruption has fallen principally upon a city that benefits only partially from the national air transport system. Because these environmental costs have been borne locally, no effort has been made to eradicate them through the technological improvements on a national scale of which the national system is capable. Equivalent situations exist in other major U.S. cities and will undoubtedly become as acute as that at Kennedy Airport as the demand for air travel increases. It does not seem possible to solve these local airport planning, construction, and management problems independent of a federal plan for development of the national air transportation system.

Because of its massive and unfavorable environmental impact, an airport is no longer considered an unmixed blessing to a local community. The almost certain opposition by local residents to the siting of new airports had made the expansion of existing airports a more attractive alternative to airport authorities faced with a need for providing more flight capacity. It can be seriously questioned whether it is in the best long-run interest to expand an older airport near the heart of an urban area rather than provide for more future capacity in a more remote location in which proper environmental safeguards can be established. Any study of national policy on airport siting would have to consider whether urban airports such as Kennedy should not be phased out at a future stage in the development of an environmentally compatible national air transport system.

Fragmentation in Planning for Airport Siting and Expansion

At the federal level there is not yet a comprehensive plan and authority for managing a rational expansion of the air transportation system. The FAA is principally concerned with aircraft safety, and the CAB with aircraft scheduling and air fares, but the problem of airport siting and its environmental effects has not received equal attention at the national level. There is also little evidence of recognition that ground transportation connections to airports are equally a part of the air transportation system and the airport-location problem.

Contrary to common opinion, regional agencies do not have a free hand in siting or expanding airports. The history of PONYA's attempts to locate a fourth jetport is one of repeated failure to secure agreement among the many state and local interest groups, including private ones, as to who should bear the undesirable costs for the benefit of the metropolitan region. By default, the search for more regional air capacity has now narrowed to Jamaica Bay. Even if New York City should agree to the proposed expansion, it might be blocked by state authorities or private legal action. The provision of new airport capacity is not made more rational by being played out at more parochial governmental levels. On the contrary, the siting of an airport is thus more likely to be determined by the capitulation of the politically weakest community rather than by a balancing of costs and benefits to the region and the nation.

We therefore recommend that the Secretary of Transportation prepare a plan for the expansion of airport capacity in regions that are now congested, recommend sites for new airports, and acquire them if necessary to ensure the construction of adequate airports and ground access systems as a part of a national air transportation system. Congress should be requested to authorize these actions where necessary. Such site selection and development must provide for full local participation and prevent the creation of environmental hazards.

Improving the Air Transport System

The expected increase in air travel in the next several decades calls into question the appropriate future use for urban airports such as Kennedy. Regional jetports should properly be located away from urban centers, surrounded by adequate noise buffer zones and linked to the city by high-speed ground transport. Inner-city airports should be retained for V/STOL or interurban

usage, or phased out altogether. A long-range plan for future use of existing airports should be prepared by the Department of Transportation to guide the orderly development of the national air transport system.

The capacity of airports and the airways to handle aircraft is limited by the air-traffic-control system. It is generally acknowledged that the present system is obsolete and that improved systems are available that would increase the capacity of the existing airspace and airports to handle more aircraft more safely. The selection and implementation by the FAA of an advanced air-traffic-control system are urgently needed if a more efficient utilization of existing (and proposed) airports is to be achieved.

The present usage of existing capacity at Kennedy and other congested airports is very wasteful. The promotional policies of both the FAA and the CAB have encouraged maximum loading of the airspace and scheduling of air service. Only recently has the FAA limited the use of congested airports in order to reduce passenger delays. But the FAA and the CAB should act together to so limit the usage of overcrowded airports and airlanes that the maximum number of passengers may be safely and conveniently carried by the existing system. This may require imposition of landing fees and the restricting of peak-hour flight schedules by competing airlines where wasteful duplication of service exists. The FAA and the CAB should jointly undertake a complete study of the procedures for maximizing the system passenger capacity while minimizing congestion and flight delay, and should recommend corrective action.

For the short-term future, increased passenger capacity at Kennedy Airport will be a result of increasing aircraft size rather than growth in aircraft-handling capacity of the airport. But the new jumbo jets will be used for long-distance or heavily traveled routes. For short interurban or regional routes, V/STOL aircraft are likely to become increasingly important as passenger carriers that can use urban airports. Demonstration V/STOL programs should be tried soon to test the usefulness of this new mode of air transportation.

The development of new technology to increase the passenger handling capacity on the ground side of the airport has been sadly neglected. Each airport is left to solve its own ground transportation problems, which it passes on to the local community by asking for highway construction or rail links. Federal recognition of the necessity for development of ground transportation systems for airport access is a necessary first step.

Protecting the Environment from Airports

Under present circumstances, and for the foreseeable future, an airport is a great environmental hazard to the surrounding area. In choosing a new site or expanding an existing one, we are faced with the prospect of an irreversible change for the worse. Ideally, we should look for a large area of land (for buffer purposes) of otherwise low value that can be made accessible to urban areas by ground transportation. The possibility of technological improvements in ground and air transportation that reduce the requirements for land area and accessibility to the urban center, and thereby reduce the environmental cost, must be considered. Because of their demands upon land area, airports will most often compete with conservation and recreation areas for the scarce open lands in urban and suburban regions. Environmental quality for urban dwellers cannot be maintained unless a diversity of land usage, including parks and recreation areas, is preserved against constant encroachment for commercial uses.

The federal safeguards in the Environmental Policy Act of 1969 require careful investigation of environmental effects before approval of airport construction or expansion by the federal agencies involved. But these required environmental assessments of a proposed plan cannot substitute for a national environmental policy for airport siting in which environmental costs are a determining factor in site selection.

Substantial reduction of noise and air pollution from existing or new aircraft would bring major environmental relief to the environs of the nation's airports. The FAA and the new Environmental Protection Agency should promulgate the necessary stringent standards to which the manufacturer and user of aircraft must conform. These agencies should also recommend community noise and air-pollution standards to guide local or regional authorities in the construction and operation of airports and the development of communities surrounding them.

1 AIR TRANSPORTATION FOR THE NEW YORK REGION: NEEDS AND ALTERNATIVES

INTRODUCTION

Air transportation is vital to contemporary American life. It makes a major contribution to the productivity of the nation's economy and the high standard of living of its citizens.

The air transportation industry is especially important to the New York region. The region's pre-eminence as a financial, commercial and cultural center depends on the availability of rapid and reliable air service to all parts of the nation and the world. In addition, the air transportation industry, its suppliers, and ancillary activities are major employers, which annually add millions of dollars to regional income.

Projections of future demand indicate a continued growth in the use of air transportation to transport people and goods. The region's airports are already seriously congested. Construction of additional runways at Kennedy Airport has been proposed as a means of eliminating this congestion and providing capacity for future growth.

The undeniable benefits of air transportation do not necessarily justify the construction of additional runways at Kennedy Airport. Additional runways should be built only if the benefits from runway expansion exceed the costs and no lower cost alternatives exist that provide the same benefits, where costs include social and environmental costs.

It was not possible to do a comprehensive benefit–cost evaluation as part of this study. However, we do examine the alleged benefits of additional runways at Kennedy Airport. This evaluation raises serious questions about the necessity of constructing additional runways.

At minimum, there appears to be a variety of alternative measures that should be implemented before the irreversible action of taking Jamaica Bay for airport use is considered. This chapter examines the existing use of the region's airports, assesses the benefits from additional runways, and considers a number of alternatives to the Jamaica Bay expansion proposal.

Our analysis of the existing use of the region's airports suggests that they are currently operating far below peak efficiency and that considerable scope for increasing air passenger use exists. Moreover, the analysis of current airport use suggests that if new methods of allocating capacity are not introduced, the construction of additional runways might provide only limited and transitory improvement. Therefore, we briefly consider a number of administrative and pricing tools that would provide a better utilization of the region's airport capacity. These administrative actions would immediately improve the quality of air service to and from the region, and might delay for several years or eliminate entirely the need for additional runway capacity.

It is also evident that an expanded set of technological alternatives, including techniques to increase the capacity of existing airports, should receive more serious consideration. Thus, the chapter concludes with a brief survey of these alternative methods of improving the quality of intercity transportation services to New York.

THE GROWTH OF AIR TRAVEL

At the outbreak of World War II the nation's commercial airlines provided only slightly more than a billion passenger miles of air service a year. Three decades later (1970), this total had grown to 125 billion revenue passenger miles, with most of the growth occurring within the last 20 years. (Only 8 billion revenue passenger miles were provided in 1950.[1])

Rapid growth in the number of air travelers has been accompanied by significant broadening of the air travel market. A 1955 "travel market" survey of U.S. households conducted by the Survey Research Center of the University of Michigan revealed that only 7 percent of the total adult population made trips by air in the previous year. Indeed the survey showed that three quarters of the adult population had never traveled by air.[2] However, by 1962 a similar survey revealed that the share of the U.S. population who are experienced air travelers increased by more than 50 percent during the seven-year interval (1955–1962), from 23 to 36 percent.[3] A 1969 survey by Gallup indicated that nearly half of the population had flown one or more times.[4] By 1969 travel by air accounted for 75 percent of intercity trips by common carrier as compared with only 9 percent in 1948.[5]

Even so, the 1969 Gallup survey indicated that only 17 percent of the population had taken an air trip during the previous year, and low-income groups continued to be heavily underrepresented among air travelers. Two thirds of adults with income above $10,000 a year had taken at least one air trip during their lifetimes while fewer than one third with incomes below $10,000 had flown at least once.[6] Of course, the disproportion is even greater if trip frequency is considered. In spite of growing use of air carriers by middle- and low-income people, it remains true that high-income and business travelers continue to account for most intercity trips by air. This fact should be kept firmly in mind when subsidies to civil aviation are contemplated.

The reasons for the growing popularity of air travel are easily identified. Air travel has become faster, more frequent, more convenient, and cheaper. In 1949, the largest and fastest operating commercial aircraft was the DC-6B; nine years later the jet era began with the introduction of the Boeing 707.[7] Today nearly all airline passengers fly on pure jets. Replacement of slower piston aircraft and turboprops by jets sharply reduced intercity travel time. In spite of serious congestion, the 1969 average airborne speed on scheduled flights was more than three-quarters higher than it was 10 years before. During the same period, the price of air travel declined steadily. In dollars of constant purchasing power, i.e., constant 1957–59 dollars, the price per passenger mile declined from 7.06 cents in 1950 to 4.60 cents in 1969.[8]

Impressive as the growth in air travel during the past 20 years has been, the FAA estimates that passenger travel will triple again in the next 10 years, to a total of almost 400 million passengers a year, and that air cargo will grow to six to eight times its present volume.[9]

[1] Paul Cherington, *Airline Price Policy: A Study of Domestic Airline Passenger Fares* (Norwood, Mass.: The Plimpton Press, 1958), p. 23.

Growth in the number of trips has been comparable. In 1949 U.S. scheduled airlines carried slightly fewer than 17 million passengers; in 1969 they carried more than 159 million. Air Transport Association of America, *1970 Air Transport Facts and Figures* (Washington, D.C.: Air Transport Association, 1970), p. 5.

[2] The survey also determined that 30 out of every 100 individuals whose family income was $10,000 or more had taken air trips in the preceding year, as against only two out of every 100 in the "below $5,000" income group. However, a large share of the air trips made by high income family members were for business reasons. John B. Lansing, *The Place of Air Travel in the Travel Market, Selected Findings of the 1955 National Travel Market Survey Reported to the Travel Research Association, November 1956* (Ann Arbor: Survey Research Center, Institute for Social Research, University of Michigan), Table II.

Of all air trips in 1955, 55 percent had been for business reasons, and business reasons accounted for almost two thirds of the air trips by persons having incomes of more than $10,000 a year. John B. Lansing and Ernest Lilienstein, *The Travel Market 1955, A Report to the Travel Research Association* (Ann Arbor: Survey Research Center, Institute for Social Research, University of Michigan, 1957).

[3] John B. Lansing and Dwight M. Blood, *The Changing Travel Market* (Ann Arbor: Survey Research Center, University of Michigan, 1964), p. 89.

[4] The Port of New York Authority, Aviation Economics Division, "Market Research and Forecasting for the Airport Market," March 9, 1970, p. 3.

[5] Cherington, p. 29, and Air Transport Association of America, *op. cit.*, p. 5.

[6] Port of New York Authority, *op. cit.*, p. 3.

[7] By the end of 1959 jets provided about 20 percent of the total passenger service and turboprops provided another 14 percent. Air Transport Association of America, *op. cit.*, p. 16.

[8] Air Transport Association of America, *1966 Air Transport Facts and Figures* (Washington, D.C.: Air Transport Association, 1966), p. 10; Air Transport Association of America, *1970 Air Transport Facts and Figures;* and U.S. Bureau of the Census, *Statistical Abstract of the United States: 1970* (91st edition), Washington, D.C., 1970, p. 38.

[9] U.S. Congress, Senate, Aviation Subcommittee, Committee on Commerce, *The National Airport System,* 90th Congress, 2nd Session, U.S. Government Printing Office, Washington, D.C., 1968, p. 4.

GROWTH OF AIR TRAVEL IN THE NEW YORK REGION

The New York region has long been a leader in commercial aviation. Its share of domestic air travel averages roughly 12 percent throughout the decade 1949–1959. In the past decade it has declined to about 10.5 percent with some indications of an accelerated decline.[10] The region's share of international air travel has declined even more rapidly. Even so, the region continues to be the dominant gateway for transatlantic air service, accounting for 72 percent in 1968 as compared with 90 percent in 1948.[11] These declines are easily explained. The demand for air travel depends on the levels of income, population, and employment, and other parts of the nation, particularly the South, Southwest, and West, are growing much more rapidly than the East in these terms. In the transatlantic market, introduction of long-range jets permitted nonstop service between Europe and an increasing number of cities in the rapidly growing parts of the United States.

In spite of a declining share of both domestic and international travel, the annual number of airline passengers using the region's airports in the last 20 years has grown more than eightfold, from just over 5 million in 1950 to an estimated 42 million in 1970. PONYA forecasts more than a doubling of air passenger trips by 1980.[12]

The region's airports are also heavily used by general-aviation aircraft and all-cargo flights. In 1968, the region's three major airports served an estimated 239,000 general-aviation flights and 37,000 scheduled all-cargo flights.[13] Approximately half of the general-aviation flights were air taxi flights and half were business and private aircraft.

[10] Port of New York Authority, Aviation Economics Division, "84 Air Traffic Centers Comprising About 90 percent of U.S. Domestic Traffic," February 17, 1969 (mimeo).

[11] Port of New York Authority, "Market Research and Forecasting for the Airport Market."

[12] See Appendix B.

[13] Regional Plan Association, "The Region's Airports," *Regional Plan News* (July 1969), p. 16. A 1963 survey of general-aviation movements by the Tri-State Transportation Commission indicates that even though the 239,000 general-aviation flights were nearly a fourth of the total movements at the region's three major airports, they accounted for only 11 percent of all general-aviation movements in the region. Of the remaining 89 percent of general-aviation movements, approximately 52 percent were accommodated at 16 well-equipped secondary airports and the remaining 37 percent at 51 minor general-aviation airports.

AIR TRANSPORTATION AND THE REGION'S ECONOMY

Airlines and related activities employ large numbers of workers. In August 1969, an estimated 59,727 persons were directly employed at the region's airports.[14] Moreover, as CEIR, Inc. pointed out in a 1959 report to PONYA, many regional firms owe all or part of their prosperity to airport business or the unequalled accessibility provided by the region's airports.[15] The report said:

> Airplanes and the people who fly them in and out of the region form a core around which is built a network of related industrial activity. For descriptive purposes, this complex of aviation and other business can be called the primary civil air transportation industry of the New Jersey–New York Metropolitan Region. The revenues of this group exceeded a billion dollars in 1959.[16]

In all, CEIR estimated that in 1959, 121,000 jobs and $682,000,000 in wages and salaries were generated for residents of the New York region by air transportation.[17] Updated estimates for 1965 in a PONYA report (1966) attribute 162,000 jobs and $1,149,000,000 in wages to air transportation. These estimates are summarized in Table 1-1.[18]

The CEIR report further emphasizes the importance of air transportation in maintaining "the preeminent economic position of the New Jersey-New York Metropolitan Region as the unchallenged champion of the nation's institutional life . . . the (nation's) financial center, the style center, and the entertainment and cultural center, and its historical role as the preferred

[14] *Responses from the New York Port Authority,* August 3, 1970.

[15] CEIR Inc., *The Economic Relationship of Air Transportation to the Economy of the New Jersey–New York Metropolitan Area.* Summarized in: The Port of New York Authority, "A Report on Airport Requirements and Sites in the Metropolitan New Jersey–New York Region" (New York: 1961), pp. 3–4, and Chapter II, pp. 4–13.

[16] Port of New York Authority, "A Report on Airport Requirements and Sites in the Metropolitan New Jersey–New York Region," May 1961, p. 5.

[17] It should not be concluded from our presentation of these estimates that we consider them valid secondary benefits to be set against the costs of runway expansion in an economic evaluation of the benefits and costs of runway expansion. First, only incremental benefits and costs are pertinent to the Jamaica Bay proposal. Second, our subsequent analyses suggest that there are preferred, i.e., lower cost, methods of expanding capacity. Finally, we have not considered CEIR's methodology carefully enough to determine what part, if any, of these alleged benefits can be considered secondary benefits of airport capacity.

[18] Port of New York Authority, *supra,* December 1966, p. 14.

TABLE 1-1 Estimated Total Regional Employment and Earnings Generated by Air Transportation

	Number of Employees		Wages and Salaries ($1000)	
	1959	1965	1959	1965
1. Direct employment				
A. At airports	36,550	44,600	238,665	382,000
B. At off-airport offices and other locations	14,195	16,500	102,725	150,000
2. Indirect employment created				
A. By purchase of materials locally by the air transportation and related service industries	10,530	12,500	61,180	90,000
B. By passenger activities including:				
a. Taxicab, airport, and terminal operations	1,150	2,000	5,830	12,000
b. Company personnel arranging transportation	2,860	5,100	12,190	30,000
c. Convention or visitor generated business	20,235	34,000	83,300	180,000
C. By other business activity generated by spending wages and purchasing goods and services	35,280	47,500	178,890	305,000
Total	120,800	162,200	682,780	1,149,000

Source: The Port of New York Authority, *Airport Requirements and Sites to Serve the New Jersey–New York Metropolitan Region 1966* (New York: December 1966), p. 14.

headquarters location for major United States and foreign companies operating in national, international, and large regional markets." [19] This view was pressed on the study group by virtually every city official and is emphasized in the New York City Planning Commission's 1969 report, *Plan for New York City: A Proposal,* which states: "Air transportation is vital to the national center, and, in providing it, New York has great advantages: The accessibility of its three major airports to its business districts; its dominant position as a gateway for overseas flights; its frequency of service to all parts of the United States." [20]

No authoritative evidence exists that permits a satisfactory evaluation of the relationship between increased air service and the maintenance and growth of the region's national center function. We accept the view that frequent, fast, and high-quality air service is one important contribution to New York's dominance as a headquarters for national corporations. However, no one could provide us with a quantitative estimate of the importance of high-quality air service in comparison with other factors or specify exactly how increases in airport capacity would affect the quality of air service or the region's competitive position.

Corporate executives and others, in evaluating the relative attractiveness of New York City and other locations, presumably consider the quality of scheduled air services and the ease of travel to and from the region by corporate aircraft. As analyses of the present and future use of the region's three major airports (presented subsequently in this chapter) indicate, there is an important difference between increasing runway capacity and increasing the quality of air transport serving the region. The most promising measures for obtaining immediate improvements in the quality of the region's air service are not additions to runway capacity but techniques that would increase the productivity of existing runways. If such measures are not taken, increases in runway capacity might achieve only minor improvements, if any, in the quality of air service to the region.

[19] Port of New York Authority, *supra,* 1961, p. 11.
[20] New York City Planning Commission, *Plan for New York City: A Proposal,* 1969, p. 28.

CAPACITY OF THE REGION'S AIRPORTS

Airports perform a variety of functions: the provision of runways for aircraft to land and take off, waiting rooms, restaurants and other service facilities for passengers and their friends, and facilities for the service and maintenance of aircraft and the handling of air freight. Moreover, the airport is only one component in the air transport system. Other important components include the airways, the regional air space, and the ground access system.

The quality of air service depends on the capacity of each link in the system. If the capacity of other links is inadequate, additions to runway capacity would provide few or no benefits. The proposed construction of additional runways in Jamaica Bay would increase the number of aircraft that can land at or take off from Kennedy Airport during a given period of time. However, additional runways might simply create bottlenecks at other points in the system. At Kennedy Airport, the ground

access system seems to be a particularly vulnerable link.

The number of aircraft that an airport can accommodate without delay depends on many human and physical factors. Thus there is no single measure of even runway capacity. Weather conditions produce the largest systematic variations in capacity. Under poor weather conditions, instrument flight rules are in effect and the airport can accommodate many fewer aircraft than it can under good weather conditions and visual flight rules.

The lower instrument-flight-rule capacity figure is the relevant measure of capacity because of the extreme importance of schedule reliability. Although this figure cannot be determined exactly, a widely used estimate for the region's three major airports is approximately 173 total movements per hour under instrument-flight-rule conditions.[21] When the Newark expansion is completed in 1972, the capacity under instrument flight rules at the region's three regional airports will be increased by another 10–20 movements. The Jamaica Bay runway proposal would increase the peak-hour instrument-flight-rule capacity of the region's airports by an estimated additional 35 movements.[22]

PEAK-HOUR USE OF THE REGION'S AIRPORTS

It is difficult to estimate how many aircraft would attempt to use the region's airports during the peak hours because their actual utilization is restricted by capacity. Moreover, as a result of the long delays at several congested airports, there are FAA quotas during instrument-flight-rule conditions, which may discourage some users.[23] However, it is likely that existing delays and congestion at the region's airports have had a greater impact on airport use during peak hours than have the FAA quotas.

TABLE 1-2 Scheduled Air-Carrier and General-Aviation Operations in the New York Region between 6:00 and 7:00 p.m. during July 1969

Type Flight	Arrivals	Departures	Operations
Scheduled air carrier			
Domestic	60	69	129
Oversea	15	11	26
Subtotal	75	80	155
General aviation	—	—	25
Total operations	—	—	180

Source: Port of New York Authority, *Official Airline Guide*, July 1969.

From an analysis of actual airline schedules during July 1969, we determined that there were approximately 155 air carrier movements scheduled at the region's three major airports during the busiest peak hour, 6:00 p.m. to 7:00 p.m.[24] In addition, there was an average of about 25 general-aviation movements during the same hour, bringing the estimated peak-hour demand to 180 (Table 1-2). These estimates, which refer to a period following the imposition of the FAA quotas and the imposition of a $25 minimum landing fee for the three major airports in August 1968, are probably fairly representative of the present situation.[25] The number of movements is not very different during the remaining hours of the peak period (Appendix A, Table A-2).

The analysis that follows focuses on the use and capacity of the entire regional airport complex. Although there is not perfect substitutability of capacity among airports (for example, La Guardia does not accommodate four-engine jets), to a first approximation, increases in capacity at La Guardia or Newark are

[21] Port of New York Authority, *supra*, 1966, p. 28.

[22] This estimate is the difference between AIL (Aircraft Instruments Laboratory) theoretical capacity estimates of 74 movements under instrument-flight-rule conditions for Kennedy Airport in 1975 with the existing runway configuration and comparable estimates of 109 instrument-flight-rule movements in 1975 with additional runways in Jamaica Bay. During 60 workdays in the June–August 1969 period at Kennedy Airport, actual instrument-flight-rule movements in the 3:00 p.m.–8:00 p.m. period averaged approximately 58 movements per hour. PONYA, "Responses from the New York Port Authority," August 3, 1970 (mimeo).

[23] In June of 1969 the FAA imposed movement quotas on the region's airports as well as at congested airports in other parts of the country. This quota system permitted up to 200 movements per hour at the three airports between 6 and 7 p.m. (capacity under instrument-flight-rule conditions is estimated at 173 movements) consisting of 42 general-aviation movements and 158 air-carrier movements (see Appendix A, Table A-1).

An October 1969 analysis by PONYA, "Effect of the FAA Allocations," concluded that the quotas had little effect on air carrier schedules. Any reduction in delay that has resulted from the quotas seems to come largely from the elimination of about 5,000 general-aviation flights per month at the region's airports (PONYA, "Effect of the FAA Allocation," October 1969).

[24] Because of congestion, average actual movements will differ from scheduled movements. We considered the scheduled movements to be the more meaningful measure of peak-hour demand.

[25] During July 1969, general-aviation movements fully used their FAA quota at Kennedy, but not at La Guardia or Newark. Air carriers fully used their allocations at La Guardia, nearly used them at Kennedy, and averaged about five operations below the allocation at Newark. This pattern has remained relatively unchanged; in June 1970, the distribution of air-carrier movements was nearly identical, but general-aviation movements had increased slightly to the point where they exceeded their quotas slightly at Kennedy and exceeded them by about 25 percent at La Guardia during some hours. Total peak-hour movements in the region, however, remained below the quota.

substitutable for increases in capacity at Kennedy. The division of aircraft movements into scheduled-air-carrier and general-aviation categories reflects both their markedly different operational characteristics and a presumption that, on the average, larger air-carrier aircraft provide more benefits per movement than do smaller general-aviation aircraft.

General aviation is a heterogeneous category of small aircraft that includes sophisticated corporate aircraft, private planes, and air taxis. Each carries only about a tenth as many passengers per unit of expensive peak hour capacity as scheduled air carriers.[26] The 25 or so general-aviation flights during the 6 p.m. to 7 p.m. peak-hour carry fewer passengers than three air carrier flights.

Small passenger loads alone are not proof that general aviation's use of the region's airports should be discouraged or discontinued. However, differential passenger capacity is one measure of the relative benefits of different aircraft that should be given serious consideration in allocating expensive peak-hour airport capacity.

Advocates of airport expansion have minimized general aviation's contribution to existing congestion at the region's airports, and particularly at Kennedy, where many of the air taxi operations use so-called non-duty runways to avoid payment of the $25 minimum flight fee. However, our analysis indicates that current general-aviation use of the region's three major airports is substantial and that, as the discussion of PONYA projections in Appendix B indicates, *general aviation accounts for virtually all the projected growth of peak-period aircraft movements during the next decade.* Moreover, during instrument-flight-rule conditions, when capacity at Kennedy Airport is most severely stressed, all air taxi operations must use duty runways. Also, air taxis will sometimes insist upon use of STOL runway 14–32 to avoid payments of the $25 fee even when use of another runway would interfere less with airport operations.

Imposition of a $25 minimum landing fee in August 1968 reduced general-aviation usage of the three airports by 40 percent in one year. This suggests that a minimum landing fee of $100 during peak hours would largely eliminate peak-hour general-aviation usage of the region's three major airports.[27] A $100 peak-hour landing fee is far less than the full long-run costs of providing additional runway capacity and a still smaller fraction of the average delay costs imposed on other users by an additional general-aviation movement during the peak period.[28]

It is difficult to justify additional runways when existing marginal users pay an average of only $11 to use Kennedy's runways.[29] At this rate the benefits from the extended runways would be valued at only $350 per peak hour or at roughly $843,150 a year (365 days times 6 peak hours times 35 additional movements times $11). If the $25 minimum is used as the measure of benefits to small aircraft using the airport during peak hours the value of additional capacity provided by the expansion is less than 2 million dollars a year. Since the proposal has a direct capital cost of between 200 million and 300 million dollars (including no computation of environmental or social costs from expanded airport operation), the case for immediate additions to peak-hour runway capacity at Kennedy Airport is, by this measure at least, exceedingly weak.[30]

SCHEDULE COMPETITION AND AIR-CARRIER USE OF THE REGION'S AIRPORTS

Reductions in general-aviation use of the region's three major airports could eliminate current congestion and

[26] No information is available on the number of passengers carried by corporate and private aircraft; however, it is unlikely that it is larger than the average number carried by air taxis, which is only about five passengers.

[27] Actually, because of the provision that permits licensed air taxis to use non-duty runways under visual flight rules, the average minimum peak-hour landing fee for general aviation at Kennedy is only about $11. The average for air taxis is even lower. Since these aircraft are permitted to use duty runways during instrument-flight-rule conditions, they must pay only about $5 times (proportion of total hours that are visual-flight-rule) plus $25 times (proportion of total hours that are instrument-flight-rule) per landing for all-weather landing rights.

[28] Carlin and Park, in an important study for PONYA, estimated that an additional general-aviation arrival at Kennedy during peak hours imposed average delay costs on other aircraft and their passengers amounting to approximately $1,793. Similarly, they estimated that a peak-hour general-aviation arrival at La Guardia imposed delay costs on other users of $588 and that the delay costs at Newark were of a similar order of magnitude. During instrument-flight-rule conditions the delay imposed by an additional general-aviation aircraft arrival would be about twice as large, $3,800 and $1,200. An hour's delay for a fully loaded 747 under these circumstances would cost $21,510. We regard $100 as a fairly modest charge for the "right" to impose delay costs of this magnitude on other users. A. Carlin and R. E. Park, "The Efficient Use of Airport Runway Capacity in a Time of Scarcity," The RAND Corporation, Memorandum RM-5817-PA (August 1969).

[29] At Kennedy during 1969, two thirds of general-aviation flights used a non-duty runway at a cost of $5. The average peak-hour general-aviation landing fee at Kennedy is then only $11, i.e., $(0.3\times\$25)+(0.7\times\$5)=\$11$.

[30] Large revenues from concessions, rentals, etc., attributable to these marginal flights might justify the proposed expansion. However, because small aircraft carry few passengers, they contribute very little to airport receipts from these sources.

provide a margin of capacity for future growth in air-carrier movements. Eliminating the 25 or so peak-hour general-aviation flights would reduce peak-hour use of the region's airports to 155 movements, a level well below the estimated instrument-flight-rule capacity of 173 movements per hour. This gain in peak-hour capacity is 70 percent of that which would be obtained from the PONYA Bay runway proposal.

If present pricing policies are retained after the elimination of peak-hour general-aviation flights, however, the result may be only an increase in peak-hour air-carrier movements. Thus, any reduction in congestion from the decrease in general-aviation flights would be lost. Ironically, our analysis of current passenger movements and of the schedules of airlines serving New York indicates that the number of peak-hour flights in several city-pair markets is already excessive and could be reduced with no reduction in the benefits to air travelers.

The current pattern of schedule competition is rational from the viewpoint of individual airlines; however, it yields totally unacceptable results for the society at large, all air travelers, and the economic welfare of the New York region. The wasteful overscheduling of air-carrier flights results from the regulations imposed upon airlines and the gross underpricing of peak-hour capacity.[31]

Airline fares, which are regulated by the Civil Aeronautics Board, are fixed and identical for all flights between the same two cities. Therefore, an airline can affect passenger demand only by varying the quality of its product. Flight frequency is an important element of the quality of air transportation. In general, an increase in flight frequency will reduce waiting time for a trip by producing shorter intervals between flights and raising the probability of obtaining a seat on each flight.[32] However, existing schedule competition in many markets provides few benefits to air travelers, and, in the aggregate, this competition has raised the cost and lowered the quality of commercial air service to and from the region. These conclusions are based on an examination of air-carrier schedules and an evaluation of the relationship between schedule frequency and other dimensions of the quality of air travel.

[31] This evidence is consistent with the findings of a number of studies of air transportation. See Lucile Keyes, *Federal Control of Entry into Air Transportation* (Cambridge: Harvard University Press, 1951), Ronald Miller, *Domestic Airline Efficiency: An Application of Linear Programming* (Cambridge: MIT Press, 1963), and Richard Caves, *Air Transport and Its Regulators* (Cambridge: Harvard University Press, 1962).

[32] The elasticity of demand with respect to frequency of flight has been estimated to be .4 to .6 by Arthur De Vany in *Time in the Budget of the Consumer: The Theory of Consumer Demand and Labor Supply under a Time Constraint*, Ph.D. dissertation, UCLA, 1970. This elasticity is closer to unity in Great Britain, where markets have not developed as extensively as they have in the United States. Since elasticity is a negative function of flights, the United States, having a far greater number of flights, would be expected to have a lower elasticity. Note however, that when all airlines increase frequency, the resulting congestion may cause late arrivals with the result that schedule delays offset the greater schedule frequency.

THE QUALITY OF AIR TRAVEL

It is exceedingly difficult to measure or even identify all the factors affecting the quality of air service to the region. Moreover, it is clear that these factors will be valued differently by different users. In any event, in any discussion of the quality of service provided by the air travel system, among the most important factors are safety, travel time, reliability, directness of the trip, flight frequency, number of destinations served, comfort, high probability of being able to obtain a seat at the preferred departure time, and cost.

Most travelers consider safety a highly important factor in the quality of an air trip. Indeed, many contend that safety is an absolute that cannot be traded off against increases in airport capacity, reductions in time (delay), or other factors in trip quality. Yet the system operates in quite a different way. Existing congestion at major airports during instrument-flight-rule conditions and the consequent overloading of the air-traffic-control system increase the probability of mid-air collisions and other aircraft accidents. The overloading arises from an attempt to operate more flights at the region's airports during instrument-flight-rule conditions than can be accommodated. Our analysis suggests that excess demand for runway capacity results from policies that encourage wasteful competitive scheduling practices during peak periods and permit excessive use of the airport by general aviation. Further safety hazards are created by mixing light aircraft into the traffic stream and the generally lower competence of general-aviation operators.

Most persons would rank time savings and schedule reliability second only to safety. Much of the popularity and growth of air travel results from the travel-time savings it offers over competing forms of transportation for all but the shortest intercity trips. Although the present discussion deals primarily with flight time and airborne delays, it is well to remember that the air passenger is concerned with the total trip time and that the time spent in the air is only a part—in many instances

the smaller part—of the total trip time.[33] The remainder consists of terminal time (baggage handling, passenger processing, etc.) and ground access time. The point may already have been reached in the New York region at which the improvements in the quality of air service can be more efficiently gained by improving access to and from the region's airports than by further reductions in flight time. Even so, most air travelers are still very concerned about flight time and schedule reliability; therefore, it is appropriate to inquire how well the present system performs in terms of minimizing travel time and travel-time delays.

Overscheduling of commercial-aviation flights and excessive use of the region's airports by general aviation produce large delays. The extent and nature of these delays have been carefully documented in a recent study for PONYA by the RAND Corporation. In that study, Carlin and Park determined that peak hour delays at Kennedy Airport during the period April 1967 through March 1968 (prior to the FAA quotas) averaged 25 minutes. During instrument-flight-rule departure and arrival conditions, average peak-period delays exceeded an hour. Although delays at La Guardia and Newark are somewhat shorter than at Kennedy, they are still undesirably large, and particularly under instrument-flight-rule conditions. (Peak-hour departure and arrival delays for all three airports and different weather conditions are summarized in Appendix A, Table A-3.)

Carlin and Park estimated that the aggregate cost of these delays in 1968 to the users of the region's three major airports exceeded $49 million. If the Bay runways would eliminate these delays, yearly benefits of this magnitude would be a strong argument for their construction. Unfortunately, there is little basis to believe these and subsequent additions to airport capacity will provide any significant long-term reduction in delays or other improvements in quality if the present methods of allocating peak-hour capacity are continued. Under the present policies, the potential benefits of airport expansion are likely to be dissipated through an increase in general-aviation activity and through increases in schedule frequency as air carriers add new peak-hour flights and move former peak-hour flights back into this slot.[34]

Many of the benefits theoretically available from greater schedule frequency are not realized. Most competing peak-hour flights are scheduled to depart at the same time. (Because of congestion, actual departures may be quite different.) This characteristic of the present system is illustrated vividly by peak-period schedules between Chicago and New York. In the two-hour period 4 p.m.–6 p.m., 16 nonstop flights depart from O'Hare Airport in Chicago for New York. Nine of these depart within 35 minutes and six within 20 minutes of 5 p.m. (a 6 p.m. arrival in New York). Four flights have identical scheduled departure times (5 p.m.) and three of these serve La Guardia Airport.

This pattern is repeated in every major market. It is most unlikely that any service will leave Kennedy Airport at the scheduled time, and even less likely that it will arrive on schedule. The air traveler gains very little by leaving 15 minutes earlier when delays normally average 25 minutes, as at Kennedy Airport.

Much of the responsibility for this excessive schedule frequency in several markets lies with the federal government, particularly the CAB and the FAA. However, PONYA cannot escape a major share of the responsibility for allowing this inefficient air carrier use of the region's airports during peak hours and the serious deterioration in the quality of the region's air service that has been the inevitable result.

Our examination of current airline schedules raised serious doubts in our minds about the benefits provided air travelers by the large number of competing flights currently operating in many markets.[35] Therefore, we

[33] Existing and anticipated delays and the "relative slowness of local access to and egress from transportation terminals" appears as the second principal conclusion in the Executive Summary of the Northeast Corridor Report. The project's analysis estimates that only 31 percent of the average CTOL (conventional take-off and landing) aircraft trip within the corridor was spent in the air. The report's first conclusion, also concerned with ground transportation, was the important reminder that auto transportation will remain as the strongly dominant mode for intercity trips within the corridor, regardless of the improvements which can feasibly be made to other modes. In 1968 automobile trips accounted for 68 percent of intercity passenger miles within the corridor as contrasted with 11 percent for air. Office of High Speed Ground Transportation, U.S. Dept. of Transportation, *Northeast Corridor Transportation Project Report,* April 1970, Rept. NECTP-209, pp. S-1, S-12, 1–17.

[34] This is a familiar pattern in highway use in which a new (faster) highway draws drivers off existing roads until congestion on the new highway raises travel time until it just equals travel time on the next best road, at which point some people will switch back to the old road. Runway congestion and highway congestion are essentially identical phenomena in that they are caused by a failure to charge the marginal user the full cost of his use of the scarce capacity. Whereas highway use is hard to charge for, there are no such problems with runway use and no major difficulties in instituting an efficient pricing system.

[35] Seventy U.S. and foreign cities currently receive at least one scheduled nonstop flight (to or from) New York during the three busiest hours. During the same three hours, there are approximately 465 scheduled air-carrier movements. Obviously, peak-period (3 peak hours) flight frequency differs greatly among these cities. Eight domestic cities have 12 or more movements during the afternoon peak period and these account for 148 of the 369 movements serving domestic cities.

decided to determine how many air carrier movements could be eliminated during the 6 p.m.–6:59 p.m. peak hour, while providing at least hourly service to all cities having at least one flight during the hour. Although rather arbitrary, this flight frequency is somewhat less than the average delay experienced at Kennedy Airport during instrument-flight-rule conditions in 1967–68. The actual hypothetical schedule provides considerably more frequent flights in most markets. We constructed hypothetical airline schedules in the following manner:

1. The number of peak-hour passengers arriving and departing on nonstop flights was estimated for all city pairs. This estimate was obtained by multiplying average load factors for 6 p.m.–6:59 p.m. flights serving Kennedy Airport (the only available data on load factors by flight) times the number of seats currently scheduled in each market.
2. The number of flights per hour in each market was computed by dividing the estimated number of passengers arriving from or departing to each city during the peak hour by the number of available seats per aircraft. Available seats per aircraft was based on the largest aircraft now in use in that market, assuming an 80 percent load factor to allow for fluctuations in peak hour demand.

It would have been desirable to do similar analyses for the entire 24-hour period. This was impossible in the short time available. However, we doubt that the findings of a more elaborate analysis would differ in any important respect.

The resulting consolidated schedule is summarized in Table 1-3. (The hypothetical consolidated schedules for each city are presented in Appendix A, Table A-4.) This analysis indicates that with existing equipment, the number of air-carrier movements during the hour 6 p.m.–6:59 p.m. could be reduced by 34 while still providing a minimum of hourly nonstop service (for all markets currently receiving at least one departure or arrival during the peak hour). Of course, these nonstop services could be further augmented by direct flights. For example, a nonstop departure to Chicago could be scheduled through to Los Angeles, Denver, or San Francisco, thereby increasing service frequency to these markets. In all but three markets (Miami, Los Angeles, and Baltimore), the consolidated schedule still provided two or more departures in the hour. The low frequency in these markets results more from low initial frequency (largely because the major duplication occurs during other peak hours) than from the schedule consolidation.

By eliminating general aviation (25 operations) and reducing the duplication of air-carrier service (34 operations), the total number of peak-hour aircraft movements in the system can be reduced by 59 operations. The estimated number of instrument-flight-rule scheduled peak-hour movements would then total approximately 121 as compared with an estimated system capacity of 173 movements. This leaves the region's airports with 52 peak-hour movements that could be used in a variety of ways to improve the quality of air service to and from the New York region. For example, some might be allocated to high-value general-aviation use or charter flights. The remainder might be used to increase the quality of commercial air services by increasing peak-hour frequency in some markets or by providing nonstop peak-hour flights to some cities not now receiving such service.

The hypothetical schedule consolidations summarized in Table 1-3 are limited by the size of available aircraft and in particular by the inability of La Guardia to accept four-engine jets. The largest commercial aircraft in service that can be used at La Guardia Airport is a stretched 727, which has 180 seats.[36] However, the air bus (DC-10/L-1011) will be available in 1972 and will have operating characteristics that will permit its use at La Guardia. Therefore, we did a second schedule consolidation assuming the availability and use of the air bus. The results of this analysis, summarized in Table 1-4, demonstrate the dramatic impact of the air

TABLE 1-3 Hypothetical Consolidated Peak-Hour Air-Carrier Operations in the New York Region Using Existing Equipment

	Hypothetical			
Type Flight	Arrivals	Departures	Movements	Actual Movements (July 1969)
Domestic	42	59	101	129
Overseas	11	9	20	26
Total	53	68	121	155

[36] There are, however, no practical technological limits on aircraft size. The size of existing commercial aircraft is limited by expected passenger loads rather than technology.

The Regional Plan Association, in commenting on the secular growth in aircraft size, has suggested a reasonable estimate of the size of the largest operating aircraft in 1990 would be 1,500 seats, and that, if the present growth rate in size of aircraft continues, a 2,000-passenger aircraft after 1990 would be indicated. The authors add that it is technically feasible today. Regional Plan Association, Regional Plan News, No. 89, July 1969, p. 12.

TABLE 1-4 Hypothetical Consolidated Peak-Hour Air-Carrier Operations in the New York Region Using the Air Bus

Type Flight	Arrivals	Depar-tures	Move-ments	Actual Movements (July 1969)
Domestic	36	44	80	129
Overseas	10	9	19	26
Total	46	53	99	155

bus on seat capacity. Using the same minimum hourly frequency, it is possible to remove an additional 22 peak-hour flights from the schedule, thereby reducing the required number of peak-hour movements to 99. As in the previous example, this capacity could be used in a variety of ways to improve the quality of air service to the region. (The results of these consolidations for those cities with flights arriving in or departing from New York during the peak hour are summarized in Appendix A, Table A-4.) Unlike the schedule consolidation that relies on existing aircraft, departure frequency is reduced sharply when the air bus is employed. This is illustrated in Table 1-5, which summarizes existing frequencies (assuming an equal spacing of flights), those based on existing equipment, and those assuming availability of the air bus. Use of the air bus leaves only one market (Chicago), where current peak-hour passenger departures justify more than a single hourly departure.

Schedule consolidations could be accomplished through administrative or economic means (landing charges). However the overscheduling is eliminated, the benefits are roughly the same—a decrease in congestion that would reduce the total cost of air transportation in the region, and larger loads per aircraft movement, which would reduce the cost of serving high-volume city pairs.

With existing fare structures, these consolidated flight schedules would be very profitable to the commercial airlines.[37] At a later point, we will discuss how these "valuable" schedule slots might be allocated among air carriers. However, it is sufficient to point out now that the large operating savings resulting from these schedule consolidations should permit sizable reductions in the price of air travel, and particularly in very dense markets. The resulting increases in air travel would have to be incorporated in the forecasts of demand for runway capacity.[38]

Part of these cost savings could also be used to pay a larger share of the direct and indirect costs of airport operation. Currently, the adverse effects of noise on humans are inadequately considered by air carriers and airport operators in making decisions about aircraft design and use, and airport operations. A portion of the operating cost savings from schedule consolidation might well be devoted to paying for quieter engines or other means of reducing the adverse impact of the airport on surrounding communities.

TABLE 1-5 Schedule Frequency in Domestic Markets with Schedule Consolidation

Schedule Frequency	Actual	With Existing Aircraft	With Air Bus
10 minutes	1		
15 minutes	1	1	0
20 minutes	5	2	0
30 minutes	8	9	1
60 minutes	2	5	16
Total	17	17	17

A NOTE ON FUTURE DEMAND FOR RUNWAY SPACE

Construction of additional runways at Kennedy Airport would take an estimated seven years. Therefore, the decision to begin construction should depend less on current conditions than on the demand for capacity in seven years. A detailed discussion and evaluation of the available forecasts of airport demand and of the methodology used in making them is contained in Appendix B. However, because of the importance of these projections to our evaluation of the benefits of airport

[37] It is paradoxical, but probably true that higher landing charges would increase air-carrier operating costs by less than they would be reduced through the economies that the higher landing charges would bring about. Competition among the airlines would, with CAB approval, then bring about some reduction in fares. However, if the consolidation is achieved through administrative means, a grant of a peak-hour landing slot would become a grant of a highly valuable limited monopoly right, the profits of which would accrue to the airline rather than to the air traveler or airport operator.

[38] CAB estimates of the price elasticity of demand for air travel suggest that air passenger travel will increase by 1.6 percent with each 1 percent decrease in fare levels. Source: "The Demand for Air Travel: A Regression Study of Time-series and Cross-sectional Data in the U.S. Domestic Market," by Samuel L. Brown and Wayne S. Watkins. Paper given at the 47th Annual Meeting of the Highway Research Board: National Research Council, Washington, D.C., January 16, 1968. However, because of the ease with which average aircraft size can be increased, it is doubtful that these increases necessarily imply much increase in peak-hour aircraft movement.

TABLE 1-6 Alternative Forecasts of Instrument-Flight-Rule Peak-Hour Airline Aircraft Movement Demand, by Airport

	Kennedy		La Guardia		Newark		Region Total	
	PONYA (1966)	RAND (1969)	PONYA (1966)	RAND (1969)	PONYA (1966)	RAND (1969)	PONYA (1966)	RAND (1969)
1967 (actual)	87	87	36	36	32	32	155	155
1970 (projected)	73	93	33	66	35	43	141	202
1975 (projected)	59	94	36	69	42	56	137	219
1980 (projected)	62	87	39	69	51	57	152	213

Sources:
H. S. Campbell *et al., Alternative Development Strategies for Air Transportation in the New York Region, 1970–1980,* Memorandum RM-5815-PA, August 1969, p. 13.
The Port of New York Authority, *Airport Requirements and Sites to Serve the New Jersey–New York Metropolitan Region,* 1966, p. 22.

expansion, a brief summary of the principal findings of our review is presented at this point.

Two sets of projections of peak-hour aircraft demand for runway space at the region's three major airports have been published: (1) projections for 1970, 1975, and 1980 published by PONYA in 1966,[39] and (2) projections for the same years included in a RAND Corporation study published three years later.[40, 41]

Despite some important differences between the two sets of projections, both clearly point to the growth of general aviation as a major source of future peak-hour demand for the region's three major airports. Indeed, in the earlier study, projected increases in general-aviation usage account for all the increases in peak-hour demand. The 1966 PONYA projections show no growth in the number of peak-hour air-carrier movements at the region's airports between 1967 (actual) and 1980 in spite of a more than twofold increase in the number of air travelers (Table 1-6).

The RAND study does project a substantial growth in peak-hour air-carrier movements; from 155 in 1967 (actual) to 213 in 1980 (Table 1-6). Virtually all the projected increase occurs in the three-year period 1967–1970, when peak-hour air-carrier movements are expected to increase by more than 30 percent. We were unable to obtain data on actual increases in peak-hour movements between 1967 and 1970, but total yearly movements increased by only 14 percent during the three-year period.

[39] The Port of New York Authority, "Airport Requirements and Sites to Serve the New Jersey–New York Metropolitan Region," New York: 1966.

[40] Campbell, H. S., D. M. Landi, and A. J. Rolfe, "Systems for Air Transportation Serving the New York Metropolitan Area, 1975–1980," RAND Corporation Memorandum RM-5819-PA (Santa Monica: August 1969).

[41] Campbell, H. S., A. Carlin, S. L. Katten, and others, "Alternative Development Strategies for Air Transportation in the New York Region, 1970–1980," RAND Corporation Memorandum RM-5815-PA (Santa Monica: August 1969).

The difference between the PONYA and RAND projections of air-carrier movements results from markedly different projections of total passenger demand. The PONYA study assumed that, in 1980, air passenger trips to and from New York would be 65 million; the RAND study assumed that the 1980 figures would be 91 million. However, the two studies assume the same proportion of total travel occurring in the peak hour (8 percent) and the same number of passengers per peak-hour air-carrier movement. Thus, the ratio of total passengers to aircraft movements is identical in the two studies—427,000 annual passengers per peak-hour movement.[42]

The larger increase in projected air-carrier demand in the RAND study is partially offset by a smaller projected growth in general aviation. The RAND study does not present general-aviation forecasts for years beyond 1975; however, in that year an estimated 61 general-aviation flights are to use the region's three major airports during peak-hour instrument-flight-rule conditions. This represents a 28 percent increase in peak-hour instrument-flight-rule general-aviation movements between 1967 (actual) and 1975 and a 56 percent increase between 1970 (projected) and 1975. The projected increase between 1967 and 1975 in the PONYA study is 119 percent.

As noted earlier, proponents of airport expansion minimize the contribution of general aviation to existing congestion and future airport demand; however, examination of current and projected use of the region's airports makes clear that the alleged need for additional capacity is predicated on a rapid and heavily subsidized growth in general-aviation activity. Growth in air-carrier movements appears to be either not a factor at all or only a small factor in the future demand for air-

[42] This ratio in 1980 for the PONYA study is 65,000,000 annual passenger trips ÷ 152 daily peak-hour movements=427,000. The ratio for the RAND study is 91,000,000 annual passenger trips ÷ 213 daily peak-hour movements = 427,000.

port facilities. Heavy current and projected usage of the region's three major airports by general aviation during peak hours is, in turn, the result of a system of charges for runway use during peak hours that are but a fraction of the costs of providing additional capacity.

ADMINISTRATIVE AND PRICING METHODS OF INCREASING RUNWAY PRODUCTIVITY

The findings of our analysis of existing and projected airport use in the New York region are hardly novel. Every "independent" evaluation of airport congestion at the nation's major airports has reached nearly the same conclusions.[43] The following excerpts from the report by the Aviation Subcommittee of the Senate Commerce Committee are typical[44]:

> There is severe congestion existing today, in the air, on the runways, in the terminals, and in the ground approaches to the airports. Other ways must be sought to alleviate this congestion at and around our nation's airports. These solutions entail better utilization of existing airport facilities and impinge to some extent upon the virtually unlimited access which all segments of aviation have at airports today . . .
>
> Congestion in the air around airports and on the runways is caused by a combination of general aviation aircraft flying into and out of major hub airports and the peak hour scheduling practices of the airlines. This congestion can be isolated further to certain periods of time during the day. It is not prevalent around the clock on a 24-hour-a-day basis. Much of today's congestion at the major hub airports can and should be eliminated by a more effective utilization of existing airport facilities . . .

In their August 1969 report to PONYA, Carlin and Park discuss several methods to achieve a more efficient use of runway space at the region's three major airports. These include two runway pricing alternatives, equilibrium marginal cost pricing and proportional marginal cost pricing, and several administrative measures.

Carlin and Park contend that equilibrium marginal cost prices (prices equal to the marginal costs that an airplane imposes on others using the airport) would promote the most efficient use of airport capacity. However, they reject this pricing policy on the grounds that fees of the magnitude implied by this policy would provide PONYA with "an embarrassment of riches" and require the renegotiation of long-term leases. Neither of these objections seems very compelling to us, particularly since airport users impose heavy costs on the surrounding communities in the form of noise, congestion, and air and water pollution. The "riches" obtained from higher landing fees might well be devoted to offsetting some of the environmental damages caused by the airport.[45] Second, the need to renegotiate long-term leases cannot be an overriding consideration in an evaluation of this kind. The sanctity of existing long-term leases cannot be considered as an absolute any more than can the sanctity of a Jamaica Bay bird sanctuary or its coastal wetlands. All these competing values must be considered in the broader context of the benefits and costs to society.

As a way out of the "embarrassment of riches" dilemma, Carlin and Park propose the use of proportional marginal cost prices. Proportional marginal cost prices are designed to yield the same yearly revenue as the present system of landing charges, but would vary by time of day and by aircraft type in proportion to the marginal delay costs caused by these operations. Table 1-7 summarizes simplified proportional marginal cost price schedules for Kennedy and La Guardia Airports.[46] It is useful to compare the proportional marginal cost prices with the "value of service" fees existing on August 1, 1968, summarized in Table 1-8. (After August 1, 1968, as noted previously, PONYA instituted a minimum $25 fee for the use of duty runways during certain busy periods.) The latter set of charges do not vary by time of day (extent of congestion), depending instead only on aircraft weight and whether the user is a lessee or not.[47]

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[43] Independent evaluations are studies not sponsored by a special interest group, such as the commercial airlines, general aviation operators and their trade associations, and airport operators. Examples of the latter are contained in: U.S. Congress, House of Representatives, 91st Congress, *Aviation Facilities Maintenance and Development,* Part 1, Hearings Before the Committee on Interstate and Foreign Commerce, Serial No. 91–22. Other "independent" analyses reaching virtually identical conclusions include: Joseph V. Yance, "Movement Time as a Cost in Airport Operations," *Journal of Transport Economics and Policy,* Vol. III, No. 1, January 1969, pp. 1–9; *idem,* "Efficient Allocation of Airport Capacity," Paper presented at Southern Economic Association Meetings; St. Louis, Mo., November 14, 1969 (mimeo); Mahlon Straszheim, "Airport Congestion and its Solution: Investment, Pricing, and Scheduling Adaptations," Paper presented at the American Economic Association Meeting, Chicago, Ill., December 27–29, 1969 (mimeo); Regional Plan Association, "The Region's Airports," *Regional Plan News,* No. 89 (July 1969).

[44] U.S. Congress, Senate, Aviation Subcommittee, Committee on Commerce, *The National Airport System,* 90th Congress, 2nd Session, U.S. Government Printing Office, Washington, D.C., p. 7.

[45] This possibility is recognized, but presumably discarded, by Carlin and Park, *op. cit.,* p. 116.

[46] These prices are a smoothed set of proportional marginal cost prices assuming the present practice of base computing landing fees for each airport separately.

[47] At La Guardia, where congestion is much less, landing fees for air carriers are between 3 and 4 times as high as at Kennedy and there is no exemption from the $25 minimum fee. This

TABLE 1-7 Simplified Proportional Marginal Cost Prices (in dollars) Yielding Current Port Authority Airline Revenue at Each Airport

Hour of Day	Present Minimums [a]	Kennedy				La Guardia			
		Air Carrier		General Aviation		Air Carrier		General Aviation	
		Arr.	Dep.	Arr.	Dep.	Arr.	Dep.	Arr.	Dep.
00–01	5	5	5	5	5	0	0	0	0
02–07	5	0	0	0	0	0	0	0	0
07–08	5	0	0	0	0	5	5	5	5
08–09	25 [b, c]	5	5	5	5	30	25	15	15
09–10	25 [b, c]	10	10	10	10	30	25	15	15
10–11	5	10	10	10	10	20	15	10	10
11–12	5	10	10	10	10	20	15	10	10
12–13	5	10	10	10	10	20	15	10	10
13–14	5	10	10	10	10	70	65	40	35
14–15	5	10	10	10	10	70	65	40	35
15–16	25 [c]	25	15	20	15	125	105	70	60
16–17	25 [c]	100	45	85	40	110	95	65	55
17–18	25 [c]	80	50	70	45	80	70	45	40
18–19	25 [c]	80	50	70	45	80	70	45	40
19–20	25 [c]	45	35	40	30	30	25	20	15
20–21	5	45	35	40	30	30	25	20	15
21–22	5	20	15	15	15	5	5	5	5
22–24	5	10	10	10	10	0	0	0	0

[a] The $5 minimum applies to departures only; the $25 applies to one departure *and* arrival if either occurs during hour specified.
[b] Monday through Friday only.
[c] Scheduled air taxis can avoid these minimums by using nonduty runways during instrument-flight-rule conditions. As a result the average general-aviation charge at Kennedy during these hours was $12.
Source: Carlin and Park, *op. cit.* p. 129.

From this evaluation of marginal cost pricing, Carlin and Park conclude that:

> Proportional marginal cost pricing, however, with total air carrier fees equal to present Port Authority collections would increase airport efficiency while benefiting most of the users through decreased congestion.
>
> . . . proportional marginal cost fee schedules would "discourage small airplanes somewhat more than the present minimum fees charged during peak hours, but would result in roughly the same range of fees as at present . . .
>
> If proportional pricing reduced general aviation duty runway use to one-quarter of pre-August 1960 levels, the schedule evaluator indicates that delay costs to Kennedy arrivals would be reduced to $6 million annually." [48]

In their discussion of runway pricing alternatives, Carlin and Park point out that PONYA's introduction in August 1968 of a minimum $25 landing fee during certain busy hours was a valuable first step toward a more rational pricing policy.[49] Moreover, they show that until the region's airports became congested, a reasonably defensible case existed for the "value of service" pricing of runways used by PONYA. However, they point out that "like most pricing systems, this one has tended to be retained after the conditions that favored

TABLE 1-8 Schedule of Charges (in dollars) for Use of Public Landing Areas (1968, prior to August 1)

Charge per Takeoff and Landing for	Kennedy	La Guardia	Newark
707, Series 300	78	[a]	135
727, Series 100	38	142	61
DC-9, Series 10	21	85	33
FH-227 (air carrier)	10	45	17
DC-3 (nonlessee)	9	24	10
Lear Jet (Model 25)	5	14	6
Aero Commander (500V)	5 [b]	6	5 [b]
Cessna 172	5 [b]	5 [b]	5 [b]

[a] Not applicable.
[b] Determined by the $5 minimum rather than aircraft weight.
Source: Carlin and Park, *op. cit.*

anomaly, where the more congested airport is one fourth as expensive as the less congested one, is due to the method of computing landing fees. These charges are obtained by dividing total costs (operating costs plus *historical* construction and land-acquisition costs) by total use. La Guardia is more expensive than Kennedy because it has recently undergone extensive expansion.

[48] Carlin and Park, *op. cit.* p. vii.

[49] *Ibid.*

its adoption have changed." [50] The object of "value of service" pricing was to encourage small airplanes to use the airport capacity which would otherwise have been wasted. When there is excess demand, the continued use of "value of service" pricing makes congestion worse by encouraging low-value users to use the large and often more convenient air-carrier ports.

Carlin and Park provide no estimates of equilibrium marginal cost prices at the region's major airports during peak hours. However, their discussion of equilibrium marginal cost pricing indicates they believed these prices would be considerably higher than the recommended proportional marginal cost prices. If they were correct in this judgment, proportional marginal cost prices would leave some excess demand for runway space during busy periods and some congestion. For this reason, Carlin and Park suggest two combination pricing–administrative measures that might be more efficient than either a "pure" proportional marginal cost pricing scheme or any of the "pure" administrative methods outlined in their report. The first of these proposals is the issuance of short-term transferable permits for schedule "slots" during peak hours in proportion to current use. Users would be permitted to trade permits for these "slots," but permits covering future periods would always be reissued to the same initial users. The number of permits issued for each hour would be chosen administratively to approximate the efficient number. The second proposal combines proportional marginal cost pricing and administrative measures to limit use to a more efficient level.

Any of the proposals of Carlin and Park would increase the efficiency of airport operations and the aggregate welfare of airport users. However, our investigation suggests that Carlin and Park may have been too hasty in their rejection of equilibrium marginal cost pricing. The overall level of existing charges for airport use fails to recognize either the current opportunity cost of airport real estate or any of the heavy environmental costs imposed by airport operation on surrounding communities. As many as possible of these additional costs should be charged to airport operators and airport users. Finally, we believe Carlin and Park underestimate the effect of higher peak-period landing fees on air-carrier schedules. Our analyses of airline schedules suggest that prices at the level shown in Table 1-8 might significantly reduce the number of peak-hour flights by air carriers. A recent request to the CAB by Trans World, United, and American Airlines for permission to reduce collectively seat-mile capacity on 15 U.S. air routes supports the view that excess capacity exists in several markets and suggests air-carrier response to higher landing fees might be much greater than is commonly believed.[51]

If our judgment about the price elasticity of general-aviation and air-carrier movements proved to be more correct than that implied by the Carlin and Park analysis, peak-period equilibrium marginal cost prices might not be much higher than the proportional marginal cost prices summarized in Table 1-7.[52] Under these circumstances, the "embarrassment of riches" feared by Carlin and Park might not occur.

Even though our analysis suggests that a peak-hour landing fee of $100 might be close to the equilibrium marginal cost prices for the region's three major airports, considerable uncertainty remains. If the present slump in air traffic continues, it might be sufficient to increase the minimum landing fees to $50.[53] If excess demand continues, the fees might then be raised to $100 and $150 successively.

OTHER ALTERNATIVES FOR IMPROVING INTERCITY PASSENGER TRAVEL

The methods of modifying runway use described above would provide an immediate improvement in the quality of air service to the region. None of the proposals to construct more runways can make this claim. In addition, these measures might demonstrate that the provi-

[50] *Ibid.*, p. 112.

[51] A *New York Times* story on August 29, 1969, reported that "The airlines contended that elimination of excess capacity on the routes was essential to avert serious economic difficulties for the companies . . . and that in the last quarter of 1969, 56 percent of the seats in the markets involved were unoccupied." Four of the routes included New York (New York–Los Angeles, New York–Phoenix, New York–San Francisco, and New York–San Diego). Robert Lindsey, "Three Airlines Join to Request Flight Cuts on 15 Routes," *New York Times*, August 29, 1970, pp. 1 and 49.

[52] This should not be read as an endorsement of this particular price schedule. In particular, we can think of no valid reason for charging a lower price for a more congested, and presumably more desirable, airport than for a less congested one.

[53] The minimum should apply to all aircraft using the airport during instrument-flight-rule conditions. If aircraft are permitted to use off-duty runways during visual-flight-rule conditions and duty runways during instrument-flight-rule conditions, the result is the same as if they were permitted to use duty runways at all times at a reduced rate. From the point of view of aircraft operators, the fee for all-weather use of the airport is the expected landing charge, i.e., the landing fee for use of the airport during instrument-flight-rule times the probability of instrument-flight-rule conditions plus the landing fee for use of the airport during visual-flight-rule times the probability of visual-flight-rule conditions.

sion of additional capacity should be postponed.[54] This deferment would save large amounts of real resources, would prevent an irreversible commitment of a natural resource, and would widen the range of alternatives.

Our evaluation of technological alternatives to the Jamaica Bay runway expansion was necessarily limited, but it suggested three propositions:

1. That the introduction of new air-traffic-control systems, based on existing technology, would permit large increases in runway capacity at Kennedy, La Guardia, and Newark Airports without increasing the area devoted to runways;
2. That in the next decade or two it may be possible to develop other and better methods of increasing intercity passenger capacity; and
3. That neither of these developments will occur unless Congress, the Department of Transportation, and the FAA provide much stronger leadership, since many of the alternatives for improving transportation lie outside the jurisdiction and competence of PONYA or any other local body.

Our evaluation of air-traffic-control technology persuaded us that major improvements in control can be achieved within the next decade and that these improvements could fundamentally change the relationship between runway capacity and the area needed for runways. Improvements in air traffic control would permit increases in capacity well beyond the increase provided by the Jamaica Bay runway proposal with no, or only small, incursions into the Bay. (A more complete discussion of air traffic control and its relationship to the area needed for runways is contained in Chapter 4.)

We were equally persuaded that these desirable improvements in air traffic control are unlikely to occur in time unless Congress, the FAA, and the Department of Transportation act much more aggressively. A major program of research and development for air traffic control will require substantial federal funding. The new aviation trust fund could provide these large sums of money for the development and implementation of such a system. However, funds needed for this development will probably not be available, if trust fund monies are spent for the construction of additional runways at Kennedy Airport and elsewhere. Congress and federal officials should avoid using trust fund monies for unnecessary and avoidable additions to existing airports. Research and development, testing, and implementation of improved air-traffic-control systems should have first claim on the aviation trust fund.

Improvement in air traffic control is simply an alternative method of increasing runway capacity for conventional air transportation systems. There are, however, many other possibilities to improve the region's accessibility, some of which appear advantageous to increases in capacity at the region's three major airports.

STOL (short take-off and landing) and VTOL (vertical take-off and landing) systems are two of the most promising of these alternatives. The interest in V/STOL is hardly surprising. STOL and VTOL systems have a number of possible advantages as methods of increasing capacity in short- and medium-distance markets, over expansions of existing CTOL (conventional take-off and landing) airports. Specifically, these systems could provide service to locations more convenient to Manhattan and could thereby provide short-distance air travelers with faster and more convenient service to the core. Moreover, since destinations within 250 miles of New York City currently account for 23 percent of all domestic and overseas air passenger trips from the region and for 43 percent of all aircraft movements, the development of STOL and VTOL is a useful alternative to the construction of additional CTOL runways at the region's three major airports.

T. F. Kirkwood and S. L. Katten evaluated the potential of VTOL and STOL systems in the New York region as part of the studies of air transportation systems carried out by the RAND Corporation for PONYA. They concluded that "by 1980 a downtown VTOL port operating in competition with the major airports might attract on the order of 10,000 passengers a day (about 9 percent of the total air passenger traffic in the New York area)." This would reduce air-carrier arrivals at the region's airports by more than 200, or about 20 percent, per day in 1980. Even greater use of V/STOL could be induced by discontinuing CTOL services between New York and those cities most efficiently served by V/STOL. If this were done V/STOL might handle as many as 30,000 passengers and reduce CTOL use of the region's three major airports by roughly 40 percent.[55]

[54] If equilibrium marginal cost pricing is used to allocate runway space, it provides an unambiguous test of whether additional capacity is needed. Additional capacity is justified when the aggregate payment for peak period runway use (aggregate yearly revenues from the peak period) equals the properly discounted costs of additional capacity, including any incremental social costs, such as greater environmental damage to surrounding communities. In addition, there may be some incremental social benefits from additional capacity beyond the benefits to runway users. We doubt if these are anywhere as large as the incremental social costs, but further research is needed to judge this question.

[55] T. F. Kirkwood and S. L. Katten, *The Potential of* V/STOL *Aircraft for Passenger Travel in the New York Region,* the RAND Corp. Memorandum RM-5816-PA, August 1969, Santa Monica, California, p. v.

The potential of V/STOL figures prominently in the Regional Plan Association's July 1969 assessment of proposals for a fourth airport. The authors of the Association's report observe that Eastern Airlines and American Airlines have been testing a commercially available STOL aircraft, the Breguet 941, which seats 64 passengers and cruises at 250–280 mph. The report concludes that STOL aircraft are likely to be "a more significant source of diversion than either the peripheral airports or high speed conventional rail." [56]

The Northeast Corridor Transportation Project has conducted the most comprehensive analysis of intercity passenger transport alternatives for the Boston–Washington Corridor. Its findings about V/STOL's feasibility and potential were even more optimistic than those by RAND or the Regional Plan Association. The authors of the Northeast Corridor Transportation report conclude that a STOL system could be developed by 1975 that would account for 12 percent of the Corridor intercity travel market (as a percentage of passenger miles) as contrasted with 3 percent for CTOL. If a STOL system were not installed, their analyses suggest that CTOL would account for approximately 9 percent of the intercity passenger miles in the Corridor in 1975.[57] Moreover, the analysis indicates that the STOL system would reduce the number of passengers using New York's CTOL airports for trips to Corridor cities by two thirds.[58]

The estimated capital cost of this Corridor STOL system is $195 million or somewhat less than the lower bound estimated cost of the proposed Jamaica Bay runways. Moreover, the estimated incremental annualized costs of this project, using a 10 percent return on investment, equal the annual revenues.[59]

In spite of the enthusiasm for STOL systems apparent in the Northeast Corridor Project, RAND, the Regional Plan Association, and similar analyses of New York's intercity transportation problem, many difficult problems must be solved before such systems begin operation. For example, many aviation experts doubt the reliability and safety of STOL systems because of control problems during high winds. Others believe that STOL enthusiasts have underestimated the difficulties of providing independent air navigation systems.

Many of these STOL critics are VTOL enthusiasts, who see great promise in VTOL to develop safe and effective short- and medium-range air systems. The unsolved technological–economic problems are far more numerous for VTOL than for STOL, but if a safe and economic VTOL system can be developed, the benefits would appear to be much greater. Several of the hypothetical system alternatives evaluated by the Northeast Corridor Project included both STOL and VTOL. The VTOL system evaluated in the Corridor study had an estimated capital cost that was five times that of the STOL system; however, it too was expected to break even in 1975 with a 10 percent return on investment. Moreover, it provided an even larger reduction in CTOL passenger miles (Corridor intercity trips only). In the system alternative including both STOL and VTOL, the 1975 shares of Corridor travel were estimated to be CTOL (2 percent), STOL (10 percent), and VTOL (14 percent).[60]

It is apparent that both VTOL and STOL deserve serious study as ways to increase the quality and quantity of intercity travel to and from New York. However, as with improvements in air traffic control, the development of V/STOL systems appears beyond the capacity of PONYA acting alone.[61] Early realization of the apparent benefits from V/STOL will require a stronger federal role in the research, development, planning, and implementation of these systems. If an aggressive program of research and development were begun immediately, one of these technologies might well be available by the time capacity at the three major airports becomes inadequate.

[56] The Regional Plan Association report questions the desirability of building a fourth airport and proposes instead a variety of measures for improving the efficiency of the existing airports similar to those outlined in this report. Regional Plan Association, "The Region's Airports," *Regional Plan News,* July 1969, No. 89, p. 14.

[57] The Northeast Corridor Project did elaborate "systems analyses" of nine alternative corridor systems that might be developed by 1975. These alternative systems consisted of different combinations of intercity modes. This figure is based on alternative II, which consists of auto, bus, CTOL, demonstration rail (expanded turbotrain and metroliner service), and STOL. *Northeast Corridor Transportation Project Report,* p. S-13.

[58] *Northeast Corridor Transportation Project Report,* p. 1–19.

[59] This is because fares in the STOL and VTOL systems were set at a level that exactly equated annualized costs of revenues with a 10 percent return on investment.

[60] VTOL was included in four of the nine Alternative Corridor Systems. The market share refers to Alternative No. VI, which consists of auto, bus, CTOL, STOL, and DEMO rail. It is essentially identical to Alternative II, except for the addition of VTOL.

[61] For example, Kirkwood and Katten point out that the quality of V/STOL service will depend critically on the development of V/STOL ports at central locations in other cities. Moreover, a V/STOL system for New York alone probably does not provide a large enough market for V/STOL aircraft to justify their development in the absence of subsidy. Early development of a V/STOL system then would appear to require federal leadership and planning at minimum cost and likely a model subsidy for research and development. Kirkwood and Katten, *op. cit.,* p. 84.

INTERCITY GROUND TRANSPORTATION

Trips between New York and the five major cities on the Boston–Washington rail line account for 17 percent of all domestic and overseas enplanements at the region's three major airports. Moreover, 27 percent of aircraft departing from these three airports have their first stop in one of these cities. Thus it is hardly surprising that many persons have suggested improving intercity rail service between New York and Washington and New York and Boston as a way of reducing the load on the region's airports.

Like STOL and VTOL, improved rail service in the Northeast Corridor would provide an alternative not currently available. Many persons might well prefer these services and for many trips it would be more direct and faster than existing or proposed CTOL services. Thus, increases in capacity obtained from improved intercity rail services might provide greater benefits than equivalent increases obtained by expanding Kennedy, La Guardia, or Newark Airport.

The Northeast Corridor Project evaluated three conventional rail alternatives, representing successively higher performance capabilities and higher costs. The first, DEMO, consisted of an expansion of present metroliner and turbotrain service by private or public means to meet the increases in demand for rail passenger service forecast for 1975. New equipment, comparable to the Metroliner, and the elimination of some grade crossings would permit sustainable top speeds of approximately 125 mph. Its estimated capital cost is $70 million, and it would produce an estimated annualized surplus (incremental annual revenues minus incremental costs) of $83 million a year in 1975.[62]

Although the Corridor Project analysis indicates that patronage of the main-line rail passenger service between Boston–Washington and intermediate points would increase between 1968 and 1975, rail patronage for the entire Corridor would decline as a result of the elimination of existing services off the main line. Since the study does not forecast 1975 modal shares without DEMO (by implication, the study assumes that DEMO is the minimum action that will be taken), it is not possible to estimate the relief these hypothesized improvements would provide CTOL. However, because of DEMO's limited route structure, a large proportion of the trips diverted to DEMO originate in or are destined for New York. Therefore, it is obvious that implementation of the DEMO program would reduce demands on the region's airports, although by much less than the V/STOL alternatives discussed previously.

The second level of rail improvements evaluated in the Corridor study, HSRA (high-speed rail on existing right-of-way), involved upgrading the existing Penn-Central route from Boston to Washington to permit passenger trains to run at a sustained top speed of 150 mph over substantial portions of the track. These improvements, which have an estimated capital cost of nearly $1.6 billion would permit terminal-to-terminal speeds over the entire route of 109 mph as contrasted to 72 mph for the DEMO system. It was estimated that HSRA would capture 12 percent of the Corridor intercity travel market as contrasted with 8 percent for DEMO. As with the DEMO system, the share of Corridor intercity trips originating in or destined for New York City is much larger. Unfortunately, the Project's analysis indicates this higher performance rail system would require a subsidy of $27 million a year in 1975 and would probably not be commercially viable for 10 to 15 years beyond 1975.[63]

The Corridor Project also considered a still-higher-performance conventional rail system, HSRC (high-speed rail on new right-of-way). HSRC would be a completely new 200 mph passenger railroad serving the centers of the seven largest Northeast Corridor cities and four suburban park and ride terminals located near major highways. The concept is similar to the Japanese New Tokaido line, but calls for a higher level of performance in the equipment. Unfortunately, HSRC has an estimated capital cost of $2.6 billion, would require a subsidy of $67 million a year in 1975, and would attract only 15 percent of the Corridor intercity travel.[64]

In addition to the three conventional high-speed rail systems, the Corridor Project evaluated a 300-mph Tracked Air Cushioned Vehicle System (TACV). The TACV used in the Corridor studies would operate over the same route and use the same terminal locations as the HSRC system. Because of its limited route structure and heavy dependence on ground access systems, TACV captures only a marginally larger share of the market—18 percent as contrasted with 15 percent for HSRC and 12 percent for HSRA—with significantly higher capital costs—$3.3 billion for TACV as compared with $2.6 billion for HSRC and $1.1 billion for HSRA.[65] TACV would have an annualized deficit in 1975 of an estimated $148 million per year. The Corridor study estimates TACV would break even in 1995, but in the interim it would have required a subsidy totaling $1.2 billion over the 20-year period 1975–95. By comparison, the HSRA system is expected to break even between 1985 and 1990 and would have an accumulated deficit by that time of $355 million. The much greater tech-

[62] *Northeast Corridor Transportation Project Report,* p. S-22.

[63] *Northeast Corridor Transportation Project Report,* p. 5–16.

[64] *Northeast Corridor Transportation Project Report,* p. S-22.

[65] *Ibid.*

nological uncertainties as well as the large capital cost and yearly subsidies would appear to make TACV a less promising alternative than any of the high-performance rail systems.

Any discussion of intercity ground transportation must consider the role of highway transportation. In the entire United States, auto travel accounted for 87.7 percent of total intercity passenger miles in 1968, and travel by bus accounted for an additional 2.3 percent. Highway's share of the Northeast Corridor travel market was somewhat less than its share of the national market, but it still accounted for 76 percent of total intercity passenger miles, with 67.6 percent of these provided by automobiles and 8.4 percent by bus.[66]

By 1975 the Corridor Project anticipates that both automobile and bus shares will be larger. Automobile travel is expected to increase its market share from 68 to 73 percent and bus from 8 to 9 percent. During the same period intercity passenger miles by air are expected to decrease from 11 to 9 percent.[67]

There have been significant technological improvements in highway systems since World War II. The limited access highway, for example, has produced improvements in the speed and safety of highway transportation comparable to the improvements in air travel produced by jet aircraft. Thus, the average off-peak trip time between downtown Washington and midtown New York declined from 7 hr, 33 min in 1950, to 5 hr, 14 min in 1952, and to 4 hr, 16 min in 1963. Similarly, the trip time between midtown New York and downtown Boston declined from 6 hr, 2 min in 1950, to 4 hr, 56 min in 1958, and to 4 hr, 28 min in 1966.[68] The improvements were nearly as great for shorter intercity trips. Most of the forecast growth in the highways' share of Northeast Corridor intercity travel projected for 1975 would result from the further time savings expected from the completion of highways currently planned or under construction.

The dominance of highway transportation in providing short- and medium-distance intercity passenger trips has created some interest in automated or electronically controlled highways. Automated highways could provide substantial increases in the comfort, speed, and safety of intercity automobile travel. If these developments should occur, it would be exceedingly difficult to devise common-carrier systems that would provide superior service for trips under 200 miles.

ADDITIONAL JETPORTS

The construction of a new jetport, either on land or in the sea, is the final alternative that has received widespread attention.

Arguments for a new jetport have been based primarily on the alleged need for additional runway capacity. We find these arguments less persuasive than others, which would emphasize the potential of a properly designed and well-located jetport to reduce the environmental costs of airport operations in the New York region and to provide a more efficient structure of air services. A high capacity jetport, with adequate noise buffers and improved ground transportation facilities, might permit the closing of one or more existing major airports. In addition to possible environmental benefits from removing some aircraft operations from heavily populated areas, a single large jetport with as much capacity as two or more of the existing airports could substantially increase airline efficiency. Moreover, the region's boundaries continue to expand and, as population and economic growth continue, existing airports will become less and less accessible to a growing portion of the region's businesses and population. This continued growth and expansion of the region may sufficiently change the pattern of origins and destinations of airport users to justify the development of one or more major CTOL airports on the region's periphery. The development of these peripheral CTOL airports could occur independently, in conjunction with the relocation of existing airports for environmental and efficiency reasons, or as part of a plan to develop a complex of V/STOL ports serving both suburban and central locations.

The solution of New York's transportation problems depends to a large extent on the actions of local airport authorities in other parts of the country. This great interdependence makes it exceedingly difficult for a local agency such as PONYA, which does not even en-

[66] *Northeast Corridor Transportation Project Report,* pp. 2–9.

[67] The great advantages of highway modes, and particularly the auto, are their schedule frequency and ubiquity. These characteristics permit them to have lower door-to-door travel times for short trips than air and rail systems. As a result the highway modes account for a larger share of short than of long trips. Thus, in 1968, air accounted for 53 percent of Boston–Washington trips, 47 percent of Boston–New York trips, and 36 percent of New York–Washington trips, but only 1 percent of New York–Philadelphia trips. Similarly, bus accounted for only 1 percent of Boston–Washington trips, 7 percent of Boston–New York trips, 10 percent of New York–Washington trips, and 6 percent of New York–Philadelphia trips. Auto accounted for 43 percent of Boston–Washington trips, 41 percent of Boston–New York trips, 45 percent of New York–Washington trips, and 74 percent of New York–Philadelphia trips. *Ibid.* pp. T2-10 and S-12.

[68] *Northeast Corridor Transportation Project Report,* pp. T-2–14.

compass the entire New York region, to plan effectively. Comprehensive plans and policies to accommodate the anticipated growth in air travel require a broader perspective than the New York region. Either the federal government or an interstate agency in the Northeast Corridor will have to assume greater responsibility for the siting and operation of airports. PONYA, which has served the region well for 23 years, might be a model for a national or Northeast Corridor public corporation of this kind.

APPENDIX A

TABLE A-1 Existing FAA Quotas at New York Airports

	Kennedy [a]	La Guardia	Newark	Total
Air carrier	70	48	40	158
General aviation	10	12	20	42
Total	80	60	60	200

[a] Air-carrier allocation increases to 80 in the 5–8 p.m. period.

TABLE A-3 Average Peak-Hour Delays by Type of Weather and Airport

	Length of Delay (min)		
	Kennedy	La Guardia	Newark
Arrivals			
Good VFR [a]	19.1	4.0	5.4
Marginal VFR [b]	46.0	7.9	9.2
Marginal IFR [c]	60.5	17.1	26.1
Bad IFR [d]	68.8	15.3	28.3
All	25.1	4.6	8.0
Departures			
Good VFR [a]	11.7	6.2	4.1
Marginal VFR [b]	13.3	10.4	13.0
Marginal IFR [c]	21.3	16.4	17.9
Bad IFR [d]	21.6	10.7	35.6
All	12.4	6.9	6.6

[a] Ceiling of at least 2,000 feet; visibilities of at least 5 miles.
[b] Ceiling of at least 1,000 feet; visibilities of at least 3 miles.
[c] Ceiling of at least 500 feet; visibilities of at least 1 mile.
[d] Ceiling of less than 500 feet; visibilities of less than 1 mile.
Source: A. Carlin and L. R. E. Park, *The Efficient Use of Airport Capacity in a Time Scarcity*, The RAND Corp., Memorandum, RM-5817-PA, August 1969, Tables A.16–A.22.

TABLE A-2 Summary of Peak-Period Aircraft Movement Activity, July 1969 [a]

	Departures		Arrivals		
Hour of Day	Air Carrier	General Aviation	Air Carrier	General Aviation	Total Movements
Kennedy International Airport					
1600–1659	23	5	38	6	72
1700–1759	23	4	37	3	67
1800–1859	31	5	35	5	76
1900–1959	35	5	33	4	77
2000–2059	32	5	34	5	76
La Guardia					
1600–1659	21	4	22	4	51
1700–1759	21	5	24	5	55
1800–1859	21	4	20	4	49
1900–1959	22	2	26	3	53
2000–2059	23	3	23	3	52
Newark					
1600–1659	16	4	16	4	40
1700–1759	14	5	14	6	39
1800–1859	16	4	18	3	41
1900–1959	16	3	18	3	40
2000–2059	15	3	18	3	40
Region					
1600–1659	60	13	76	14	163
1700–1759	58	14	75	14	161
1800–1859	68	13	73	12	166
1900–1959	73	10	77	10	170
2000–2059	70	11	75	11	167

[a] Excludes New York Airways STOL and all helicopters.

TABLE A-4 Possible Consolidations of Domestic Flights Serving New York Airports, July 1969, 6–7 p.m.

Cities Served		Flights	Total Seats	Load Factor, Kennedy Airport	Total Passengers	Seats Needed at 0.80 Load Factor	Operations Eliminated	
							Rule 1	Rule 2
Chicago	A	6	697	0.44	305	381	3	4
	D	6	658	0.62	406	508	2	4
Atlanta	A	1	96	[a]	[a]	[a]	0	0
	D	2	235	0.83	195	244	0	1
Miami	A	3	391	0.63	246	307	1	2
	D	2	244	0.36	88	110	1	1
Los Angeles	A	3	414	0.58	240	300	2	2
	D	2	283	0.40	113	141	1	1
Hartford	A	2	120	[a]	[a]	96	1	1
	D	0	0	0	0	0	0	0
Boston	A	4	471	0.36	170	212	2	3
	D	3	306	0.71	217	271	0	2
Detroit	A	2	144	0.55	79	99	1	1
	D	4	435	0.68	296	370	1	3
San Francisco	A	3	414	0.51	211	264	1	2
	D	3	397	0.36	143	178	1	2
Syracuse	A	2	134	0.63[b]	84	105	1	1
	D	1	69	0.63	43	54	0	0
Baltimore	A	2	120	0.60[b]	72	90	1	1
	D	2	153	0.60	91	114	1	1
Jacksonville	A	1	90	[a]	[a]	[a]	0	0
	D	2	223	0.61	136	170	0	1
Albany	A	2	88	0.69	61	76	1	1
	D	1	44	[a]	[a]	[a]	0	0
Cleveland	A	2	264	0.61	161	201	0	1
	D	2	197	0.88	158	197	0	1
St. Louis	A	1	125	[a]	[a]	[a]	0	0
	D	3	267	0.80	214	267	1	2
Washington	A	6	524	0.80	420	524	3	4
	D	3	315	0.80	252	315	1	2
New Orleans	A	0	0	0	0	0	0	0
	D	3	279	0.80	224	280	1	2
Birmingham	A	0	0	0	0	0	0	0
	D	2	184	0.80	147	184	0	1
Pittsburgh	A	2	189	[a]	[a]	[a]	0	1
	D	2	225	[a]	[a]	[a]	0	1
Totals								
Arrivals							18	24
Departures							10	25
Total operations							28	49

[a] Includes 1 cargo flight.
[b] Load factor assumed equal to arrival or departure load factor, whichever is available.
Source: Official Airline Guide, July 1969, Port of New York Authority.

TABLE A-5 Possible Consolidations of Overseas Flights Serving New York Airports: July 1969, 6–7 p.m.

Cities Served		Flights	Total Seats	Load Factor	Total Passengers	Seats Needed at 0.80 Load Factor	Operations Eliminated	
							Rule 1	Rule 2
London	A	3[a]	264	0.92	243	304	2	2
	D	0	0	0	0	0	0	0
San Juan	A	2	328	0.90	367	458	0	1
	D	1	165	[b]	[b]	[b]	0	0
Freeport	A	2	239	0.65	155	193	1	1
	D	0	0	0	0	0	0	0
Copenhagen	A	2	284	0.79	224	280	1	1
	D	0	0	0	0	0	0	0
Rome	A	0	0	0	0	0	0	0
	D	3	428	0.36	154	193	2	2
Total								
Arrivals							4	5
Departures							2	2
Total operations							6	7

[a] Includes 1 cargo flight.
[b] Data not available.
Source: Official Airline Guide, July 1969, Port of New York Autority.

APPENDIX B
PROJECTIONS OF FUTURE DEMAND FOR PEAK-HOUR CAPACITY AT THE REGION'S AIRPORTS

All existing projections of future demand for airport capacity by PONYA and others contain a fundamental flaw. Just as the current demand for airport capacity depends on the price charged for it, future demand depends on future prices. All PONYA demand projections for the New York airports implicitly assume a continuation of the inefficient pricing systems currently in use. As a result, some undetermined portion of the projected future demand for airport capacity is unjustified in terms of social costs and benefits. This and other difficulties are better understood by a review of existing forecasts of future demand for airport capacity.

There are two sets of projections of the future demand for runway capacity at the region's airports, which have been used to justify the need for additional runway capacity. These are projections of the demand for airport capacity in 1970, 1975, and 1980 published by PONYA in 1966 and forecasts for the same years published by the RAND Corporation three years later. Although the RAND projections were done as part of a PONYA study and depend heavily on the PONYA projections, there are some important and difficult-to-reconcile differences between the two sets of figures.

Both sets of projections of future peak-hour aircraft demand for runway space contain independent projections of general-aviation and air-carrier demand. A basic building block for the air-carrier projections in both the PONYA and RAND studies are forecasts of New York Region Air Passenger Demand prepared by PONYA. The 1966 PONYA study assumes air passenger travel at the region's airports will increase from approximately 26 million in 1965, to 40 million in 1970, to 54 million in 1975, and to 65 million in 1980. The report of that study emphasizes that these projections of future passenger travel are far more conservative than those developed by other groups, such as the Air Transport Association and commercial airlines. In the intervening period, PONYA apparently became more convinced of this position, because the RAND projections (which are based on passenger forecasts provided by PONYA) assume that there will be 70 million passengers in 1975 and 91 million passengers in 1980 (Campbell *et al.*, 1969, p. 2).

Although these forecasts of future passenger travel are crucial to many aspects of airport planning (such as terminal design and the provision of ground access) and are widely used in support of runway-expansion proposals, they are virtually irrelevant to the question of whether additional runway capacity should be provided. Growth in the number of peak-hour aircraft movements, which is the relevant figure in discussing runway capacity, is only loosely related to the aggregate growth of passenger travel. The principal intervening variables are the proportion of travel during the peak

TABLE B-1 Average Seating Capacities of Conventional Aircraft Serving the Metropolitan Area

Airport	1975	1978	1980
Kennedy	192	240	272
Domestic	163	211	245
Overseas	220	269	300
Newark	132	156	172
La Guardia	127	148	162

Source: Campbell *et al., Systems,* p. 5.

hour and the average number of passengers carried per plane (Table B-1). Both the PONYA and RAND forecasts assume that peak-hour passenger travel will be a constant fraction of all travel and that average aircraft load will increase as larger aircraft are introduced. In the RAND study the number of passengers carried per plane was obtained by multiplying the figures in Table B-1 by 0.80, the average peak-hour load factor assumed throughout. These projected average aircraft loads were provided by PONYA and are the same as those used by PONYA in its 1966 forecasts.

In spite of their common methodology and the heavy dependence of the RAND study on PONYA projections, the two studies provide very different pictures of the peak-hour capacity needed in the future, and, even more importantly, of the source of increased demand. As the data in Table B-2 indicate, *the 1966* PONYA *projections show no growth in the number of peak-hour airline movements at the region's airports between 1967 (actual) and 1980,* despite a more than twofold growth in the number of air passengers. By comparison, the RAND projections of peak-hour airline aircraft movements (Table B-2) imply that the number of peak-hour air-carrier movements will increase by nearly a third.

Virtually all the difference arises in the three-year period 1967–70, when air-carrier movements during peak hours are expected to increase from 155 (actual) to 202. The reasons for this rapid and unusual pattern of growth are not identified in the RAND report. Because of the unusually rapid increase in movements projected during 1967–1970, recent experience is of considerable interest. We were unable to obtain estimates of peak-hour movements at the three airports; however, total yearly movements increased by only 14 percent between 1967 and 1970. Of course, this may have been a period of abnormally slow growth because of general economic conditions. Still, this discrepancy makes the large projected increase in the RAND study all the more difficult to understand.

In spite of a projected zero growth in air-carrier movements during the period 1967 to 1980, the PONYA report anticipates a rapid increase in congestion at the region's airports during the decade 1970–80, if runway capacity is not increased. Specifically, it projects an excess demand (excess of forecast demand over capacity) for the regions three airports of 33 in 1970, 62 in 1975, and 112 in 1980 (PONYA pp. 29 and 28, and 22). The explanation for this apparent inconsistency is the rapid growth of general aviation projected by the 1966 PONYA study. Between 1970 and 1980, PONYA projected a more than 100 percent increase in general aviation (business and corporate, air taxi, and private industrial aircraft) instrument-flight-rule peak-hour movements. These facts illustrate the essential irrelevance of many of the arguments intended to justify airport expansion by reference to anticipated growth in commercial aviation. *All the projected growth in demand for runway space at the region's airports in the 1966* PONYA *study is attributable to the growth of general aviation.*

PONYA also provided the forecasts of general-aviation movements used in the RAND study. The differences between the forecasts, summarized in Table B-3, are of considerable interest and are particularly relevant to the role of pricing and administrative restraint. The PONYA forecasts of general aviation included in the

TABLE B-2 Alternative Forecasts of Instrument-Flight-Rule Peak-Hour Airline Aircraft Movement Demand by Airport

	Kennedy		La Guardia		Newark		Region Total	
Year	PONYA (1966)	RAND (1969)	PONYA (1966)	RAND (1969)	PONYA (1966)	RAND (1969)	PONYA (1966)	RAND (1969)
1967 (actual)	87[a]	87	36[a]	36	32[a]	32	155[a]	155
1970 (forecast)	73	93	33	66	35	43	141	202
1975 (forecast)	59	94	36	69	42	56	137	219
1980 (forecast)	62	87	39	69	51	57	152	213

[a] Obtained from 1969 RAND study.

Sources

H. S. Campbell, *et. al., Alternative Development Strategies for Air Transportation in the New York Region, 1970–1980,* Memorandum RM-5815-PA, August 1969, p. 13.

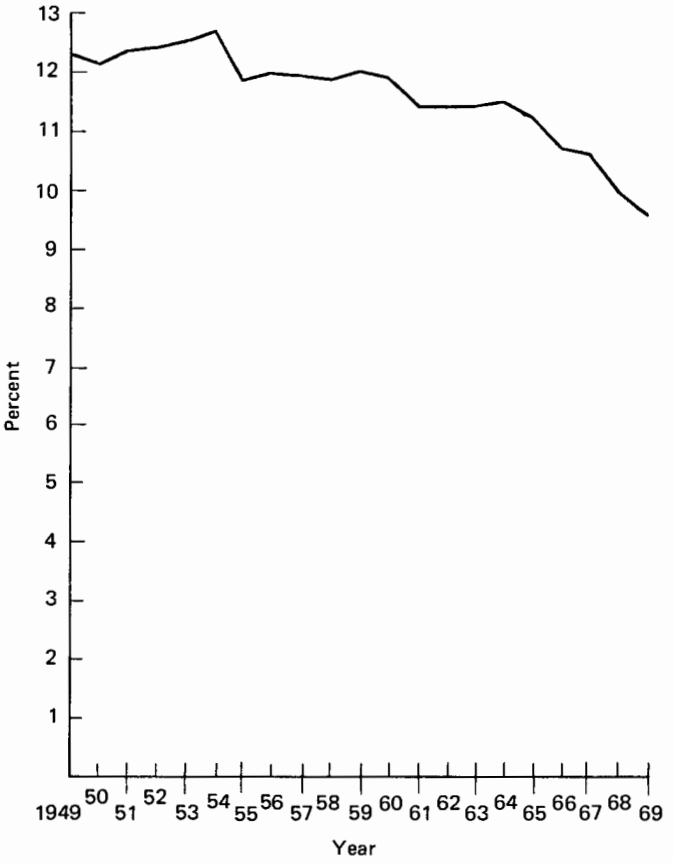
The Port of New York Authority, *Airport Requirements and Sites to Serve the New Jersey–New York Metropolitan Region, 1966,* p. 22.

RAND study, although still quite large, are much smaller than those included in the PONYA study. The most important change during the interval was the imposition of a minimum landing fee for the use of duty runways. As indicated previously, this small increase caused a decline in peak-hour general-aviation usage of more than 40 percent at all three airports. It is likely that the discrepancy between the RAND and PONYA forecasts of general aviation is explained by the extrapolation of these reduced levels of general-aviation use. This strongly illustrates the proposition that future demand depends on future prices in precisely the way that current demand depends on current prices. As a consequence, it is not possible in projecting future demand to avoid the question of what prices *should be*.

Even though there is less information to evaluate the effects of higher landing fees on air-carrier movements, there is no doubt about the direction of the effect. Higher landing fees during peak hours will reduce commercial-aviation movements. Since current and projected landing fees are far too low, it is difficult to escape the impression that there may be excess capacity in the existing system.

We observed earlier that the forecasts of total passenger volumes had relatively little to do with the demand for runway space. Even so, these forecasts are of considerable relevance to airport planning. Therefore, it is worthwhile to comment briefly on some recent developments that could have a large effect on the 1980 forecasts.

The PONYA forecasting procedure bases its forecasts of domestic travel to and from the region on national passenger travel forecasts. The latter are derived from estimates of the frequency of air travel by income and age categories obtained from survey data for the population as a whole. There are serious questions that could be raised about the appropriateness of these procedures. However, we do not propose to delve into this complex set of issues. Rather, we are concerned with some particularly sensitive aspects of the forecasting procedure, which could have a very large effect on forecasts of travel in the New York region.



Source: The Port of New York Authority, Aviation Department Aviation Economics Division, February 17, 1969, (mimeo).

FIGURE B-1 New York's share of domestic air travel.

The forecasts of travel to and from the New York region are obtained by multiplying a projection of the region's share of national travel times the national forecasts. This share, 10.5 percent in the 1980 forecast, is a simple extrapolation of the region's share of national travel since 1948. Figure B-1 illustrates this

TABLE B-3 Alternative Forecasts of Instrument-Flight-Rule Peak-Hour General-Aviation Demand by Airport

	Kennedy		La Guardia		Newark		Region Total	
	PONYA (1966)	RAND (1969)	PONYA (1966)	RAND (1969)	PONYA (1966)	RAND (1969)	PONYA (1966)	RAND (1969)
1967 (actual)	9[a]	9	23[a]	23	11[a]	11	43	43
1970 (forecast)	16	7	32	23	14	9	62	39
1975 (forecast)	27	11	46	36	21	14	94	61
1980 (forecast)	37	—	61	—	30	—	128	—

[a] From 1969 RAND study.
Sources: H. S. Campbell, *op. cit.*, and Port of New York Authority, *op. cit.*

ratio. Recent experience, however, suggests the possibility of a more rapid decline in the region's share of domestic passenger travel than the 1980 forecasts assume. Since the forecasts are highly sensitive to this fraction, this is of considerable importance. If the fraction in 1980 were 9.5 percent instead of 10.5 percent, the same national forecast would yield a 1980 regional forecast of 63 million instead of 70 million domestic passenger trips. Using the ratio of peak-hour movements to yearly passenger movements used in the PONYA and RAND reports, this implies 16 fewer domestic peak-hour air-carrier movements in 1980 than the 1980 RAND forecast.

The preceding discussion of the procedures used to forecast future demand for peak-hour capacity should make it clear that existing forecasts are subject to considerable uncertainty and that they are based on a very limited concept of demand. Specifically, they project future traffic with the implicit assumption that the existing nominal charges for expensive peak-hour capacity will be continued. This may be all right for forecasting hypothetical traffic; however, we question whether such procedures justify the expenditure of millions of dollars of public moneys and a further, and possibly unnecessary, encroachment into Jamaica Bay.

2

JAMAICA BAY AS A RESOURCE FOR THE PEOPLE OF NEW YORK CITY AND THE SURROUNDING REGION

INTRODUCTION

Jamaica Bay is a large body of rather polluted water lying in the midst of a great city, surrounded by several million people who have a pressing need for better facilities for their recreation and housing, abutting on a heavily congested major international airport, and containing in its center a marsh and wildlife sanctuary that is important to the entire northeastern United States.

SPECIAL FEATURES OF JAMAICA BAY AS A PART OF THE ENVIRONMENT OF THE PEOPLE OF NEW YORK

Jamaica Bay is one of a series of tidal estuaries that run along the south shore of Long Island. The landscape of the Bay and its environs as we now see it was created by geological forces during the last 10,000 years. During this time the retreat of the continental glaciers has been accompanied by sinking of the land along the shores of Connecticut and New York, and a rise in sea level of some 120 feet. When the changes in sea level ended about 5,000 years ago, the eastern end of Long Island began to erode, and the sand that was generated by this began to move like a river along the shoreline toward the west at a rate of a half-million cubic yards a year. This sand, still moving, formed beaches such as the Rockaways, which separated shallow estuaries and salt marshes along the south shore of Long Island, and protected them from the open sea.

Before the intervention of men, Jamaica Bay was a roughly circular marshland of 25,000 acres, protected from the ocean by the Rockaway peninsula. There was a central zone, and an outer zone, of shallow marshes, which were separated by a circular moat of somewhat deeper water, through which the tide ebbed and flowed. It remained thus until the beginning of the present century, when the City of New York initiated an ambitious plan to develop Jamaica Bay as a seaport. This plan emphasized the natural zoning of the Bay by widening and deepening the moat between the inner and outer zones of marshland. In the western and northern part of the moat, a channel was dredged that ultimately became 1,000 to 1,500 feet wide and 30 to 40 feet deep. The fill from this dredging was used to raise the marshes outside the moat, with the idea of building piers and docks there. Later, other fill was dredged up from the Bay to create Floyd Bennett Airfield and what is now Kennedy International Airport. Still other fills were created from solid waste and from the disposal of the sludge from sewage treatment, until finally almost all of the marshland of the outer zone had been destroyed, and only 13,000 acres of the Bay remained. In spite of all this, about 4,000 acres of

marshland that was originally inside of the moat remains, and is largely intact. Although a rail line, a highway, and a dredged channel have beeen cut through it, and some construction has occurred in the community of Broad Channel and in the bird sanctuaries, this large natural area is not greatly changed from its original condition.

Today, as one looks down upon the Bay from an aircraft, one sees a body of water that is roughly in the form of a half-circle, with the marshland its center (see Figure 2-1). The truncated base of the circle, southerly along the ocean, is the Rockaway peninsula, built up with houses and apartment buildings, with some retail businesses, and a wide sandy beach on the ocean side. At the western tip of the Rockaway peninsula is Breezy Point. This contains the Jacob Riis State Park, the partly abandoned U.S. military reservation of Fort Tilden, a private colony of summer houses, and some undeveloped park land. Just north of Breezy Point, at the western angle of the Bay, is the Rockaway Inlet, the 4,000-foot channel that connects the Bay with the ocean. The tides ebb and flow through this channel twice daily, providing a cleansing action essential to the health of the marshland.

Across the Rockaway Inlet, the Marine Parkway Bridge connects Breezy Point with Brooklyn by way of Flatbush Avenue. Just north of the channel, on the western shore of the Bay, is Floyd Bennett Naval Air Station, created four decades ago by filling in one of the marshy islands that then made up the outer zone of marshland. Above Floyd Bennett Field, all along the northwestern shores of the Bay to its northern apex, the narrow, gently sloping beaches and the shallow waters of the outer zone of marshland remain. The mouths of the creeks that once transected the marshes are still to be seen; but the marshes that stood behind the beaches have been filled in by refuse and sludge, covered by sand, and graded. The shores of the former creeks have been bulkheaded, and many of them have been turned into stagnant basins. The watercourses that once drained into the creeks from the open lands of Brooklyn and Queens have long since been replaced by sewers. Large sewage-treatment plants stand at the heads of several of the basins. The beaches themselves are cut off from the filled-in marshland behind them by the Shore Parkway, usually occupied by a four-lane jam of automobiles that is impassable to pedestrians, except at a few points.

At the northernmost part of the shore of the Bay, a small area of the outer marshland has been converted into low-lying private housing developments—Howard Beach and Hamilton Beach—located immediately adjacent to Kennedy International Airport and at the end of one of its busiest runways. The airport itself occupies almost the entire northeastern shore of the Bay. It was created in the early 1940's by dredging sand from the bottom of the Bay and filling in some 4,500 acres of the outer marshland. The hole from which this sand was taken remains alongside the airport as "Grassy Bay"—not only the deepest but also one of the most stagnant areas of the Bay, partly because it has been blocked off at its southeastern end by the extension of runway 4L, which lies across it like a dike and juts out into Jo Co Marsh.

At the very southeastern angle of the Bay, at the base of the Rockaway peninsula, there is a part of the Town of Hempstead in Nassau County. This is the only part of the shoreline of the Bay that is not in New York City. Most of the shoreline, including the airport and the Rockaway peninsula, lies in the Borough of Queens; but most of the central area of the Bay, and most of its northwestern shores from Floyd Bennett Field almost to Howard Beach, lie in the Borough of Brooklyn.

The low marshy islands of the center of the Bay are now some 4,000 acres in area. The northern and western parts of this marshland are the least altered from their original state. The eastern marshes have been bisected by a rapid-transit line and a roadway, which provide the chief means of access to the Rockaways. Two brackish ponds, created in 1953 when fill was dredged up to repair the rapid-transit lines, form an important part of the wildlife refuge. On one of the southernmost islands of the central marsh lies the community of Broad Channel, a settlement of several thousand people who built their homes on City land more than a generation ago and have refused to leave since. Despite the City's disapproval, and despite all efforts to dislodge them, they continue to live in a variety of shacks and semi-permanent houses on five-year ground leases without city services, providing their own fire department, maintaining their own roads, and draining the sewage from their septic tanks into the Bay.

The waters of Jamaica Bay were once acclaimed for their purity. During the last century the Bay was the site of major commercial oyster and clam fisheries, as well as a sport-fishing ground. Fresh water then entered the Bay from the perimeter and salt water entered at the mouth with the tides. The Bay then contained the abundant life of a coastal marsh, including the juvenile forms of ocean fish that found a nursery in the shallow nutrient-rich waters. When the natural streams and springs were supplemented by a rapidly increasing flow of city waste, and dredging markedly increased the time required for natural flushing of the Bay, the imbalance resulted in a gradual

pollution of the waters. In 1921 the Bay was closed for commercial shellfishing because of pollution. Now, some 254 million gallons of wastes flow into the waters of the Bay each day. Although these are highly treated, the Bay is nonetheless generally regarded as an open sewer. This impression has been strengthened by the frequent occurrences of oil spills that color the surface of the water.

In fact, most of the Bay is not in such bad shape as its reputation implies. In the large central zone, except very near Broad Channel, the water much of the time meets the bacteriological standards for bathing water (see Table 2-1). In part, the natural ecosystem of the Bay protects itself and the waters of the Bay. Much of what is "pollution" for men is food for such filter feeders as mussels, which therefore thrive and provide free tertiary treatment for the sewage. Nevertheless, the ecosystem is ailing. The cord grass, *Spartina,* which is the most abundant and characteristic plant of the marshes, is yellowing in Jo Co Marsh directly at the end of runway 4L. In Grassy Bay, Bergen Basin, and similar buffer zones at the perimeter of the Bay, the quality of the water is poor. The level of dissolved oxygen is low; numbers of coliform bacteria are high; the number of living species is small; these species are less diverse; and the species that are characteristic of a productive and healthy estuary have been replaced in part by those typical of polluted waters. The "standing crop" of finfish in the Bay as a whole averages less than one pound per acre, as compared with 73 pounds per acre in San Francisco Bay, and 200 pounds per acre in Laguna Madre, Texas.

Thus, the proposal to extend the runways of Kennedy Airport into Jamaica Bay is not a proposal to intrude human artifacts into virgin ground. The situation has almost no similarity to the situation in which it was proposed that a jetport be constructed beside the Everglades National Park in Florida. Birds live and nest in both areas, but in the Jamaica Bay area many of them nest beside freshwater ponds, which were constructed out of fill emplaced in 1953. Only a few small islands within the Bay remain almost as they were 70 years ago, and even these have been gouged by shallow drainage trenches to prevent the breeding of mosquitos.

Yet, if Jamaica Bay is not a wilderness, it is no less a great natural resource for the people of the City of New York. It could be important if it were simply a large open and developable space near an enormous city; but it is potentially much more than this. It has the potential for modification into a remarkable facility for outdoor recreation and education. It is still an important part of the dwindling wetlands of the northeastern United States, and it provides a most significant support for the fish and bird population of the New York area.

Some of the special features of Jamaica Bay and its relation to New York City are worthy of more extended comment.

TABLE 2-1 Coliforms (most probable number per 100 ml)[a]

Station	Geometric Mean		
	Top	Bottom	Average
Rockaway Inlet	15.5	17.0	16.2
Mill Basin	298.3	96.5	169.6
Paerdegat Basin	384.3	407.2	395.6
Canarsie Pier	227.7	162.6	192.4
Long Island RR Trestle	19.5	17.1	18.3
Bergen Basin	275.9	222.2	247.6
Coney Island Outfall	11.0	11.4	11.2
Jamaica Bay Group Total	81.5	64.7	72.6

[a] Readings for Summer 1969, *New York City Harbor Pollution Survey Data,* Computer Printout, New York City Environmental Protection Administration, Bureau of Water Pollution Control.

Location of the Bay

The location of this large body of water with a surviving natural area in its center, in the midst of one of the world's greatest cities, is quite unusual. There is no other area like it in New York City, and there is probably no other area quite like it within a city of this size anywhere.

Relation of the Bay to the Surrounding Population

The Bay is bordered by sections of Brooklyn and Queens, and by the Town of Hempstead in Nassau County. Brooklyn is New York's largest borough—a major city of 2.6 million people with a density of some 33,000 people per square mile and in some areas up to 125,000 per square mile. The population of Queens is at the 2-million mark, and it is the only one of the four major boroughs whose population is growing—by some 8.5 percent between 1960 and

FIGURE 2-1 Aerial photograph: Kennedy Airport, Jamaica Bay, and environs.

1 Brooklyn
2 Canarsie
3 Howard Beach
4 John F. Kennedy International Airport
5 Inwood
6 Broad Channel
7 Rockaways
8 Breezy Point Park
9 Floyd Bennett Field

1970. Its overall density is less than 18,000 per square mile—approximately that of Boston or San Francisco—but there are certain areas with a density of 80,000 per square mile. Its residential character and relatively high per capita income are characteristics shared by neighboring Nassau County.

Much of central Brooklyn within five miles of the Bay is severely overcrowded and impacted. Its population lacks job opportunities, recreational facilities, and decent and safe housing. Parts of central Queens share these shortcomings. Partly as a result of this, the development of the areas on the periphery of Jamaica Bay has been accelerating in the last 20 years, despite such nuisances as the noise of the airport, the pollution of the water and the air, and relatively poor access. The major new uses of the shoreside area have been for low-density housing and public institutions and facilities. The evidence of familiar types of social and political alienation has been strong in the deteriorating areas of central Brooklyn. Moreover, under the seemingly intractable pressures from the airport and a perceived lack of attention from government, another type of alienation has been growing in the burgeoning white working and lower middle-class neighborhoods that immediately abut upon the shores of the Bay.

Within two airline miles of the shores of Jamaica Bay—a 30-minute walk if there were any sidewalks—627,000 people were living in 1960. Within five miles there were 2.5 million people. Adding to this the 840,000 who live in the Town of Hempstead in adjacent Nassau County, one finds that Jamaica Bay is immediately adjacent to a larger population than is any other potentially usable beach and water-recreational resource in the entire United States. More people live in New York City near Jamaica Bay than live in Los Angeles near the Pacific Ocean. Neither Coney Island nor Central Park has so many people so close to it.

Many of the people who live around Jamaica Bay are members of the less privileged social and economic groups of our society. For these people the Bay represents one of the few available sites for outdoor recreation. Fifty-two percent of Brooklyn's families and 36 percent of the families in Queens had incomes below $6,000 in 1960. Fourteen percent of Brooklyn and 8 percent of Queens were non-white at that time. If patterns of racial segregation continue, the non-white population of both boroughs will probably increase. Many of the people who live in these boroughs have no automobiles with which to travel to outlying beaches.

Relative to the rest of the metropolitan area, it can be expected that the incomes of those who live in these parts of Brooklyn and Queens will go down in the future rather than up. The median age of the population of these boroughs, like that of New York City as a whole, is dropping. The number of children in school is growing, while the number of adults is declining. School enrollments have increased 10 percent in the last decade. In relation to other areas of the metropolitan region, these areas have an increasing proportion of children and adolescents for whom facilities for outdoor recreation are especially desirable.

Topography of the Bay

Some natural features of the Bay lend themselves to the satisfaction of many of the needs of the surrounding population. The shallow waters, the gently sloping shores, and the narrow beaches that remain along the northwest boundaries of the Bay, and the still underused sandy beaches of Breezy Point peninsula, provide an unusual potential for constructing facilities that might satisfy some of the needs of these people for recreation. Similarly, the level area of Floyd Bennett Field and the area of some of the filled-in marshland north of the Bay might be used to satisfy some of their needs for housing.

The Natural Areas

The waters of the estuary are still very important as a breeding area for the finfish of the ocean littoral of New York, and the marshland of the Bay is an important breeding and nesting ground for the bird life of the entire northeastern United States.

Location of the Airport

On its northeastern shore, Jamaica Bay has an airport of international importance, which depends, in part, upon the Bay for its operations. Kennedy International Airport is the largest of the three public-carrier airports serving the New York metropolitan region. It handles all international flights and essentially all the long-haul domestic travel. It is the second busiest airport in the world. It has a greater number of larger and noisier aircraft than the other airports in the New York region.

The ability of the people of the surrounding areas to tolerate the noisy operations of Kennedy Airport depends in large measure upon the presence of the Bay. So far as it has been possible, all aircraft from Kennedy take off and land over the waters of the Bay, which acts as a "noise sink," protecting the surrounding community from the sound of these aircraft.

ROLES OF JAMAICA BAY IN THE HUMAN ECOLOGY OF THE NEW YORK AREA

The people of New York have used Jamaica Bay in a number of ways. Not all these uses have been compatible with each other. Uses can be divided, roughly, into two groups based upon their compatibility with each other.

In the first group of uses one can include (a) the use of the Bay as a source of food, (b) the use of the Bay as a site for human recreation, (c) the use of the shores of the Bay as a site for human habitation, and (d) the role of the Bay as a functioning part of the natural systems of the New York area. All the uses in this group are based upon or associated with "clean," or "unpolluted," water, relatively little destruction of natural topography and natural systems, and physical surroundings and human artifacts (buildings, parks) that are generally regarded as esthetically pleasing.

In the second group of uses one can include (a) the use of the Bay as a seaport and as a channel for water-borne commerce, (b) the use of the Bay as a site for waste disposal, (c) the use of the Bay as a source of building material, and (d) the use of the Bay as an adjunct to an airport. All these uses are to some extent associated with pollution of the natural waters, major alterations or destruction of natural topography and of living systems, physical surroundings and human artifacts (wharves, barges, dumps, oil spills) that are not generally regarded as esthetically pleasing, and noise, smoke, and commercial and industrial activities of various types.

There is no *a priori* reason for presuming that uses of the Bay of one type will necessarily provide more benefits to the human community than uses of the other type. Uses of both types have provided great benefit to the people of the City in the past, and still do. However, since the two types of uses are largely incompatible with each other, it is important to determine, if possible, which uses will provide benefits that cannot easily be provided in other ways, and which uses will, in the long run, provide the greatest amount of benefit for the largest number of people. One must consider in this balance the relative costs and benefits that the airport presently provides to the people of the community, and also the effect that the proposed extension of the runways will have upon the various uses to which the Bay might be devoted.

Uses for Habitation, Recreation, and Conservation

Before we consider the potential future uses of the Bay, it is worthwhile to consider the present and past uses of the Bay in some detail. We can begin by considering the uses that we placed in the first group.

Use of the Bay as a Source of Seafood

Shortly after people first settled around Jamaica Bay, they began to use it as a source of food. Throughout the 19th century, until the beginning of World War I, the Bay provided clams, oysters, lobsters, crabs, and finfish for the people of New York. These delicacies were highly valued at that time, partly because the Bay was regarded as a particularly good source of seafood. At the turn of the century, the Oystermen's Association of Canarsie operated 266 boats to work 500 to 600 oyster plots in the Bay. In addition, they boated 10,000 bushels of clams each year, according to the New York Fish and Game Commission.

The commercial production of seafood from the Bay was destroyed in part by the dredging of the channels in the first and second decades of this century, and it was finally forbidden for reasons of health in the early 1920's, when the waters had become seriously polluted. In spite of this, local fishermen have continued to eat their catches, and commercial clammers have continued to dig up shellfish from time to time, transplanting them to other and cleaner estuaries until they have purged themselves of infectious agents and can be sold. Nevertheless, Jamaica Bay is no longer seriously considered as a commercial source of seafood, in spite of the fact that many finfish and shellfish remain in the Bay (and the number could be expected to increase under the proper circumstances in the future).

The Use of the Bay as a Site for Recreation

Since men first settled in the New York area, they have used Jamaica Bay and its shore as a site for human recreation. In previous centuries, when commercial fishing went on in the Bay, clamming, crabbing, and sport fishing were major recreations for people from nearby Queens and Brooklyn. Even as recently as the 1920's, more than 400 boats were available for rent, and bait sales were 20 times what they are now. After the City health department banned the taking of shellfish in the 1920's, the hardy squatters of Broad Channel nevertheless continued to rent hundreds of boats to fishermen on weekends. They still rent boats, but far fewer; and at Canarsie Pier, even today, in one of the more polluted regions of the Bay, bait can be purchased and 70 rowboats are available. Many privately owned power boats use the Bay for recreation. Fishermen still come to Jamaica Bay from all over New York.

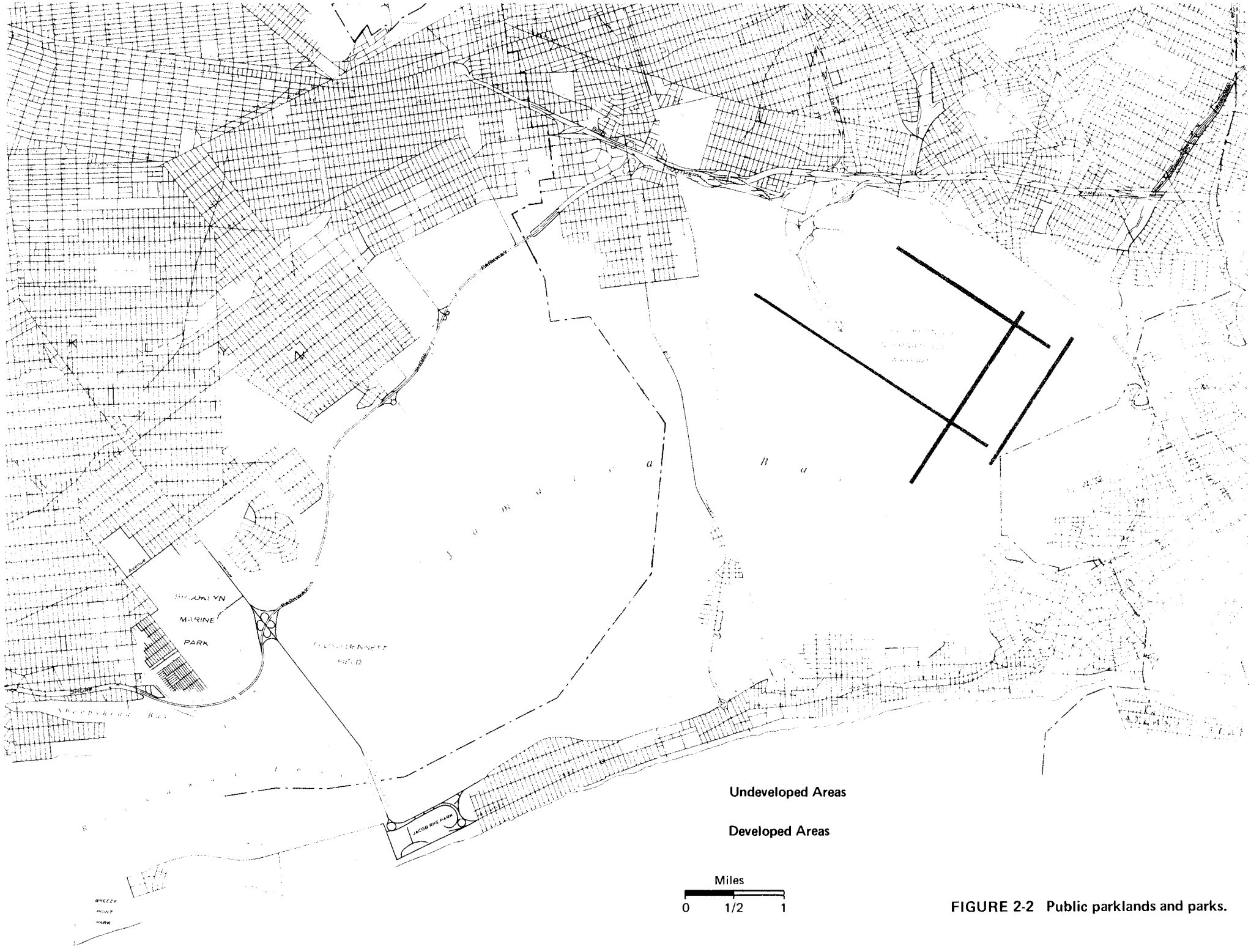


FIGURE 2-2 Public parklands and parks.

On sunny days they line the bridges across the Bay, they line the piers along the Bay, and they stand along its shores. The fish, like the fishermen, are hardy. Their numbers have been depleted but they are still there, and fishing in Jamaica Bay remains a recreation for many people who live nearby.

People also come to swim in the Bay in unbelievably large numbers. Many of them make their way across the hazardous stream of automobiles along the Shore Parkway and onto the littered beaches on the northwest shore. People swim from piers, from boats, and even from the shore by the sludge tank at the end of the garbage dump by the entrance to Bergen Basin—except just after a rainfall, when the sewage floating out of the Basin is too rank even for the least fastidious swimmer. A great many of the swimmers are youths and some are children, but many are adults.

Many old people come out to the Bay from the surrounding neighborhoods. They sit in the shade of the trees on Canarsie Pier or in the park at the end of Howard Beach, and they play cards or try to converse between the noises of the jets taking off from runway 31L. Sometimes they just sit quietly on the few benches available, holding their hands over their ears when a very noisy plane passes above.

Even before the present bird sanctuary was constructed, many people used to come to watch the birds on the marshes. Now they come at the rate of 50,000 per year from all over the City and from many parts of the country—schoolchildren, ornithologists, students, and birdwatchers.

The continued use of the Bay and its shores as a site for recreation, and an interest in the preservation of its remaining natural areas, were largely responsible for the transfer of the Bay and its marshlands, and the transfer of the undeveloped beaches along the northwestern shores, to the City Department of Parks. Jamaica Bay was mapped as a park in 1938. It was formally transferred to the jurisdiction of the Department of Parks in 1948. This Department became the Parks, Recreation and Cultural Affairs Administration in 1968. (See Figure 2-2.) The mapping of this area as a City park in a sense constituted a commitment on the part of New York City to develop the Bay as a site for recreation. This has been more a potential than an actual commitment, since it has not been followed by any significant appropriation of money, or by any effort to develop the parks that have been mapped, except for the wildlife refuge.

However, there has been a major program for the improvement of the quality of the water in the Bay. This is a necessary prelude to the development of the Bay for human recreational use. Also, there has been some development of the wildlife refuge, not only through the construction of the brackish water ponds, which are necessary for the breeding of some species, but also by the hiring of a full-time curator for the area and the laying out of the trails. The City's commitment to Jamaica Bay as a park thus seems to have some validity despite the parallel and continuing commitment to other uses of the Bay for purposes that are not compatible with its use as park land.

The development of the Rockaway peninsula as a site for recreation was not hindered by the pollution, the filling of marshland, and the commercial development that hindered the recreational use of the Bay proper. For the Rockaways, transportation was the problem. There were only two roads of access to the beaches on the Rockaways—Cross Bay Parkway and Marine Parkway—and, for many years, a branch line of the Long Island Railroad, which ran across the Bay on a trestle. After the trestle burned in the early 1950's it was replaced a few years later by a spur of the New York City subway, which was built on a fill crossing some of the central marshland. To get to the Rockaway beaches, a potential bather in another part of the City has had to have access to an automobile or he has had to take a long slow ride on a train. As a result, the Rockaway beaches have developed as an area of private apartments, houses and some summer houses, in which street parking for outsiders is severely restricted. The major public park—Jacob Riis State Park—was first developed in 1925 and primarily serves people who come to it by automobile. It has a large parking lot, but the use of it, like the use of all the beaches on the peninsula, has been limited by the inadequate means of getting to it. On hot days, the two access roads to the peninsula become so jammed with automobiles that the parking lot at Riis Park sometimes never fills up. On such days the single subway line, with relatively infrequent trips, cannot deliver nearly as many people to the beaches as might wish to get there.

The Use of the Bay as a Site for Human Habitation

In the beginning the marshland of the outer zone was a barrier to the use of the shores of the Bay as a site for homes. Later the sludge fills and garbage dumps along the north shore, Floyd Bennett Field along the west shore, and Kennedy International Airport to the northeast provided equally effective barriers to the building of homes. Nevertheless, the pressure of the demand for housing gradually caused the building of human dwellings to creep toward the Bay. At Howard Beach, on the northwestern end of Kennedy Airport, a poorly drained area of marshland has been made into a small

private housing development. In the Inwood section of Hempstead, at the southeastern end of Kennedy, a similar development has taken place. The Rockaway peninsula has long since been built up and some of it —at Arverne—is now the site of urban renewal, which, incidentally, lies directly in the approach path to runway 4R at Kennedy Airport. Floyd Bennett Field is now proposed as a site for middle-income housing, and at Spring Creek the sludge-filled marshes of the outer zone are planned to be the site of low-income housing.

The problem presented by these housing developments is discussed in Chapter 3. At the present time they are of greater concern in relation to the airport than in relation to the Bay; but their presence and their increasing number do indicate the increasing pressure for people to use the shores of the Bay as a living site. And the plans for Floyd Bennett, Spring Creek, and Arverne indicate that there is some commitment in this direction on the part of some public authorities as well.

Role of the Bay in the Natural System of the New York Area

Jamaica Bay, even in its present state, continues to be an active part of important natural systems in the New York area. Its salt marsh and estuary are the only major natural area left to the people of the City. In 1954, the Bronx contained nearly 2,000 acres of coastal wetlands; by 1964 the total was a mere 50 acres. Over a third of the wetlands of Queens were lost during the same 10-year period. Half of the wetlands of Brooklyn were disappearing at the same rate. Nassau County lost 4,635 acres of its 1954 total of 14,130 acres in this same span of years.

Of the remaining estuaries in all of the United States, 27 percent have been slightly modified, 50 percent are moderately modified, and 23 percent are classified as severely modified. In the Middle Atlantic zone, which includes Jamaica Bay, 5 percent of the remaining estuaries have been slightly modified. In 1907 the marsh area of Jamaica Bay was 16,000 acres. Today only 4,000 acres remain, and all of this has been somewhat modified.

A study of the coastal marshes of Connecticut has shown that the losses of wetlands there have been caused mainly by supposedly minor encroachments of roads, parking lots, and marinas. If this rate of disappearance is projected into the future, half of the coastal marshes of that state will have disappeared in 35 years. This is not an unusually high rate, and it is probably the norm for most of the east coast.

At the turn of the century, Jamaica Bay was a salt marsh estuary typical of those along the Atlantic and Gulf coasts from Canada to Mexico. Its 16,000 acres of marshland were penetrated by shallow winding channels. The edges of the marsh were bordered by smooth cord grass, *Spartina alterniflora,* and the inner portions were covered by *Spartina patens.* Low-lying areas of the marsh were submerged at each high tide, and nutrients in the form of organic detritus were regularly flushed by the tides into the surrounding water of the Bay and then into the ocean. Estuarine salt marshes such as this are among the most productive ecosystems of the world, with rates of primary productivity higher than those of most forms of intensive agriculture. The rich supply of nutrients produced in these estuarine ecosystems forms the basis of the food chains that support most of the commercial fish and sport fish and shellfish of the Atlantic coast.

Continued dredging of the Bay has increased its mean depth from about three feet to 16 feet, with a corresponding increase in the residence time of conservative (i.e., non-decomposing) substances from 10 days to an estimated 35 days. The result of these and other alterations has been to change the Bay from a natural estuarine ecosystem to an artificial salt marsh–brackish water–phytoplankton system.

At the present time, Jamaica Bay is moderately polluted from a variety of sources, but it is still a reasonably healthy ecosystem that is able to function as a tertiary treatment system for the effluents it receives. Its health is, in part, explained by the fact that most estuarine organisms are adapted to tolerate relatively large variations in their environment. Estuaries are subject to unusually wide ranges of salinity, temperature, and turbidity, for example, as compared with freshwater or marine ecosystems. Tolerance to such variations is a characteristic of estuarine organisms.

Nevertheless, Jamaica Bay shows many symptoms of stress beyond those that would normally be encountered in a natural estuary. Most of the marsh vegetation appears from gross examination to be in a healthy, productive condition except for that of Jo Co Marsh at the end of runway 4L. There is a reasonably good diversity of organisms in the Bay, which is a source of its present stability, but they are characterized by the presence of some species that are associated with organic pollution, and by the absence of other species that occur in most natural estuarine systems. Local areas near the mouths of treated sewage or storm-sewer outfalls, such as Grassy Bay, Bergen Basin, Thurston Basin, Paerdegat Basin, Mill Basin, and Old Mill Creek, which receive the heaviest burdens of pollutants, have longer average residence times (that is, low rates of

water exchange), and are characterized by large numbers of coliform bacteria, low levels of dissolved oxygen, and, at certain periods, high levels of biochemical demand for oxygen. These areas show a poor diversity of species, generally, and they are especially deficient in those species that usually indicate that an ecosystem is productive and healthy.

Although more than 60 species of finfish and shellfish occur in the Bay, their numbers have declined over the years, and their productivity is poor. A survey of finfish in October 1969 showed a standing crop of less than one pound per acre at all stations; in June 1970 the values ranged from no fish per acre in Grassy Bay to a high of 6.5 pounds per acre in North Channel.

Although pollution had progressed by 1921 to the point at which it was closed for commercial shellfishing, the Bay has never been destroyed as an important habitat and nursery for both shellfish and finfish. This is perhaps best illustrated by two observations: (a) Many people still fish in Jamaica Bay and still take their catch home to eat (despite a reported taste of oil). (b) In recent years commercial shellfishing has returned to the Bay.

Pollution has, of course, decreased fishing in the Bay. This may be one of the reasons why some species of fish have survived in the polluted waters. Others have barely survived. Even so, the Bay at present contains more than 60 species of fish and shellfish, including such well-known ones as flounder, tom cod, eel, shad, menhaden, hake, mullet, fluke, snapper, blue fish, and even a few small weakfish. Among shellfish there have been blue crab, clams, oysters, mussels, and bay scallops.

Any major decrease in the area of the Bay or any impairment of its circulation might have very harmful effects upon the remaining fish. The warm, shallow, nutrient-rich Bay waters are nurseries for many oceanic fishes as well as many Bay species. Loss of wetlands in the past two decades has already been accompanied by a decrease of 80 to 90 percent in the catch of some species of commercial fish in the same region. The only remaining nurseries for such fish in the New York Harbor are Jamaica Bay and the Hudson estuary. They, like the other surrounding wetlands, have become more important as their number has diminished.

The marshland of Jamaica Bay also provides a very important feeding ground and nesting area for the birds of the northeastern United States. This was true long before men arrived on the scene, and it remained true when the Parks Departments acquired jurisdiction over the surviving marshes in 1948. Observing the abundance of birds on the marshes, they considered the creation of a wildlife sanctuary. On the advice of the United States Fish and Wildlife Service, they decided upon the creation of freshwater ponds to increase the breeding of non-marine water fowl, and to attract them during the seasons when they were not breeding.

In 1954, the Parks Department and the New York State Department of Conservation agreed on the basis for operating this area as a wildlife preserve. The dikes for the two ponds were constructed by the New York Transit Authority under an agreement with Park Commissioner Robert Moses. The Transit Authority had purchased the old fire-damaged wooden trestle that had supported the Long Island Railroad's spur to the Rockaways. In exchange for permission to dredge sand from Jamaica Bay to create a permanent embankment for the new rapid-transit line, the Transit Authority agreed to construct the dikes that created the two ponds.

Since 1954 the wildlife refuge has been managed to a point at which it has become one of the outstanding bird refuges in the Northeast. It has been referred to as "unique" and "an ecological treasure" because of its location in New York City close to millions of people and because it has survived countless threats to its existence. In addition to the openness of the Bay and the greenery of the salt marshes, the outstanding attribute of this refuge is its wealth of easily observable bird life. Anyone who stands on the shores of Jamaica Bay, whether or not he is interested in bird life, cannot fail to be impressed by the variety and number of birds that he can see. Four hundred and twelve species of birds, according to competent authorities, have appeared in the New York area. This is about half of all bird species recorded for the continental United States. The wealth and variety of species reflect the ecological diversity of the region around New York, which ranges from sea level to an altitude above 1,800 feet; and the diversity of habitats, which range from hardwood forest and pine barrens to barrier beaches, from lakes and streams to salt marshes and tidal flats. New York is the meeting ground for southern bird species such as glossy ibises and black skimmers, northern species such as great black-backed gulls, and western forms like the gadwal and pintail ducks. In this sense the area is ornithologically unusual.

Of the 400 or so bird species recorded for the New York area, approximately 300 have been recorded for the Jamaica Bay refuge. By discounting some 50 species that rarely occur, one may estimate that well over half the total number of bird species that occur in the New York area can be seen in the Jamaica Bay wildlife refuge. A popular guide to the birds of the New York area rates the Jamaica Bay wildlife refuge in the highest category as a locality of widespread interest. It has been said of this refuge that it is a "must for any

birder; one of the best places in the entire region." [1] Through careful management, the wildlife refuge has been responsible for the establishment of several species of herons, egrets, and ibises, which have moved outward to colonize areas in New England and the Northeast where they were formerly not found. The refuge is one of the most important waterfowl areas in the North Atlantic states, providing a resting area, feeding place, and winter refuge for 29 species of ducks and geese. In a given winter, it may harbor 20 to 25 percent of all Long Island waterfowl.

Thus it is evident that the use of Jamaica Bay as a site for human recreation and habitation, and as a preserve for marine and bird life—the first uses to which it was ever put—have been revived to some extent during the last 30 years. In many ways this revival has been more in the form of an expressed intent to preserve the Bay for such uses rather than of any active move in this direction. Nevertheless, the mapping of the Bay as park land, and the development of the wildlife refuge, have given some substance to this intent, and the major effort to improve the quality of the water in the Bay, which we shall discuss in the next section, has had the clearly stated intent of making it possible to preserve the Bay for "Group 1" uses.

Uses for Commerce, Industry, and Waste Disposal

In the meantime, the commercial and industrial uses of the Bay, and its use as a site of waste disposal—the uses that we placed in the second group—have continued, but there have been notable efforts to suppress some of them.

Use of the Bay as a Seaport

The Bay as a seaport was abandoned in the 1920's when it became evident that the industrial and commercial support for such an enterprise would not be forthcoming. However, this did not happen until after a channel had been dredged along the Bay's western and northern parts. This channel has been more or less maintained, as has a shallower channel paralleling the Rockaway peninsula along the southern shore of the Bay. The southern channel runs as far as Inwood to the inlet known as "Head of Bay." Some barge traffic passes along both of these channels, the most important part of it traversing the main channel to Bergen Basin, to deliver oil and gasoline to the tank farm that serves Kennedy Airport. The remainder of the water traffic through the Bay consists largely of private power boats and other pleasure craft that utilize the marinas at Mill Basin and along the Bay shores of the Rockaway peninsula. The barge traffic, especially, is a major source of the pollution of the surface of the Bay by oil.

There is relatively little industry around the shores of the Bay, but there is some likelihood that more will be developed, because tank farms and power plants, all of which depend on barge traffic, have been developed in the Inwood area. If this continues there will be an increase in the use of the Bay for water-borne commerce in the future. Nevertheless, since the tank farms at Kennedy Airport are supplied primarily by commercial pipelines at the present time, it might be possible to make this the source of the oil supply for the whole area, and to abandon the barge traffic entirely.

Use of the Bay and Its Shores for Waste Disposal

For many years the City of New York has used Jamaica Bay for disposal of liquid waste, and it has used the marshlands that surround the Bay for the disposal of solid waste. It continues to do so, but it is making a serious and expensive effort to stop using the marshes for the deposit of refuse and sludge, and to alleviate the effects on the Bay that are produced by the disposal of sewage.

Sewage disposal and water pollution. Originally, fresh water from the open lands of Brooklyn and Queens flowed down the many creeks that fed into the waters of Jamaica Bay. As the surrounding area was built up, these sources of fresh water were covered over, filled in, and dried up. They were replaced by storm drains and sanitary sewers, which emptied into the heads of the "basins" formed from the mouths of the former creeks as the marshes of the outer zone were filled in. As the City grew, water for drinking and other municipal purposes was brought in from Westchester County and the Catskills, and the net outflow from the sewers of Brooklyn and Queens into the Bay probably increased; but this fluid outflow was in the form of sewage of human and industrial origin. By 1930, untreated sewage was flowing into Jamaica Bay at the rate of millions of gallons a day.

Beginning in 1931 the City of New York initiated a program of sewage treatment in an attempt to control some of the effects of liquid waste on the waters surrounding the City. The program was based upon the construction of plants at the mouths of the sewers where the sewage is oxygenated, and the solid part is allowed to settle. This process removes its offensive odors and some of its bacteria. The solid material, after

[1] John Bull, *Birds of New York Area,* Harper & Row, 1964, New York.

further treatment, becomes "sludge," which is then used to create land fill or is carried out to sea in barges. The remaining clarified liquid is chlorinated to kill any surviving dangerous bacteria, and then discharged into the waters around the City. Over the last four decades large plants for treating sewage in this manner have been constructed at Coney Island, at Hendricks Creek, at Bergen Basin, and on the Bay shore of the Rockaways, and pumping stations have been erected at the heads of other basins to transfer the waste from the sewers there to the treatment plants (see Figure 2-3). The City's basic program, long under way, is scheduled for completion in 1972.

The "secondary" treatment plants surrounding Jamaica Bay produce sludge that is not malodorous and a liquid effluent that is not infectious to humans, even though its esthetic qualities leave something to be desired. Nevertheless, these plants have some serious defects as protectors of the natural character of the Bay. They do not remove dissolved materials—especially inorganic salts—which may substantively influence the characteristics of the water in the Bay and can become a threat to the health of its marine and plant life; nor do they remove industrial wastes.

Perhaps most important to humans, these plants are constructed to handle only the effluent of a dry day—some 220 million gallons. If there is a heavy rain, or even a short, sharp one, the volume flowing from the sewers rises markedly, for the storm sewers are not separated from the sanitary sewers in most parts of New York City. The increased volume of sewage exceeds the capacity of the treatment plants and automatically bypasses them, flowing directly into the Bay. After a rain storm the concentration of coliform bacilli in the waters of the northern and eastern parts of Jamaica Bay rises significantly, and the surface of the water at the mouths of the various basins is covered with the recognizable detritus of the bathrooms of Brooklyn and Queens.

The cost of separating the City's storm sewers from its sanitary sewers has been estimated to be as much as $20 billion. However, an ingenious alternative, based upon the trapping and chlorination of storm waters, was initiated in 1965. It was suggested by the observation that, when a rainstorm occurs, it is the first part of the storm-water overflow that flushes out the sanitary sewers and that contains most of the sewage; the latter part of the overflow is largely storm water. The plan calls for "auxiliary treatment plants," which will trap the first part of the storm overflow and hold it for secondary treatment, and chlorinate the latter part of the overflow in which the sewage is quite dilute. It is expected that 90 percent of all storm drainage can be taken care of in this manner. The first such auxiliary treatment plant was started at Spring Creek in 1968. It is expected that it will be completed in March 1971 and that field tests will have been finished by December 1972. Three other auxiliary plants at Fresh Creek, Paerdegat Basin, Bergen and Thurston Basins, and Hendricks Creek are scheduled to be completed by 1978.

The massive New York City program of sewage treatment, of which Jamaica Bay plants are a part, will receive $353 million from the City's capital budget in 1970–71. Of this amount $142 million will be provided by New York City, $210 million by New York State, and $975 thousand by the federal government. The completion of the program appears to be reasonably certain, since it is being financed in large part by state and federal grants under continuing programs aimed at improving the water quality of the region. In addition, the City's commitment to this program in the past has been a steady one. The goal of the program is to attain bathing water quality for the waters of Jamaica Bay by 1978 (that is to say, to obtain water of New York State Water Resources Commission Class SB, or of Interstate Sanitation Commission Class A). The waters at the mouth of the Bay already have this quality. By 1974 the northwestern shores of the Bay above Floyd Bennett Field should have attained this quality also, and the construction of new beaches in this area might be begun.

Many of the sources of pollution of the waters into the Bay will be eliminated as the City accomplishes its goal of auxiliary treatment plants, but some will remain unless other remedial measures are taken. Compounding the effects of these sources of pollution is the general geometric configuration of the Bay: small cul-de-sacs along the perimeter, including Bergen, Thurston, and Paerdegat Basins; relatively stagnant areas such as Grassy Bay; a complex of basins connected in series, such as the Beach Channel–Hassock Channel–Head of Bay–Thurston Basin complex; and some areas without sewage treatment such as the Broad Channel community. In general, the northern and eastern parts of the Bay have water of poor quality, whereas the western and southern parts, with the exception of the Broad Channel area, have water of relatively good quality.

The map in Figure 2-4 shows the major air and water pollution sources in Jamaica Bay and the surrounding areas that are affected by this pollution.

Sources of pollution, in addition to the City's sewers, can be seen on this map. Of particular interest are the barge-traffic routes and the fuel-oil terminals located mostly in the eastern and northern parts of the Bay. These areas are primarily sources of oil spills, which are frequent enough to cause a pollution hazard as well as

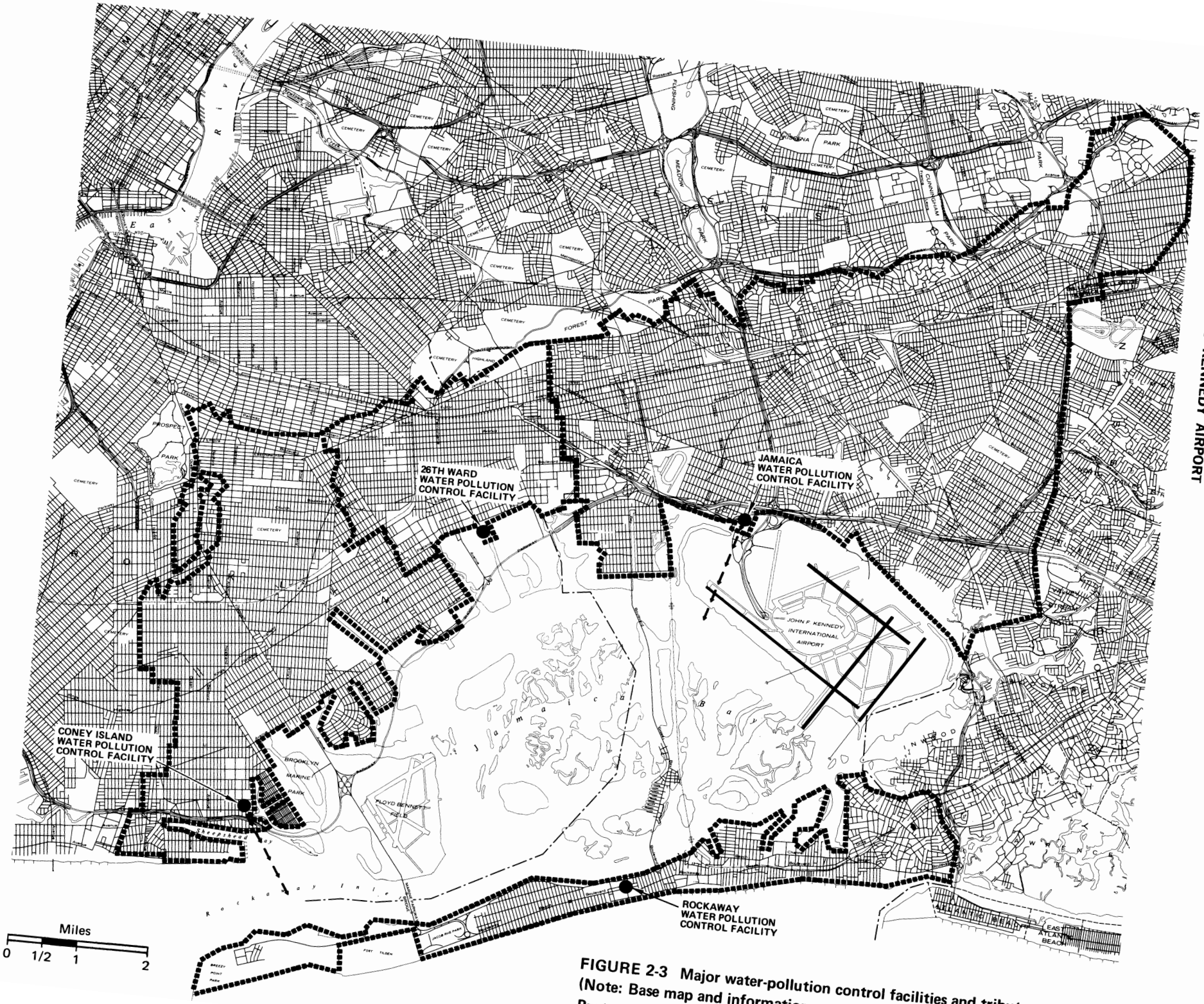


FIGURE 2-3 Major water-pollution control facilities and tributary areas. (Note: Base map and information supplied by New York City Environmental Protection Administration.)

a nuisance. Another potential source of pollution exists in the sanitary land fills, which might be breached at some time or produce pollution through leaching. Other sources are the general air pollution from the airport and from nearby automobile traffic, the incinerators, the power plants, the numerous marinas that ring the Bay, and the Broad Channel community.

Solid-waste disposal. As New York City grew around Jamaica Bay and began to dump its sewage into the Bay, it also began to deposit its solid wastes on the marshes of the outer zone, both in the form of sanitary land fills and as plain garbage dumps. (A sanitary land fill consists of refuse deposited on a surface and then covered with material at a frequency and to a depth that will prevent such nuisances as bad odors, insects, and rodents. A garbage dump is simply a dump.) Before the 1930's the City dumped a good deal of its solid waste into the ocean, but it had to stop this after a 1933 Supreme Court ruling that prohibited the general dumping of solid wastes into the ocean. Partly as a result of this, the deposit of solid wastes as sanitary land fills around the periphery of the Bay increased in the 1930's just as the sewage-treatment programs were getting under way. In 1965, Brooklyn and Queens each produced 1.7 million tons of solid waste, of which 947,000 tons were deposited in Queens, much of it on the Jamaica Bay marshes (see Figure 2-4).

Most of the disposal of solid waste around the Bay has been in the form of sanitary land fills. This sort of filling is coming to an end, if for no other reason than that no marshland is left to be filled. However, the City and Nassau County have continued to maintain several open garbage dumps. One of these lies between Bergen Basin and Howard Beach at the northwest end of the busiest runway at Kennedy Airport, and another lies at Edgemere at the southwestern end of runway 4R. Both of these dumps attract a great many herring gulls—the birds most frequently involved in fatal strikes with aircraft. In 1965 one of the dumps of Jamaica Bay was described by an authority on herring gulls as having "more gulls than all the area north and east of Cape Anne in Massachusetts, that is to say, more than all of Nova Scotia and Maine, which we often think of as the heartland of gull survival." [2] A conservative estimate of the number of herring gulls that winter in Jamaica Bay at the wildlife refuge has been 20 to 30 thousand, but some authorities feel that perhaps as many as a million herring gulls spend the winter in the New York City area.

[2] William H. Drury, Jr., "The Herring Gull and Man," Proc. 61st Ann. Conv. National Audubon Society, 1965, pp. 9–11.

The Use of the Bay as a Source of Building Material

In Jamaica Bay the surface materials of the bottom are a mixture of sand, silt, and clay intermixed with organic material, about five or six feet in depth. Underlying the surface material is a vast layer of sand with some gravel, which accumulated as an outwash from the once nearby glaciers. The sand in Jamaica Bay ranges to depths from 90 to 230 feet below mean sea level, having an average thickness of about 150 feet. Although it is variable in size, it is of excellent quality for use as fill. It has a median size range of about 0.75 to 1.0 millimeter, with less than 10 percent of the material below 0.1 millimeter.

Over the past 70 years Jamaica Bay has been subjected to extensive dredging and filling. Since 1900, an average of three dredging permits per year have been issued by the Corps of Engineers of the New York District. To gain some idea of the total volume of material that has been dredged up in recent years, the New York District of the Office of the Corps of Engineers has furnished the following information on dredging permits. (The actual volume of dredging may be slightly below that authorized by the Corps.)

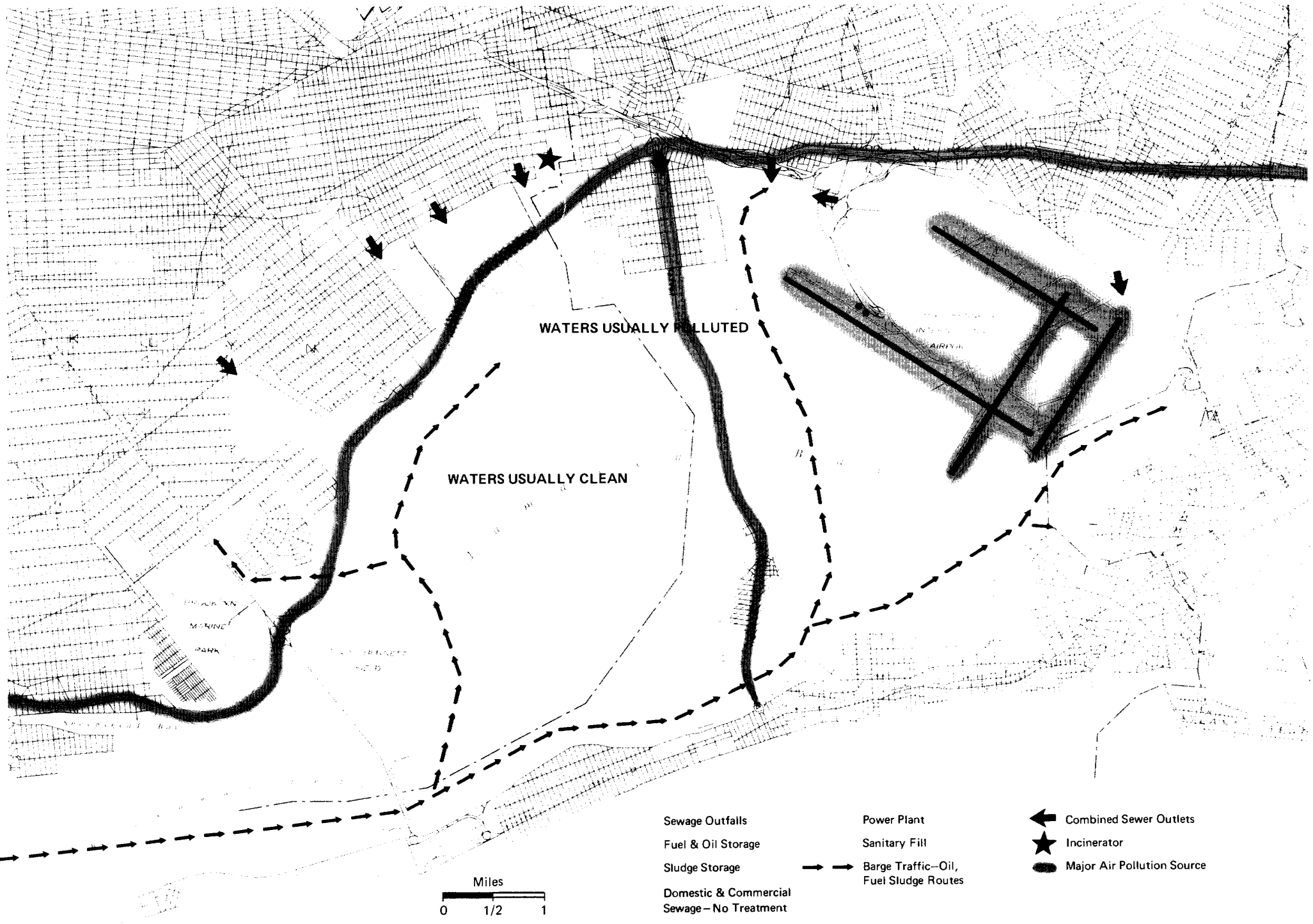
J. F. Kennedy International Airport (1938)	60×10^6 cu yds
Easterly runway extension (1958)	4.3×10^6
Westerly (4L) extension (1962)	11.5×10^6
Sanitary fill along north shore (1938–present)	10.0×10^6
Seaplane runways near Floyd Bennett Field (1942)	2.5×10^6
Fill for New York State Mental Hygiene Hospital (1969–70)	3.6×10^6
Beach Channel High School	2.0×10^6
Twin Pines Village (planned)	1.0×10^6
	93.9×10^6 cu yds

Dredging Permits Issued

	Number
1-1-00 to 12-31-05	6
1-1-06 to 12-31-10	3
1-1-11 to 12-31-15	17
1-1-16 to 12-31-20	6
1-1-21 to 12-31-25	34
1-1-26 to 12-31-30	23
1-1-31 to 12-31-35	14
1-1-41 to 12-31-45	20
1-1-46 to 12-31-50	12
1-1-51 to 12-31-55	14
1-1-56 to 12-31-60	21
1-1-61 to 12-31-65	19
1-1-66 to 12-31-69	13

In addition to this, there has been dredging in other years for the development of the Rockaway peninsula, Floyd Bennett Field, Canarsie Pol, Marine Park, and other areas, but the dredging records are not readily

FIGURE 2-4 Air- and water-pollution sources in Jamaica Bay and environs.



available. Nevertheless, a conservative estimate of the total dredging in Jamaica Bay would suggest that at least 125 million cubic yards of material has been dredged for a wide variety of purposes. It is obvious that very little of the bottom of the Bay remains in its original natural state.

In 1907 Jamaica Bay was 24,670 acres in extent. Eight thousand five hundred acres of this was water surface area and the marshland was 16,170 acres. The filling of some of the fringe areas of the Bay proceeded slowly until about 1938, when the yearly pace of land-filling abruptly accelerated with the increase in sanitary land-fills, and with the filling of the major part of the Kennedy Airport site. These and similar activities have now reduced the total acreage of the Bay to 13,000—9,000 of it in water, and 4,000 in marshland.

Since 1938, when major dredging began, the half-life of the Bay has been estimated to be only 35 years. In other words, every 35 years, at the current rate of dredging and filling, the area of the Bay will be reduced by half.

Accompanying this dredging and filling there has been a deepening of the water portion of the Bay, which has produced a present average depth of about 16 feet. The original average depth of the waters in the Bay was approximately three feet. One can estimate that about 70 percent of the present volume of the Bay is the result of dredging.

A computation of the present "retention time" for conservative substances in the Bay is about 35 days. This is based on the assumption that the major sources of pollution and the freshwater inputs are near the head of the estuary. If we assume that a similar spatial distribution of waters was present when the depth was three feet, then the retention time originally would have been about 10 or 11 days. Thus, one of the net effects of the dredging and deepening of Jamaica Bay has been an increase in the retention time over the years. This, in turn, means that pollutants take about three times as long to be flushed out of the Bay today as they would if it had remained in its original condition.

Both New York City, because of its ownership of the Jamaica Bay park land, and the United States Army Corps of Engineers, because of the existing navigation channels, have jurisdiction over dredging in Jamaica Bay. Although dredging in the Bay is not encouraged by the City, several projects are currently under way, including the obtaining of fill for the Beach Channel High School and the Twin Pines Housing Project. After these projects are completed, it is not anticipated that any large-scale dredging will be allowed unless it can be shown that some enhancement of the environment will result.

Applications for permits for dredging are made to the Office of the District Engineer. Permits are issued after a study by the Corps. Until 1970, public hearings on permits were held only if objections were forwarded to the Corps. In practice, most permits were issued without public hearings.

Under the National Environmental Policy Act of 1969, dredging and filling by any federal agency must include a detailed statement on (a) the environmental impact of the proposed action, (b) any adverse environmental effects that cannot be avoided should the proposal be implemented, and (c) alternatives to the proposed action. With this stated national policy it should be more difficult to justify any large-scale dredging or filling of marshlands, estuaries, or coastal zones in Jamaica Bay in the future.

Use of the Bay as an Adjunct to an Airport

Quite aside from the fact that Kennedy International Airport was constructed from the marshland of Jamaica Bay in the first place, the water areas of the Bay now act as an important adjunct to the airport, without which it might not be allowed to operate at all. The basic runway system at Kennedy consists of parallel runways in the 4-22 (southwest, northeast) and the 13-31 (southeast, northwest) directions. Only one runway in each of the principal directions is equipped for instrument landing and is also long enough to take the longest and heaviest aircraft. In the 4-22 direction, aircraft taking off toward the northeast must pass over several Nassau County communities at low levels, while those taking off to the southwest pass over the Bay and over rather narrow stretches of the Rockaways. In the 13-31 direction, aircraft taking off toward the northwest, if they continue in a straight line, pass directly over Queens and Central Brooklyn, while those taking off toward the southwest pass over somewhat shorter stretches of Inwood and Atlantic Beach.

In order to counteract the effect of noise on surrounding communities PONYA has instituted certain flight procedures for planes taking off and landing at Kennedy. These require that the 13-31 runways be used in preference to all others, and that takeoffs, so far as possible, be in the northwest direction. Pilots are instructed to begin their runs at the southeastern end of the runway and to lift off as soon as possible. As soon as they are well off the ground they are required to turn left sharply to avoid flying over Brooklyn and Queens any more than necessary. When they have reached prescribed altitudes they are required to reduce the power of their engines and to pursue a level flight over the Bay and over the Rockaways. When the 4-22

runways must be used, attempts are made to have the flights take off or land at the southwesterly end so that the noise is again over the Bay. By these maneuvers much of the noise of planes taking off and landing is directed over the waters of the Bay. PONYA monitors noise intensity at a single location in each flight path and reports excessive noise occurrences to the airlines. There is widespread disagreement among people of the affected communities concerning the efficiency of this program, but there is no doubt that it does have the effect of decreasing the load of noise upon inhabited areas as a whole.

Popular attitudes toward Jamaica Bay. Altogether, it is quite apparent that, during the first half of the 20th century, the people of New York were intent upon converting Jamaica Bay to commercial and industrial uses, and that they have rather changed their minds about this in the second half of the century. Despite their protestations, the reasons for their change of heart and course may not have been entirely altruistic. It could be contended that they did not convert the Bay into a seaport primarily because industries were not attracted to its shores and the venture was a financial failure. The City initiated their major program for treating the sewage flowing into the Bay in large measure because the Bay threatened to become an intolerable, malodorous nuisance, and a hazard to human health, if such a program was not carried out. They are ceasing to dump solid waste on the shores of the Bay coincidentally as the last marshland available for dumping is being covered. They have not yet quit dredging the Bay; those involved in issuing permits for dredging simply state that it will probably have to be discontinued because of new federal regulations.

Many New Yorkers would contend that the recent positive measures that the City has taken to preserve the Bay have been half-hearted and, to some extent, fortuitous. The bird sanctuary is in large part a fortuitous creation of man—the secondary result of the dredging of two holes in the marsh to obtain fill for an embankment for a rapid-transit line. The ponds that resulted from this dredging are as much a monument to the entrepreneurial ingenuity of Robert Moses as they are a testimony to the foresight of the City Parks Department. In spite of present enthusiastic descriptions of the educational value of the bird sanctuary, it has no facilities except a few paths, and those who wish to visit it must obtain special permits in advance. A cynic might argue that as a bird sanctuary Jamaica Bay attracts far more herring gulls to its garbage dumps than ibises and ducks to its marshes.

For 50 years the people of the New York area who control the destinies of the Bay clearly did not regard it is an important natural area. Originally it was 25,000 acres of saltwater estuary and active wetlands, with an average depth of three feet, washed with ocean tides and fed by freshwater creeks from Long Island. The activities of the people of New York have converted the Bay into 13,000 acres of heavily polluted ocean inlet, dredged to an average depth of 16 feet and, in some places, to a depth of 30 to 50 feet, fed by 220 million gallons a day of partly treated effluent from the City's sewers, surrounded by sanitary land fills, with a few surviving fish, and a barely surviving marshland in the center. Considering its history and its present condition, it is hardly to be wondered that PONYA has seriously proposed to convert a substantial part of the remainder of the Bay into an airport.

Yet it would be altogether too cynical to assume that the gradual changes in the use of Jamaica Bay that have taken place during the last 20 years have been fortuitous, selfishly motivated, and not supported by a large number of people. Over the years, people of New York City who have lived around the Bay have stubbornly continued to fish in it, to swim in it, to boat upon it and to sit under the sun along its shores. Despite all discouragements and disappointments, they have agitated among themselves, and with their local politicians, for its preservation, and for its use by the people around it. They have made their homes around it where they could, even in poorly drained marshes by garbage dumps and sewage outfalls, and at the ends of runways. At Broad Channel, where they have been denied the right even to own the land upon which they live, and have been forced to provide their own services, they have stubbornly refused to leave their homes by the marsh because, they say, they like to live there.

At the same time, able and energetic men, with a vision of the Bay that might not be readily excited in a person other than a sanitary engineer, have continued to perceive the oily, turbid, and odorous waters of the Bay as potentially clean and clear, and a place for thousands of people to swim and fish. For many years, with little public recognition, these men have labored to create on the shores of the Bay some of the most efficient and effective sewage-treatment plants in the world. They have tirelessly sought the money to construct and operate them.

There have been similar people on the staff of the Parks, Recreation and Cultural Affairs Administration. This branch of the City government is perennially the last to receive a piece of the City's capital budget, and is forced to support its activites on whatever crumbs of money can be found. Members of its staff have found it expedient to make whatever arrangements they could

to develop the marshes and the bird sanctuary. They have stubbornly clung to the concept that the peripheral land and the beaches should be parks, even though there have been no prospects in sight for developing them. However inconvenient and incomplete their bird sanctuary may be, ornithologists, scholars, and students from many parts of the world have regarded it as highly valuable; and schoolchildren, as well as many people who simply enjoy the quiet, solitude, and beauty of nature, have gone to it to find satisfaction and pleasure in the marshes and their bird life.

Many people have made preservation of the marshes and of the bird sanctuary a commitment of labor and of love. To all these and to many other people in the City, the idea of using the remainder of Jamaica Bay as part of an airport is abhorrent. To them it is, and always has been, a resource to be developed for the recreation and education of the people of New York.

THE POTENTIAL OF JAMAICA BAY AS A SITE FOR RECREATION AND HABITATION, AND AS A FUNCTIONING PART OF THE NATURAL ECOSYSTEM

The Potential of the Bay as a Site for Recreation

Recreation as a Basic Human Need

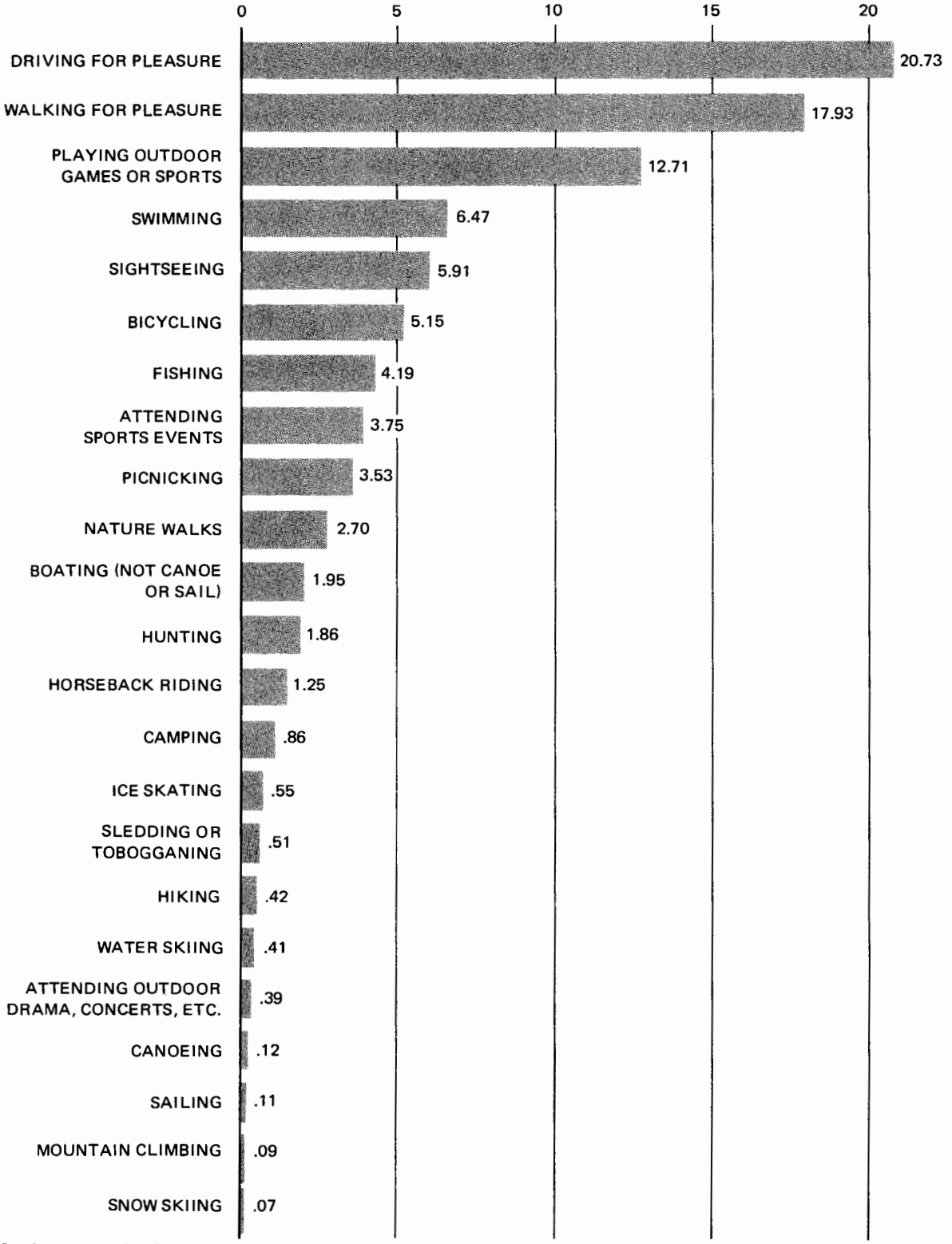
The human need for recreation is in one sense difficult to estimate; in another sense it is not at all difficult to estimate. About one-third of the daily cycle of each man's life is given over to that sustained, purposeful activity requiring attention, which Tom Sawyer defined as "work"—"things a body must do." Another third is given over to sleep. The remaining third, more or less, is given over to a variety of activities. Some of these are important for the maintenance of the body; some are important for the maintenance of an active role as a part of human society; some are important for the maintenance of significant relationships with other people; and many such activities are forms of recreation. Some activities are not necessarily purposeful, and are engaged in because of the rest and the satisfaction that they provide.

Recreation, in the words of Tom Sawyer, is made up of "things a body wants to do." Recreation takes many forms. It includes the vigorous active play of children and adolescents, the body-contact and competitive sports of adults, the purposeful pursuit of games and hobbies, the intellectual and emotional stimulation of plays, movies, or reading, the aimless conversation of gossiping or "goofing off," and the quiet sitting and musing of the aged. All these activities seem to have a common and important beneficial effect. They enable people to recover and "relax" from the physiological mobilization, alertness, and fatigue that are associated with "doing what a body has to do." Because it provides a "letdown" in alertness, and a change of focus of attention, a period of recreation is an important period of replenishment, and for many people it is an essential prelude to rest and sleep.

The ability of people to find means of recreation is so great, their capacity to substitute one form of recreation for another is so striking, and their ability to postpone it or do without it for long periods of time is so well known, that it is difficult to say how much of what form of recreation is needed by whom and when. To be sure, there is evidence that schoolchildren who are deprived of opportunities for play do less well than those who are not, and there is evidence that extension of the hours of school work beyond a limited number may meet with diminishing returns. There is clear evidence that muscular exercise increases the physical fitness of people at almost all ages, though the evidence that this prolongs life or prevents disease is less convincing. It is quite probable that people who have access to good recreational facilities are longer-lived and have lower morbidity rates than people who do not have such access; but there are a great many reasons why such people might be healthier, and recreation itself may contribute little or nothing to this.

The best evidence for the essential need of people for periods of recreation comes from experimental investigations. In general, if one sets up a human task to be done continuously over time, one finds that the capacity of people to perform this task will fall off if it is continued indefinitely. Ultimately the subject will not be able to continue at all. Simply interrupting the task for periods of eating and sleeping is not enough; there must be other periods of "rest," and, sooner or later, there must be periods during which the subject must return to other activities and interrupt completely the task in which he is involved, or he will not be able to continue effectively. Experience in industry, in the military, and in education all point in the same direction: If people are required to engage in sustained activity requiring alertness and attention for extended periods of time, the indefinite extension of these periods ultimately leads to a degradation of performance. The level of best performance can be restored only if the task is interrupted for a period of other activities, part of which must be regarded as "recreational."

Altogether, it appears that people have a need for periods of "rest" and "recreation" of some hours each



Source: Outdoor Recreation Resources Review Commission, *Outdoor Recreation for America*, U.S. Government Printing Office, Washington, D.C., 1962, p. 34.

FIGURE 2-5 What Americans do most: Number of activity-days per person, 12 years and over, June 1, 1960–May 30, 1961.

day, and they have need of longer periods of recreation of the order of a day or more at intervals of the order of a week or more. This seems to be an essential human physiological need. Although popular folklore is replete with stories of people who can work effectively 70 or more hours a week, year in and year out, without periods of recreation, the clinical experience of physicians and psychiatrists suggests that people who try to do this are subject to sustained symptoms of fatigue, irritability, and insomnia; to impairment of their interpersonal relations, particularly with members of their immediate families; to frequent disturbances of organ function involving, for example, the gastrointestinal tract; and to the intermittent occurrence of disabling disorders such as vascular headache. Not infrequently, people who work unremittingly many hours a day for long periods without vacation become subject to prolonged disabling illnesses, especially illnesses of a depressive nature.

The Need of the People of New York for Facilities for Outdoor Recreation

Of the many types of human activity that may become recreations, those that Jamaica Bay might provide are outdoor activities. At the present time it is not possible to establish an objective standard measure of the adequacy of outdoor recreation in a given area. What people need in recreation tends to be a function of their culture, and of the constraints of time, money, and access under which they live. It is also not possible with the information now available to establish the value of outdoor recreation in improved efficiency, mental health, or general well-being of a population as a whole. Yet, regardless of whether the needs and benefits of outdoor recreation for a particular group of people can be determined empirically, the American public has decided that outdoor recreations are highly valuable, and gives them high priority among the things for which they are willing to spend money.

What people actually do for outdoor recreation may be the best measure of their real preferences, and presumably of their needs. This generalization must be qualified by recognizing the constraints created by the physical capabilities of people, the time available to them, their incomes, and their access to sources of information. What Americans actually did for outdoor recreation in the year 1960–61 is shown in Figure 2-5. For some activities the differences in participation by geographical areas are negligible, but for others they are significant. For example, a substantially higher proportion of people participate in swimming and walking for pleasure in the Northeast than in the rest of the country. The expressed preferences of people for various kinds of outdoor activities are generally similar to their rates of participation, but are not identical in all cases.[3]

In 1960 in cities of over a million population in the northeastern United States, swimming was the preferred outdoor activity, picnicking was second, driving for pleasure third, walking fourth, and fishing fifth. Swimming was the preferred activity of 76 percent of boys aged 12–13 and 83 percent of girls in the same age group.[4]

Swimming ranks third in participation rate among outdoor activities. It is exceeded in popularity only by driving and walking for pleasure. Forty-five percent of the American population over 12 years of age went swimming in 1960. In the northeast region, swimming ranked higher than in any other area in the country, and was rated at 6.82 person-days per year. The rate of participation by number of swimming days is about twice as high for whites as it is for "non-whites," and "non-white females" participate about half as often as "non-white males." Adolescents from age 12 to age 17 had the highest swimming participation rate in any residence category. Throughout the nation, white-collar workers did the most swimming, but in the Northeast, professional and technical workers had the highest participation rates. These participation rates refer exclusively to people aged 12 and above; they would undoubtedly be higher if younger children were included.

Except for swimming, fishing is the most popular of the water-oriented activities. It is a preferred activity among one third of the American population, the highest preference being among boys in the 12-to-17 age group. The proportion of people who prefer fishing as a recreational activity varies inversely with the size of the place of residence. The participation rates for whites and non-whites are roughly equal. Among occupational groups, craftsmen and foremen have the highest participation rates.

Fishing, unlike horseback riding, ordinarily does not bestow status on the participant. People with family incomes under $1,500 a year rated fishing as their first preference. This group rated swimming lower in preference than did any other income group. People with family incomes over $20,000 had less interest in fishing than did any other income group. This upper-income group had a higher preference for playing outdoor games than did any other. Generally speaking, the

[3,4] Outdoor Recreation Resources Review Commission, *Outdoor Recreation for America,* U.S. Government Printing Office, Washington, D.C., 1962.

higher the educational level, the higher the preference for swimming and the lower the preference for fishing.

Nature walks, including birdwatching, were a recreation in which 14 percent of the American population took part in the summer of 1960. The percentage of people participating in this recreation was roughly the same for all sections of the country, but the number of days per person in the Northeast was about double that in other sections. Boys and girls between ages 12 and 17 accounted for one third of the total participation. However, nature walks were a preferred activity for only 3 percent of the population. The participation rates were generally highest for middle-income groups except in the Northeast, where the highest participation rate occurred in the highest-income group. Whites participated at a rate approximately twice that for nonwhites. Here again, participation rates would undoubtedly have been higher if younger children had been included in the figures.

In 1967, the publicly administered outdoor recreation system of New York City included 2,079 separate units with a total area of 37,991 acres (Table 2-2). New York devotes a larger percentage of its total area to parks than does any other of the 11 largest cities in the United States. However, this figure is misleading, because 17.4 percent of the New York park land was undeveloped, 26.5 percent was under water, and 3.5 percent consisted of wetlands. A large proportion of the undeveloped park land and of the park land under water lies in Jamaica Bay.

Considering the size of its population, New York is comparatively deficient in most major facilities for recreation, except perhaps museums, zoos, and amphitheaters. Chicago, for example, has more swimming pools and tennis courts. The percentage of the total city expenditures spent on recreation in New York was lower than that of any of 15 cities studied in 1968. In per capita operating expenses for recreation, New York fell roughly in the lower third of these cities. It spent less per capita than did Chicago, Baltimore, Pittsburgh, Atlanta, Minneapolis, Oakland, Dayton, Tampa, Peoria, or Portland, although it spent more per capita than did Los Angeles, San Antonio, St. Louis, or Nashville.

TABLE 2-2A Inventory of Outdoor Recreation Facilities (New York City Total)

Type	Number	Acres	Percent
City-wide parks	26	18,745	49.3
Borough parks	28	8940	23.5
Community parks	70	3670	9.7
Athletic fields	37	177	0.5
Park strips, triangles	592	4685	12.3
Marginal area parks	27	38	0.1
Neighborhood parks and playgrounds	1299	1736	4.6
Total	2079	37,991	100.0

TABLE 2-2B Park and Recreation Acreage Reported by The Department of Parks, Board of Education, Public Housing Authority, New York City, June 1966

Components	Department of Parks	Board of Education	Housing Authority	Total
City-wide and borough parks	27,684	—	—	27,684
Community parks	3670	—	—	3670
Neighborhood parks, playgrounds, and school fields	836	929	149	1914
Other components	4723	—	—	4723
Total acreage	36,913	929	149	37,991
Percent of acreage supplied by each agency	97.2	2.4	0.4	100

Source (for both Tables 2-2A and 2-2B):
The National Recreation and Park Association, *A Study of New York Outdoor Recreation Needs*, Mimeo, 1967.

Among the boroughs of New York City, there are considerable differences in the number of available recreational facilities. Manhattan has less recreational land per person than does any other borough. Brooklyn has the next least; it has about two acres per thousand people. Queens has roughly five acres of recreational land per thousand people. These figures can be compared with those for Westchester County, which has approximately 20 acres of recreational land per thousand people, and Morris County, New Jersey, which has 16 acres per thousand. It is difficult to evaluate the facilities comparatively by borough summaries, partly because there are substantial differences among neighborhoods within single boroughs. When the Community Council of Greater New York attempted to grade facilities in each of 74 neighborhoods, they found a mixed pattern, but there was some correlation between the median incomes of boroughs and their public recreation facilities, as might be expected.

Special Recreational Needs of the People of Brooklyn and Queens

The special characteristics of the human population that surrounds Jamaica Bay in Brooklyn and Queens have been mentioned in the first part of this chapter. To

repeat some of the characteristics mentioned: Brooklyn has 2.6 million people with a density of some 33,000 people per square mile. Queens has 2 million people with a density of some 18,000 per square mile. Much of central Brooklyn is severely overcrowded and impacted. Its population is lacking job opportunities, recreational facilities, and decent and safe housing. Parts of central Queens have the same characteristics. The evidence of social and political alienation has been strong in some of these areas. Within two airline miles of the shores of the Bay, there are 627,000 people. Fifty-two percent of Brooklyn families and 36 percent of the families in Queens had incomes below $6,000 in 1960; 14 percent of Brooklyn and 8 percent of Queens people were non-white at that time. The median age of the population of New York City as a whole was dropping, and the number of schoolchildren in schools was growing in these areas, while the number of adults was declining. In relation to other areas in the metropolitan region, these areas have an increasing proportion of children and adolescents for whom facilities for outdoor recreation are especially desirable.

Other Estimates of the City's Need for Recreational Facilities

The need of the people of New York City for recreational facilities has been recognized by the City's planners. An assessment of projected recreational needs for the New York area led the Regional Plan Association to argue for near tripling of recreational areas in the tri-state region from 67,000 acres in 1958 to 176,000 in 1985.[5] The Tri-State Transportation Commission estimated that by the year 2000 about 770,000 acres will have to be set aside for recreation and leisure-time activities.[6]

These are not extreme forecasts. For example, Tri-State's statistics indicate that merely to provide sufficient space so that New Yorkers would be able to participate in outdoor recreation as much as the average person in the United States, one third of New York City would have to be park land. Most of this area is needed for football and baseball fields and for picnic areas. The present pressure on recreational resources in the City is reflected in the use of Coney Island. On a typical hot non-working day, the density on the beaches of Coney Island is 4,000 people per acre, or about 10 square feet per person. This may be compared to the three square feet per person that was allocated in the slave ships of the 18th century, or the 12 square feet per person recommended by the Department of Defense for bomb shelters. The general estimate for comfortable beach bathing is about 750 persons per acre or 50 square feet per person.

The need for beaches in New York City has been best expressed in the words of the Outdoor Recreation Resources Review Commission in 1962 [7]:

> The fantastic crowding of beaches close to New York City renders superfluous all surveys, studies and analyses that seek to prove that more close-in beaches are needed. It would be impossible to develop enough close-in beaches to meet the present demand, let alone create an oversupply for the future.

All the evidence, therefore, indicates that the people of New York have a pressing need for new facilities for outdoor recreation. This is true especially of low-income groups in the City's population, and most especially of the children, adolescents, and young adults. These people have special need for facilities that they can reach on foot or by rapid transit. Their greatest need is for facilities for swimming, for fishing, and for park areas that can be used for playing fields or picnicking, for walking and for the quiet sitting of older people.

The Capacity of Jamaica Bay to Provide Beaches and Swimming Areas

In its plans for the development of the Bay, which were put forward at the request of the Study Group, the City Department of Parks and Recreation has proposed the construction of nine beaches, seven marinas, and an expanded educational program at the Wildlife Sanctuary. The proposed nine beach areas would have six miles of beach front and be about 450 feet in depth for a total of about 327 acres. Using the Bureau of Outdoor Recreation's standards of 750 persons per acre with allowance for areas not fully usable, the Park Department has calculated a maximum capacity of 245,250 people per day, for a total of 7,245,000 per season.

In the absence of a prior proposal of this sort, the Study Group on its own investigated the possibilities for the development of beaches, associated parking areas, and year-round recreational facilities on the shores of the Bay for the use of nearby residents. We find that numerous sites are available for such develop-

[5] Regional Plan Association, "Race for Open Space," 1960. pp. 29–31.

[6] Tri-State Transportation Commission, "Outdoor Recreation in a Crowded Region," 1969. p. 2.

[7] Outdoor Recreation Resources Review Commission, *op. cit.*

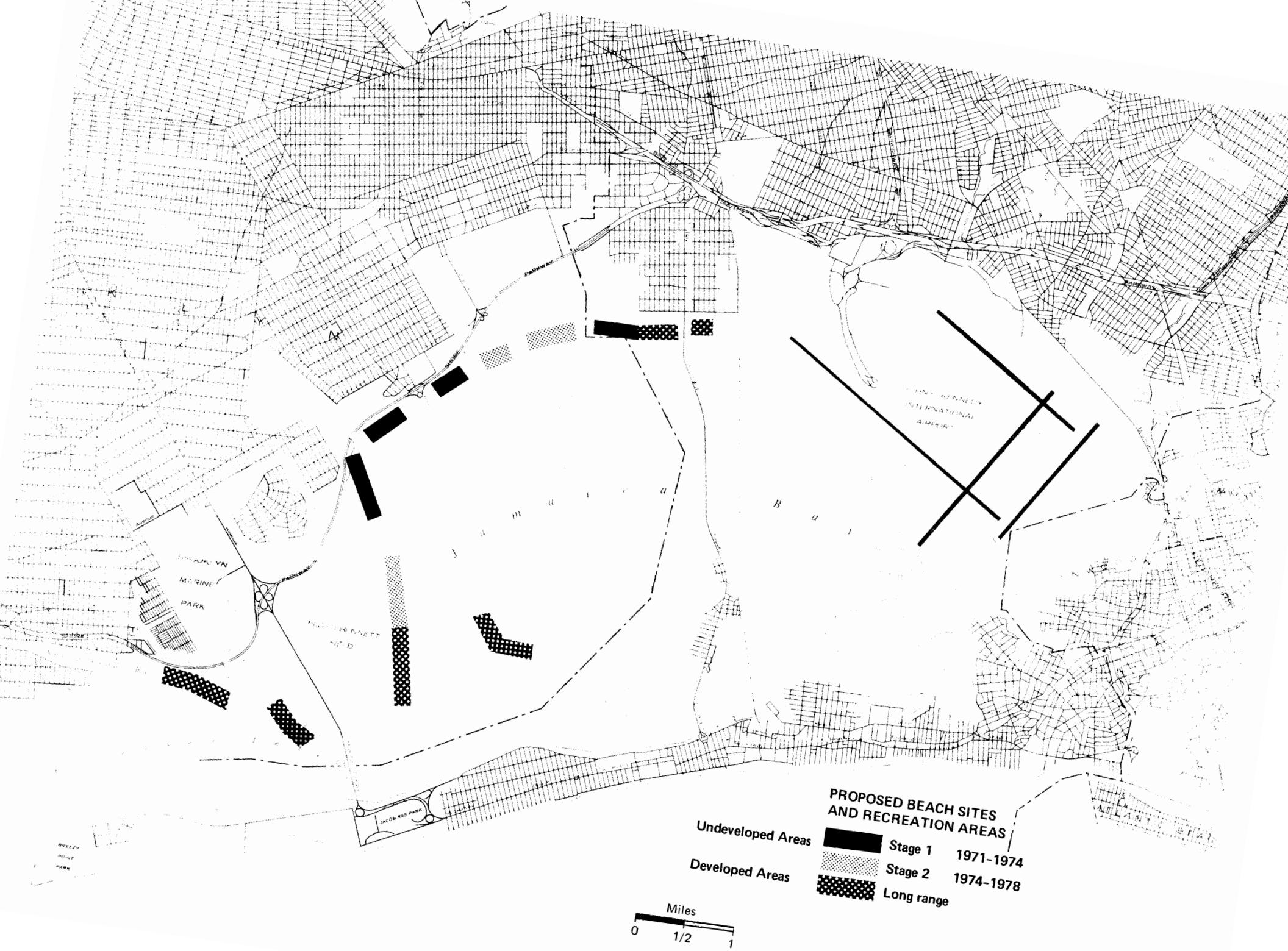


FIGURE 2-6 Potential beach development

ment. The study group considered a method of developing these recreational facilities by dredging sand from the Bay, the dredging to be done without disturbing the basic elements of the wildlife refuge and nesting and feeding areas of the Bay.

The beaches were conceived of as being constructed in two stages. The location of the first and second rounds of construction can be seen in Figure 2-6. The first stage of development might take place on the western and northwestern part of the Bay, where the present water quality is reasonably good to begin with, and where nearby residents could make maximum use of the new facilities. At present the Shore Parkway represents a barrier to access to the proposed recreational areas. Both pedestrian and auto passageways across this would have to be provided. Also, at present (summer 1970), the 26th Ward treatment plant does not chlorinate effectively; however, this difficulty is to be remedied within the current year.

A schematic profile for a possible recreational area is shown in Figure 2-7. The detailed arrangement of the playing fields, game areas, parking areas, and beach facilities might assume many configurations.

Using the Shore Parkway right-of-way as one boundary, it was proposed that a minimum width of 900 feet be filled when needed on the Bay side. The fill would be obtained by dredging the far side of the present channel that runs along the western and northwestern parts of the Bay. By so doing, the boating channels, water circulation and dispersion patterns, as well as the wildlife areas, would be essentially unaffected by the construction. Ample channel access from the marinas along the Bay would be preserved.

The major part of the proposed project would involve the placing of fill on the Bay side of the Shore Parkway. For dredging and placing the fill, a unit cost of $0.75 per cubic yard was assumed to be reasonable after discussion with the New York District Office of the Corps of Engineers. Thus, approximately three nautical miles of recreational area might be placed with a minimum width of 300 yards, allowing a 100-yard width for the beaches on the slope of 1 on 30, rising to a maximum elevation of +10 feet for an estimated emplacement volume of 6.5 million cubic yards at a cost of $4.9 million. The cost of the additional spaces for parking automobiles (which would be held to a minimum) and the shoreside recreational facilities are more difficult to estimate, but these should not be much in excess of $2 million, yielding a total investment of approximately $7 million.

Although it is not anticipated that bathing-quality water will be produced in the entire Bay until about 1978, certain areas of the Bay currently have waters of reasonably high quality, and some other areas will be improved within the next year as a result of the construction of the chlorination contact tank for the 26th Ward treatment plant and the construction of the Old Mill Creek Auxiliary Water Pollution Control Unit. The recreational land behind the beaches could, of course, be constructed almost at once. Thus it might be reasonable to set a target date as early as 1974 for the opening of beaches and backup facilities along Bergen Beach, Spring Creek, and on both sides of Canarsie Pier. At such an early date in the sewage-treatment programs it might be necessary to close down one or more of the beaches for a few days following heavy storms, because complete storm-water treatment would not be available at that time. However, for the major part of the swimming season the waters along these beaches should be of bathing quality. The recrea-

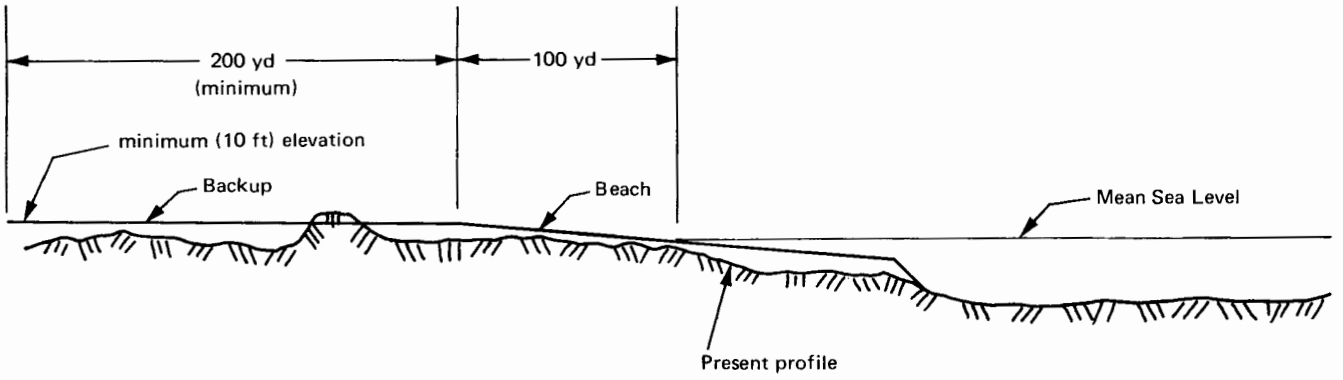


FIGURE 2-7 Schematic diagram of beach and backup recreational area.

tional areas could, of course, be used without interruption as soon as they were constructed.

The plan developed by the Study Group would ultimately produce beaches of some 120 acres (excluding the playgrounds between them). Assuming that these beaches held to the standard of 750 people per acre, which has been recognized for recreational beaches, the capacity of the facilities would be about 90,000 swimmers per day. However, the demand for beaches in New York is such that one might reasonably assume that more than 90,000 people, and possibly as many as 200,000 people, would occupy the proposed beaches on a warm Sunday afternooon. One would hope that the actual density could be kept lower than that of Coney Island, and it might be wise to plan deliberately for no more than 200,000 people under any circumstances.

One method of controlling density would be to limit the parking facilities for automobiles to approximately 10,000 spaces. This would accommodate not more than 40,000 swimmers arriving by automobiles. The remaining bathers would be forced to arrive on foot or by public transportation. During a typical season, assuming 20 full-capacity days and 30 half-capacity days, the beaches would serve some seven million people, estimating 2,000 persons per acre as the actual use in the face of overwhelming demand. Ultimately, as other facilities were constructed, one would hope that this crowding could be cut down. Considering the benefits attributed to the creation of bathing beaches at a value of $0.50 per use (a figure customarily used by the U.S. Corps of Engineers), a beach project for Jamaica Bay would realize its cost in two to four years.

The dredging for the beaches, if done properly, would not permanently damage the bottom fauna of the Bay. It would not involve the removal of amounts of fill from the Bay, or the deepening of the Bay to any significant extent. It would consist primarily of the transfer of material from the outer side of the existing man-made channel to the shore side, thus shifting the location of the channel. The marine organisms will reestablish themselves from planktonic larval forms and will return to normal levels of abundance and species diversity in a relatively short time.

The Study Group's estimates for the cost and capacity of the beach areas that might be constructed are of the same order of magnitude as the estimates of the City's Parks, Recreation and Cultural Affairs Agency. Our findings support their general contention that the construction of beaches along the northern and western shores of Jamaica Bay would not be highly expensive, and that a great many people could be served by these.

The Capacity of Jamaica Bay to Provide Shoreside Parks and Year-Round Recreational Areas

Approximately 3,500 acres of park land or potential park land lie along the periphery of the Bay (see Figure 2-6). The acreage of these shoreside beach areas would be approximately the same as the total area of the islands within the Bay (Table 2-3). Except for Canarsie Pier, these park land areas must be thought of as potential rather than actual parks. The existence of Marine Park notwithstanding, these areas that are marked as parks are not now gathering places or recreational areas for people. They are used only by a few isolated individuals or small groups merely for walking and exploration.

The reason why these parks are underused or not used at all are, in general, these: (a) they are not accessible because of the presence of the Shore Parkway and other natural barriers, (b) they are land-filled areas that have not been sodded, marked off or supplied with any facilities for recreation, (c) some of them are not parks at all, but are still ongoing land-fill operations. This is especially true of the areas to the east. Marine Park is only partly developed. It contains almost 2,000 acres of potentially attractive recreational land, but, like other park areas near the Bay, it lacks means of access by mass transit.

Canarsie Pier is the most popular park area on the Bay. Indeed, it is almost the only one that is a completed park and is also accessible. It is a well-known landmark. Canarsie Park, which is alongside the Pier on the Bay shore, contains 300 acres, but it too is underdeveloped. Both Canarsie Park and the park area at nearby Howard Beach, which has somewhat better developed facilities, are quite close to Kennedy International Airport. They are within the NEF 45 noise-zone area at the end of runway 31L. The amount of noise that they receive greatly limits their usefulness.

The park areas in most immediate need of development are those along the northern and western shores of the Bay. These are potentially some of the most attractive park and playground areas, having a pleasant view, being away from the greatest noise, and being nearest to the projected beaches. They border on areas of highly concentrated populations that lack adequate recreation or leisure-time facilities.

A total of two million people could be within 30-minute walking distance of these parks if they were developed.

Undeveloped park areas on the eastern shores of the Bay near Inwood are close to Kennedy International Airport. They are too noisy for most park and play-

TABLE 2-3 Development of Shoreside Beach Areas

Item	Borough	Property No.	Location	Acreage	Present Development		
					Developed		Undeveloped
1	Brooklyn	B-57	Marine Park—Flatbush, Gerritsen and Fillmore Avenues to Jamaica Bay	1821.726	Playground	Amount (Units)	Fill and marshy areas
					Swings	36	
					Slides	3	
					Monkey bars	1	
					See-saws	8	
					Wading pool and shower	1	
					Comfort station	2	
					Dressing room	1	
					Handball courts	12	
					Shuffleboard courts	5	
					Horseshoe pitch courts	8	
					Tennis courts (hard surface)	12	
					Basketball courts	7	
					Baseball fields	6	
					Little league fields	3	
					Softball fields (turf)	1	
					(hard surface)	4	
					Soccer fields	1	
					Cricket fields	3	
					Safety surfacing		
					Other features		
					Golf course (18 hole)		
					Field house		
					Deep Creek Marina		
					Rowboat rental		
					Bait and tackle shop		
					Mooring		
2	Brooklyn	B-166D	Park—East Mill Basin to Paerdegat Basin west of Shore Parkway and Mill Basin east of Shore Parkway	346.281	2 Ball fields		Rest of area is undeveloped
3	Brooklyn	B-18	Canarsie Park—Paerdegat Basin to Fresh Creek Basin, Seaview Avenue to Shore Parkway	301.115	Playground	Amount (Units)	Area along Paerdegat Basin
					Swings	8	
					See-saws	6	
					Slides	2	Area facing Bay
					Basketball stands	2	
					Climbing equipment		
					Turf ball fields	6	
					Comfort station		
					Recreation bldg.		
					Flagpole		
					Sandlot ball fields	3	
					Canarsie Pier		
					Recreation pier		
					Parking		
					Canarsie Pier Marina		
					Boat rental (rowboats, runabouts, skiffs)		
					Mooring		
					Excursion boat rides		
					Bait station		
					Lockers		

TABLE 2-3 Development of Shoreside Beach Areas—Continued

Item	Borough	Property No.	Location	Acreage	Present Development		
					Developed		Undeveloped
4	Brooklyn	B-165	Spring Creek Park—Spring Creek Basin to Fresh Creek Basin to Shore Parkway to Jamaica Bay	617.670			No development Marshy area—Fill
5	Queens	Q-323	Spring Creek Park—North Shore of Jamaica Bay from Sheridan Avenue to Shellbank Basin	212.600			No development—marshy area—fill
6	Queens	Q-91	Frank M. Charles Memorial Park—Hawtree Basin, Shellbank Basin, Jamaica Bay	39.500	Playground Swings Slide Climbing equipment Turf ball fields Basketball standards Tennis courts Handball courts Benches	Amount (Units) 2 1 3 5 2	Area facing Bay undeveloped
7	Queens	Q-295	Recreation Area—Hamilton Beach, Jamaica Bay	31.900			Undeveloped
8	Queens	Q-309	Jamaica Bay Park	9,151.803 (Upland—2,867,971; underwater 6,283,832)	Wildlife sanctuary Bayside marina Rowboat rental Mooring Bait shop		Undeveloped—underwater
9	Queens	Q-7	Michaelis–Bayswater Park—B. 32nd St., Dickens Ave. Northern Basin	25.000	Neighborhood playground Slides Swings Climbing equipment Adventure equipment Spray heads—shower area Flagpole Turf ball fields Bike stands Comfort stations Volley ball court Tennis courts Basketball courts Handball courts Benches	Amount (Units) 3 5 2 1 3 4 6	Area facing Bay
10	Queens	Q-371	Edgemere Park—Somerville Basin, Conch and Norton Basin, Almeda Avenue	253.719 (10 acres developed)	Playground Slides Swings Sand pit Climbing equipment See-saws Safety surfacing Tennis courts (clay) Handball courts Ball fields Flagpole PFEU	Amount (Units) 2 4 2 8 2 2 1 2	

TABLE 2-3 Development of Shoreside Beach Areas—Continued

Item	Borough	Property No.	Location	Acreage	Present Development		Undeveloped
					Developed		
					Hopscotch courts Shuffleboard Benches Comfort station All developed areas are along Almeda Avenue		
11	Queens	Q-204	Park Beach Channel Drive between Cross Bay Parkway and B. 106th Street	7.430			Undeveloped and in process of being surrendered for school purposes
12	Queens	Q-28	Marine Park Beach Channel Drive—B. 116th to 124th Street	12.000			No development—narrow run of land between Beach Channel Drive and Bulkhead Wall
13	Queens	Q-49	Jacob Riis Park—Jamaica Bay, Atlantic Ocean, B. 149th to 169th Street	236.363	Playground	Amount (Units)	
					Swings	17	
					Slides	7	
					Comfort stations	4	
					Handball courts	24	
					Paddle tennis	6	
					Basketball courts	6	
					Single goals	4	
					See-saws	24	
					Bathhouse	1	
					Baseball fields	5	
					Pitch/Putt golf course		
					Tennis courts	4	
					Bleacher sections	4	
					Benches and promenade only along Jamaica Bay frontage. Bathing beach on ocean front		
14	Queens	Q-420	Breezy Point Park—Jamaica Bay to Rockaway Point Blvd., Beach 184th St. to Beach 201st St., and Breezy Point Blvd. to the Atlantic Ocean; Fort Tilden to the tip of the Rockaway peninsula	836.800 acres (270 acres mapped)			Undeveloped

ground activities at the present, and they can be expected to remain in high-noise areas for some time.

The evidence in general indicates that the park land areas around Jamaica Bay should be developed for activities requiring open playing fields and grassy areas, with some special facilities such as tennis courts, and also with facilities for walking, for picnicking, and for some of the quiet activities of older people.

The 3,500 acres of park land behind the beaches would be in addition to the 120 acres of sandy beach land that would be built, plus the 240 acres of backup facilities immediately behind them. It is more difficult to predict the use that might be made of these recreational grounds with accuracy than it is to predict the probable usefulness of the sandy beach areas. An important feature of these park lands is that they will not have simply

a seasonal use. They will be usable for most recreational purposes in the spring and the fall, and, by suitable preparations such as the flooding of some playing fields, parts of them could be used for winter sports such as ice skating. Assuming an occupancy of the average of five people per acre for three shifts a day for 3,500 acres and 150 recreational days, the total use of these facilities might be on the order of eight million person-visits per year.

The Capacity of Jamaica Bay to Provide Facilities for Boating

The 9,000 acres of water in the Bay provide an important opportunity to develop boating. The Parks Department estimates that marinas in seven immediately developable locations could provide canoeing, sailing, and rowing for 330,000 people in a season.

However, the boating capacity for Jamaica Bay is especially difficult to estimate. If the total water surface of the Bay is used allowing five acres per boat and assuming 2.2 persons per boat, and if we assume a turnover of two per day, we arrive at a total capacity of 5,544 persons for a single day. A more realistic estimate would have to take into account water areas too shallow for boating and areas restricted around bird refuges and swimming areas, which one must estimate would remove 50 percent of the total water surface for boating. This would cut the capacity in half, for a maximum daily boating capacity of 2,772. If one uses the Parks Department's estimate of 20 days of maximum and 30 days of half maximum, one arrives at a total annual capacity in number of visits of the order of 100,000. This lower estimate is probably much more realistic.

In the interest of boating, the areas of the Bay might be zoned, with power boats restricted to the main channels, sail boats in the Grassy Bay–Broad Channel area, and canoes and rowboats in the water around the islands. The principal marinas might be in the Broad Channel area and off Cross Bay Boulevard north of the wildlife refuge. Marinas for power boats might be developed in the basins and along the Rockaway shore. Small sandy beaches on some of the islands might permit boat landings for picnicking, swimming, or bird observations; but these would have to be carefully controlled in the interest of the preservation of the wildlife refuge.

The demand for fishing boats and pleasure boats will undoubtedly use the Bay's capacity to the fullest. Indeed, according to the Tri-State Transportation Commission's method of calculations, the Bay in full use would meet only one eighth of the needs of the people of Brooklyn and Queens who might wish to go boating.

Capacity of Jamaica Bay to Provide Facilities for Fishing

Fishing is much more popular among the people of New York City than is commonly realized. Although the interest in fishing in the large cities of the Northeast is less than it is in other parts of the country, it has been estimated that upwards of 10 percent of the boys and men in the New York region will go fishing in a given year.

As we have indicated, the Bay at present contains more than 60 species of fish and shellfish, including many well-known edible species of finfish. If the pollution in the Bay is largely abated, it might become a great potential resource for recreational fishing after it has had time to cleanse itself generally.

There is also the possibility of an incompatibility between fishing and other recreational uses of the Bay, but this appears to be minor. The Bay is big enough to provide fishing areas separate from those for power boating and swimming, which are apt to disturb fish or fishermen. The region between the marginal beaches and the central wildlife preserve would be suitable for fishing, and part of it could be reserved for that purpose. In addition, some fishing piers exist, and more could be sprinkled among the swimming beaches. Finally, swimming is largely confined to summer months, and fishing could expand to at least some of the beach areas in other seasons.

Dredging and filling, such as that proposed to make more beaches, could either harm or improve fishing depending upon how it is done. To the extent that shallow waters are increased in area, the fishing, and particularly the shellfishing, will improve. This could be accomplished, for example, by converting some of the filled islands to submarine banks by using the excess sand for beach fill. There is also an opportunity to decrease the area of deeply dredged channel if ocean-going barge traffic is to be replaced by pipelines to deliver fuel oil to the tank farms at Kennedy Airport. The cessation of dredging, once the beaches are built, might also reduce the turbidity of the Bay, with extended benefits both to the general ecology and to recreational fishing.

It is more difficult to estimate the capacity of the Bay for fishing than it is to estimate its capacity for boating because fishing is subject to variations in the supply of fish. Using the same formula as that used to determine the amount of boating, it is possible to estimate an annual capacity of 100,000 people fishing from boats alone. Perhaps another 100,000 visits per year for pier fishing would be a reasonable projection. These calculations would bring the annual fishing capacity to

around 200,000 fishermen visits. In making these calculations it would appear that we have projected a doubling of the number of boats on the same acreage of water, which, in fact, does not happen. Most fishing takes place in the early morning or late afternoon, while most boating tends to occur in the middle of the day, and it is likely that boating trips will be of shorter duration than fishing outings. Taking these factors into account, there should not be more than one boat per five acres for either purpose in the Bay during most of the day.

The Transportation Necessary for Adequate Recreational Use of Jamaica Bay

The intensive use of Coney Island for swimming is, in large measure, a result of its great accessibility. Four subway lines to Coney Island can deliver 200,000 people per hour to the beach. A similar accessibility by rapid transit is essential if recreational areas around Jamaica Bay are to be used to their full potential.

The proposed recreational areas are presently served by the 14th Street Canarsie line, which ends at the Rockaway Parkway Station about one and a half miles from Canarsie Pier, and by the Nostrand Avenue line, which ends at Flatbush Avenue Station, about four miles from the waterfront in the Mill Basin and Bergen Beach areas. The combined capacity of these two lines might reach 80,000 passengers per hour, provided service were frequent enough during periods of high demand, such as the times when the recreational area is being used for swimming. On the other hand, bus transportation to the waterfront from the nearest subway stations could hardly attain a level of 10,000 passengers per hour. This would limit the number of people who could reach the recreational areas by mass transit to approximately 40,000 per day.

Three proposed subway extensions are under consideration (see Figure 2-8): (a) a Nostrand Avenue extension to Avenue U, (b) a Utica Avenue subway connecting Avenue U with the New Lots line, and (c) an extension of the 14th Street Canarsie line eastward to the Spring Creek area, and westward to intersect both the Utica Avenue and Nostrand Avenue lines. These extensions would bring additional subway transit to the Marine Park, Mill Basin, and Spring Creek areas at points approximately one and a half miles from the waterfront. They would add 50 percent to the passenger capacity of the lines serving this sector of Jamaica Bay. However, travel to the beach from the subway stations by bus and walking would very likely reach only a fraction of the capacity of these mass-transit lines.

Assuming that subway extensions into these areas are needed at their present state of development, a study should be made of the possibility of rearranging and even increasing these extensions to bring mass transit directly to most of the waterfront area. For example, the proposed interconnector line that ties the 14th Street Canarsie, Utica Avenue, and Nostrand extensions might be run along Avenue U eastward from the Nostrand Avenue extension terminal, across Paerdegat Basin, and along the Canarsie waterfront, and then northward along Fresh Creek to the 14th Street Canarsie terminal (see Figure 2-8). This would require only one and a half miles of subway beyond the present plan, but would bring mass transit very close to three miles of waterfront recreation area, and would make available the full capacity of the subway lines (120,000 passengers per hour) to transport people to the beach areas. The additional cost of this rerouting would be approximately $40 million.

Access to parking lots along the proposed beach front is presently mostly blocked by the Belt Parkway. Overpasses at each beach and parking area will be required to provide for access to local streets. A frontage road to permit easy distribution of people by bus and automobiles without using the Belt Parkway would be highly desirable.

At the present time there are no pedestrian overpasses along the Belt Parkway. If subways are to bring large numbers of people, many pedestrian overpasses would be needed. These would have to be integrated with the street positions and subway stops beside the Parkway, and the recreation areas on the Bay side. They would also have to be sufficient in size and number to overcome the obstructing effect of the Parkway.

An Estimate of the Assets and Deficiencies of Jamaica Bay as a Site for Recreation

Provided with adequate means of access, with its shoreside parks and beaches fully developed, with its sanitary land fills covered and sodded, with its natural area preserved, and with its waters cleared of much of their pollution, Jamaica Bay would undoubtedly become a major recreational and esthetic attraction for the people of the City of New York. There is little reason to doubt that its shoreside facilities—the park lands, playing fields and special facilities such as basketball and tennis courts—and its facilities for fishing and boating would be heavily used. There is also little reason to doubt that its beaches would be used very heavily. Probably one of their attractions, in addition to their great convenience, would be that they would provide swimming in the relatively calm waters of a bay on which there is little or no surf. Swimming at ocean beaches is essen-

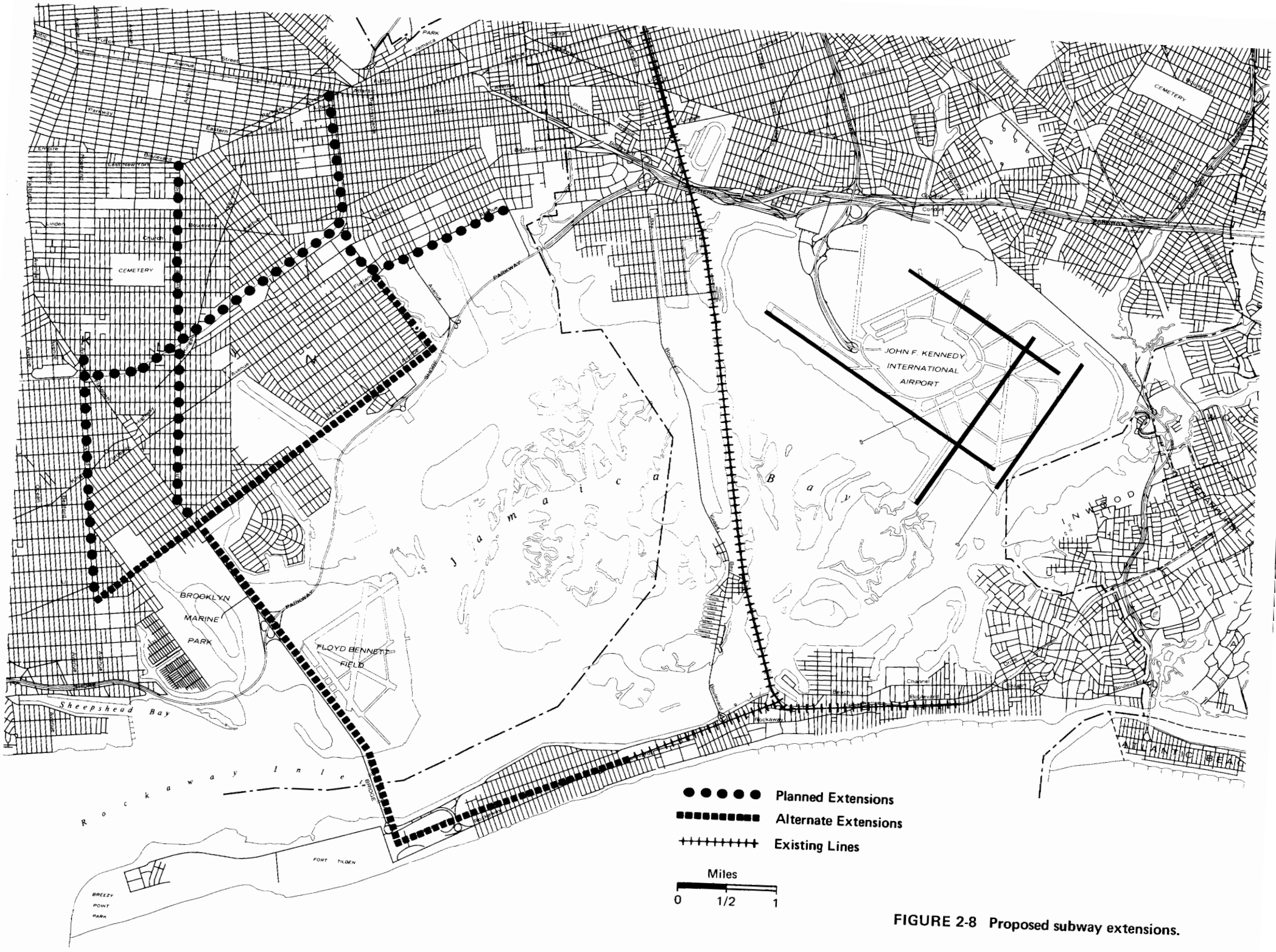


FIGURE 2-8 Proposed subway extensions.

tially surf bathing. Young children, older people, and those who actually like to swim may find a gentle sloping beach along a bay much more attractive than an ocean beach.

Nevertheless, some may have reservations about the use of Jamaica Bay as a site for swimming, even after its waters have had the full benefit of the ambitious program of sewage treatment that the City proposes. However, there is evidence that people can, and do, bathe in waters much less pure than those required by the proposed bathing-water standards, and that they do so with impunity. Based upon present knowledge, there is every reason to believe that when the waters of Jamaica Bay reach these standards they will be entirely safe for human swimming and bathing. Nevertheless, in this instance, one would not be guarding bathers against unintentional and casual pollution of a bathing beach; one would be deliberately creating a bathing beach at which a great many people would bathe repeatedly in waters that might be highly polluted if they were not constantly under treatment.

Before bathing beaches are created in Jamaica Bay, it would be wise to have the entire sanitary program reviewed in detail, and all its safeguards and possible points of breakdown studied in a manner that was not possible for this Study Group in the period of time available to it. One should consider, in this connection, the possible toxic effects upon people of industrial wastes that can be introduced into sewers, and that will not be removed by the proposed methods of treatment; for circumstances presumably might arise in which relatively large amounts of toxic substances introduced into a sewer might reach bathers in significant concentrations. Also to be considered should be the possible costs and benefits of removing all the present outfalls of the Jamaica Bay and Coney Island sewage-treatment plants away from their present positions in Grassy Bay and Rockaway Inlet, and carrying them far enough out to sea to make sure that the effluent from them will not affect any beach used by people.

Breezy Point Beaches as Alternative to Those of Jamaica Bay

In view of the plan to develop Breezy Point as a beach area, one might ask, "Why should one develop the Jamaica Bay beaches at all?" Breezy Point contains four and a half miles of sandy ocean beaches up to 1,000 feet in width, and there are 1,350 acres of land that could be made into parkland. According to the National Park Service, Breezy Point could be developed to accommodate 300,000 visitors per day, or 27 million visitors per year.

The problems relating to Breezy Point are access, convenience, and cost. Access to Breezy Point for any significant numbers of New Yorkers by the present means of transportation is out of the question. Even today, on hot days, automobiles back up all the way across the Marine Parkway Bridge and onto the Shore Parkway. They similarly clog the Cross Bay Boulevard. Automobiles that finally arrive at Riis Park meet others trying to leave to go home. The single, two-fare subway across the Bay to the Rockaways does not even extend to Breezy Point. Even if it were extended this far it could not handle the crowds that would wish to get to Breezy Point.

The National Park Service proposes to provide access by means of ferries, with a 20-minute ride from a terminal at Coney Island. Quite aside from the fact that this terminal will depend upon the already overcrowded subway lines to Coney Island, it is doubtful that enough ferries could be provided to transport the crowds that would try to get to Breezy Point. (If the three miles of beach at Coney Island attract one million visitors on a hot day, it is not reasonable to expect that only 300,000 would try to get to the four and a half miles of beaches on Breezy Point. Three-hundred thousand might be desirable, but 600,000 would be more reasonable, and one million might be realistic.)

The ferries probably represent an effort by the National Park Service to find a substitute for what is undoubtedly the only real solution to the use of Breezy Point: a rapid transit line from Utica Avenue down Flatbush Avenue and across the Rockaway Inlet. If the Utica Avenue line is extended to Avenue U, according to present plans, and if this line can be taken across the present Marine Parkway Bridge as a surface line, the additional cost would be about $60 million to $100 million; but if the Utica line extension is not built, and if the crossing of Rockaway Inlet requires a new bridge, the total cost of providing adequate access to Breezy Point will be around $300 million.

This is not the only major cost of opening up Breezy Point. A good part of the land area (400 acres) and some of the best ocean beach on the peninsula are occupied by the 2,700-family Breezy Point Cooperative, a private development of summer homes. Up to now, by common consent, the City has not attempted to condemn and take over this cooperative area, and it seems to have no plans to do so for at least another 10 years. If it did, the purchase cost might well be on the order of $100 million.

Unless adequate transit connections are built, and until the lands of Breezy Point Cooperative are obtained, Breezy Point will not become a fully useful facility for the millions of New Yorkers who need it.

Even if Breezy Point is built, it can provide no adequate substitute for the convenient, close-in parks and beaches and the boating and fishing facilities of Jamaica Bay, which can serve the large nearby population of Brooklyn and Queens. Altogether, it is desirable for the people of New York City that both Jamaica Bay and Breezy Point be developed, and that neither one be regarded as a substitute for the other.

The Potential of Jamaica Bay as a Site for Human Habitation

When its waters have been cleaned up and its parks and beaches have been built, and when its rapid-transit lines are constructed, the land around Jamaica Bay can become a place for people to live. It will provide many of the amenities that are missing in modern urban life at the present time. If these amenities are to be preserved, however, it will be important that the density of the surrounding population be controlled and that a wall of high-rise apartment buildings not be allowed to grow up behind the parks, blocking off the Bay from the rest of the community. If this requirement were met, then the use of the land around the Bay as a place for people to live would be highly compatible with the use of the Bay as a place of recreation and will complement it. This matter is dealt with at greater length in Chapter 3.

The Potential Role of Jamaica Bay as a Part of the Natural Systems of the New York Region

Compatibility with Recreational Uses

The effect of improving the water quality of the Bay. The expected improvements in water quality, which will be produced by the secondary treatment of sewage, will be mainly related to human health standards. They may have undesirable effects upon the natural ecosystem. There will be a decrease in coliform bacteria and a reduction in the biochemical oxygen demand levels, which will benefit the ecosystem, but nitrates and phosphates will remain. These may lead to overfertilization and blooms of undesirable algae, and the further reduction of desirable species. A variety of other pollutants, such as oil and kerosene, heavy metals, hexane soluble materials, polychlorinated biphenols, various hydrocarbons, and other materials that may be discharged through storm or combined sewers, and that pass through sewage-treatment plants, will continue to enter the Bay. The biological effects of most of these materials are not known with any accuracy. If they increase in concentration, either through a reduction in the volume of water or an increase in the absolute amounts discharged into the Bay, they could have serious deleterious effects upon the ecosystem.

Considerations of the welfare of natural systems thus reinforce the considerations of the welfare of human swimmers (see discussion above). These, too, suggest that the outfalls from the sewage-treatment plants should be removed from the Bay and carried far enough out to sea so that they will not damage natural systems in the Bay or near the shore. Yet there may be no simple solution to this problem. Removing the sewage plant effluent from the Bay would remove its major input of fresh water. This might cause an increase in the salinity of the Bay, which might drastically alter its flora and fauna. Also, the freshwater transport to the ocean together with the tidal action is the major source of the flushing of the bay which is so important to its health. The net effects of this move could be determined only after careful study.

Potential effects of swimming, boating, and fishing on the natural ecosystem. The stresses that would be placed upon the natural ecosystem of Jamaica Bay by the various kinds and amounts of recreation that have been proposed will be insignificant in comparison with those that are now imposed by other sources. An ecosystem the size of Jamaica Bay can easily accommodate a variety of recreational uses by a large number of people as long as the Bay is intelligently zoned for specific purposes.

The development of swimming beaches along the shores of the Bay would not affect the natural ecosystem, aside from the fact that commercial and private shellfishing could not be permitted in these areas. It would be undesirable, however, to construct bathing beaches and camp sites on the islands that are breeding habitats for several birds.

The demand for boating is closely related to the demand for fishing and the numbers of fish available. If improvements in water quality and pollution abatement were to allow the productivity of fish to return to former levels, the Bay could sustain a very high level of fishing pressure without deleterious effects upon the natural environment. It would be advisable, however, to restrict power boats to open waters outside the central marsh areas to protect the bird population from undue disturbance or harassment, and to preserve a different environmental quality in these areas.

Potential Use of the Wildlife Refuge for Recreation and Education

The major role of the wildlife refuge in the future appears to be a continuation of its current use for recreation. It is now used primarily for nature walks and nature photography. Most of this activity centers around the West Pond because of the existing gravel path that encircles the pond and leads back to the small parking lot.

A greatly increased use for recreation is compatible with the preservation of the refuge. Such an increased use is also desirable and necessary in view of the current demand.

Intensive nature study and photography are consistent with the protection of the refuge. The wildlife are easily observed from the paths, with no damage to them or to the marsh and pond areas.

The Parks Department now plans to build additional paths around the East Pond on the eastern side of Cross Bay Boulevard. This may well triple the capacity and enable as many as 100 to 150 thousand people to visit the refuge during the course of a year. There are also plans to build several new ponds with similar encircling walkways. With these new ponds the recreational potential might rise to as high as 200,000 people per year.

The proposal of the Parks Department for the construction of an Interpretive Center will create new opportunities for both education and recreation. Many of the educational features of this new center will lend themselves to recreation also. These include wildlife films; slide shows and film strips; talks on the wildlife of the Bay; lectures on the ecology of the salt marsh by scientists and students; and tape recordings of the wildlife sounds in the marsh.

The water parts of the Bay can be used to develop an approach to nature study in addition to that presented by the paths. Boat trips for wildlife viewing would be possible except in the breeding season. The marsh ecosystem has an amazingly complex web of interrelationships, and a study of the marsh flora and fauna can provide an interesting introduction to the concept of ecosystems. This, too, lends itself to presentation by guides with lectures and demonstrations.

A major part of the program planned for the wildlife refuge is educational. Naturalists believe that one of the most vital needs of people today is to understand the workings of natural ecosystems and the intricate relations of all organisms to the system. This, they think, is peculiarly important for people in densely populated urban areas such as New York City. There are general plans for the staff of the refuge to utilize the assistance of private national conservation and environmental organizations, and to draw upon the educational resources of the universities, colleges, and museums in New York City to provide a faculty that can teach schoolchildren as well as students at high school and college level.

The area will continue to be available to graduate students for study.

The Parks Department's planned Interpretive Center would be the core of the City's environmental education program. It would be prototype of the City's programs for environmental education, an attempt to make ecology part of the Natural Science Workshop and of the Marine Science Program at Far Rockaway High School. The Natural Science Workshop involves several thousand schoolchildren in School District 23 in the Borough of Queens.

In the planned program at the new Interpretive Center, it has been suggested that introductory background materials might be presented by the classroom teacher before a field trip to the refuge. A briefing session or presentation of added materials and information would precede the actual trip. These presentations might include films, slides, and related materials. If the teacher had not been trained in an ecological workshop, one of the technical naturalists at the center could assist in this education, so that an effort would be made to expose the schoolchildren to the habitats of the salt marsh as if they were in their own backyard. They would be given an opportunity to examine the system directly and to see the wildlife they read about in living interrelationships with each other. There would be informational signs along the paths and possibly a small part of the marsh might be set aside for study and experimentation by the visiting students. To avoid damage to the marsh, the plot of ground that is utilized might be rotated regularly, and wooden walkways could be constructed so as to bring the visitors into direct contact with the marsh without damaging it.

In sum, it can be said that there is considerable enthusiasm in the City Parks, Recreation and Cultural Affairs Administration for the development of environmental education of this sort.

THE EFFECT OF THE EXTENSION OF THE AIRPORT UPON THE USE OF JAMAICA BAY

The Effect of the Present Airport

The present condition of Jamaica Bay has been determined only to a small extent by the fact that Kennedy International Airport lies alongside it. Jamaica Bay

is as it is because of past attempts to develop it as a harbor, because sewage has been dumped into it, its bottom has been dredged, and its shoreline has been used for sanitary land fills. Only one part of the Bay, Grassy Bay, is a direct result of the presence of the airport. This part is, however, of particular interest because it shows what dredging and filling can do to the Bay.

What is now called Grassy Bay was originally a combination of tidal channels and salt marshes resembling somewhat the present island and channel network north of Pumpkin Patch Channel. It remained in a healthy natural state until the dredging and filling took place to form the major land mass upon which Kennedy International Airport now stands. In the place of the prior marshland this dredging and filling produced a deep hole. This, in turn, formed a large stagnant impoundment which is now called "Grassy Bay," a name previously applied to an area of the Bay slightly northeast of its present location. From its creation in its present form in 1946, Grassy Bay has been a burden on the water quality of Jamaica Bay. It is the largest problem area of the Bay.

The factors contributing to the poor quality of the waters in Grassy Bay are these: (a) Grassy Bay is deep, being as much as 50 feet in depth at mean low water level at several locations; (b) it has a small tidal prism that is small relative to its volume (approximately 10 percent) and it has a long retention time (of the order of 100 days); and (c) circulation through Grassy Bay is poor because of constrictions of the channel at its northwestern end by Cross Bay Boulevard, and a stagnant zone at its southeastern end near the extension of runway 4L.

Adding to these problems is the fact that the outfall from the sewage-treatment plants on the north shore of Jamaica Bay is located in Grassy Bay. Also, a major storm drain enters Bergen Basin, which in turn flows into Grassy Bay; and oil barges must transit through Grassy Bay to terminals in Bergen Basin. All this adds greatly to the pollution in Grassy Bay.

As a result of these factors, the following statements can be made about Grassy Bay relative to Jamaica Bay as a whole:

1. It has the highest mean biochemical oxygen demand (approximately 4 milligrams per liter) in the Bay.
2. It has the lowest amount of dissolved oxygen, which reaches zero milligrams per liter at the bottom during the summer months.
3. It has the highest concentration of nitrogen and soluble phosphorus (2.8 milligrams per liter and 1.2 milligrams per liter, respectively).
4. It has the largest percent of clay in the bottom sediments, together with the highest index of putrescibility (16.1 milligrams per gram).
5. It has the highest concentration of hexane-extractable material (0.9 milligrams per liter).
6. Its sediments have a high sulfide content (3.9 milligrams per gram).
7. It contains few benthic animals (essentially none), a high total count of coliform bacilli (300 MPN per liter) and a low diversity of species.

Aside from the fact that its creation is associated with the creation of Grassy Bay, Kennedy International Airport causes trouble for the Bay chiefly because of the noise of its aircraft. The primary adverse impact of this noise is on the human communities around the Bay, rather than upon the Bay itself. Its effect on these communities will be discussed elsewhere. The flight patterns of Kennedy Airport determine the effect of noise on the Bay itself. Aircraft taking off from runway 31L pursue a curving flight path that carries them over the northern and western shores of the Bay. Noise from these aircraft is worst at Howard Beach, just at the end of the runway, but the NEF 35 contour extends beyond Canarsie Pier. The Howard Beach recreation area is almost useless for old people because of the noise; but the Canarsie Pier is used by them apparently without adverse effect other than annoyance. Noise probably has slowed the development of the north shore area for housing, but it has not prevented it. Most of the central areas of the Bay are located away from aircraft flight patterns and are in silent areas. Some parts of the Rockaways, however, are heavily affected by noise at the present time.

Some General Effects That New Runways in Jamaica Bay Might Have on the Use of the Bay for Recreation, Habitation, and the Conservation of Natural Systems

Because the effects of new runways in the Bay will depend so much upon their location and configuration, a detailed consideration of the probable effects of several discrete proposed configurations of runways is included in Chapter 4 of this report. The discussion in this section will be concerned primarily with general points that are applicable to all configurations of runways to some extent.

The Effect of Any Addition to the Airport on the Bay as a Whole

The use of part of the Bay and of its shoreline for an airport is a use of the type that we placed in Group 2

in our discussions of uses early in this chapter. It is a commercial and industrial use. The construction of any addition to the airport will be associated with some alteration or destruction of the natural topography, and of the natural life however small this may be in some cases. It will have an effect upon the water quality of the Bay. In the past, the effect of such construction has been primarily to increase the adverse effects of pollution from all sources. There will also be some air pollution from the planes themselves. The effect of this upon the grass of Jo Co Marsh is visible. Some of the human artifacts inevitably associated with an airport—hangars and tank farms, for example—will not be generally regarded as esthetically desirable in an otherwise natural setting. The operation of an airport will always be associated with noise and a large amount of ground traffic from automobiles and trucks. These will increase as the airport enlarges. These features of the airport, as it now exists, already make it to some extent incompatible with the use of the Bay as a place for people to live and play, and to enjoy the natural systems that are preserved there. Since all of these human uses are based upon a need for clean and unpolluted water, a minimal destruction of the topography of the natural systems, and esthetically desirable buildings and human activities, in the last analysis one must say that, other things being equal any addition to the airport will have an adverse effect upon Jamaica Bay as a resource for the people of New York and the surrounding area. In any event, it is hard to see how a city park that has an airport alongside it or in the midst of it can be a more desirable park than one that does not. From the point of view of what we have called "Group 1 uses" of Jamaica Bay, it will be desirable to restrict the activities of the airport as far as possible, and ultimately to remove it to another site. This, of course, is not the only factor that must be considered in the decision as to whether or not to build new runways, but it is a very important one for the people of New York.

The Effect of New Runways on the Recreational Uses of the Bay

Swimming and bathing. All the proposed beaches on the northern and western part of the Bay will be within the NEF 30 contours, even with FAA specifications of 108 EPNdb for engine noise. Some beach areas, including parts of Canarsie, Floyd Bennett, Twin Pines, and the Spring Creek area, will fall within the NEF 35 contour. These contours represent rather high noise levels, which would certainly interfere with relaxed sunbathing, and picnicking and quiet conversation on the beach. However, swimming itself may be an inherently noisy activity, and one would doubt that this would be interfered with to any significant extent.

In view of the great demand for bathing beaches in New York City at the present time, if the bathing beaches were constructed along the northern and western shore, it is quite probable that they would be used to capacity regardless of the noise of aircraft passing over. Nevertheless, they would probably be regarded as less attractive for this reason, particularly by those who would be seeking quiet and rest. If a "quiet engine program" goes forward and 98 EPNdb engines become standard, the Twin Pines and Spring Creek beaches will still fall within the NEF 30 contour, if the use of runway 31L continues as it is at present.

The Effect on Water Quality in Jamaica Bay

The effect of new runways on the quality of the water within the Bay will depend primarily upon their extent, their configuration and the manner in which they are constructed. If a large configuration of runways were constructed with production of deep and stagnant areas within the Bay, blockage of natural channels of tidal flow and an elimination of the marsh and part of its assimilative capacity, the effects upon water quality could be severe. If this were accompanied by continued fuel oil deliveries by barge and a continuation of the oil spills that now occur, this would have an additional adverse effect.

On the other hand, if new runways did not involve a large area of the Bay, if they were located primarily near the present airport and in Grassy Bay, if they required rather little dredging and filling or were built on piles, if they did not impede the circulation of the Bay, and if they did not destroy any of the natural marshland, their effects upon water quality might not be very great.

Effect on Shoreside Parks

Present or new park lands in the eastern part of the Bay, and in the Inwood section, will remain within the NEF 30 contour regardless of whether there are new runways, quiet engines, or any combination of these. Whatever use is to be made of these areas will have to be compatible with this amount of noise, probably as long as the airport is located where it is.

On the other hand, the park areas to the northwest and north of the Bay, although they now fall within the NEF 30 contour, might be markedly improved if new quiet engines were developed. It has been estimated that, with such engines, but with no changes in the runway, only about one-fifteenth of the available park land area (specifically that just south of Howard Beach)

will remain in the NEF 30 contour. Also, some configurations of new runways would remove all or part of this park land from the NEF 30 contour even with the present engine. In short, the construction of new runways in the Bay might, under some circumstances, decrease the impact of noise on the park.

Noise at the present level over these park lands would probably not interfere significantly with their use for otherwise noisy games or active sports. However, the parks at the eastern end of the north shore would be distinctly less desirable for quiet activities such as picnicking, walking, or sitting and talking. But even these activities would probably continue at the western end of the new park lands if the present noise level were continued.

Effect on Boating and Fishing

Sailing and fishing are quiet activities. Fishing is notably a contemplative recreation for many people. At the present time there is little aircraft noise over the center of the Bay, and this adds to its attractiveness as a boating and fishing area. If new runways were built that occupied part of the Bay, and thus diverted flight patterns to areas over the center of the Bay, it might have a serious adverse effect upon both boating and fishing. They would be far less pleasant with noisy aircraft flying directly overhead. Furthermore, the runways would occupy some of the area of the Bay, thus making that much less of it available for boating. Some configurations of the new runways would destroy parts of the marsh, and some might contribute heavily to an impairment of water quality in the Bay. Both of these could have the effect of destroying the few remaining finfish within the Bay, thus abolishing fishing entirely.

Effect of New Runways on the Wildlife Refuge and the Natural Systems of the Bay

Any extensive building of new runways within the Bay could have drastic and, in fact, fatal effects upon the natural systems of the Bay. It might, in effect, destroy the wildlife refuge and all its recreational and educational potentialities.

Any runway configuration that entered the marshes would reduce the area of marsh vegetation in the Bay. One runway configuration, which was extensively considered, would destroy about 1,000 acres of marsh. This would include the largest block of marsh in the Bay, Jo Co Marsh, as well as Duck Creek, East High Meadow, Jack's Hole, and Broad Creek marshes, as well as several unnamed ones. This would produce a direct physical loss of nesting habitats for such species as clapper rails and seaside sparrows, as well as a direct physical loss of foraging area, resting area and cover for thousands of birds on the refuge. Jo Co Marsh, for example, is a most important foraging area for herons, egrets, and ibises on the refuge, even for those that nest on the western side of the Bay.

Any runway in the Bay would also reduce the total water area of the Bay. This also would provide a direct physical loss for foraging and resting areas for wildlife especially for water fowl which occur in thousands in Grassy Bay and its environs, as well as herons, egrets, and ibises which feed at the edges of marshes a well as on them. In addition to this, thousands of shore birds regularly migrate through the refuge and feed on the mud flats near the airport, most of which would disappear with construction of most of the proposed runway extensions.

Several proposed runway extensions would reduce the area of non-marshy types of vegetation in the refuge, especially that surrounding the East Pond. This would eliminate the nesting, roosting, and resting habitat of herons, egrets, and ibises in that area, thereby reducing the productivity of some of the refuge's more spectacular and interesting species.

As a consequence of the reduction of marsh area, the water area, and non-marsh vegetation, the overall reproduction of wildlife in the refuge would be reduced. Two examples can be cited: a salt marsh of the quality of Jo Co Marsh can support 60 pairs of clapper rails per 190 acres, and 142 pairs of seaside sparrows per 32 acres.

Some of the proposed runway extensions would generate noise within the NEF 40–45 contours over the refuge. Such an increase in noise exposure would be entirely incompatible with any of the kinds of recreational or educational activities currently engaged in or contemplated at the refuge.

If runway extensions produce an overall reduction in marsh and water acreage in the Bay, this would create a new hazard of bird strikes to aircraft in addition to the hazard already in existence, which was created by the extension of runway 4L onto Jo Co Marsh. Large flocks of waterfowl would fly across the new runways from one traditional ground to another unless, of course, all of Grassy Bay and the other nearby areas were drained and filled.

The overall effect of some of the new runways and runway extensions would be to eliminate part or all of the central and eastern parts of the refuge as a viable sanctuary for wildlife and to prevent its use in recreation and education. If the eastern and central parts were destroyed, it is questionable that the western parts of the refuge would continue to exist in their present

condition. The central and eastern parts of the marsh may, in fact, be acting as a kind of buffer during the breeding season. In addition to this, the marshland itself is a whole system that supports itself in part through its integrity. It has been estimated that any reduction in the amount of marshland of the order of 50 percent or more might lead to the death of all the marshland in the Bay, and the disappearance from the Bay of the natural systems upon which the bird life and the marine life depend. The effect that this would have upon bird life in the northeastern United States and upon fishing in the New York area has been discussed in previous sections of this chapter

Bird Hazards to Aircraft

Serious concern about the costly and sometimes fatal consequences of bird strikes on aircraft in flight has been expressed by authorities throughout the world. There have been two fatal U.S. air carrier accidents due to bird strikes. In 1960, a Lockheed Electra ingested a large number of starlings into its engines during takeoff at Boston's Logan Airport, and crashed, causing the death of 61 persons. In 1962, a Viscount was struck by two whistling swans at about 18,000 feet over Maryland, and 17 persons were killed. It is estimated that damage to commercial aircraft costs about $4 million a year. Between 1961 and 1966, the FAA spent over half a million dollars on bird-strike research. Nevertheless, bird strikes throughout the United States and Canada have continued to increase.

J. L. Courtney of the Department of Transport of Canada has noted that

> The progress from low to high speed aircraft, from piston to compound jet engines, from four engines to three and two, and from simple to increasingly complex aircraft control systems have all tended to increase the vulnerability of aircraft to impact and engine ingestion damage.
>
> The large increases in the numbers of passengers carried on each aircraft has greatly increased the potential loss of life in the event of an aircraft accident resulting from collision with birds. The trend to larger, faster, more complex jet aircraft carrying more and more passengers is expected to continue in the foreseeable future. We can expect succeeding generations of aircraft to be more and more vulnerable to damage from collision with birds.
>
> The risk of a catastrophic accident resulting from collision of aircraft with birds is increasing.

Risk of Disaster

Schaefer[8] calculated that engine ingestion of a four-pound bird will usually cause power shutdown and there is about a 50 percent chance of shutdown with ingestion of a one-pound bird. These calculations are for current jet engines on medium-sized aircraft (B-727, DC-9, B-707, DC-8) and do not necessarily apply to the new, larger jets (B-747, LC-1011, DC-10). There is no risk when one of four engines fails and only a minor risk when two of four or one of three fail, but almost certain disaster with shutdown of three or four of four, two or three of three, or two of two engines. Of the 35 incidents of engine ingestion of birds in Canada in 1968 and 1969, three resulted in aborted takeoffs and one resulted in power reduction, but there were no cases of complete power shutdown.

The probability of bird ingestion is a function of several factors, including bird-flock density, engine separation, and frontal area of the engine intake.

Given that the frontal areas of the large jets (B-747, LC-1011, DC-10) are increasing by factors of 4 to 6, Schaefer[9] calculates that the chances of multiple ingestion of birds may increase by as much as 16 to 36 times.

Given the condition of dense flocks of birds of one pound and larger, Schaefer[10] concludes that there is a high risk of aircraft disaster through multiple engine ingestion, and that the risk of ingesting more than one bird has increased drastically with the introduction of newer, larger engines.

Bird-Strike Hazard at Kennedy Airport

During the period 1962 to 1966[11] Kennedy Airport ranked first in the United States in total number of bird strikes reported (109) and ninth in number of strikes per 10,000 operations (0.66). The absolute number of strikes was 22 percent greater than the second-ranked airport, O'Hare.

The number of strikes at Kennedy has remained high, in spite of various bird-control measures that have been instituted.

A study of bird hazards at Kennedy by Bull[11] and observations by PONYA personnel show that far more strikes occur than are reported by pilots and ground crews on FAA Form 3830, and that most of the strikes occur on or near runways adjacent to Jamaica Bay. There is an especially high risk of bird strikes at the south end of runway 4L where it extends into the Bay

[8] Schaefer, G. W. *Bird Hazard to Aircraft: Its Magnitude, Major Causes, and Reduction by Radar Detection.* Proceedings of the World Conference on Bird Hazards to Aircraft, National Research Council of Canada, Ottawa, 1970.

[9] *Ibid.*

[10] *Ibid.*

[11] U.S. Dept. of Interior, Bureau of Sport Fisheries & Wildlife for Federal Aviation Administration. *Control of Birds on and around Airports,* SRDS Report No. RD-68-62. 1968.

TABLE 2-4 Characteristics of Selected Bird Species That Are a Potential Strike Hazard to Aircraft over Jamaica Bay

Species	Weight (pounds)	Range of Flying Altitudes (ft)	Maximum Expected Flock Size	Maximum Expected Total Numbers
Great blue heron	5–8	0–200	100	25–50
Common egret	2	0–200	100	300
Black brant	3–4	0–1000	10,000	30,000
Scaup	2–3	0–1000	20,000	23,000
Black duck	2–3	0–500	2800	5000
Herring gull	3	0–1000	2000	30,000
Black-backed gull	4	0–1000	100	3000

at Jo Co Marsh, and where Bull[12] recovered 55 carcasses of herring gulls that were not reported in strikes.

A Department of Interior report[13] concluded that herring gulls and greater scaup constitute the greatest hazards to aircraft at Kennedy Airport because of their sizes and numbers and principal areas of concentration. Herring gulls are abundant at garbage dumps in the Jamaica Bay area and as many as 8–10,000 have been observed at one time at the Edgemere land fill, about a half mile south of the approach pier to runway 4R. Greater scaup occur in large numbers in Jamaica Bay from about mid-October to April, when rafts of from 4,000 to well over 10,000 have been observed in the vicinity of the airport. Although few scaup carcasses were recovered by the Department of the Interior, they concluded that ducks involved in strikes may fall into the waters of the Bay, rather than on runways, and not be found.

Effect of Runway Extensions

The added risk of increasing the bird-strike hazard with runway extensions into Jamaica Bay raises the question of acceptable bird-strike rate. If the goal is absolute safety, then the present strike rate is undesirable, to say the least, and it would be difficult to argue that increasing this rate, however slightly, would be acceptable.

Table 2-4 shows the weights, altitudes and flock sizes of some potentially hazardous species that occur on Jamaica Bay. These species weigh well over one pound, occur in large, dense flocks, occur at critical altitudes for aircraft operations, and present a flock shape of large numbers of birds at the same altitude, so that an aircraft flying through the flock at a takeoff or glide angle would have a particularly high risk of engine ingestion.

Herring gulls and greater scaup are the only major hazards at the present time because they are the only species that concentrate in large numbers in the immediate vicinity of the present runways. Meanwhile, the flight paths of most of the other species are far enough from present flight patterns that the aircraft using runways 31L and 4R are at high enough altitudes during takeoff and landing to be above the flight paths of most of the birds. However, some of the proposed new runways would intrude directly into the normal flight paths of most of the species listed in Table 2-4, which would drastically increase the bird-strike hazard.

For example, black brant weigh three to four pounds and may occur in flocks as large as 10,000 birds, with as many as 30,000 present on Jamaica Bay at one time. Their main flights within the Bay area may be at altitudes as high as 1,000 feet, but are usually below this altitude, between the area south of Yellow Bar Hassock and Black Wall Marsh, Pumpkin Patch Channel, and Norton Basin, across or dangerously near the proposed new runways 13R-31L, 4L-22R, and 4C-22C. Even though greater scaup are now considered a major hazard, the strike risk from this species would increase drastically. Their main movements are from west of North Channel Bridge to the northern part of Grassy Bay and Broad Creek and Jack's Hole marshes. The exposure of flying aircraft to large flocks of this species is nowhere near as great at the present time as it would be with the new runways; thus, the possibility of disastrous strikes would be increased tremendously with the new runways. Similar observations can be made for all the species listed in Table 2-4, and possibly others.

Most birds, and especially waterfowl, return annually to traditional breeding and wintering areas, following the same flight paths year after year. Attempts to change the habits of potentially hazardous birds and to scare them away from runways with various artificial sounds, etc., have been singularly unsuccessful. The only effective remedy appears to be to remove the food and habitat they are attracted to. FAA recommendations are (Advisory Circular AC 150-4200-3) that "attention should be taken to fill, level, and clear airports and adjacent lands which create bird refuges and increase bird hazards by providing feeding, bathing, loafing and nesting places." In order to reduce the bird strike hazard at Kennedy Airport to acceptable levels with the construction of new runways in Jamaica Bay, it would be necessary to drain and fill all of the waters within the perimeter and adjacent to the runway systems, includ-

[12] *Ibid.*
[13] *Ibid.*

ing all of Grassy Bay, most of Broad Channel and some of the areas southwest of Cross Bay Boulevard. For Configuration 4, in Chapter 4, this would amount to a minimum of approximately 3,870 acres, or 29.8 percent of the Bay, of which about 27 percent would be marsh and the remainder open water. Even after these measures were taken, the risk of bird strikes would still be higher than at present, because of flights of brant and other species that would continue to occur between areas such as Pumpkin Patch Channel and Norton Basin.

These estimates are based on Configuration 4, in Chapter 4. Different configurations would require different amounts of fill to minimize the bird strike hazard and would have different risks of strikes. The question is one of degree. From present evidence, one would have to conclude that the existing extension of 4L increased the strike hazard significantly, and that any further extension into the Bay would have the same effect. It is impossible to derive a firm estimate of the exact increase in bird strike probability with each 100, or 1,000, feet of runway extension, but on the basis of the numbers and distributions of different species of waterfowl in the Bay, one would have to conclude that there would be a geometric increase in strike hazard for every given amount of extension into the concentration areas of these birds.

ROLE OF ADMINISTRATIVE AND GOVERNMENTAL ORGANIZATIONS IN DETERMINING THE POTENTIAL USES OF JAMAICA BAY

If there is a genuine intention to use Jamaica Bay for the purposes that we include in our Group 1, that is to say, an intention to have people live around it and use it as a place for recreation, while preserving its natural systems—then it should be recognized that there are a number of threats to the attainment of this goal in addition to those which have already been discussed. Some of these threats arise inadvertently out of political and governmental arrangements, but others are being created by activities that are in a limited way designed to create some improvement in the Bay or some part of it.

As the extensive literature on intergovernmental cooperation and confusion in the New York metropolitan area attests, any issue as far-reaching as determination of a new land use for part of Jamaica Bay will require the participation of several dozen agencies at the community, borough, city, state, regional and federal levels. The system by which these interact is at best a diplomatic one, with no common legislative or administrative process.

City Agencies

At the City level, the governing agencies—mayor, Board of Estimate, City Council—will all be involved. The participation of the mayor will include the advice of most of the major City departments. The Board of Estimate automatically adds the interests of the presidents of the boroughs directly affected. It includes, besides the mayor, the president of the City Council, and the controller. The City Council also provides a vehicle for the expression of the interests of people throughout the City.

Members of the City Council from Queens might be expected to join the borough president of Queens, who is a member of the Board of Estimate, in concern for such Queens problems as the future of the Broad Channel community, relative noise exposure over Queens, impact of change on the residential character of the Bay margins and the Rockaways, and the jobs that the airport provides. Members of the Council from Brooklyn, with their borough president, might be expected to be concerned with implications for noise exposure, the ethnic mix of housing near the Bay, the potential for expansion of housing resources, the availability of transportation to any new recreation areas, and the broad economic impact of expansion or contractions of Kennedy Airport on the citywide job market.

If new runways were to be constructed, the Board of Estimate would have to approve an amendment to the lease that PONYA holds on Kennedy Airport to encompass the area for new runways and to provide appropriate rental payment to New York City. Since that amendment to the City's long-term lease to PONYA might include a consideration for loss of that part of the Bay and might provide the City with resources to develop the rest of the Bay for recreation or other purposes, the Board of Estimate's role is critical. PONYA has the potential and the precedents for providing capital construction funds or services to the City in exchange for required City easements, approvals or investments. These funds can come either from the bonds sold to cover construction costs of major PONYA projects or from direct charges on the airlines, negotiated as lease amendments.

The City Council must approve any budgetary allocation for development and maintenance of facilities at the Bay. Action by interested citizen groups can have a major impact on council decisions. Party, ethnic,

religious or private interest group politics may change the weights at any time.

The executive agencies that affect the City government's decisional processes include the following:

The Parks, Recreation and Cultural Affairs Administration. According to the city charter (a state law), the Board of Estimate may assign land for park purposes; and the right of the City to its parks is inalienable. The Parks Administration is responsible for the development of City parks, recreation and cultural facilities. Within its budget of $50 million annual operational expenses and $50 million capital expenses, the Bay has held relatively low priority. Parks, like other City agencies, has its own constituency among private groups devoted to its purposes.

The Environmental Protection Administration. The Environmental Protection Administration oversees the greatest public capital investment in the Bay, the water quality improvement program. It operates the major sanitary landfill operation on the fringes of the Bay. It has concerned itself with overall environmental planning and with environmental "watchdog" activities.

The City Planning Commission. A long-term plan has just been completed. It focuses on New York as the "national center" and on neighborhood regeneration. It discusses the viability of the Bay as a recreational resource and the possibility of new runways in the Bay. While its conclusions are not programmatic, the City Planning Commission is responsible for approving zoning changes.

The Economic Development Administration. The Economic Development Administration is a major instrument for carrying out the central thesis of the City Plan for New York as the "national center," and the plans for job and business expansion and promotion. It contains the Department of Ports and Terminals, which must issue permits for any filling-in or construction on any part of the waterfront.

The Housing Development Administration. The Housing Development Administration has been under intense pressure, as New York's housing crisis deepens, to find sites for publicly aided and private housing. Some publicly aided projects have been built on the Bay margins and on the Rockaways and a major state-aided project (Twin Pines) is now under way. The Housing Development Administration has held to a strategy of redeveloping existing overcrowded city neighborhoods.

The Transportation Administration. The Transportation Administration has its focus on a 10-year plan to relieve the crowded highways to and from the airport. It has no direct control over the subway system, nor the Long Island Railroad, which is expected to provide a direct rail link to Kennedy Airport. (These belong to the Metropolitan Transportation Authority, a state agency.) The City Transportation Administration has an interest in maintaining Floyd Bennett Field for general-aviation uses, while the Housing Development Administration wants to use it for housing.

The Budget Bureau. Recreational facilities for the Bay will cost money. The Budget Bureau will be involved, particularly in setting priorities for expenditures. It is also possible that the Bureau will coordinate the inputs of all the other agencies in this list and draft a position for the mayor's approval.

Other City agencies with an interest in the Bay include the Board of Education, which has an interest in ecological education; the Health Services Administration which has facilities around the Bay and shares an interest in the clean water program; and the Human Resources Administration, which might be concerned with the jobs and community development potential of the area.

An interagency council has been set up to represent the major City interests in the Bay. If such an agency ever becomes operational, it offers the promise of providing more thorough analysis of the factors involved in Bay development for the mayor and Board of Estimate.

Another city involvement is that of the communities in Nassau County. Their concern rests primarily in portions of the Town of Hempstead and on the issue of noise. The county executive and the town boards of supervisors of the County are involved in these concerns.

State Agencies

The critical role of New York State with regard to the future of the Bay comes under three main headings:

1. The governor has the power of veto on new activities of PONYA. He, therefore, has final control over any program for the expansion of Kennedy Airport. (The governor of New Jersey also will have power of veto.)

2. The probable role of the state legislature, which would have to approve the demapping of park land

and give its permission for any new public use such as runways in the Bay.

3. The State Department of Environmental Conservation, which controls the water quality in the Bay, and is investing several hundred million dollars in sewage-treatment facilities.

Other State involvements include: the possible requirement of a permit from the State Department of Environmental Conservation for excavation and filling in the Bay; and a permit from the State Commissioner of General Services for topping new beaches with underwater sand from New York State waters.

The significant New York State investment in Jamaica Bay and Kennedy Airport have led to a major State interest in their development. The mass transit link to Kennedy Airport from Manhattan is important to the Metropolitan Transportation Authority (MTA), as is possible relocation of the Cross Bay MTA rail line. The State Parks Department would like to see its plans for open space and state beaches implemented in environs of the Bay. The State Housing Department has financed a large number of housing projects on the Bay margins and in the Rockaways. The quasi-public New York State Urban Development Corporation is the vehicle for development of part of the housing in the Arverne Urban Renewal Project and might be involved in the housing alternative for Floyd Bennett Field.

State legislators from New York City and Nassau County have influence on the processes of state government. At least one Queens assemblyman has made the noise issue at Kennedy Airport a principal concern. Another has pointed out that any airport development that shifts noise from white neighborhoods to black neighborhoods would be strongly opposed, perhaps by direct action of the people involved, but, at least, through their assemblyman.

Federal Agencies

The federal presence in the development of Jamaica Bay includes many agencies, some created only in the last two or three years. Precedents for actions by these agencies are sparse. Major decisions probably will have to be made at the highest levels.

The Congress has an interest in environmental legislation and can be expected to monitor programs closely. Several congressmen have a special interest in environmental problems caused by aircraft noise and others are interested in recreational uses of the Bay.

The principal involvements are as follows:

1. The Federal Aviation Administration regulates the airport facility—including the navigational and other airport aids located in the Bay. The FAA's involvement reflects in part the Department of Transportation's responsibility to control the airways and to begin to develop a rational allocation of transportation resources nationwide. Under the Airport and Airways Development Act of 1970, the Secretary of Transportation must approve projects for airport development and the federal subsidies for such development. The Secretary of Transportation must consult with the Secretaries of the Interior and Health, Education and Welfare on the impact of airport development projects on "the protection and enhancement of the national resources and the quality of the environment of the nation." The Department of Transportation's own authorizing act requires extensive consultation with the Departments of the Interior, Housing and Urban Development, and Agriculture where the use of publicly owned recreational areas or waterfowl refuges are required for a transportation project. In addition, route-granting by the CAB can continue to exacerbate the capacity problems at Kennedy Airport or ease them.

2. The Federal Water Quality Office finances a large portion of the program to improve the quality of water in the Bay. Its approval of development changes would have to be conditioned on studies of effects on water quality. It shares control over that quality with the State.

3. The Army Corps of Engineers maintains navigation channels in the Bay and issues permits for dredging. The Corps is undertaking a study of ways to improve Bay navigation by widening and deepening the channels.

4. The Coast Guard shares responsibility with the Corps of Engineers for monitoring oil spills.

5. The President's Council on Environmental Quality has issued interim guidelines to federal agencies this year to implement parts of the National Environmental Policy Act of 1969. These guidelines will require the Department of Transportation to consult with a number of federal agencies, including the Department of Housing and Urban Development, before proceeding with a major alteration of the Bay. The consultations must take place in a context of concern for environmental quality, with a strong focus on the human environment.

6. The Office of Management and Budget must assure compliance with the requirement in the Intergovernmental Cooperation Act of 1968 that all federal

aid for development purposes (including any federal financial assistance for new runways) "be consistent with and further the objectives of State, regional and local comprehensive planning."

7. In addition, a pending bill in the House of Representatives (H.R. 12436) would greatly increase the federal presence in Jamaica Bay. According to this bill, "Jamaica Bay—all islands, marshes and hassocks," as well as the outer perimeter of Floyd Bennett Field, would be incorporated in a "New York Harbor National Seashore," to be administered by the Department of the Interior. The bill states explicitly that "lands owned by the States of New York or New Jersey or political subdivisions thereof may be acquired only by donation," and this would clearly govern Jamaica Bay, which is City-owned land. The bill has been referred to the House Committee on Interior and Insular Affairs and has not emerged.

Secretary of the Interior Hickel released a report prepared by the Bureau of Outdoor Recreation and the National Park Service proposing a "Gateway National Recreation Area." The boundaries of the proposed recreation area correspond closely to the boundaries described in H.R. 12436. They include the shores on the western part of the Bay which are presently zoned as parks. The proposal has been referred to the Office of Management and Budget. The four senators from New York and New Jersey recently called for speedy and favorable action on Gateway.

8. Looming over Jamaica Bay is a project of the Army Corps of Engineers to construct a hurricane barrier along the Rockaways and across the Jamaica Bay inlet. The project was authorized by Congress in 1965. Funds have been appropriated for investigations of the effect of the project on waterflow in the Bay. Under the terms of the authorization bill, the City will be expected to pay a third of the construction costs. Funds for construction have yet to be appropriated.

Regional Agencies

Regional agencies should be mentioned here in relation to the Bay and the runways question. The Port of New York Authority builds and manages the airport system for the New York metropolitan area. It would have to conduct public hearings on any airport development. PONYA's "constituency" includes the airlines, whose life will be affected significantly by the resolution of the expansion question. The Tri-State Transportation Commission has a significant planning role in the future of the transportation system for the region. Its comment must accompany any application for federal funds. The private Regional Plan Association's independent studies and planning activities have some public and political weight in the regional system.

The Special Role of the Parks, Recreation and Cultural Affairs Administration of New York City

This section would not be complete without some mention of the present attitude of the New York City Parks, Recreation and Cultural Affairs Administration, as this was perceived by the members of the Study Group during the course of this investigation. So far as Jamaica Bay is concerned, it appears that this agency has been more concerned with what might be called "cultural affairs" than with "parks and recreation." The major focus of its interest, as transmitted to the Study Group, has been to preserve the marshland and develop the wildlife refuge. They have centered their activities upon the development of facilities for nature walks and for the education of schoolchildren, and, in some of their verbal communications, they have described Jamaica Bay as "a natural wonder, like the Grand Canyon."

Commendable as these activities and attitudes may be, they are, after all, directed toward a very small segment of New York's population, and focused upon a type of activity that is preferred primarily by upper-class people, and in relatively small numbers. Some of the staff of the agency gave no clear indication of being aware of the types of recreation that are so greatly needed by the people of New York City, and the capacity of the Bay for providing these. They seemed to be especially insensitive to the pressing needs of the hundreds of thousands of people from lower-income neighborhoods in the surrounding areas. Perhaps the best evidence of this has been the agency's almost total failure to push forward with any program for developing the beach and shoreside areas on the northwestern and northern shores of the Bay.

It is indeed true that the Parks, Recreation and Cultural Affairs Administration has had a low priority as a recipient of the City's funds, but there seems to be no evidence that they had made an active exposition of their case, or that they have carried out the vigorous campaign for funds that might well have procured for them some of the relatively small investments that they would need initially. Their helplessness in the face of their need is in striking contrast to the vigor and imagination of those members of the Environmental Protection Administration who are concerned with water quality and sewage treatment. While the Parks, Recreation and Cultural Affairs Administration has been paralyzed by the difficulties of getting a few million dollars

to develop parks around the Bay, the Environmental Protection Administration, and particularly those concerned with water quality, has been able to raise hundreds of millions of dollars for treating the sewage that falls into the Bay. Members of that agency, in fact, appear to have a far more realistic appraisal of the needs of the surrounding population and the potentialities of the Bay for meeting these needs than do some of the senior members of the staff of the Parks, Recreation and Cultural Affairs Administration.

One suspects that this is an outgrowth of the basic orientation of the people at the top level of that agency at the present time. On the basis of their behavior in relation to the Bay up to now, it would appear unlikely that they would press forward with the vigor necessary to develop the recreational facilities that it might provide. An indication of this is their willingness to cede the entire Bay and its north shore to the federal government as part of Gateway, in spite of the National Park Service's evident lack of interest in developing the very recreational facilities that are so greatly needed.

The Proposed Hurricane Barrier

In 1960 and 1962, two major storms occurred in the New York area, accompanied by high winds and high tides. During these storms, water backed up into Jamaica Bay and there was flooding of low-lying areas on the periphery, particularly in areas such as Howard Beach just to the northwest of the airport and in the Edgemere–Inwood section to the southeast. Property damage was estimated at $15 million in the first storm, and less in the second, but no lives were lost. High tides and waves caused some damage along the beach at the Rockaways. As a result of this, there were requests for federal action to protect the residents of the Rockaways and those who live around the Bay from the effects of storm damage and flooding. The U.S. Army Corps of Engineers was authorized to develop a plan to provide this protection.

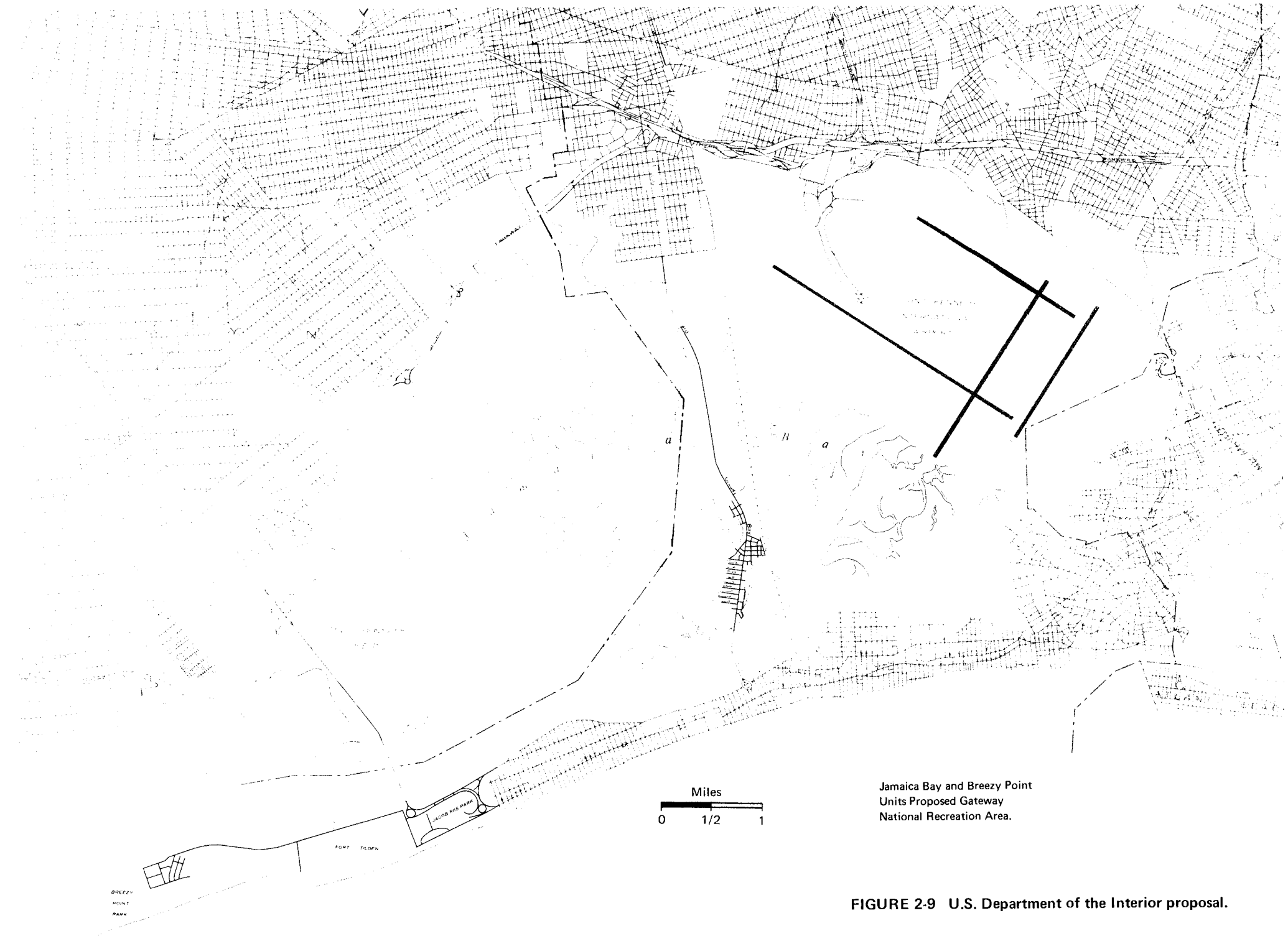
As an outcome of this mandate, the Corps of Engineers drew up plans for a dike and sea wall 18 feet above mean high water (8 feet above the 10-foot elevation of the beach) to run along the Rockaway peninsula from the base of the peninsula to Riis Park (6 miles). This wall would run along the landward side of the ocean beach, in front of the shoreside building. At Riis Park it would cross the peninsula and run along the Bay shore to the western side of the Marine Parkway Bridge. It would be crossed at points by ramps and stairways. In order to protect the Bay itself from flooding, there would be a hurricane barrier 4,530 feet long across Rockaway Inlet to a dike 1.2 miles long on the Brooklyn shore. There would be a 600-foot opening in the center of the barrier, protected by gates that could close at the time of high water. The entire project was planned to cost $53 million in 1965, of which the federal government would pay $36 million.[14]

Tests carried out at the simulation basins of the Corps of Engineers at Vicksburg indicate that the barrier would protect the Rockaways and the Bay from the effects of tides and waves created by any anticipated storm, except one so large that it could be expected only "once in a thousand years." Such a storm, it may be added, would flood the tip of Manhattan up to the Wall Street area. It has been reported that these simulations indicate that there would be no interference with the ebb and flow of the tides through the Bay, which is so important to its continued health. A study by the Division of Water Supply and Pollution Control of the United States Public Health Service in 1963, based on a mathematical model and on admittedly inadequate data, suggested that the erection of the barrier would not cause any serious damage to the water quality in the Bay. Further studies were requested, based on hydraulic models.

Members of the Study Group were of the opinion that the hurricane barrier, if erected, might do serious and possibly irreparable damage to plans to use Jamaica Bay for human recreation. They were not convinced that the tidal flow would not be interfered with significantly. Being aware of the marginal adequacy of this flow at the present time and the great difficulty that the Bay now has in protecting itself from the heavy load of pollutants that it receives, the Study Group was of the opinion that the erection of the barrier might seriously compromise the water quality of the Bay. The plan to have people bathe and swim in waters, which in any case would contain a modest proportion of treated sewage effluents, creates problems enough without adding to them the problems that might be created by partially damming the outflow from the Bay at its mouth.

Nor can the potential effect of this barrier upon the Rockaways be overlooked. At the present time the Rockaway beaches are readily accessible from street levels, and people of all ages have easy access to them and to the boardwalk. Parts of the Rockaways have, in fact, become preferred areas for the retirement of older people, who like to walk on the boardwalk and sit by the beach on sunny days. To separate these people from the beach by a barrier some 8 feet high, which

[14] 89th Congress, 1st Session. House Document No. 215, U.S. Government Printing Office, Washington, D.C., June 23, 1965.



Jamaica Bay and Breezy Point
Units Proposed Gateway
National Recreation Area.

FIGURE 2-9 U.S. Department of the Interior proposal.

can be surmounted only by means of a flight of stairs or a ramp, would be a hardship for many of them. It could significantly reduce the convenience and attractiveness of the Rockaway shore front for many potential users.

The Study Group also questioned the need for such a very large and expensive barrier, with annual costs of over $400,000 per year, to provide the protection that some have asked. Hurricanes are rather rare in the New York area; there are about three severe storms in 100 years; few have caused any loss of human life. Since 1667, there have been only four storms as severe as the two that occurred in 1960 and 1962. During the past two decades the tracking of hurricanes and the provisions for advanced warnings have improved to the point at which hours or days of warning now can precede the arrival of a storm. Under these circumstances arrangements for the evacuation of shoreside areas of the Bay and of the Rockaways could readily be made if these were needed. Some of these areas are, in fact, quite low-lying. Some of Howard Beach, for example, is low enough so that it is threatened with flooding at times of heavy rain. However, the total amount of property damage that might occur here is not nearly as great as the expense of building and maintaining the proposed hurricane barrier, especially if one includes in this expense the cost of the damage done to the environment by impairing the water of the area for other human uses.

Possibly a wiser solution and a much less costly one would be to provide these specially exposed people with storm-damage insurance, underwritten by the government. An even better solution in the long run would be to raise some of these communities to the elevation necessary to ensure the adequate drainage that they need under normal circumstances. The members of the Study Group were of the opinion that the construction of the proposed hurricane barrier and sea wall should not be undertaken unless it can be demonstrated that its initial benefits are actually necessary, that they cannot be produced by other and less damaging methods, and unless it can be shown, by adequate statistics, that there will not be a negative effect on the quality of the water in the Bay.

The Gateway Project

In 1969, two bills (H.R. 11804 and H.R. 12436) were introduced into Congress with the aim of creating a National Seashore or the Gateway National Recreation Area (see Figure 2-9). This area is supposed to combine five pieces of land. Four of them are islands or peninsulas of New York harbor, which are now accessible only by private transportation, and the fifth is Jamaica Bay. Most of the land in two of these (Sandy Hook and part of Breezy Point) is federally owned, belonging to the Department of Defense. Gateway envisions providing access to and between all these sites by a ferry shuttle, and developing them as a recreational facility for people of the entire New York metropolitan region, including the surrounding counties.

In contrast to the other parcels of land, Jamaica Bay is easily accessible by present and projected public transportation. In its initial form, the Gateway proposal did not include the park lands to the north and west of the Bay, but in its most recent form it does include these. The City Parks, Recreation and Cultural Affairs Administration has expressed no misgivings about donating the interior of the Bay and the north and west shore park lands to the federal government. There appear to be three reasons why that agency is seeking a federal initiative in this area: (a) the City seems to see this as a way of obtaining federal funds to develop these areas; (b) the City welcomes what it regards as the expert assistance and guidance of the Department of the Interior and the National Park Service in the areas of conservation and recreation, and (c) the City Parks Department wishes to be relieved of the recurring threat to Jamaica Bay and its surrounding park land, which is created by the conflicting interests of a variety of City agencies. Various of these agencies have pressed repeatedly for the use of parts of the shore and of the interior of the Bay for transportation facilities, for residential housing, and for similar projects. The recent proposal to extend the runways of Kennedy Airport into the Bay is just the latest of many such threats to this park land.

The Gateway proposal, as described in the various documents made available to the members of the Study Group, and as explained by the staff of the National Park Service, envisions little capital investment within the Bay, and none at all along the northern shores. In the Bay the Park Service plans to construct a few trails and a General Interpretive Center. They regard the park lands on the northwest shore as being included only in order to prevent alternative development. The only shoreside activity contemplated under Gateway is the refurbishing of the Canarsie Pier. Members of the staff of the National Park Service made it clear that that agency is wary of getting involved in the business of running city parks. They appear to be resisting any role in developing the beaches along the shores of Jamaica Bay for this reason.

In the view of the members of the Study Group, what is needed in Jamaica Bay and along its shores is precisely what the National Park Service does not wish to de-

velop: a city park. Although the Gateway project as now envisioned might protect Jamaica Bay from uses not compatible with its natural systems, the members of the Study Group perceived in this project a potentially serious threat to the City's use of this resource, which is so important to its own people. Despite statements to the contrary, we were not impressed with the National Park Service's awareness of the needs of central city people for recreational facilities, nor were we impressed with its commitment to meeting these. The Gateway plan to forego the development of the northern and western shorelines of the Bay would effectively prevent the City from providing these as recreational facilities for a segment of its population that is most sorely in need of such facilities. Furthermore, the Gateway plan does not, in our opinion, provide for adequate transportation facilities to Breezy Point, and it envisions such a delay in the development of Breezy Point that this site, too, may be long denied to City residents as an effective recreational facility for meeting their pressing needs.

The evidence indicated to the Study Group that Jamaica Bay and the City-owned park lands around the periphery of the Bay are essential to the people of the City of New York for their use as a City park and as an educational facility. The Group concluded that these should be controlled and administered by an agency of government that can be made immediately responsive to the needs of the people of the City as expressed through their City government. It appears to us that the National Park Service is not yet really prepared to build or maintain parks and access facilities for that part of the nation's urban population that is, in effect, without access to present national parks. In view of this, we believe it is much more reasonable for the federal government to make grants in aid to New York and to other cities for construction of the parks that their people need, and for the construction of the needed access facilities, *including the expensive rapid-transit lines,* which, on a per capita basis, are not more expensive than the access roads that have been built to national parks in some of the outlying regions of the country, in order to serve those members of our society who have automobiles.

3 PRESENT EFFECTS OF AVIATION IN THE ENVIRONS OF KENNEDY AIRPORT

INTRODUCTION

The dramatic evolution of aviation, as reflected in both airports and aircraft, has held the fascination of the American public almost without interruption since the Wright brothers' initial flight. From a global perspective, it is easy to perceive as a major factor in a nation's overall economy and in its position of international power and prestige. From this perspective, Americans have acquired the habit of equating each new advance in aviation technology with national progress or favorable change. A different perspective is needed, however, from which to assess more precisely and deal with the effects of aviation growth as it relates to the scale of urban communities.

For many communities in the United States, the growth of aviation has been a mixed blessing, at best. Indeed, while industrial growth based on aviation has occurred in most metropolitan areas, the combined characteristics of aircraft, airports, and operations in aviation during the past decade have produced intolerable environmental effects in many communities. Many pre-existing neighborhoods have been reduced to marginal habitability as a result of the negative effects created by aviation growth, and the quality of life in hundreds of others has been severely impaired. These adverse impacts of aviation growth, which cannot be escaped by those in the affected communities, must not be ignored in the process by which decisions affecting development of the national air transportation system and its individual airports are made.

COMMUNITIES IN THE KENNEDY AIRPORT ENVIRONS

Whatever may be the benefits from aviation that accrue to the nation and to the New York region, for many individual communities surrounding Kennedy Airport and its environs the adverse influences associated with aviation or with the airport itself are facts of everyday life. These are the communities located within areas of severe noise exposure resulting from takeoff and landing operations at the airport and upon which the impact of other airport-associated negative effects are great. For many of these same communities, Jamaica Bay, the natural setting for Kennedy Airport, affords an important actual or potential resource for recreation and an amenity environment. Since both the quality of the environment and ultimate recreational opportunities in Jamaica Bay are affected by the operations and development of the airport, growth of operations centered on the airport will affect the interests of all the communities located within about seven miles of any of the margins of

Jamaica Bay. These are the communities for which the development of the airport or Jamaica Bay or both will affect the future demands for land, traffic capacity on existing streets and new traffic arteries, and special public facilities related to aviation growth.

Functional linkages between Kennedy Airport or Jamaica Bay, or both, and identifiable communities extend to include all or part of a total of 44 traditional political and civil subdivisions. These include the counties of Kings, Queens, and Nassau; the City of New York; the boroughs of Brooklyn and Queens; the Town of Hempstead; five incorporated towns and villages; five congressional districts; five state senate districts; five city council districts; seven state assembly districts; and ten school districts. These communities, which are shown in Figure 3-1, bear most of the immediate burden of any adverse effects of present aviation operations as well as any growth and development at Kennedy Airport, and most of them do not benefit from the airport in any substantial way.

In addition to the officially defined communities that comprise the environs of the airport and Jamaica Bay, a number of special areas and subcommunities must be recognized. Though lacking formal representation in the traditional structure of government, they have achieved recognition as communities in their own right by virtue of special characteristics of location, ethnic concentration, type or quality of development, social or economic function, or other generally recognized associations. Thus, such communities as Broad Channel, Hamilton Beach, Howard Beach, Inwood, Woodmere, Arverne, and Canarsie require consideration in any comprehensive evaluation of community interests in relation to present and prospective effects of aviation growth and recreational-resource development.

Thus defined, the communities of the environs of Kennedy Airport and Jamaica Bay include a total of 2,600,000 people and occupy a land area of some 90 square miles, or 12 times the area of the airport itself. They include a diversity of people, political interests, housing, commercial facilities, and industrial development.

Transcending the diverse characteristics of these communities is the pervasive problem of environmental degradation, which they share as a result of proximity to the airport. This general problem must be examined in some detail in order to understand its special characteristics and their separate and aggregate effects.

ENVIRONMENTAL POLLUTION

The atmosphere, land, and open water that surround the communities in the Kennedy Airport environs are adversely affected by a variety of pollutants directly associated with aviation and the development of the airport. The diverse nature of these pollutants, ranging from invisible yet unwanted sound to microscopic yet toxic particles, and further to heavy objects falling from aircraft, makes a precise assessment of their aggregate effect difficult. It is nonetheless important that each of these types of environmental pollution be given specific consideration as it affects the lives and expectations of the people in these communities.

Aircraft Noise

Noise, simply defined as unwanted sound, is an acknowledged characteristic of life in most of the New York metropolitan region. Aircraft noise, primarily from planes landing and taking off, is an additional and oppressive factor in the communities of the Kennedy Airport environs. Aircraft noise can be termed an objectionable factor in the environment of these communities not merely because measured levels of sound exceed established norms, but because a continuing and intensifying pattern of public response to the amount of aircraft noise in the environment of these communities emphatically declares it to be objectionable. Aircraft noise is all the more oppressive to people in high-exposure areas because it has proved to be beyond the reach of any traditional legal remedies or democratic complaint processes available to citizens seeking relief from noise nuisances.

Aircraft noise in the environs of Kennedy Airport interferes with sleep and relaxation, with conversation, and with radio, telephone, and television communications. It disrupts school classroom and assembly activities by preventing or impairing communications between teachers and pupils, and it disrupts religious services and other public and private meetings in which continuous voice communication and music are essential components. It interferes with outdoor recreation, including organized sports and games, by masking or disrupting communications among players and by stifling spectator response and enjoyment. It interferes with outdoor living, including family activities such as picnics, gardening, and cookouts. It also disturbs contemplative activities and quiet reading.

The disruptive effects of aircraft noise impose an undeniable burden upon several hundred thousand people who live in the environs of Kennedy Airport. This burden can be expressed in terms of aggravated irritability resulting from discomfort and psychological stress caused by prevention or interruption of sleep; the pre-emption of significant periods of time during which

a person cannot perform normal tasks involving auditory communications; losses in the relative monetary value of residential or other property; and possible physiological harm resulting from the cumulative effects of episodes of intrusive aircraft noise, which in some cases may be permanent reduction of hearing acuity.

Research on the problems of human response to aircraft noise in the vicinity of airports to date has been limited mainly to measuring the likely responses of noise-exposed communities to aircraft noise under a variety of conditions of exposure. Very little research has been done to establish a clear relationship between environmental noise, including aircraft noise, and public health. Research on the propensity of urban populations to raise objections to aircraft noise, however, has advanced to the point where it is now possible to predict with a high level of confidence characteristic patterns of community response to projected noise exposure. The latter is determined by a given frequency of overflights, the total number of flights and typical duration of each, the time of day during which overflights occur, the sound spectra and output levels of the aircraft engines to be used, and flight-path characteristics. Integration of these factors permits the delineation of Noise-Exposure Forecast (NEF) areas within which various degrees of community reaction against aircraft noise exposure may be expected. Figure 3-2 shows schematically how NEF values are developed. (For a more detailed discussion, see Chapter 4.)

Noise-Exposure Forecast areas may be defined by calculating the numerical value of the NEF index at all locations surrounding an airport. Contours of NEF values of 30 and 40 define three NEF areas that are particularly important for practical land-use planning and analytical purposes: NEF less than 30, NEF between 30 and 40, and NEF greater than 40.

Table 3-1 indicates the degree to which noise-sensitive development in several major categories of land use is likely to be compatible with the levels of noise exposure characteristic of each NEF area. The notation "Yes" in the table indicates that the particular category of land use should suffer no adverse effects from the given level of noise exposure. The word "No" indicates that, unless extensive and perhaps expensive design precautions are taken in the construction of buildings or facilities, the given levels of aircraft noise will result in severe interference with the activities typical of the land use. It is important to note that, for each "Yes" or "No" indication in the table, a range of noise exposure is given, within which building construction or open use of land should be avoided unless a detailed analysis is made to determine specific noise-reduction requirements.

While there is agreement that residential environments should generally be less than NEF 30, the current data are insufficient to specify more precisely what the acceptable level should be.

The NEF methodology has been developed during the past four years as an improvement of an earlier technique devised to provide a means of translating physical measurements of noise into an index of community annoyance useful for planning airports and related land

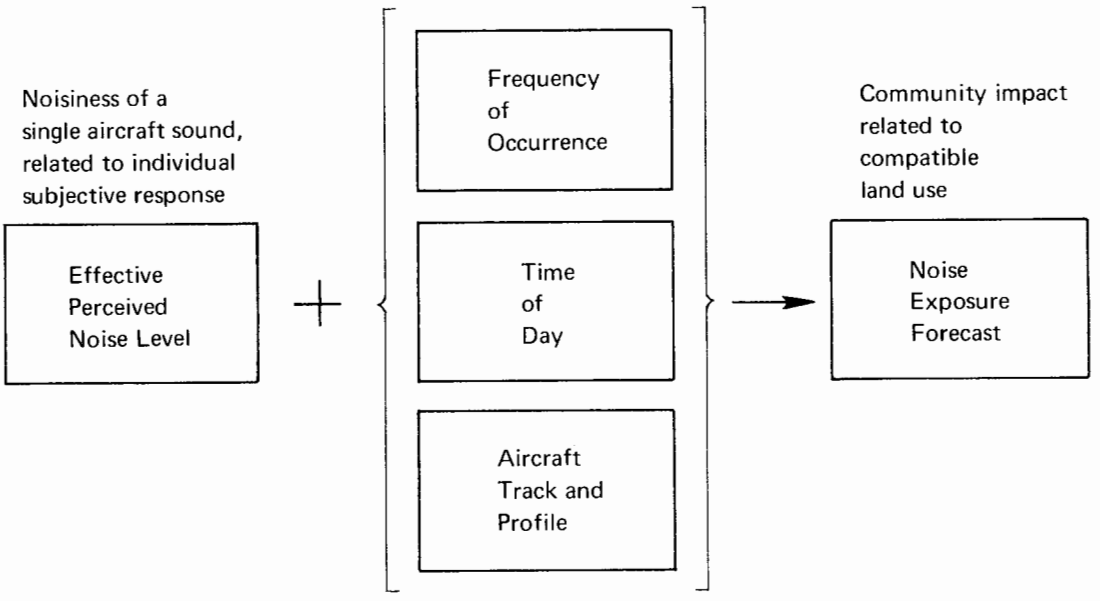


FIGURE 3-2 Construction of the noise-exposure forecast.

TABLE 3-1 Land Use Compatibility Chart for Aircraft Noise

Noise-Exposure Forecast Areas	Land Use Compatibility								
	Residential	Commercial	Hotel, Motel	Offices, Public Buildings	Schools, Hospitals, Churches	Theaters, Auditoriums	Outdoor Amphitheaters, Theaters	Outdoor Recreational (Nonspectator)	Industrial
<30	Yes	Yes	Yes	Yes	[c]	[a, c]	[a]	Yes	Yes
Between 30 and 40	[b]	Yes	[c]	[c]	No	No	No	Yes	Yes
>40	No	[c]	No	No	No	No	No	Yes	[c]

[a] A detailed noise analysis should be undertaken by qualified personnel for all indoor or outdoor music auditoriums and all outdoor theaters.
[b] Case history experience indicates that individuals in private residences may complain, perhaps vigorously. Concerted group action is possible. New single-dwelling construction should generally be avoided. For apartment construction,[c] applies.
[c] An analysis of building noise reduction requirements should be made, and needed noise control features should be included in the building design.
Source: Bolt Beranek and Newman Inc., *Aircraft Noise and Airport Neighbor: A Study of Logan International Airport.* Technical Report No. DOT/HUD 1ANAP-70-1, March 1970, p. 9.

use. Community responses to the effects of aircraft noise in the environment range from individual complaints about occasional overflights to concerted group action, including extensive litigation, against airport operators, airline companies, and government agencies. The NEF is now a generally accepted rational method for describing the degrees of community annoyance associated with noise exposure in the vicinity of existing airports and for predicting the likely impact, in terms of community annoyance, of extensions of existing airports, intensification of flight operation at existing airports, and of entirely new airports. Experience during the past decade has shown a correlation between responses predicted by this method and the actual reactions of people and established communities that fall within such noise exposure zones. In the light of this accumulated experience, contemporary planning and design practice for new airports and urban communities requires that all the zone of NEF 40 be included within the actual boundaries of an airport wherever possible, and that as much of the zone of NEF 30 as it may be practical to acquire be included as well in the airport site.

Under the continuing pressures of aviation growth, traffic at Kennedy Airport has intensified steadily since the airport was established by the city in 1947. With the introduction of jet aircraft in 1959 into commercial service, the propensity of the airport to project its influence great distances beyond its boundaries into populated areas became apparent. Thereafter, zones of aircraft-noise exposure expanded steadily into the surrounding communities with each year's increment of additional air traffic and the progressive replacement of piston engine aircraft by louder and more powerful jets. Today, as a result of these trends, more than 700,000 people live within the noise-exposure zone of NEF 30 associated with Kennedy Airport. Areas currently exposed to noise levels of NEF 30 and 40 in the airport environs are shown in Figure 3-3.

During mid-1969, a study was made of community attitudes toward noise, based on individual interviews with a sample of over 1,000 randomly selected residents in 169 different locations, living within the zone of NEF 30 in the environs of the airport.[1] Sample areas with very high aircraft-noise exposures were chosen in the study, in order to determine community reactions to intense noise environments. Respondents were asked by a process of indirect questioning about the extent of annoyance they experienced from intrusive aircraft noise. Only 7 percent reported no annoyance, while 93 percent said they were annoyed. A total of 68 percent of the sample population said aircraft noise interfered with rest and relaxation inside their homes, and 75 percent reported interference with rest and relaxation outside. Moreover, 80 percent reported interference with conversation, 86 percent with television listening, and 53 percent with sleep. Sleep difficulties severe enough to affect health were reported by 44 percent of the persons sampled, and 37 percent reported nervousness, 29 percent headaches, and 11 percent weariness associated with continued exposure to aircraft noise. Despite the lack of definitive data bearing on the relationship between repeated arousal from sleep or other disruptive effects of noise and specific physiological or mental ill health, it is difficult not to acknowledge this

[1] Tracor Document No. T-70-AU-7454-U, "Community Reactions to Airport Noise," September 4, 1970.

level of noise exposure as an adverse factor in even the most conservative definition of a healthy residential environment.

Noise has not been established as a necessary and sufficient cause of any disease except the deafness that results from prolonged exposure to loud noise. However, this does not mean that noise may not have other important effects on health. Noise, in the medical sense, is not just random sound, with no information content. It has two characteristics: (a) it is unwanted and intrusive and (b) it does carry information. These two characteristics may cause it to have undesirable physiological consequences.

In a NEF 30 area, the sound of a jet plane is intrusive; it intrudes upon sleep, it prevents conversation, and it interrupts many kinds of relaxing activity. It also conveys information; the person who hears the sound knows that it comes from a jet plane. If he is an experienced listener, he can guess which kind of jet is making the sound, whether it is landing or taking off, and how low it is. The intrusion of the sound may interrupt his much-needed sleep or rest, or interfere with activities that are important for him. The knowledge of the source of the sound may create in him resentment, anger, and fear. The physiological changes that often accompany these emotions can have an adverse effect upon many illnesses and especially upon those associated with emotional disturbances.

Disorders of mood, thought, and behavior are exceedingly widespread in the American population. The National Health Survey[2] reports that, in 1960–62, 32.4 percent of people between the ages of 18 and 79 complained of insomnia, 4.9 percent stated that they had experienced nervous breakdowns, and an estimated 58.5 percent of the population had been bothered by "nervousness" at one time or another. When people who experience symptoms such as these report that the noise from jet planes has an adverse effect upon their health, there is a credible basis for supposing this may be true. If we apply the estimates from the National Health Survey to the population of approximately 700,000 people living within the NEF 30 contour of Kennedy Airport at the present time, we arrive at an estimate that approximately 227,000 people in this group may suffer to some extent from insomnia. Among these, approximately 103,000 people may have had nervous breakdowns or experienced impending nervous breakdowns. Although the full effects of the noise of aircraft upon the health of these people have never been measured precisely, it seems quite certain that aircraft noise is creating a serious public health problem.

Other substantial evidence is available to support the need for public concern about environmental noise as potentially inimical to community health. For example, research reported at the American Medical Association Environmental Health Congress in 1969 indicates that noise above 75 db (A), a level regularly produced in communities bordering Jamaica Bay by aircraft using Kennedy Airport, will produce[3]:

> various temporary changes in the physiological state. The most important of these is a reduction in the size of the median and smaller arterials. Some of the side effects of this phenomenon are an increase in pulse rate, a pa!ing of the mucus membrane throughout the organism and an increase in respiration rate. This is probably related to the autonomic system. Studies of animals and humans show that this effect is temporary. There are no valid data to show that they carry over to produce permanent effects. Some investigators have postulated that these temporary effects may become chronic if they reoccur frequently over long periods of time and theoretically can produce hypertension, ulcers and dermatoses. Further studies in the comparisons of non-noise exposed groups with respect to these problems are essential before valid conclusions can be drawn.

One of the most insidious aspects of aircraft noise pollution in the environs of Kennedy Airport is the penalty it imposes upon children in public and private schools. The periodic inundation of schools by high levels of aircraft noise has the critical effect of reducing the net effective teaching time available to students during the school year. This results from the fact that many overflights of public and private schools in the environs of the airport produce a total eclipse of communications in the classrooms, even with the windows closed. This intrusion of aircraft noise necessitates a pedagogical approach known somewhat bitterly among teachers and school officials in the New York region and elsewhere as "jet-pause teaching." Without detailing the minute-by-minute interference of airport operations upon noise-impacted schools in the airport environs, it is difficult to provide precise quantitative estimates of the daily interference that results. Experience has shown, however, that substantial speech interference with school operations occurs in areas within the zone of NEF 30 unless "sound conditioning" measures are employed in school construction.

As shown in Figure 3-4, at least 136 public schools of the New York City school system are located within the zone of NEF 30 for Kennedy Airport. School utiliza-

[2] *Selected Symptoms of Psychological Distress.* National Center for Health Statistics. U.S. Public Health Service Publication No. 1000, Series 11, No. 37. Aug. 1970.

[3] Aram Glorig, "Non-Auditory Health Effects," 6th Congress on Environmental Health, American Medical Association, Chicago, April 28–29, 1969, p. 3.

tion data for 1969 furnished by the New York City Planning Commission indicate that about 172,000 pupils attend these schools each day. An additional 85 private schools are also located within the NEF 30 zone in New York City and at least 12 more public and private schools are within this noise exposure zone in Nassau County. The combined total enrollment of public and private schools located within the zone of NEF 30 is conservatively estimated at 275,000 pupils. Variations in flight patterns at the airport from day to day have the effect of distributing the noise burden among the many schools within the zone of NEF 30, and the degree of interference with classroom communications is considerably less for schools at the outer margins of the zone than for some of those, such as P.S. 42, 105, 146, and 181, and J.H.S. 198. In some of the latter schools, in heavily impacted areas such as Howard Beach, the Rockaways, Rosedale, and Inwood, teachers complain that brief instructional periods must be sandwiched between frequent interruptions by aircraft noise.

On a typical day in Arverne planes were observed approaching the airport at low altitudes at approximately two-minute intervals during an hour in the early afternoon. With each overflight, a 20-second interval of noise from the passing aircraft was sufficient to eliminate all except shouted communications on the school site and in typical classrooms with windows closed. Thus, 10 minutes of the hour, or about 17 percent of a typical 50-minute class period, were sacrificed to environmental noise pollution. For pupils in schools in such noise-vulnerable locations, this translates into the loss of more than an entire school day each week, the actual lost time depending upon the pattern of traffic flow at the airport. While this example illustrates one of the extreme situations of aircraft-noise exposure in the environs of Kennedy Airport, its implications for the impact of environmental noise on education throughout the zone of NEF 30 are clear. This analysis is limited to actual time lost to pupils and teachers as a result of aircraft noise interference. It does not attempt to evaluate induced fatigue or irritability, both well-known effects of noise on humans, nor does it take into account any higher rate of teacher turnover in the school system as still other community costs of aircraft noise.

Air Pollution

Kennedy Airport is a significant source of air pollution for many of the communities in the airport environs. The effects of the airport on the quality of the air in the surrounding communities are perceived primarily in three forms: particulate matter and smoke from jet engines idling or running on richer mixtures during takeoff; emissions of automobiles, trucks, and buses serving Kennedy Airport; and fuel-oil and sanitary-sewage odors produced as a result of spillage or operating procedures at the fuel terminal and sewage-treatment plant located near the northwesterly sector of the airport.

While precise data on the severity of all these effects of the airport on air quality are scarce, reactions from residents of nearby communities on the air pollution problem are abundant. Interviews and meetings produced numerous direct complaints about soiling of clothing, laundry, dwellings, and automobiles, which residents of the airport environs relate directly to operations at the airport because of the pervasive kerosene odor that characterizes the soilage of garments and objects and because of the obvious settling of plumes of jet aircraft exhaust smoke into the areas in which they live.

In the vicinity of Bergen Basin, resident complaints derive from the obviously oily characteristic of the waters at the head of the basin, where inadequate tidal flushing action encourages the buildup of high concentrations of spilled fuel oil. The malodorous characteristic of Bergen Basin is exacerbated periodically by overflows of untreated or partially treated sewage from the plant serving the airport, and during periods of stable atmosphere the gentle sea breezes of the summer months distribute the obnoxious vapors to the surrounding communities. Interviews with residents of Howard Beach, for example, revealed a lingering community fear of potential conflagration or fire hazard associated with the circulating odors of fuel in the airport environs. Residents of Howard Beach and other communities close by the airport also are inclined to associate oily residues, which must be washed from houses and automobiles periodically, with the dense plumes of smoke emitted by jet aircraft approaching and departing Kennedy Airport. The recent revelation by airline pilots, never previously acknowledged by the airline owners, that raw fuel is dumped overboard after takeoff, confirms the validity of these common complaints. Air pollution thus has become both an esthetic and a practical nuisance clearly related to aviation by communities in the airport environs.

The major pollutants emitted from jet aircraft are the same as those emitted from automobiles. The pollutants include carbon monoxide, hydrocarbons, nitrogen oxides, and particulates. Carbon monoxide is generally a significantly smaller fraction of total pollutants in jet exhausts than in automotive exhausts. Hydrocarbon emission is important in jet engines generally only under idling or taxiing conditions. The particulate emission includes both visible and invisible. Smoky

engines are now being fitted with redesigned combustors to eliminate visible particulate emissions. A source of hydrocarbon emission unconnected with engine operation is evaporation during fuel-handling operations. This source is presumed to be normally small in the case of aircraft kerosene.

A number of studies have estimated the emission of jet-engine pollutants at Kennedy Airport.[4] The general conclusions that may be made from these studies are that the emissions *are* significant, but that they are probably of a lower level than those produced by other sources in the surrounding urban environment. The emissions from Kennedy Airport are slightly less per unit area [5] (much less for carbon monoxide) than those averaged for the entire New York metropolitan area, and considerably less than those for Queens County as a whole.

Jet pollutants appear in the air in the airport operating areas, and are carried into neighboring areas by the wind. Studies of the dispersion of pollutants confirm that they may be concentrated in a narrow zone downwind of an operating runway or taxiway, particularly under conditions of very small crosswind.[6, 7] Thus, though the amount of pollution from the airport in a neighboring area may be relatively small on the average, it may be large at a particular time and place.

The Effect of Jet Air Pollution on Jamaica Bay

One obvious effect of jet operations over Jamaica Bay is the direct emission of pollutants into the air over the Bay. Pollutants are convected by the wind and may affect humans, birds, and plant life. On the average, this effect is not severe and is probably weaker than the effect of air pollution from other sources in central Brooklyn or Queens.

Localized effects of air pollution may be more serious. Visual observation indicates a degradation of the predominant *Spartina* grass over the northeast half of Jo Co Marsh, and it is speculated that this degradation is a consequence of take-off operations on the contiguous runway 4L of Kennedy Airport. No detailed study of this alleged damage to the marshland has been made, however.

An indirect effect of air pollution on Jamaica Bay is produced by the absorption of pollutants into the water. This effect has not been examined quantitatively, but is presumed to be small. There are evidences of hydrocarbons in the sediments of Grassy Bay next to Kennedy Airport, but this effect is thought to be a consequence of petroleum discharges into the Bay from various sources.

New York City's General Air Pollution Problem

If the problem of Kennedy Airport's aircraft pollution emissions appears to be relatively unimportant, this is only because the airport is located within the dense urban environment that is New York City. New York City has a general problem of severe air pollution, unconnected with its airports, derived from the immense emissions of automobiles, space-heating plants in buildings, incinerators, and power plants.

A prime culprit here, as everywhere in the United States, is the automobile. Little has yet been done on the difficult national task of reducing automobile pollution, and, because of the dependency of Kennedy Airport on automobiles and buses for ground access, it is important to consider the contribution that airport-generated vehicles make to the airport environs.

Automobile Emissions at Kennedy Airport

It has been suggested that the emissions of automobiles, trucks, and buses serving Kennedy Airport are at least as important in polluting the air of the airport and its environs as the jet aircraft operating there. This factor can be estimated roughly in two different ways. One measure is a comparison of the density (in miles per square mile) of heavily used traffic arterials on Kennedy Airport and in typical urban or suburban areas. (The vehicle traffic on the Van Wyck Expressway Extension on Kennedy Airport is observed to be but little less dense than on the feeder thoroughfares, the Van Wyck Expressway and the Belt Parkway.) Another measure is a comparison of the pollution produced per passenger within a radius of a couple of miles of the airport by the aircraft he flies on and by the automobile he comes or leaves in.

On either basis, it is concluded that the automobile contribution is not insignificant, and is of the order of half the jet aircraft pollution, on the average. Since the jet-pollution emission densities are less than urban averages, the pollution in the surrounding communities from

[4] M. Nolan, "A survey of air pollution in communities around the John F. Kennedy International Airport," Public Health Service, DHEW, Taft Sanitary Engineering Center, Cincinnati, June 1966.

[5] "Nature and control of aircraft engine exhausts," U.S. Senate Document No. 91-9 (DHEW), U.S. Gov't Printing Office, Washington, D.C., 1969.

[6] N. Milford, G. McCoyd, L. Aronowitz, and J. Scanlon, "Air pollution by airports," Grumman Research Dept. Rept. RE 383J, July 1970.

[7] James A. Fay, "Air pollution from future giant jetports," Preprint 70–78, Air Pollution Control Association, June 1970.

automobiles serving Kennedy Airport should be less than that from other automobiles in the communities. However, a more thorough study of this problem is needed before a more accurate assessment can be made.

Water Pollution

Residents and officials representing communities of the Jamaica Bay and Kennedy Airport environs almost invariably complained to Study Group interviewers that pollution of the bay and its estuarine areas by "oil" has been a serious local problem. Some complaints were expressed in terms of the difficulties boat owners have in keeping hulls and fittings clean, while others reflected general disgust or fear of fire and explosion. Most complainants associated the oily pollutants with Kennedy Airport.

The technical aspects of water quality in the Bay generally are discussed in Chapters 2 and 4 of this report, but it is important to emphasize here that there is ample cause for concern among residents of the communities in the airport environs about water pollution as a local environmental consequence of the airport's existence. Studies indicate that there is a real and potentially serious type of pollution in Jamaica Bay owing to the spillage and leakage of petroleum products used at the airport. The hazards of such pollution to the local communities include specifically damage to beaches and tidal marshes, wildlife, and recreation facilities, and also fire and explosion hazard.

Major hazards to safety and to fish and wildlife come from accidental spills that discharge large quantities of petroleum products in the Bay. Such incidents have been rare. A severe explosion in June 1970 damaged the Jamaica sewage-treatment plant; it was due to a volatile liquid, believed to be gasoline. The source of this inflow is suspected as having been on Kennedy Airport, but the actual origin remains undetermined. Although oil discharges into the Bay of identifiable origin that are sufficiently serious to warrant legal action are rare (there were three in fiscal year 1970), the potential for a major accident remains great.

It does not take a major spill to damage the water quality for recreation or wildlife. All petroleum products are toxic to marine life in varying degrees. An oil or kerosene slick on the water surface severely degrades the water for recreational purposes. The experience of a variety of observers, including small-boat operators, federal fish and game wardens, the manager of the New York City Wildlife Refuge, U.S. Coast Guard officers, and inspectors for the U.S. Army Corps of Engineers, suggests that oil slicks are present on parts of Jamaica Bay much of the time. It is apparent that many beach and marsh areas are fully polluted by oil spillage, and the almost inescapable conclusion is that the communities near Kennedy Airport are indeed bearing a substantial burden of environmental degradation as a result of the presence of the airport itself and the careless handling of fuels and other oil products.

Falling Objects

An aspect of environmental degradation for the communities in the environs of Kennedy Airport is the hazard posed by objects falling from planes passing overhead during landing or takeoff operations at the airport. While falling objects present a significantly lower level of hazard than crashes involving entire aircraft, the increasing frequency of such occurrences, involving aircraft wheels, landing gear, and miscellaneous metal items, has demonstrated potential to increase the anxiety of residents in the airport approach zones. The probability of serious bodily injury or loss of life associated with objects falling from overflying aircraft is relatively low in the environs of most airports, but property damage involving homes, automobiles, and commerical facilities may be extensive. Frequently, psychological shock may be experienced by persons involved in or aware of such an incident. As a consequence, the reality of heightened exposure to falling objects cannot be dismissed as an aspect of environmental pollution in the communities that comprise the environs of Kennedy Airport.

EFFECTS ON COMMUNITY DEVELOPMENT AND CHANGE

The communities of the environs of Kennedy Airport are subject to some of the most dynamic forces of change in the metropolitan region. Many of these forces are associated directly with the growth of aviation at the airport, while others derive from economic and social pressures of the metropolitan area and have their effects in the communities of the airport environs in spite of the airport's influence. Frequently, the presence of the airport and its influences in the surrounding communities produce direct conflict between some of the critical forces of urban change, both in planning and in actual development.

Pressure for Incompatible Land Usage

The crowding of facilities on the Kennedy Airport site and the great intensity of its air traffic operations combine to produce substantial pressures for the development of land in the nearby communities to establish airport service and support functions. Such development may include motels, restaurants, warehousing, aviation industry dealerships, and a wide variety of commercial facilities ranging from food caterers to rental-car agencies. Nearly all such operations require close proximity to the airport; thus the operators are willing and able to pay premium prices for nearby land. The result of such economic pressures is often the pre-emption of sites in established neighborhoods well suited to long-term residential use. While conversion of sites in established neighborhoods may produce benefits in tax ratables of higher value and needed service functions in support of a growing aviation industry, such development frequently degrades the quality of the neighborhood environment by introducing heavy truck and other commercial traffic, nighttime operations, and more or less extensive employee parking on nearby residential streets. The communities in the environs of Kennedy Airport provide numerous examples of this type of non-residential incursion into established or developing residential areas. Design and development standards may be applied to control the quality of such development and to ease the transition between potentially incompatible land uses, but the evidence is overwhelming that few, if any, such controls are in effect.

The rapid growth of the air-freight component of the aviation industry may be expected to generate especially strong pressure for non-residential areas in the environs of Kennedy Airport. The Tri-State Transportation Commission estimates that the existing floor area devoted to air-cargo uses outside the Kennedy Airport site is 800,000 square feet and reports that the immediate expansion needs of a dozen concerns engaged in the air-cargo business range from 50 to 300 percent. Translating their demand into single-story building and site requirements, the Commission estimates a need for about 180 acres of land for air-cargo industrial expansion in the airport environs.[8]

The proximity of the overcrowded airport also has the effect of escalating land values in the airport environs as property owners and speculators pursue profits from prospective developers of airport-related commercial facilities. Under such market circumstances, the only alternative for property owners with sites not actually suited for commercial or industrial use is to seek higher-density housing, however undesirable the site or setting may be for such a land use. A result of this speculative process is to compound the functional incompatibilities between residential and nonresidential development in the immediate airport environs so that both exist in an inefficient and often mutually antagonistic relationship.

Inhibition of Land Use and Development Planning

Public fascination with the growth of aviation has had curious and inconsistent effects on the process of planning for land use and development in the environs of Kennedy Airport.

For example, Floyd Bennett Field, a former Naval Air Station of 1,320 acres at the westerly edge of Jamaica Bay, is soon to be relinquished by military authorities and will become available for other use, either public or private or both, in some combination. Much of the tract lies within the noise-exposure zone of NEF 30 associated with Kennedy Airport, and public authorities, knowledgeable about the adverse environmental effects and typical human response to be expected under this degree of noise exposure, have advocated the use of the site for a general-aviation airport, intended in part to ease the congestion of Kennedy Airport. The logic of converting a former military airfield to a contemporary general-aviation airport is acceptable as far as it goes, but in this case the location of Floyd Bennett Field is such that its air-traffic operations would almost certainly interfere critically with those at Kennedy Airport under instrument-flight-rule conditions. In any event, aviation considerations have dominated the formulation of alternatives for the use of this strategic site.[9]

On a smaller scale, public authorities responsible for planning and development in the immediate environs of the airport and Jamaica Bay have consistently and systematically ignored the environmental factor of aircraft noise in both planning and building housing and other noise-sensitive facilities on sites exposed to substantial levels of aircraft noise generated by operations at the airport. The pattern of public actions suggests

[8] Tri-State Transportation Commission, *Metropolitan Aircraft Noise Abatement Policy Study—JFK International Airport*, June 1970, p. 11.

[9] Still other public agencies, reflecting undoubtedly greater optimism as to the adaptability of individuals to oppressive levels of aircraft noise, have advocated the development of the Floyd Bennett Field site as a new community with a population of up to 180,000 persons.

that aircraft noise may be ignored officially as long as the increments of population or residential acreage introduced into the noisy environment as a consequence of public policy are small enough, regardless of how many actions are involved. Evidence of the incremental approach to insinuating large numbers of people in new housing units into zones of severe aircraft-noise exposure is found in projects such as Louis H. Pink Houses, where nearly 1,500 dwelling units have been built on a site of about 31 acres, and in Twin Pines, where about 5,700 dwelling units were built on a site of 300 acres, and in the Linden Plaza project, where over 1,500 units were built on a site of about 16 acres. It is difficult at times to understand the rationale employed in the public development process, especially with respect to alleviating adverse environmental conditions, when the New York City Board of Estimate unanimously approves a zoning change to permit construction of a high-rise apartment project directly under the approach to an all-weather instrument runway, even though the expected noise levels, as described by FAA officials, would be "equivalent to a diesel freight train traveling at 50 miles an hour and passing at a distance of 100 feet every 45 seconds." [10]

Perhaps, as the foregoing example illustrates, public confusion and lack of municipal willpower to restrict land usage near airports that is incompatible with airport operations are reflected most frequently in the proliferation of development plans and zoning changes that ignore the noise-exposure factor. There is ample evidence, however, that even the most rudimentary principles of compatible land usage are sacrificed under still other pressures of expediency. For example, despite the long tradition of complaints against aircraft noise as an oppressive factor in the Town of Hempstead lying east of Kennedy Airport, with frequent references to the community undercurrents of fear associated with the potential crash hazard, the same community has failed to restrict in any way residential development in high-noise-exposure zones, and in fact has permitted new building construction in residental areas of severe noise exposure close to Kennedy Airport. Moreover, the Town of Hempstead has permitted a steady increase in the number of petroleum-fuel terminals, propane-storage tanks, refineries, and commercial gas holders in the area just east of the airport and well within the approach zones to the main intercontinental jet runway. All such structures and installations obviously represent potential conflagration breeders in the event of a future crash in the heavily developed area.

[10] *New York Times,* Oct. 25, 1967.

The apparent lack of official concern for both actual and potential adverse effects of aviation in the environs of Kennedy Airport amounts to an official concession that the growth of aviation is somehow to be accepted as the dominant and inevitable influence on public policy affecting both the development of land and the quality of community life, whatever the cost. The dredging of a major hole in the bottom of Jamaica Bay and the filling of 4,000 acres of tidal marsh to create Kennedy Airport on the site of the Idlewild Country Club is the obvious result of such an assumption being made more than 30 years ago. The extension of runway 4R-22L into Jo Co Marsh by additional filling of the Bay and the blockage of channels for needed tidal circulation in 1964 is yet another example of this concession. Still further evidence of the dominance of regional aviation interests over local environmental concerns is reflected in the failure of the FAA to promulgate rules affording adequate protection to communities near airports from excessive noise caused by takeoffs and landings, coupled with the decision of the federal courts that FAA nevertheless had pre-empted the field; thus, an ordinance of the Town of Hempstead, enacted under its police power to protect public health, safety, and welfare by regulating noise from overflying aircraft, was held invalid.[11] This decision, and others like it, have contributed greatly to the sense of futility of both residents of communities in the airport environs and their local officials about obtaining any relief from the oppressive effects of aircraft noise, air pollution, and lingering fears of crash.

It is this pervasive sense of futility that underlies, but does not excuse, the continuing actions of officials of the communities in the airport environs to intensify the development of land in the airport environs for uses patently incompatible with noise from operations at the airport. These actions also ignore the increasing potential for disaster created by encouraging higher population densities in the immediate environs of a major jetport, which is compounded by the proliferation of facilities for the storage of volatile and explosive fuels in the same areas. The pursuit of such land use and development policy is tantamount to a bizarre kind of

[11] *American Airlines, Inc.* v. *Town of Hempstead,* 272 F. Supp. 226 (E.D.N.Y. 1967), affirmed, 398 F. 2d 369 (2d Cir. 1968) certiorari denied, 393 U.S. 1017 (1969). The court recognized the distractions and discomforts caused by aircraft noise for residents of Hempstead, a suburb of New York City to the east of Kennedy Airport, and noted that ordinarily noise control would be a legitimate subject for the local police power, but stated "The legislation operates in an area committed to Federal care, and noise limiting rules as do those of the ordinance must come from a Federal source." (272 F. at 231).

environmental brinksmanship, the result of which must almost inevitably be a major disaster for both the aviation industry and the communities of the Kennedy Airport environs.

THE COLLISION COURSE OF AVIATION AND COMMUNITY INTERESTS IN THE KENNEDY AIRPORT ENVIRONS

Kennedy Airport provides the national prototype for major jetports in the United States moving inexorably toward a confrontation between airport and community interests. Many well-established and important jetports in urbanized areas throughout the country operate now virtually in a state of seige because of conflicts between the airports and their surrounding communities. The primary cause of the conflict is the noise generated by approaching and departing planes. The noise from ground run-up of aircraft engines aggravates the problem of community annoyance in the vicinity of some airports where engine-maintenance functions are performed.

Evidence of the growing conflict between communities and airports is apparent in the litigation brought by property owners to achieve relief from the adverse effects of aircraft-noise exposure and in a variety of political responses. Political response ranges from individual complaints about occasional noisy takeoffs and landings phoned to control towers by homeowners to the extreme of gubernatorial campaigns in which resisting the development of additional jetports to serve the metropolitan region becomes a salient issue. The pattern of community complaints against airport noise has intensified steadily since the introduction of jet aircraft into the commercial fleet a decade ago. The evidence of organized public protest against the airport-noise nuisance in the environs of Kennedy Airport is abundant. One particularly poignant episode of protest culminated in the formation of a 100-car convoy of irate residents of communities in the airport environs in an attempt to tie up Labor Day traffic on expressways and ramps serving the airport in order to call attention to their plight. It is significant that both the intensity of operations at the airport and the density of residential development in the immediate airport environs have increased since the time of that particular episode of concerted group action by the community against the airport-noise nuisance.

Residents in the communities of the Kennedy Airport environs who have risen to protest the degradation of their environment are the victims of inadequate public policies governing both land use and development planning and airport operations. It may be argued that not all residents of high-noise-exposure areas are unwitting victims of obvious weaknesses in public policy, inasmuch as many residents elect on their own initiative to reside in areas in which considerable noise may be expected and are under no apparent compulsion to remain there. Such an argument, however, ignores the reality that many new residents of high-noise-exposure areas are unaware of the accumulating evidence of either the severity of the noise to which they will be exposed or of their own likely inability to adapt over longer periods of time than is usually available for house-hunting. There is also evidence indicating that some prospective purchasers of homes in areas obviously vulnerable to aircraft-noise exposure are deliberately misled to believe that "runway closings" or the immediate advent of "quiet engines," or both, will assure that the property under consideration will have a satisfactory residential environment. The naïveté of such purchasers is perhaps regrettable and their vulnerability may indeed suggest the need for consumer-protection guidelines to enable the housing market to function more reasonably. The fact remains, however, that substantial and increasing numbers of residents of communities in the environs of Kennedy Airport are rebelling against the environmental onslaught that the growth of aviation has imposed upon their communities. The formation of such organizations as the Citizens for a Quieter New York and the Town–Village Aircraft Safety & Noise Abatement Commission (TVASNAC) in the Town of Hempstead, and the activities of these groups, provide ample evidence of the sense of determination among citizens to deal with the environmental-noise problem and of the growing sophistication of their approaches. The tenacity of the latter organization, which represents a number of the communities in the environs of the airport most beleaguered by aircraft noise and least obviously benefited by aviation, reflects the growing resolve of residents of the noise-exposure areas to mobilize full-time staff as well as volunteer efforts to persuade their officials and representatives at every level of government, including the United States Congress, of the need to obtain substantial relief. The recent establishment by the mayor of New York of an Office of Environmental Affairs, with responsibilities including the pursuit of means to obtain relief from aircraft-noise exposure and air pollution as well as other environmental adversities in the city, offers immediate evidence of the escalating level of official concern and initial action to respond to community pressures for environmental redemption.

Given the fact of conflict between the airport and the

communities in its environs, it is useful to review the elements of the central problem in order to appreciate more fully the apparent inevitability of an eventual confrontation. Reduced to its simplest elements, the central problem of aircraft-noise exposure may be considered in terms of the source of the sound emitted, the path through which the sound travels, and the receiver of the sound by whom it may be perceived as disruptive noise. Thus, the aircraft engine, the flight path the aircraft pursues, and the human being on the ground are the three critical factors that define the severity of the noise-exposure problem in the environs of Kennedy and any major airport. Attempts to obtain relief from the problem of environmental pollution have been directed sporadically toward all three of these critical components of the aircraft-noise-exposure problem. They include attempts to produce a quieter engine, to regulate flight paths so as to avoid populated areas, to remove people from noise-exposed areas and to prevent their occupancy of such areas.

Unfortunately, the communities in the environs of New York's Kennedy Airport face the hard fact that the two components of the noise-exposure problem most susceptible to their manipulation are either already at their practical limits or are inaccessible because of lack of planning and development policy in the past. The first remedy—flight-path controls designed to divert approaching and departing planes away from populated areas and crowded airspace in the metropolitan region —necessitates turns by approaching and departing planes that are already considered an excessive compromise with flight safety by some pilots and airlines. The second remedy—preventing settlement in noise exposed areas—is beyond reach because the pattern of land usage in the environs of the airport and in most of the 50 square miles in the noise-exposure zones is already set with predominantly noise-sensitive residential development. Accordingly, the communities of the environs of the airport face primarily a problem of obtaining remedial relief from noise exposure rather than an opportunity to prevent the emergence of a problem. The third approach to obtaining relief from environmental noise generated by aircraft—based on engineering modifications to aircraft engines—is only remotely susceptible to influence by the communities of the New York airport environs, inasmuch as research on such modifications is almost entirely within the purviews of the federal government and the aviation industry. Some influence over the progress of such research may be exercised by embattled residents of the communities in the environs of Kennedy and other airports, however, insofar as their demands for relief from the effects of aircraft noise are reflected in expediting research already under way and, more importantly, in compelling the adoption of quieter engines in all aircraft in future commercial service.

It is too late to obtain relief from noise exposure for at least 300,000 residents of the communities in the environs of Kennedy Airport through the belated application of rudimentary land-use planning principles that would have avoided home building in high-noise areas. It is important, however, not to dismiss this approach to dealing with the environmental-noise problem altogether. The fact that the shores of Jamaica Bay represent for the New York metropolitan region the path of least resistance for the construction of sorely needed housing and other facilities necessitates even greater care in land use and development planning in the present than the city of New York and other agencies have exercised in the past. The current urgency for more sensitive land-use planning is underscored by the sheer lack of available open acreage in the first place, by its unique characteristics as waterfront land suitable for a variety of purposes, and by the ecological and conservation considerations raised by the Bay itself.

The collision course between aviation and community interests in the environs of Kennedy Airport will be influenced more by lack of attention in recent years to basic principles of land-use planning than by the legacy of land-development patterns set before the jet age. It is pointless to deplore the imperfections of historical land-use patterns in the vicinity of airports or any other facility capable of exerting an environmental influence of large magnitude, but it is equally pointless to seek justification for contemporary development in obsolete precedents or standards of land use and environmental quality control. Unfortunately, an apparent reliance on such obsolete precedents has characterized many of the development decisions and plans that have been carried out and are currently under way in the communities surrounding Kennedy Airport.

An analysis of the development of the margins of Jamaica Bay since 1959—the beginning of the jet age in commercial air transportation—indicates that approximately 4,500 acres of tidal marshes, ponds, open water, and low-lying land have been pre-empted by land fill and subsequent development, primarily residential, in the communities bordering the Bay in New York City and in Nassau County. This acreage is almost equal to the present size of Kennedy Airport itself, and lies for the most part within noise-exposure zones of NEF 30 or higher. It is significant also that, during the decade of this progression in bayside development for residential uses, the zones of noise exposure of NEF 30 and greater were being extended incrementally outward from the airport to include more and more developed

and developing areas each year as a function of the steadily increasing intensity of air-traffic operations at the airport and of the increasing size, power, and sound output of the aircraft comprising the commercial fleet. This process of urbanization is analogous to the otherwise routine construction of a community on a river flood-plain, even in the face of continually rising water. In the environs of Kennedy Airport, the steadily increasing inundation is by the invisible influence of noise, which, unlike the conventional flood, shows no prospect of receding. Unfortunately, almost none of the several thousand homes built in the "noise-inundation area" incorporated design features that would have afforded a measure of greater compatibility by insulating the buildings against the intrusion of aircraft noise.

Since the advent of zoning in the United States in New York City in 1916, one of the principal objectives of city plans has been to achieve functional compatibility among land uses with basically different characteristics. Zoning was quickly adopted across the United States because of the recognized economic and related benefits of controlling the development of land so as to avoid situations in which different types of land use with conflicting characteristics would create hazards or conditions inimical to the public health, safety, and welfare.

The rapid acceleration in the growth of aviation and the introduction of new jet-engine technology in the 1950's completely outstripped the capabilities of most communities, including New York City, to plan realistically or to implement proposals for achieving compatible land usage with respect to the airports and their surrounding communities. Whatever compatibility might have existed between any airport and its environs during the era of piston engines and small aircraft was almost hopelessly compromised by introducing a quantum change in the noise-generating characteristics of the airport itself as jets were introduced. As a consequence, many airport operators mistakenly concluded that the initial zoning intended to protect airports was the villain responsible for the emergence of conflicts between airports and their surrounding communities throughout the United States during the 1950's.

The record of public actions to achieve land-use compatibility in the vicinity of Kennedy Airport in the interests of either the airport or the surrounding communities is at best a tribute to the politics of environmental confrontation. Despite the intensification of community objections to noise from aircraft operations at the airport, both New York City and the adjacent Town of Hempstead have continued to encourage, through both subsidy and conventional zoning policy, the intensification of noise-sensitive land uses in well-known areas of severe aircraft-noise exposure. In several cases, federal and state financial assistance has provided direct encouragement to build still more dwellings in the same zones of noise exposure.

Land uses that are particularly sensitive to aircraft-noise exposure include schools, churches, and health facilities as well as housing. Figure 3-4, referred to earlier, shows exposure of schools. Exposure of hospitals and health-care facilities is shown in Figure 3-5.

Direct public action to escalate the conflict between Kennedy Airport and the communities in the airport environs has succeeded in expediting the introduction of a total of approximately 31,000 dwelling units within the NEF 30 area along the margins of Jamaica Bay. All these dwelling units have been established or have reached the advanced stages of project planning and commitment to construction during the past 10 years, or the era of jet aviation growth at Kennedy Airport. The total population already added or almost inevitably to be introduced into the high-noise area in the airport environs through the provision of these dwelling units by specific public-project activities is estimated conservatively at 185,000 persons, or about 27 percent of all the people now living within the contour of NEF 30. As suggested earlier, experience throughout the country in recent years confirms the likelihood that significant numbers of people and groups in areas of NEF 30 will raise formal objections to the amount of aircraft noise that already characterizes their environment. Thus, public policy to encourage the provision of housing for people in the metropolitan region has the effect of drawing a noose of community protest increasingly tighter about the principal jet airport upon which the economy of the region is said to depend.

Most of the new housing built or being planned in the high-noise areas associated with Kennedy Airport is in the City of New York. Figure 3-6 indicates the location of the publicly assisted projects involved in relation to the contours of NEF 30 and 40. Table 3-2, prepared by the New York City Planning Commission, gives several significant characteristics of each of these projects, including the agency responsible for planning and project implementation. It is particularly significant that none of the projects built to date has incorporated noise-abatement design features, such as double glazing on windows and acoustical treatment of key structural members or openings and duct work within the buildings, and that there exists only a vague suggestion that any of the projects now being planned for construction in the high-noise areas will receive any protection from intrusive aircraft noise in the course of architectural design. Interviews with public agencies responsible for planning and construction of these projects typically produced a reaction of indifference or ignorance with

TABLE 3-2 Publicly Assisted Housing Projects in High-Noise Areas (NEF ≧ 30) (Data Furnished by New York Planning Commission) [a]

Project	Key [b]	UR	State ML	City ML	Public Hsing	FHA	Area (Acres)	Dwelling Units	Completion Date	Status	Planning Agency	Noise Reduction
Arverne Urban Renewal Project a number of single projects	11	X	?	?	?	?	375.0	6500	December 1974 or a little later	Start Spring 1971	HDA/UDC	No
Fairfield Towers	2	—	X	—	—	—	16.0	1148	1965	Completed	HDA	No
Linden Plaza	3	—	—	X	—	—	16.3	1525	Winter 1971–1972	Under construction	HDA	No
Louis H. Pink	4	—	—	—	X	—	31.1	1500	September 1959	Complete	NYCHA	No
Nordeck houses	12	—	X	—	—	—	5.0	342	1960	Complete	HDA	No
Fresh Creek	5	X	—	—	—	—	260.0	2500	Uncertain	Study area in planning	HDA/CPC	No
Pennsylvania Ave. Area Wortman Ave.	6	—	—	—	X	—	5.3	336	Estimate July 1971	Pending construction	NYCHA	No
Twin Pines (about ¼ of Spring Creek)	7	X	—	—	—	—	300.0	5700	Spring 1974	To begin construction	CPC	Maybe
Hammels-Rockaway Urban Renewal	9	X	—	X	X	—	60.1	2248	December 1967	Complete	HDA	No
Seaside-Rockaway Urban Renewal	8	X	—	—	—	—	46.1	1416	December 1967	Complete	HDA	No
Bay Towers East and West	10	—	—	X	—	—	3.8	372	June 1972	Working drawings in preparation	HDA	No
Norton Basin	14	—	X	—	—	—	4.5	1400	Uncertain	No plans made yet	Private developers	No
Seaview Towers	17	—	—	X	—	—	4.0	400	June 1973	Re-design	HDA	No
Atlantic Gardens	16	—	—	X	—	—	6.5	700	June 1974	Pre-planning	HDA	No
B. 41st St. B. Channel Dr.	15	—	—	—	X	—	18.9	712	December 1972	Construction in progress	HA	No
Israel Sr. Citizens	18	—	X	—	—	—	2.9	409	In suspense	In suspense	NSDHCP	No
Ocean Park and Ocean Tower Apts.	19	—	—	X	—	—	3.2	600	January 1972	In construction	HDA	No
Roy Reuther	20	—	X	—	—	—	4.5	889	September 1972	In planning	NSDHCP	No
157th Ave. 79th St.	1	—	—	—	X	—	10.7	576	If contract is awarded, July 1972	Uncertain, planning finished	HA	No
Edgemere houses	13	—	—	—	X	—	30.0	1395	1960	Complete	NYCHA	No
Totals							1250.1	30,668				

[a] Abbreviations and acronyms:

UR—Federally assisted urban renewal
State ML—State-aided Mitchell-Lama
City ML—City-aided Mitchell-Lama
Public Hsing—Federally assisted low-income housing
HA—Housing Authority
CPC—City Planning Commission
FHA—Federal Housing Adm.
HDA—Housing Development Agency
NSDHCP—New York State Dept. of Housing and City Planning
NYCHA—New York City Housing Authority
UDC—Urban Development Corp.

[b] Key to projects shown in Figure 3-6.

respect to the present or projected levels of aircraft noise and their implications for eventual community annoyance and protest.

One of the more remarkable examples of questionable public policy in siting noise-sensitive facilities in a high-noise environment near Kennedy Airport is the proposed New York State School for Retarded Children, an institution to be built by the State Mental Hygiene Development Corporation on a 210-acre tract in the Spring Creek area of Brooklyn. This tract lies partially within the noise-exposure zone of NEF 40. Elsewhere in the United States, community annoyance in zones of this level of noise exposure has been sufficiently intense to require acquisition and clearance of several hundred dwellings from exposed areas to sustain marginal compatibility of the airport with its surrounding communities. There are indications that the proposed School for Retarded Children will have the benefit of acoustical treatment in the design and construction of school and hospital buildings, but it is doubtful that exterior noise levels compatible with any but the most dreary definition of environmental quality can be achieved at this site.

In addition to the nearly 35,000 dwelling units already built or under development by the City and State of New York in Brooklyn and Queens, the Town of Hempstead in Nassau County has undertaken an urban-renewal project with federal assistance to provide 176 units of low- and middle-income housing in the NEF 30 area generated by the principal intercontinental jet runway at Kennedy Airport. This new housing will be located in Inwood, a neighborhood characterized by a diverse mixture of industrial, commercial, recreational, and residential land uses and occupied by a predominantly black population. The project area is only one and a half miles beyond the end of the runway. While the provision of new housing in the area is a public gesture undoubtedly appreciated in the immediate community, the failure to include acoustical treatment against intrusive aircraft noise in the new dwelling units may well challenge the adaptability of future residents to the Inwood noise environment.

A pervasive concern among communities in the Kennedy Airport environs is that the collision course of aviation and local community interests will culminate in a disastrous crash. Major airline disasters in which large passenger planes have fallen into populated areas are not without precedent in the New York metropolitan region. Experience in the metropolitan region since 1951 indicates that one major crash occurs for approximately every 740,000 landings or takeoffs by domestic and overseas airlines at the region's three principal airports. Records indicate also that the vast majority of all such crashes occur within a 10-mile radius of the airport that the aircraft was approaching or leaving. This evidence alone suggests the heightened vulnerability of communities in the immediate environs of Kennedy Airport to potential crash hazard. The fact that two crashes of large jet aircraft occurred during the late summer months on the runways at Kennedy Airport itself, almost predictably according to the accumulated number of operations in recent years, provides little relief for communities in the airport environs from the lingering fear of crash that proximity to a major airport creates.

EMERGENT POLITICAL AND SOCIAL ISSUES

The uneasy relationship between Kennedy Airport and its surrounding communities raises several important issues with implications for the future of the airport, the development of communities in the airport environs, and the formulation and pursuit of both social and environmental policy.

Jamaica Bay, an Environmental Backwater Surrounded by Subsidized Housing

The apparent trend of development on the margins of Jamaica Bay suggests the presence of a subtle influence of aviation on the communities in the airport environs that may have profound implications for the eventual character and quality of community life. While it is unpopular to acknowledge the blighting effects of aircraft operations and especially aircraft noise for broad areas, the fact remains that it is for most people less desirable to live in a noisy area and one in which there is a decidedly higher probability of crash hazard than it is to live in an area without these characteristics. Accordingly, the demand for land for residential use in the immediate environs of airports is more marginal than the demand for land in areas free of airport influence. The marginal demand for such land and its more marginal values are reflected in the lower cost and value of housing constructed in such areas. There are, of course, exceptions to this general pattern, especially when other advantages of location serve to offset and sometimes override the blighting influence of environmental noise or other objectionable aspects of airport proximity.

In the environs of Kennedy Airport, and especially along the margins of Jamaica Bay, the trend in recent housing construction has been strongly slanted toward

publicly subsidized housing, including both federally assisted low-rent housing, state-aided housing, city-aided housing, and various forms of subsidy provided by the Federal Housing Administration. Figure 3-7 indicates the pattern of publicly assisted housing that has developed in the margins of Jamaica Bay largely since 1950. Much of the acreage on the margins of the Bay has been developed for housing subsidized under such programs and, as a consequence, the population and characteristics of development are becoming increasingly homogeneous and oriented to lower-income groups living at relatively high densities of development. Such a trend tends strongly to accelerate, inasmuch as there are no offsetting factors in the real estate market to attract more diversified development and people of other income groups.

It is significant that the principal exceptions to this trend are relatively low-density, primarily single-family developments such as in Woodmere and Howard Beach, which in and of themselves are relatively homogeneous. These low-density developments tend to become enclaves, such as Howard Beach, and, given the different life styles that their residents may pursue, pose differing demands for recreation and other service facilities than do the much larger and more heavily subsidized housing projects with which they share the shores of Jamaica Bay. As environmental quality declines in the Bay margins, these enclaves are increasingly susceptible to abandonment by their original settlers. Subsequently, such communities become increasingly marginal in the housing market, with the result that they eventually become occupied by families of relatively lower income, and thus the process of homogenization of the communities along the Bay margins progresses.

The significance of this process is that, as the Bay margins are developed, either initially by high-density publicly subsidized housing or eventually by middle- and lower-income groups, the capability of the community to effect restoration of any existing environmental deficiencies through the political process declines. Moreover, families in need of public housing, or some lesser subsidy for housing in a metropolitan area with an acute housing shortage, are demonstrably less articulate and less likely to complain about environmental adversities that would be held intolerable by higher-income groups. Thus, it is not too difficult to project an image of the future of Jamaica Bay in which nearly the entire periphery of the Bay within the Boroughs of Brooklyn and Queens is developed by relatively high-density subsidized housing, attracted initially by the availability of marginal sites at marginal costs, but relegated for the foreseeable future to a stultifying environment reverberating with aircraft noise night and day, reeking of fumes, grimy from particulate matter settling through the air, and deprived of adequate recreation facilities by the pre-emption of the remaining available land for airport-related commercial and industrial facilities. Obviously, such a future for the communities of the Jamaica Bay/ Kennedy Airport environs would be an unintended long-term consequence of the current public preoccupation with aviation growth, but the present trends that might make it a reality cannot be ignored.

Need for Reciprocal Limits on Airport and Housing Development in Airport Environs

Whenever conditions of conflict between an airport and the surrounding communities exist, both airport operators and local community officials face a dilemma: whether to encourage the development of still more incompatible land usage in the airport environs, and thereby intensify the conflict, or attempt to reduce the potential conflict by regulating and restricting growth of the airport itself. Unfortunately, there exists neither a forum nor adequate information in most metropolitan areas for evaluating the actual costs and benefits to either airport or community of imposing controls on either land use or airport operations to reduce the conflict between an airport and its neighbors. Neither airport operators nor the nearby communities have shown great enthusiasm for restricting their respective components of the process of urbanization, and the effect has been to exacerbate the conflicts in most areas until extreme measures, such as condemnation of developed land for airport expansion, are adopted as temporary expedients under pressure of a situation growing dramatically worse. Thus, in the absence of any reciprocal limits on either noise-generating aircraft operations at an airport or the intensification of noise-sensitive land usage in the airport environs, a process of incremental intensification of incompatible land usage is pursued by communities simultaneously with the independently competitive efforts of the airports to intensify flight operations in pursuit of greater capacity for what may be patently undersized facilities.

There is no rational basis for an assumption that airports, regardless of size, location, or the pattern of surrounding land uses, should be expanded indefinitely at the expense of environmental quality for residents of the adjacent communities. Neither is there any rational basis for a public policy that persists in intensifying the degree of incompatibility between a well-established airport and its surroundings by encouraging the construction of housing, schools, and other noise-

sensitive facilities in locations of known noise exposure. There is still less rationality in the use of federal public funds to compound conditions of community-airport incompatibility by subsidizing both noise-generating operations and the construction of building or encouragement of land uses incompatible with airport characteristics, especially in well-known zones of high noise exposure. Proper development of the airport and its surrounding communities requires that reciprocal limits be established for both airport-noise-exposure zones and land development that would be compatible with aircraft-noise exposure. Both the airport and the municipal government have an obligation to provide a high quality environment for new and established communities which implies placing limits on aircraft-noise-exposure zones and on residential development in exposed areas.

Ineffectual Noise Monitoring by PONYA

For several years PONYA has maintained a system of aircraft-noise-monitoring stations in fairly conspicuous locations in neighborhoods surrounding the airport. These monitoring stations consist of microphones mounted on public utility poles, together with apparatus for relaying sound-level readings to a central measuring and recording device at the airport. The noise-monitoring stations are located on the axes of the major runways at the airport and seem to be well known to residents of the established neighborhoods.

Unfortunately, it is difficult to perceive that the PONYA noise-monitoring system brings much aircraft noise abatement to the neighborhoods in the airport vicinity in which noise has become an increasingly oppressive environmental factor. First of all, the monitoring system is used only to measure takeoff noise, even though national experience, substantiated by our own survey, indicates that the great majority (80 percent) of community complaints about aircraft noise are generated by the more sustained and shrill engine noise characteristic of jet aircraft approaching airports for landings. PONYA claims no responsibility for planes landing until they actually touch down on the runway. This is an exceedingly fine point, which, though perhaps legalistically defensible, is viewed by residents in noise-affected areas as a misleading and evasive tactic by PONYA.

Second, it seems clear that the great majority of aircraft taking off on any of the noise-monitored runways execute turns very quickly after breaking ground contact and follow headings that avoid the monitoring stations by margins of a half-mile and often more. Thus very few aircraft ever pass directly above one of the fixed noise-monitoring stations, and the stations seldom record violations of the PONYA 112-PNdb limit on noise. Few airlines "ring the bell' often enough to incur any severe criticism for violating either the intent or the letter of the very liberal PNdb limit established by the PONYA regulation on takeoff noise. Pilots testifying before our study group readily confirmed the fact that many take what amounts to evasive action to avoid the noise-monitor locations in order to be spared the nuisance of responding to an official PONYA report or reminder that excessive noise was recorded by a monitoring station during takeoff for a given flight.

Many residents of noise-exposed neighborhoods seem to regard the noise-monitoring microphones as pathetically ineffectual gestures toward environmental-noise abatement. Some residents also view quite cynically the continuing efforts of a major airline company to "monitor the monitor" by placing a sound truck at each monitoring location with sufficient equipment to enable the operator to warn pilots of approaching planes of overly noisy takeoffs, so that corrective measures can be taken in the cockpit before the PONYA system records a violation. Theoretically, such advance warning should help to keep noise levels within the specified limits, but it appears as a practical matter that it serves mainly to divert most aircraft away from the monitoring stations. They may indeed be generating noise above the specified levels as they pass over neighborhoods lacking "black box" monitors.

Credibility of Federal Environmental Policy Guidelines

For several years agencies of the federal government have acknowledged the principle of considering adverse environmental factors when planning for residential development. This principle provides the basis for a direct approach to the prevention of harmful, unhealthy, or annoying conditions through land-use planning and building design. As new factors in environmental quality are perceived and become understood, usually under the pressure of worsening conditions and political outcry, guidelines for federal participation in development that might be adversely affected by such environmental factors are promulgated, and occasionally standards are devised. Such has been the case with respect to the environmental factor of aircraft noise in the vicinity of airports. The apparent indifference of the promulgating agencies of the federal government to their own guidelines and to the environmental conditions that result, however, has seriously undermined the

credibility and effectiveness of federal, state, and local government efforts to work toward environmental protection for people. This is apparent in the environs of Kennedy Airport and especially along the shoreline of Jamaica Bay.

Some of the most conspicuous failures of long-standing federal guidelines potentially affecting the quality of residential environments and the compatibility of major airports with their surrounding communities are evident in the non-enforcement of federal guidelines and regulations governing the construction of housing and provision of housing subsidies for residential development in areas exposed to intense levels of aircraft noise.

Since 1961, the Federal Housing Administration has given explicit recognition to the adverse effects of noise on properties near airports. A 1961 Commissioner's Letter to directors of all field offices of the agency expressed concurrence in certain conclusions reached by the FAA in a report on aircraft-noise abatement that "areas of 100 decibels of sound are not acceptable for proposed new residential development." [12] This initial position was refined to reflect improved methods of noise measurement developed in succeeding years, and in another communication in April of 1965, the Federal Housing Administration advised its insuring offices that "FHA concurs with the FAA that areas falling into the residential classification of Zone 3 [equivalent to NEF 40] are not acceptable for proposed new residential development. . . ." [13] Moreover, the Federal Housing Administration in the same letter further acknowledged that

if under the conditions applying to Zone 2 [equivalent to NEF 30 or greater] it may or may not be possible to develop properties that will be acceptable for mortgage insurance. While the exposure to sound in some instances will be severe, it may be possible that the use of acoustical treatment of a type and character acceptable to the market, such as sound-proofing, year-around air conditioning or other treatment to bring the exposure within the limits of acceptability insofar as sound is concerned.

In order to implement this element of federal policy, which was intended to prevent the construction of new housing in areas of high levels of noise exposure without incorporation of appropriate preventive measures in architectural design, the FHA Commissioner directed field offices to request from the FAA guidance and advice with respect to the effects of aircraft noise on residential properties in the vicinity of both civil and military airports. Accordingly, requests for FHA mortgage insurance presented to the agency by housing developers and financing institutions are routinely referred to the FAA for comment on the severity of noise exposure projected for the property in question.

Unfortunately, there is no evidence that any properties in the high-noise areas of the Kennedy Airport that have been proposed for FHA mortgage insurance have been rejected on the grounds of their obvious exposure to this adverse environmental influence. FHA, in fact, has been a regular participant in the financing of new housing in the high-noise areas in the environs of the airport, in both federally assisted urban-renewal projects and projects developed without other categorical public assistance. This is all the more ironic in the light of a report issued by the Federal Housing Administration on the subject of insulating housing from aircraft noise, in which the preface states: "It is, of course, not the intent of FHA to permit or encourage the construction of houses near airports or under the flight pattern near airports. This guide is intended for property owners who now find themselves located in areas subjected to bothersome aircraft noise." [14]

Still further evidence of federal concern about the adverse effects of aircraft noise in urban environments is found in a Presidential Memorandum of 1967 directing all the departments of the executive branch to cooperate with the Secretaries of Housing and Urban Development and Transportation to achieve compatible land usage in the vicinity of airports.[15] In addition, Congress has directed the Department of Housing and Urban Development to find means for providing homeowners relief from noise damages suffered in locations near airports. Section 1113 of the Housing Act of 1965 gives the Department of Housing and Urban Development (HUD) responsibility to "find means for providing relief from aircraft noise for homeowners in the vicinity of airports." In the light of this charge it is difficult to explain a decision by the Department to subsidize or otherwise encourage the use of land for housing in a known high noise forecast area.

Unfortunately, much has been lost in the translation of all such well-intentioned national policy into local action by both federal and local agencies of government. Congress has never provided funds to HUD for the purpose of carrying out the mandate of Section 1113. Moreover, both federal and local agencies of government are inclined to ignore existing criteria, guidelines, and policies or equivocate in applying them.

[12] Commissioner's Letter Number 1861, September 27, 1961, Subject: Analysis of Residential Properties Near Airports.

[13] PHA Underwriting Letter Number 1989, April 16, 1965.

[14] Federal Housing Administration, Department of Housing and Urban Development, *A Study—Insulating Houses from Aircraft Noise,* U.S. Government Printing Office, Washington, D.C., 1966.

[15] President's Memorandum to Heads of all Departments and Agencies in the Executive Branch, March 22, 1967.

In the environs of Kennedy Airport, for example, even though urban-renewal projects proposed by localities since 1965 have been referred routinely by the Department of Housing and Urban Development to the FAA to determine the vulnerability of redevelopment sites to aircraft-noise exposure, and in spite of the Federal Housing Administration policy not to accept properties in noisy locations for mortgage insurance, the Department of Housing and Urban Development has regularly approved and provided financial assistance for planning and carrying out residential urban-renewal projects in acknowledged zones of extreme noise exposure. These projects have been approved also despite the protests of the FAA and other aviation authorities.

The Inwood Urban Renewal Project in the Town of Hempstead is a salient case in point. This project, in planning and study stages for nearly seven years, is located less than a mile and a half beyond the eastern end of Kennedy Airport runway 13-31, the primary runway for intercontinental and transcontinental jet traffic. The project is to provide 45 new units of public housing, about 236 units of new housing under mortgage-assistance programs supported by the Federal Housing Administration, and rehabilitation assistance for about 200 more existing dwellings. It is in an area already heavily developed for industrial and commercial use. The project area is entirely within the zone of NEF 30 and very nearly in the zone of NEF 40. Federal authorities have reviewed the degree of official commitment to this project several times in an uneasy search for mitigating factors, and have managed to rationalize their participation in the undertaking on the grounds that the project has progressed too far to change, even to the limited extent of providing special noise insulation in buildings. Residents of the area will simply have to adapt to the noise environment, but there remains the question of whether any federal funds at all should be used to promote housing in such marginal locations.

But the Town of Hempstead is not unique in neglecting noise as an environmental factor in residential development planning. In New York, beyond the westerly end of runway 13-31, lies the Spring Creek Urban Renewal study area in Brooklyn and Queens. The City of New York has obtained federal funds and seeks eventually to develop up to 10,000 subsidized dwelling units in a situation of noise exposure about equal to that in Inwood. Other urban-renewal funds have been expended already and still more development for housing is proposed in areas located within the contours of NEF 30 in the Arverne Urban Renewal Project, which lies along the Rockaway peninsula on the shore of Jamaica Bay on axis with two other Kennedy Airport runways.

It is incumbent upon both the Department of Housing and Urban Development and the Department of Transportation, as the major federal agencies involved in the planning and financing of such conflicting development proposals, to recognize the unproductive stalemate for the airport, the city, the surrounding communities, and the metropolitan region that must result ultimately from such classic examples of noncomprehensive environmental planning. At this advanced date in the evolution of these housing projects, nearly any compromise such as housing insulation can only hope to lessen, rather than avoid, serious environmental degradation for the eventual site occupants in the communities of the Kennedy Airport environs.

The central issue is not whether public policy should favor housing and urban renewal over aviation growth, as if there were no alternative to responding separately to these needs. It is, rather, whether and for how long one federal agency should subsidize the development of housing in a marginal industrial area in which it will bear the burden of environmental noise inherent in the operations of an airport subsidized by yet another agency of the same federal government.

It is not the bureaucracies, of course, but the people who occupy housing in such locations who suffer ultimately under such adverse environmental pressures. Agencies of the federal government have a special obligation to set and maintain high standards of environmental protection for people in planning and development of subsidy programs. It is urgent, therefore, that the scarce federal funds available for airport and housing assistance be used to set examples of an enlightened approach to environmental design for people, through compatible land-use planning, building design, and airport development.

4 EFFECTS OF IMPROVED TECHNOLOGY AND OF RUNWAY EXTENSIONS

INTRODUCTION

Airports comprise one element of a very complex air transportation system. Other major components are the aircraft and the air-traffic-control system. The interaction between these components is so complex and intense that it is not reasonable to consider major changes to one without due regard for the characteristics and evolution of the other two. In particular, if an expansion of the system's capacity is needed, as seems to be the case at New York, and specifically at Kennedy International Airport, we must ask what portion of that increase is best obtained by expansion of airport size, and what portion can better be obtained by improved usage of present space, e.g., through more advanced air-traffic control. (See Chapter 1 for a discussion of pricing and other administrative arrangements designed to increase the passenger-handling capacity of the New York system.) Similarly, if a limiting or reduction of noise impact on communities surrounding the airport is in order, as suggested in Chapter 3, we must ask whether this reduction should be attained by limitation of operations, by moving the airport, or by lowering the noise output of aircraft.

Such questions fall within the scope of systems analysis, provided (1) an objective basis for choice between the alternatives can be established, and (2) the characteristics of all components of the system can be defined in a mutually consistent way. In considering an expanded airport that will not be fully operational until 1978, we must project, to that time period, the technologies of air-traffic control and of aircraft, if condition (2) is to be satisfied and the system is to be near optimum when completed.

This point is less obvious than it may at first appear, because the capabilities of our air-traffic-control system in 1978, and the technology of aircraft at that time, will depend very greatly on the resources devoted to their development. The question is not simply what *can* be done, but rather what *will* be done. We shall summarize in this chapter those technological improvements in traffic control and in aircraft that seem technically feasible for implementation by 1978, and which could influence the need for airport expansion. Some suggestions are offered in other chapters of this report for ensuring that the necessary governmental actions are taken to bring about the implementation of these desired improvements.

The first requirement for a system analysis enumerated above is even harder to satisfy. There seems to be no single standard against which alternatives for proposed expansions of Kennedy Airport can be measured. Throughout this report we consider several possible airport-expansion plans, including one suggested to us by PONYA, and describe their consequences for Jamaica Bay, for air transport, and for the neighbors

of Kennedy Airport. More specifically, we have done some preliminary evaluations of the effects of the various expansions on the water quality, recreational capacity, and bird population of the Bay, on the capacity of the airport, and on community noise.

IMPROVEMENTS IN AIR-TRAFFIC CONTROL AND THEIR EFFECTS ON RUNWAY CAPACITY

The capacity of an airport for aircraft movements is limited by its capability for handling incoming traffic under the instrument-flight-rule conditions that require landings and takeoffs in the direction with least runway capacity. At some airports (e.g., Los Angeles International) the wind direction is sufficiently constant to make a single runway direction sufficient. This is not the case in New York. Here the prevailing wind is from the northwest, and the bulk of traffic (about 75 percent) operates from southeast (130°)–northwest (310°) runways, but northeast winds require operation in the northeast (40°)–southwest (220°) direction approximately 25 percent of the time during the months of January through June, and the worst weather conditions occur when the wind is in this sector. The number of flights that can be scheduled into Kennedy Airport is therefore limited by its instrument-flight-rule runway capability in the 4-22 direction, even though most of the air traffic is handled in the 13-31 direction.

Ordinarily, an airport gives priority to incoming flights under instrument-flight-rule conditions. Furthermore, the traffic mix during periods of peak demand tends to include more landings than takeoffs, the ratio in the afternoon at Kennedy being as high as two to one, so that the instrument-landing frequency with such a mix is the principal criterion of runway capacity.

Limits on Capacity

The landing frequency on a single runway, operating independently of others, is governed by the required spacing between aircraft on landing approach (currently three miles), by the ratio of landings to takeoffs, by the availability of aircraft for landing at the time an approach becomes permissible, and by the skill of air traffic controllers. Leaving the last factor aside for the present, we note that, if the availability of aircraft is assumed, a theoretical runway capacity can be readily computed for a single runway. But since aircraft tend to arrive in the vicinity of airports at random intervals, the average rate of arrival will coincide with the theoretical maximum landing rate only if there is a large "stack" of aircraft waiting to land.

The capacity of an airport with more than one runway is influenced in addition by interactions between the aircraft operating on the various runways, unless the runways are sufficiently separated to be utilized independently. Furthermore, an airport located in a complex of other airports, as is Kennedy, may be limited in part by the air-traffic-control capability in the region as a whole.

A comprehensive review of the technology of air-traffic control has been made by the Air Traffic Control Committee of the Department of Transportation, and summarized in their report issued in 1969. The conclusion of this study that appears most relevant to the present discussion is that the present air-traffic-control and instrument-landing systems are capable of improvements that could increase airport capacity by a factor of two, with present technology. Among the improvements suggested are: reducing minimum separation between runways for independent operation, from the present 5,000 feet to as little as 2,500 feet; dual-lane runways, which reduce the interference between takeoffs and landings; reducing minimum separation between aircraft on approach. In the following discussion, the implications of the first two suggestions for Kennedy Airport will be examined. Because of the uncertainties connected with wake turbulence, the gains to be had from reduced landing interval will not be included in our estimates of capacity.

There appears to be some considerable reluctance among airport planners to include reduced runway separations and dual-lane runways in their plans for airport expansions that will be operational in the 1975–1980 time period. This reluctance seems to be based almost entirely on doubt as to whether the air-traffic-control and instrument-landing capability required by these changes *will be developed;* it is *not* based on doubts about the *availability of the technology*. In the following discussion, we assume that the decision for implementation can be made, once the advantages of an advanced system are clear.

A second, farther-reaching conclusion of the Air Traffic Control Committee of the Department of Transportation is that a new ("fourth generation") air-traffic-control system, using central data processing and perhaps a series of satellites for position fixing, seems technologically feasible. It would offer major improvements in capacity and safety, offering an ultimate capability for three-dimensional location of all aircraft within a few feet. The steps necessary to ensure progress toward such a system are outlined elsewhere in this report.

SOME POSSIBILITIES FOR RUNWAY EXPANSION

We have examined the potential increase in capacity, and the impact on Jamaica Bay and the environs of Kennedy Airport, implied by several possible runway configurations. Their effects on capacity are discussed in this section. Environmental and noise effects are considered in later sections.

Because of the uncertainties concerning the reductions in runway separation that may be feasible by 1978, two classes of runway expansion are discussed. The first two configurations (1 and 2) are predicated on the implementation of reduced requirements for runway separation and/or dual-lane runways, and so indicate the gains in capacity possible with advanced technology. For a given capacity increase, they show much less incursion on the Bay than the second class of configurations (3 and 4), which are predicated on existing air traffic regulations regarding runway separation.

It should be noted that these configurations are not to be regarded as proposals for runway construction. Clearly many factors not considered in this chapter must be introduced before proposing a plan for construction. The various configurations are intended to serve only as a set of possible alternatives, within the scope of which a useful solution may be found.

The Present Airport

Before beginning the discussion of new runways, a description of the present airport and its limitations seems in order. A plan of the runways is shown by the full lines in Figure 4-1, which also shows the proximity to Jamaica Bay and the surrounding communities.

Kennedy International Airport is limited most severely by instrument-flight-rule weather, with winds in the northeast–southwest (hereafter termed 4-22) direction. These are the prevailing winds in instrument-flight-rule weather in the late summer, which is also the period of peak traffic.

One of the 4-22 pair, runway 4L-22R, is adequate for takeoff for international flights, its length being 11,350 feet. The other, runway 4R-22L, is considered short by international standards. Its length is only 8,400 feet, but it is equipped for instrument landings. A further limitation is caused by the close (3,000-foot) spacing between runways 4R and 4L. The two runways cannot at present be operated independently under instrument-flight-rule conditions in any mode.

According to the Department of Transportation report referred to above, the theoretical capacity of the airport operating in the 4-22 direction under instrument-landing conditions, with a landing/takeoff ratio of unity, is 35 landings per hour, or a total of 70 operations per hour. Currently, instrument-landing equipment is being installed on runways 4L-22R and 13R-31L. This will lead to a double instrument-landing runway capability in the 13-31 direction, but the airport will still be limited by its capability in the 4-22 direction because of the 3,000-foot separation between 4L and 14R.

Kennedy Airport has a greater capacity for operations in the northwest–southeast direction. Runway 31L-13R is 14,500 feet in length and meets international standards for takeoff. Runway 31R-13L is 10,000 feet in length, meets international standards for landing, and is equipped for instrument landing. Since runways 31L and 31R are separated by 6,000 feet, they can be operated independently.

The ground terminal area is being expanded to accommodate wide-bodied aircraft. The Pan American terminal is being extended toward the intersection of runways 4L and 31L, and plans have been drawn for the expansion of the International Arrivals Building in the direction of runway 4L.

Configurations Using Advanced Technology

If the runway separation required for independent operation can be reduced from the present 5,000 feet to 3,000 feet, then the present airport will provide two independent runways in each direction, increasing the limiting instrument-landing capacity from the present 35 to 59 landings per hour. This is shown in Table 4-1.

Configuration 1, shown by the dashed lines in Figure 4-2, involves a minimal expansion of the airport area. It requires construction of two new runways, parallel to the existing 4L-22R and 31L-13R, and separated from them by 1,000 feet. Assuming only that dual independent operation will be permissible at a 4,000-foot spacing, the capacity is 59 landings per hour. If in addition the runways with 1,000-foot spacings could be operated as dual-lane pairs, the capacity would be 65 landings per hour.

Configuration 2, shown in Figure 4-3, is similar to the first, but uses a larger separation between the new 13-31 runway and the present 13R-31L. This would allow the two southernmost 13-31 runways to carry the bulk of the traffic, so that the present 13L-31R could be phased out or used for STOL operations. As we shall see below, some noise relief would result. The capacity is the same as for Configuration 1, but more space would be available for aircraft parking and holding in the area between the old and new 13-31 runways.

TABLE 4-1 Effect of Technology and Configuration on Airport Capacity (Landings per hour [a])

Technology (Advancing Downward)	Present Fig. 4-1	Config. 1 Fig. 4-2	Config. 2 Fig. 4-3	Config. 3 Fig. 4-4	Config. 4 Fig. 4-5
1) Current air traffic control and instrument landing	35	—	—	59	65
2) 4000-foot separation for independence	—	59	59	—	—
3)–2) Plus dual-lane operation	—	65	65	—	—
4) 3,000-foot separation for independence	59	—	—	—	88
5)–4) Plus dual-lane operation	—	—	—	65	100

[a] Computed theoretical capacity, for landing/takeoff ratio of unity.

Configurations Using Present Technology

The third configuration, shown in Figure 4-4, would provide an increase in capacity under current instrument-landing rules, with minimum incursion on the Bay. It would entail constructing one new runway 4L parallel to old runway 4L (hereafter called 4C) and displaced 2,500 feet to the northwest from runway 4C, starting at present runway 13R (hereafter called 13C), and projecting 10,000 feet into the Bay. A second new runway 31L, of 10,000-foot length, parallel to runway 31C and displaced 3,500 feet toward the Bay, would be also required.

This configuration provides the following operations: in the 4-22 direction, independent landings can be made on new 4L and 4R, and on 22L and 22R. Independent landings on 4L and takeoffs on 4C are possible, but, because of the displaced 4C threshold, takeoffs on 4C are not independent of landings on 4R. Independent landings on 22L and takeoffs on 22R are possible, but independent operation is not possible with operations on 22C. In the east–west mode, runways 31C-13C and 31R and 13L can be employed for independent landings with independent takeoffs on new runways 31L and 13R. With the exception of runways 22, there is a capability for independent operation of two arrivals and one takeoff in each direction. Two capacity estimates are shown for this configuration in Table 4-1. The first estimate considers independent operation on 22L and 22R. The second estimate considers 22L and 22C as a dual pair operating independently from 22R. This is probably an overestimate since the separation between 4C and 4L is only 2,500 feet. A configuration more comparable with Configuration 1 would include a 500-foot shift of runways 4L and 4C to the northwest. It is noted that, while limiting capacity is identical for Configurations 1 and 3, the capacity of Configuration 3 in other directions substantially exceeds that of Configuration 1.

The final configuration, suggested by PONYA and shown in Figure 4-5, is similar to Configuration 3, except that the new runways are moved farther to the northwest and southwest, to give more than sufficient separation for operation independent of the present 13R-31L and 4L-22R. The rationale for placement of the runways with greater than the 5,000-foot FAA minimum separation for independent operation is that the configuration attempts to ameliorate the noise impact upon the surrounding communities. Independent runway operation is possible for all east–west runways, although intercontinental takeoffs would be placed on runways 31L and 31C. Independent runway operation is possible in the 4-22 direction between runways 4L and 4C, and between runways 4L and 4R, but non-independent operation is obtained between runways 4C and 4R because of the 3,000-foot separation. The same limitations obtain in the 22 direction.

Three capacity estimates are given in Table 4-1 for this configuration. The first assumes independent operation of 4L with the dual-lane pair 4C-4R. The second estimate assumes independent operations of 4L, 4R, and 4C. It makes optimistic, if not generous, assumptions with respect to developments in air traffic control. The last estimate assumes dualization of runway 4L and independent operations of 4C and 4R.

Reservations and Conclusions

PONYA has estimated that aircraft movements will increase by approximately 27 percent between 1968 and 1980. The increase in passenger movements is much larger, considerable gain being expected from the wide-bodied aircraft. It seems clear from Table 4-1 that any of the suggested runway modifications would yield more capacity than would be needed at that time, the increase being at least 60 percent.

It must be re-emphasized that these estimates have neglected other factors that might limit the capacity to a lower level than that allowed by the runways themselves. Among these are terminal facilities, aircraft holding and parking space, and ground transportation. All relevant factors must be carefully considered before any final judgment can be made concerning *airport*

capacity, as distinguished from *runway capacity.* In particular, we should note that PONYA presently has plans to construct an addition to the International Arrivals Building, which would conflict with the new 14L-22R runway in Configurations 1 and 2. The location of this proposed facility would have to be changed. It appears, however, that these questions are at least to some extent independent of whether the increase in air traffic is accommodated by large increases in airport runway area, or by more efficient use of the present area occupied by runways. We therefore feel justified in addressing the question of need for runway expansion independently of these many other issues.

It can be concluded that, with seemingly modest improvements in technology, Kennedy Airport should be capable of handling the expected volume of air traffic, with a small or moderate expansion of its physical size, provided the problems of ground congestion can be solved. A major expansion, such as in Configuration 4, would yield a potential capacity far larger than any current air traffic projection would justify, and quite possibly larger than any reasonable growth of ground facilities could cope with.

AIRCRAFT NOISE ABATEMENT THROUGH IMPROVEMENTS IN ENGINE TECHNOLOGY

As air service to major metropolitan areas increases, the impact of aircraft noise on communities surrounding the airport arouses ever-increasing resentment in the affected communities resulting from the increased level of operations. The force of citizen protest is such that we must recognize the noise problem as a major impediment to increased air operations.

Of the several means for relief from this problem—buffer zones around existing airports, resiting airports, limitations on operations, and *quieter aircraft*—only the last is completely under the control of the air transportation industry. For this reason it is most subject to internally rationalized decision-making, and should be exploited to the greatest possible extent. We argue that this has not been done to date, and offer some suggestions for doing it in the future.

The first commercial jet aircraft were powered by turbojet engines derived from military development programs, which were designed with no considerations of noise. When it was recognized that the noise levels of such engines would be intolerable for commercial use, attempts at noise suppression were made, with modest results. The commercial engines were also quieter because they were derated relative to the military versions, with a corresponding reduction of jet velocity. A major improvement was obtained by the conversion of this family of turbojet engines to turbofans, with a further reduction of jet velocity, and hence jet noise. The turbomachine noise (whine or pure tone) on approach, however, became more severe with this type of engine.

Recently, the second generation of turbofan engines has been introduced (JT9D-CF6-RB211) with the Boeing 747, and the forthcoming McDonnell Douglas DC-10 and Lockheed 1011 aircraft. These engines are turbofans with bypass ratios near five. They have lower jet velocities than the first-generation turbofans, and, by careful attention to fan design, the turbomachine noise has also been somewhat reduced, with the overall result that the 747, with potential passenger capacity of 500, is some 5 EPNdb quieter on takeoff, and nearly 10 EPNdb quieter on approach than 707's and DC-8's with less than half the capacity. The DC-10 and 1011 will have even lower noise levels, near 105 EPNdb on takeoff and 107 EPNdb on approach, in order to satisfy the Department of Transportation Noise Rule (FAR 36).

In order to predict future trends, we must ask why the improvements have occurred, and how further advances can be assured. The cited changes appear to have resulted in large part from a happy coincidence of the requirements for improved aircraft performance and the requirements for noise reduction. Thus, whereas jet-noise suppression on the first (turbojet) transports imposed a small increase (about 3 percent) in fuel consumption, the first-generation turbofan reduced fuel consumption by some 5 percent, relative to the unsuppressed turbojet, and increased the takeoff thrust of the basic turbojet. Its introduction was fully justified by these two factors, the reduction in noise being in this sense a bonus. Similarly, the increase in bypass ratio from 1.5 in these engines to 5 in the current generation of turbofans is, on the one hand, allowed by advances in technology, and, on the other hand, fully justified by the resultant improvement in fuel consumption. Considerable effort has been devoted to reducing the fan noise from these engines, but neither their fuel consumption nor their weight has been appreciably increased by the modifications required for noise suppression.

Our thesis here is that the aircraft and engine design should and in fact must be compromised by noise considerations in the future—by a rational tradeoff between performance and community noise impact. Major difficulties in realizing such a tradeoff arise from the great complexity, high development cost, and long development time of engines. To receive proper weight, design criteria must enter the process very early in the preliminary design sequence, and must somehow be put in quantitative terms.

The National Aeronautics and Space Administration (NASA) Program

An extensive research and advanced development program was initiated by NASA for this purpose in 1966. It includes a broad range of basic research, but is focused by two technological developments characterized as the quiet engine and acoustically treated nacelles. The first would lead to changes in the engine design, to reduce the production of noise. The second would provide acoustical absorption in the nacelles, to reduce the radiated noise, without modifying the engine. A comprehensive summary of the program is contained in a 1968 NASA report.[1]

To put these two programs in context, we must note that, in the first-generation turbofan (e.g., JT3D), the fan and the primary exhaust nozzle contribute about equally to takeoff noise, while the fan dominates on landing approach. In the second-generation engines (JT9D, CF6, RB211), the exhaust jet is quieter because the large bypass ratio reduces the jet velocity so that the fan tends to dominate on takeoff as well as on approach. Nacelle treatment, which is mainly useful for reduction of the fan noise, but not the jet noise, can therefore reduce principally the landing-approach noise of the first-generation engines, not the takeoff noise. It would be beneficial for both operating conditions if applied to the second-generation engines. In the quiet engine, the bypass ratio and turbine inlet temperature would be chosen so as to reduce the production of noise both by the fan and by the primary jet, thus reducing both takeoff and approach noise.

Nacelle Treatment

As presented in October 1969,[2] the NASA program had led to design and test of two types of treated nacelles for the JT3D engine, and preliminary cost analyses for each. A summary of the principal results of these two programs is given in Table 4-2. It will be noted that the "long nacelle," which provides longer fan-discharge ducts and more inlet treatment than the short nacelle, gives an extra 5 db of suppression on approach, but with a much larger weight penalty and at almost twice the cost.

The approach, sideline, and takeoff noise figures in parentheses are estimates of the actual level which would be produced by the heaviest versions of the aircraft with the treatment. They should be compared with 104 EPNdb on takeoff and with 107 EPNdb on approach and on the sidelines as regulated by FAR 36 for new turbofan aircraft of 350,000 pounds gross weight, with engine-bypass ratios greater than 2.

TABLE 4-2 Nacelle-Treatment Results

Program	Short nacelle	Long nacelle
Contractor	McDonnell Douglas	Boeing
Aircraft used in test	DC-8-55	707-320B
Noise reduction (EPNdb)		
Approach	10.5 (109)	15.5 (104)
Sideline	3.5 (103)	3.5 (103)
Takeoff	3.5 (115)	3.0 (115)
Performance		
Thrust	−3%	−1.5%
Nacelle weight	+3%	+30.0%
Range	+3%	−4.0%
Cost estimates		
Retrofit price	$650,000	$1,000,000
Direct operating costs	+4–5%	+9%

TABLE 4-3 Quiet-Engine Noise Estimates

Contractor	Allison		Pratt & Whitney	
Noise level (PNdb)	Total	Jet	Total	Jet
Takeoff	104	93	106	94
Approach	105	80	104	84

Source: *NASA SP-189 op. cit.*

Quiet Engine

Studies conducted by NASA [3] showed that the following design characteristics were desirable for noise reduction:

1. High-bypass ratio—a value of 5 giving most of the advantage
2. Moderate turbine-inlet temperature, near 2000°F on takeoff
3. Single-stage low-tip-speed fan (1,000 ft/sec on takeoff)
4. Fan rotation independent of compressor

Detailed design studies by Allison and Pratt & Whitney resulted in the noise estimates given in Table 4-3, for engines sized to replace the existing JT3D on the 707, DC-8 fleet. The results show that the jet noise can be held below 94 PNdb, with fan noise dominating on both takeoff and approach.

A preliminary nacelle design was carried out by Douglas for the DC-8-61.[3] It indicated that such en-

[1] *NASA SP-189,* Conference on "Progress of NASA Research Relating to Noise Alleviation of Large Subsonic Jet Aircraft," October 1968.

[2] *NASA SP-220,* Conference on "NASA Acoustically Treated Nacelle Program," October 1969.

[3] *NASA SP-189 op. cit.*

gines could be installed, with a slight improvement in range, and a reduction of 1,800 feet in field length, at an estimated cost of approximately $4,000,000 per aircraft. This design included nacelle treatment. If we carry over the short-nacelle test results in Table 4-2, we conclude that such treatment should result in a 10-PNdb reduction in fan noise on approach and takeoff. This would result in total noise levels *below about 95 PNdb under all operating conditions* for aircraft of 350,000 pounds gross weight. With a 3-db increase per doubling of weight, this corresponds to roughly 98 EPNdb for 747-class aircraft, or a 10-EPNdb reduction from the Department of Transportation rule.

Based on these observations, we conclude that the present fleet of 707 and DC-8 aircraft could be quieted to 95 PNdb for an added investment of approximately $4,000,000 per aircraft. Ignoring the improvements in performance that might accrue, such an investment implies a 7 to 10 percent increase in ticket price. There are serious problems in capitalizing such a retrofit of aging aircraft. It may not be economically feasible. On the other hand, one interpretation of these cited conclusions is that *new* aircraft with engines properly optimized to noise criteria, should be able to meet a new noise rule, 10 EPNdb lower than FAR 36, with less than 10 percent cost penalty.

The National Aeronautics and Space Administration is proceeding with the test of engines designed to the above criteria. It has also supported extensive component work on low tip-speed fans, the results of which are now in hand.

Department of Transportation Nacelle-Treatment Study

A more detailed design study of nacelle-treatment retrofits has been conducted by the Rohr Corporation under contract to the Department of Transportation.[4] It included estimates of cost for retrofit of nearly all existing low-bypass turbofan-powered aircraft, and a possible schedule for implementation. Briefly, the conclusions are that reductions of approximately 5 EPNdb on takeoff, and 10 EPNdb on approach, can be obtained for all current aircraft powered by JT3D and JT8D engines. The new investment required is of the order of $500,000 per aircraft, which results in an average (over all airlines) increase in direct operating cost of 4.5 percent. Assuming that a small fare increase would result in no decrease in use, this increase in direct operating cost could be offset by an increase of 0.4 percent in ticket price. According to the schedule assumed in estimating costs, the retrofit would be complete by the end of 1974.

[4] Rohr Corporation, "Economic Impact of Implementing Acoustically Treated Nacelle and Duct Configurations Applicable to Low Bypass Turbofan Engines," Report FAA-NO-70-11, July 1970.

Second-Generation Turbofan Engines

Of the four "quiet engine" characteristics, the new turbofan engines incorporate only the first, with the exception of the Rolls-Royce RB-211, which has an independent fan spool (item 4 of NASA's quiet-engine characteristics). The engines all have turbine-inlet temperatures in the range of 2250–2400°F, and all have supersonic fan-tip speeds. Small amounts of acoustical treatment have been incorporated to hold the fan noise near or below the Department of Transportation rule.

These engines have higher jet-noise levels than "quiet engines" of equal thrust because of the higher turbine-inlet temperatures, which have been set near the technological limit to maximize engine thrust-to-weight ratio and minimize fuel consumption. This consideration also governs fan-tip speed, and results in higher fan-noise levels than those projected for the "quiet engine."

SST Engines

The above discussion has dealt only with turbofan engines suitable for subsonic (or transonic) aircraft. The size of these engines is determined by takeoff requirements, and their design is largely determined by the requirements of subsonic cruise. Engines for supersonic aircraft are sized by the requirement for acceleration through the transonic speed range, and their design is dictated in large part by the supersonic cruise. Three results of the latter condition are a rather low compression ratio, a high turbine-inlet temperature, and afterburning. These latter factors combine to give a very high jet velocity on takeoff. The engine sizing due to the transonic thrust requirement results in a high takeoff thrust-to-weight ratio, and hence very steep climbout on takeoff.

Such engines produce far more jet noise, for a given thrust, than current turbofans, with the result that the noise at a given distance from the aircraft on takeoff is higher. But the climb is so rapid that the community noise impact on takeoff can be lower than for current aircraft. On landing approach, advantage can be taken of variable inlet geometry, required for performance over a range of Mach number, to choke the inlet, greatly attenuating compressor noise.

The net result of these factors is the estimated noise levels given in Table 4-4, in which values for the present 707-320B[5] are also given for comparison.

The value (112) for sideline noise is the goal of an intensive noise-suppressor development program that would run in parallel with the aircraft development. The value 124 is predicated on current suppressor technology, and implies a 4.5 db reduction from the unsuppressed value.

It must be emphasized that the above values apply to the first production aircraft. Advances in engine technology such as will be discussed below will eventually permit additional reductions, provided they are not traded for improvements in performance.

TABLE 4-4 SST Engine Noise (EPNdb)

	Approach	Sideline	Takeoff
SST (prototype technology)	108	124 (112)	108
707-320B	117.5	107	116

Potential Reductions in Engine Noise

Engines for Subsonic Aircraft

As engine technology advances, it will become possible to build engines of higher thrust-to-weight ratio and/or lower fuel consumption. These gains can be traded for lower noise, in several ways, as follows:

1. Oversize engines, relative to minimum for takeoff, would permit faster climbout after takeoff.
2. Lower fan speeds would permit lower takeoff and approach fan noise.
3. Lower turbine-inlet temperatures would give lower average jet velocity.

Some developments in engine technology can be identified, which are critical, and therefore should be pursued vigorously. They are:

1. Composite materials
2. High-work low-speed fan stages
3. High-work compressor stages
4. High-work turbine stages
5. Engine control to minimize noise, for example, by allowing faster acceleration from reduced power settings, on approach

It should be emphasized that these are only some of the possibilities for improvement. There may well be others, not cited here, which could offer greater promise. For example, there is no general agreement within the engine industry that low-speed fans offer the best way to reduce fan noise in quiet engines. High-speed fans with acoustical treatment may be better. The engine industry should be given the greatest possible latitude for innovation.

The noise reductions estimated under the NASA program are available, *with existing technology,* at some economic penalty. The changes characterized by the "quiet engine" could probably be incorporated in new aircraft put into service after 1975, if the decision to do so is made soon. Nacelle-treatment retrofits of aircraft with existing engines could probably be virtually complete by 1975, again provided a decision is made soon.

SST Engines

The trends of engine developments are less well established for supersonic commercial engines than for the turbofans. Two which are very clear, however, are a systematic increase in turbine-inlet temperature, and reduction in engine weight per unit of airflow. In time, the former should permit SST engines to operate without afterburning. The two factors together should allow substantial reductions in jet velocity, with beneficial effect on the sideline noise. Further, the elimination of afterburning would make jet-noise suppression much easier.

Of the areas of engine technology listed above, items 1, 3, and 4 are crucial to the development of quieter SST engines. In addition, research on turbine cooling is needed.

Rationale of Engine Noise Limits

As our understanding of the effects of aircraft noise on people has improved, the quantitative measures of annoyance have become more sophisticated, developing from a simple limit on the PNdb level on takeoff, to specifications of values of EPNdb, at three points (Department of Transportation rule), and finally to the NEF criterion, which accounts for number of occurrences and the time of day at which they occur.

With this more sophisticated criterion for annoyance, it may not be reasonable to impose a set of fixed EPNdb

[5] Rohr Corporation, *op. cit.*

limits on aircraft. If the total NEF exposure of an airport (say, the product of the NEF times people) were to define the limit of the airport's usage, then the airlines could be encouraged to take account of this limit in planning their fleets, and the aircraft and engine manufacturers could include it in their preliminary design considerations.

To be more specific, consider the effect of aircraft size on noise. We note that, at a given level of engine and airplane technology, the NEF increment produced by an aircraft is roughly proportional to the logarithm of its gross weight multiplied by its frequency of operation. It follows that NEF exposure per passenger movement is independent of aircraft size, provided aircraft of different sizes are designed similarly, but the EPNdb of a given aircraft will increase with its passenger load. With a fixed EPNdb limit, on the other hand, the NEF exposure per passenger movement would increase with decreasing aircraft size. Assuming that noise requirements compromise the aircraft design, the large aircraft would be penalized more than the small one. Thus, the natural cost optimization with a fixed EPNdb limit would favor smaller aircraft, and would result in an increased NEF exposure for a fixed number of passenger movements.

The Department of Transportation noise rule does require a decrease in EPNdb with decreasing gross weight below 600,000 pounds, the decrease being less for approach, and more for takeoff, than would result from a simple change in aircraft size with design held constant. It represents an official estimate of "what can be achieved" with current noise-suppression technology, however, not a rationale as to what *should* be allowed, and it definitely imposes a penalty on aircraft with gross weights larger than 600,000 pounds.

An alternative to setting fixed EPNdb limits would be to establish an NEF limit for an airport and assign portions of the limit as quotas to each operator. The operator would then have the freedom to optimize his fleet and operations, subject to this quota, and perhaps some limits on individual aircraft, such as the present Department of Transportation rule. He might then find it profitable, for example, to operate very quiet aircraft with high frequency, in spite of the higher cost of the quieter engines.

This plan would make it possible to prevent an increase in NEF at a given airport as the number of passenger movements increases, whereas the current EPNdb limits in the long run imply an increase in NEF with increasing operations. It would have the further advantage of setting up natural economic incentives for the development of quieter aircraft.

EFFECTS OF ENGINE TECHNOLOGY AND RUNWAY CONFIGURATIONS ON COMMUNITY NOISE

From the discussions of engine technology and runways, it is clear that each offers possibilities for reducing the noise impact of Kennedy Airport on the surrounding neighborhoods. The purpose of the present discussion is to provide more definite estimates of these potential benefits, and to compare the reductions in noise that can be obtained, on the one hand, by moving air traffic toward Jamaica Bay, and, on the other hand, by producing quieter aircraft.

The first prerequisite for such a comparison is a measure of community noise impact that accounts for not only the amount of noise produced, at a given location, but also, if possible, the number of people exposed to the noise. It appears that the best presently available criterion for annoyance at a particular location is the Noise-Exposure Forecast (NEF), which accounts for the intensity and duration of each noise exposure and the time of day at which it occurs as well as the number of such exposures in a day. It is computed in the following way:

1. Integrate the intensity of the noise, for each occurrence, over the period of time (in seconds) for which it exceeds a level of 10 db below its maximum and add tone corrections as specified in FAR 36, to obtain the effective perceived noise level, measured in EPNdb.
2. For events occurring between 10 p.m. and 7 a.m., add 10 to the EPNdb.
3. Add the products of effective sound intensity times duration for all events occurring in a 24-hour period. This is equivalent to taking 10 times the logarithm to the base 10 of the sum of the antilogarithms of the EPNdb levels computed for each event, divided by 10.
4. From this figure, subtract the number 82.

As an example, suppose a particular location is subjected to 50 flyovers, each having an EPNdb level of 100.

Then

$$\text{NEF} = 10 \log_{10}[50 \text{ antilog}\frac{100}{10}] - 82$$

$$= 10 \log_{10}[5 \times 10^{11}] = 117 - 82 = 35$$

$$\text{NEF} = 35$$

Noise Calculations for Kennedy Airport

Computations of this type have been carried out for three specific combinations of air traffic, aircraft, and runway configuration:

1. For actual 1968 traffic and aircraft, operating from the existing airport. This case provides a reference.
2. For actual 1968 traffic and the existing airport, but with all four-engine jet aircraft equipped with the nacelle-treatment retrofit (approximately 10 EPNdb reduction on approach and 5 EPNdb reduction on take-off).
3. For Runway Configuration 4, with the projected 1980 aircraft fleet, assuming that all present two- and three-engine aircraft would have had nacelle-treatment retrofit, that present four-engine aircraft have been retired, and that all future aircraft meet the Department of Transportation noise rule FAR 36. It is expected that, by 1980, most aircraft operating from Kennedy Airport will be of the latter type, so that this last computation is insensitive to the nacelle-treatment retrofit.

Comparison of the first two cases will show the benefits to be had from nacelle-treatment retrofit alone. The last case combines the effects of increase in air traffic, from the 1968 level of 888 operations per day to the projected 1980 level of 1,160 operations per day, the effects of 1970 engine technology, and the effects of shifting a major portion of the operations to the runways in Jamaica Bay.

To supplement these calculations, estimates have been made of the NEF levels that would result with the number of operations assumed in case 3 above, but using Runway Configurations 1, 2, and 3. All the above estimates have then been repeated assuming that aircraft comply with the noise rule 10 EPNdb below the present FAR 36 ("quiet engine").

Effect of Engine Technology

The benefit to be had from the nacelle-treatment retrofit can be judged from Figure 4-6, which compares the NEF 30 and NEF 40 contours for actual 1968 operations (case 1 above) with those that would have existed had the four-engine aircraft been retrofitted (case 2 above). There is a small, but appreciable, improvement. Estimates of population densities within the NEF contours indicate that approximately 700,000 people were exposed to NEF greater than 30 in 1968, and some 120,000 to NEF greater than 40. Had the retrofit been completed then, there would have been about 500,000 people exposed to NEF 30 or more and about 60,000 to NEF 40 or more. Relief from intolerable noise exposure would have been provided to some 60,000 people at Kennedy Airport alone by this retrofit program, with substantial reduction for 200,000 people. Further, the aircraft would make less noise at *all other airports,* so that the total number of people benefited would be much larger. In view of the small cost (less than 0.5 percent in ticket price) and near-term applicability of this program, it seems essential that it be implemented immediately.

Supposing next that the airport has Configuration 1, and the 1980 level of operations, with engines mainly using 1970 technology (747, DC-10, L-1011), the NEF 30 and 40 contours would be as shown in Figure 4-6. Case 1 (1968 actual) is again included for comparison. The difference in noise contours appears small, but from population densities, it is estimated that the number of people exposed to NEF 30 or more would be about 25 percent *less* than in 1968, in spite of the *increase* in aircraft movements by 27 percent, and a much larger increase in passenger movements.

It must be emphasized that this large (relative) decrease in noise exposure per passenger movement is due almost entirely to improvements in engines between the low-bypass first-generation engines and the current high-bypass engines. This improvement has come in less than 10 years. It is not due to the change in aircraft size since, as pointed out in the discussion of engine technology, the NEF per passenger movement is independent of aircraft size for similar aircraft and engine designs.

Supposing next that, by 1980, all aircraft could be made to satisfy a noise rule lower by 10 EPNdb than FAR 36, the NEF 40 contour on Figure 4-7 would become NEF 30. About 45,000 people would then be exposed to NEF 30 or more. Thus, the quiet engines could reduce the number of people exposed to excessive noise levels by more than a factor of 10—from about 500,000 to 45,000.

Effect of Runway Configuration

The maximum noise relief is obtained with Configuration 4. Noise contours for it are compared with those for the present runway system in Figure 4-8. By shifting most (about 70 percent) of the traffic to the two new runways in the Bay, the communities just off the ends of the present runways would be relieved of their very intense noise exposure. It is estimated that the number of

people exposed to NEF 30 or more would be reduced from the 1968 level of 700,000 to some 410,000.

Much of this 40 percent reduction is, however, due to the high-bypass engines, as noted above. Configuration 4 gives an 18 percent reduction relative to the runways shown for Configuration 1 in Figure 4-6 with the same traffic and engines.

Runway Configurations 2 and 3 fall between 1 and 4 in noise alleviation, with a reduction of some 5 percent (relative to Configuration 1) for 2, and 11 percent for 3.

Summary and Conclusions

Noise from aircraft operations at Kennedy Airport imposes a heavy penalty on hundreds of thousands of people in neighboring communities. The relief that new runways and better technology can afford these people is indicated by the summary in Table 4-5. New runways deep in Jamaica Bay would help communities near the end of the present runways, by placing a greater portion of the noise over the Bay. The greatest reductions in noise must, however, come from improvements in engines. High-bypass turbofans such as are presently being installed in the B-747, DC-10, and L-1011, will, when fully adopted, yield a net noise reduction on local communities. This will occur in spite of an increase, by 1980, of 27 percent in aircraft movements, and as much as 150 percent in passenger movements. Current engine technology could yield a further reduction in noise level of 10 EPNdb, with some penalty in direct operating cost. It appears that the added cost should not exceed 10 percent on the ticket price, and would probably be much less. Such "quiet engines" could be ready for installation in new aircraft by 1975, provided a firm decision for implementation is made soon. In the interim, a substantial reduction in noise from the present aircraft fleet can be had at minor cost by means of the nacelle-retrofit program. This program could be complete by 1975.

ENVIRONMENTAL COSTS OF RUNWAY EXTENSIONS

Introduction

The environmental effects of extending runways into Jamaica Bay can be subdivided into two general categories—direct and indirect. Direct effects would arise from the modification of the Bay, its shoreline, and associated biota for each of the four runway configurations. More specifically, there would be a pre-emptive use of certain parts of the Bay together with the need for acquiring fill and disposing of unsuitable foundation materials found at the proposed sites. In addition, direct alterations to the existing biological, hydrologic, and hydrodynamic environment would occur in varying amounts for each proposed runway configuration. Further effects of an indirect nature, but of significant impact would occur with utilization of the runways to increase the total operational capacity of Kennedy Airport and to create new airplane traffic patterns. The hazard of bird strikes is one of the many indirect effects of increased airplane movements. Other indirect effects include new fuel storage and delivery requirements, increased ancillary facilities of all kinds, including provision of waste disposal and storm-water runoff, and altered noise impact on the Bay, and a modified pattern of exhaust emissions. Each runway configuration would be accompanied by different degrees of direct and indirect effects, but some effects are common to all the proposals. (See Chapter 2 for a general discussion of environmental hazards of runway construction.)

For the most part, these effects can be labeled environmental costs, but we have not found it possible to express them quantitatively. No obvious environmental

TABLE 4-5 Effects of Engine Technology and Runway Configuration on Number of People Exposed to NEF ≧ 30 (and to NEF ≧ 40) at Kennedy Airport

Technology, Advancing Downward	Present	Config. 1	Config. 2	Config. 3	Config. 4
Low-bypass engines (1968 traffic)	700,000 (120,000)				
Low-bypass with nacelle treatment (1968 traffic)	500,000 (60,000)				
High-bypass engines plus nacelle retrofit (1980 traffic)		500,000 (45,000)	480,000	450,000	410,000 (37,000)
Quiet engines (1980 traffic)		45,000			37,000

benefits will occur from runway extensions, though some ameliorative actions to reduce the environmental costs might be taken at some additional monetary cost. A more detailed assessment of the direct and indirect effects of runway extensions is attempted, in quantitative terms where possible, in the subsequent sections of this chapter, and summarized in a final evaluative array.

Pre-emptive Use of Parts of Jamaica Bay

A direct effect of extending runways into the Bay would be a decrease in the water-surface area of the Bay. The air–water interface is important in many ways, including the direct transfer of oxygen from the air to the water. For Grassy Bay, which is sparse in aquatic growth, this supply of oxygen to the water is especially important. Even if the proposed runways were to be built on piles, the obstruction of sunlight to the waters would preclude active photosynthetic processes for the area covered and would inhibit aquatic growth and reduce oxygen transfer because of less active air flow at the surface.

Reduction of the water-surface area would impinge on the recreational area available for boating. In particular, Grassy Bay is one of the major areas of the Bay that has a large and moderately unobstructed reach and is used for both motor and sail boating. Given better water quality, Grassy Bay has potential for future recreational use, including fishing and/or water skiing.

Removal of water-surface area implies removal of water volume. However, a distinction between the volume of the tidal prism (the volume filled between low and high tides) and the volume at mean low water is desirable since each plays a different role in the maintenance of the water quality of the Bay, particularly with regard to the retention time of the waters. Elimination of the low water volume in deep pools in various parts of the Bay would perhaps be beneficial because these are the waters of lower quality and they tend to increase the retention time. Hence, if selective filling were possible it would be beneficial to remove them. However, the accompanying overlying higher quality tidal prism waters participate more actively in the productivity of the Bay environment. Because of turbulent mixing and the general circulation of the Bay waters, it is difficult to place precise boundaries on the division cited, except in Grassy Bay, which does show a marked division due to thermal stratification in the summer. Thus, if Grassy Bay were to be partially filled with good substrate to reduce its depth and an opening were placed under runway 4L-22R to allow free tidal motion, improvement would occur. In general, with runway construction, both upper and lower volumes are removed, together with any aquatic life contained therein, resulting in a net decrease in water quality of the remaining Bay water.

Table 4-6 presents estimates of acreage of surface and volumes of water that would be removed by construction of each of the four proposed runways considered above. These include areas between runways which are filled in order to decrease the hazard of bird strikes, as discussed below. The amount of marshland that would be removed by construction of each of the four different runway configurations is also shown in Table 4-6.

In view of the changes that have occurred in the nature and quality of the Jamaica Bay ecosystem as a result of dredging and filling in the past, it seems likely that the amount of water area and marsh that would be removed by Configuration 4, and possibly Configuration 3, would seriously damage the remaining ecosystem. Most of the salt marsh east of Cross Bay Boulevard would either be removed or made unusable as nesting habitat for the species that now use it. The total population of wildlife would be seriously reduced and some species would disappear from Jamaica Bay if all or most of their activities were confined to the severely diminished remaining marsh area. Also, removing this amount of vegetation would seriously impair the productivity of the total system.

TABLE 4-6 Summary of Water, Marshland, and Other Land To Be Removed as a Result of Runway Extensions

Configuration	Water Surface Area Removal, in Acres	% of Bay Water Surface Area	Water Volume Removed in 10^8 ft^3	% Bay Water Volume	Marshland Removed, in Acres	% Bay Marshland	Other Land Removed, in Acres	Total Removed, in Acres	% Total Acreage of Bay
1	420	4.5	3.5	5	30	0.75	0	450	3.5
2	1180	13.0	12	17	290	7	0	1470	11.3
3	2110	23.5	14.5	20.5	690	17	0	2800	21.6
4	2470	27.5	15	21.5	1050	26	400	3870	29.8

Some of the runway proposals considered would require the physical displacement of certain structures. These include navigation aids, houses, subway lines, highways, a sewage outfall, and some entrepreneurial activities. The major displacements occur with Configuration 4. Although most of the effects of such movements on the Bay would be indirect, the displacement of the Jamaica Bay Plant sewage outfall now in Grassy Bay could pose severe water-management problems. Without a more detailed analysis of the entire sewage-treatment system and the hydrodynamics of the Bay it is not possible at this time to assess the actual impact of displacing the outfall.

Acquisition of Fill Material

Construction of any of the proposed runway extensions requires large volumes of fill of high-quality sand. On the basis of information supplied to the Study Group, it seems probable that permission will not be given to obtain this fill from Jamaica Bay as was done for the original construction at Kennedy Airport and its several subsequent extensions. However, as this decision is contingent upon other events, it is sufficient to point out the quantities that would be involved and to discuss previous acquisitions of fill from the Bay for airport construction. The estimated volumes of fill for the various plans are shown in Table 4-7.

Fill for the construction of Kennedy Airport was obtained from Grassy Bay, which greatly contributed to that Bay's poor water quality and created what is now essentially a large, deep, nearly anaerobic, biologically weak pond with poor circulation and long retention time. This condition was considerably worsened by the blocking of water circulation in Grassy Bay by extending runway 4L-22R out to Jo Co Marsh. Additional fill material was obtained for this extension from nearby channels, thereby deepening them. The environmental cost of previous work at Kennedy, illustrated by the present state of Grassy Bay, should be sufficient warning to eliminate any further consideration of obtaining even more fill from Jamaica Bay.

Disposal of Undesirable Foundation Materials

Construction of any runway requires a firm foundation. Marshland and its accompanying organic silt–clay complex is not suitable for runway foundations and must be removed prior to filling. The question of where to place this material if any of the runway extensions is constructed presents a problem that must be examined. During construction of the extension of runway 4L-22R into Jo Co Marsh, a considerable amount of unsuitable foundation material was found, removed, and disposed of in area "C," according to the U.S. Army Corps of Engineers permit. Area "C" includes part of the shoreline and waters of Grassy Bay adjacent to Kennedy Airport. The dumping of the spoil in an already overtaxed arm of the Bay added to its degradation. If it is assumed, as was found at runway 4L-22R, that anywhere from 0 to 20 feet of unsuitable foundation material exists under marshland, it is possible to compute an estimate of the disposal volume needed for each of the runway configurations. A summary of spoil-volume estimates follows in Table 4-8.

Other Environmental Modifications

An increase in the surface area of runways and the concomitant decrease in Bay area will alter the pattern of drainage into Jamaica Bay. Precipitation on any combination of soil and concrete will (1) delay its entry into the Bay, (2) decrease its volume due to evaporation and transpiration, and (3) add to the opportunity for the resulting runoff to pick up or dissolve pollutants encountered prior to entering the Bay. Rearrangement of the drain system will alter the outflow distribution into the Bay. None of these factors can be precisely predicted, but any losses should be proportional to the acreage involved in intercepting the precipitation.

Of more significant impact would be the modification of the dynamics of fluid motion in the estuary as a result of introducing runways into parts of the Bay. The experience of previous construction and extensions should serve at least as a guide as to what might be expected. As noted above, initial construction of Ken-

TABLE 4-7 Estimated Volumes of Fill

Configuration	Volume Fill in Million Cubic Yards
1	21.5
2	72
3	135
4	175

TABLE 4-8 Spoil-Volume Estimates

Plan	Millions of Cubic Yards of Spoil
1	0.5
2	4.8
3	11.5
4	17.5

nedy Airport created in Grassy Bay a deep hole resulting in poor water quality, a condition that was further aggravated by constructing runway 4L-22R, which caused a complete blockage of one end. Some of the proposed runway configurations would block off additional access to Grassy Bay and other areas. Without a complete mathematical and hydraulic study with the proposed changes factored in, it is not possible to predict with certainty how much change will occur. However, it is obvious that changes will take place in the local velocity distributions, mixing characteristics, renewal rates, and associated transport phenomena. A quantitative evaluation will be difficult. At the present time, two hydrodynamic studies of Jamaica Bay (a mathematical model produced by the RAND Corporation for New York City and a Corps of Engineers hydraulic model at Vicksburg) disagree even with regard to the present situation.

Indirect Effects

By 1980, increased airplane movements and larger aircraft size will cause a greater demand for fuel. This fuel must be delivered to and stored at the airport. The current modes of fuel transport are by pipeline and barges, primarily to Bergen Basin. Unless positive action is taken to counteract it, it is reasonable to assume that an increase in fuel demand will result in increased barge traffic to the airport.

For every barge movement and transfer operation there is a spill probability, which is fairly large at present; numerous and sometimes extensive oil slicks occur in Bergen Basin. A substantial amount of fuel (1 million gallons a day) is transported into the Basin, mostly for airport needs. The risk of increased spills with increased traffic seems inevitable unless steps are taken to divert shipment of fuel exclusively to the pipeline now supplying the airport.

For some runway configurations a rerouting of barge traffic along different routes would be required. While this in itself seems unimportant, it would represent an incremental crowding of the remaining parts of the Bay, particularly in those areas with the greatest recreational potential for boating, swimming, and fishing.

Increased air traffic would require more backup facilities, including food processing, waste disposal, and airplane servicing. Each of these facilities would, in turn, interact with the sewage-treatment plants, particularly the Jamaica Bay plant. If the net increase in population at the airport due to the increased traffic were 25,000 people by 1980, the added load to the Jamaica Bay plant would cause it to exceed the City's estimated load for that plant for the year 2000.

Another element of the proposed runway extensions that requires discussion results from the redistribution of air traffic and its effect on the natural and recreational environment. In flying new patterns on new runways, different fallout and dispersion patterns of exhaust emissions and other releases will develop, together with the development of new noise patterns and a general encroachment on the recreational and wildlife areas. Degradation of marsh grasses near the ends of new runways would occur, as is currently in evidence in Jo Co Marsh. Noise contours, as can be seen from Figures 4-6, 4-7, and 4-8, continue and will continue to impinge upon the recreational areas proposed for the northern shores of Jamaica Bay.

Bird-Strike Hazard

As noted earlier (Chapter 2), objective criteria can be used to establish an "acceptable" bird-strike rate for an airport. Presumably, any strike that would cause major impact damage or engine shutdown is potentially hazardous and undesirable, even though it is difficult to calculate the actual risk to human life.

It is equally difficult to predict the effect of a particular runway configuration on the bird-strike rate, except to estimate the potential for an increase or decrease according to operating conditions.

Kennedy Airport ranks first in the United States in absolute number of bird strikes per year and ninth in number of strikes per 10,000 operations. Operations on runways adjacent to Jamaica Bay are particularly susceptible to bird strikes. Plans for an increase in the operational capacity of Kennedy would affect the bird-strike hazard in two ways.

Operation of a dual runway system, such as proposed in Configuration 1, or any increase in operations over or adjacent to Jamaica Bay, could be expected to increase the number of bird strikes, although the strike rate would probably remain about the same as now. Aircraft would not be exposed to significantly greater concentrations of birds than they are at present. A major extension of the runway systems into the Bay, as proposed in Configuration 4, would intrude into the flight paths of additional concentrations of potentially hazardous bird species. This could be expected to increase both the absolute number of strikes and the strike rate to potentially dangerous levels. Configurations 2 and 3 represent hazards intermediate between these two extremes.

In an attempt to summarize the direct and indirect effects on the environment, an array of items have been considered, together with a scale of intensity of the

effects for each of the four runway extension proposals we studied. These are shown in Table 4-9.

Methods for Reducing the Environmental Disruption of Runway Extensions

Partially filling Grassy Bay to decrease the present water depth and reduce the unevenness of the bottom would decrease its retention time and improve its water quality. A channel under runway 4L-22R would improve water circulation in Grassy Bay and also decrease

TABLE 4-9 Jamaica Bay Runway Extensions and Environmental Costs

Extending the runways into Jamaica Bay would:	Configurations[a] 1	2	3	4
I. Direct effects[b]				
A. Pre-empt *use* of				
1. Water surface area	M	C	E	E
2. Water volume	M	C	E	E
3. Marshland and biota	M	M	E	E
4. "Firm" land and biota	N	N	N	C
5. Structures a) utilities	N	M?	M	E
b) navigation aids	M	M	M	M
c) human occupied	N	N	N	C
B. Require *acquisition* of				
1. Fill material	M	C	E	E
C. Require *disposal* of				
1. Undesirable foundation material	M	C	C	C
D. *Alter*				
1. Surface drainage to Bay	M	C	E	E
2. Estuarine fluid dynamics	M	M	E	E
3. Biological environment	N-M	M	E	E
II. Indirect effects				
A. Increased operational capacity				
1. More fuel storage, delivery, spills	E	E	E	E
2. More service facilities, treatment needed, load on system	C	C	C	C
3. Surface drainage impact on city plan for sewage treatment	M	M	C	C
B. Redistribution of traffic				
1. Exhaust emissions falling into different areas	M	C	E	E
2. Noise impact on recreation sites	C	C	C	C
3. Bay traffic	N	N	C	C
C. Bird-strike hazard (increase)	M	M	C	E

[a] *Code:*
*N*one
*M*oderate
*C*onsiderable
*E*xtensive
?questionable

[b] These represent the direct impacts of runways on the environment, but not the indirect effects that go with the use of the runways by airplanes and all the higher-order effects that they produce.

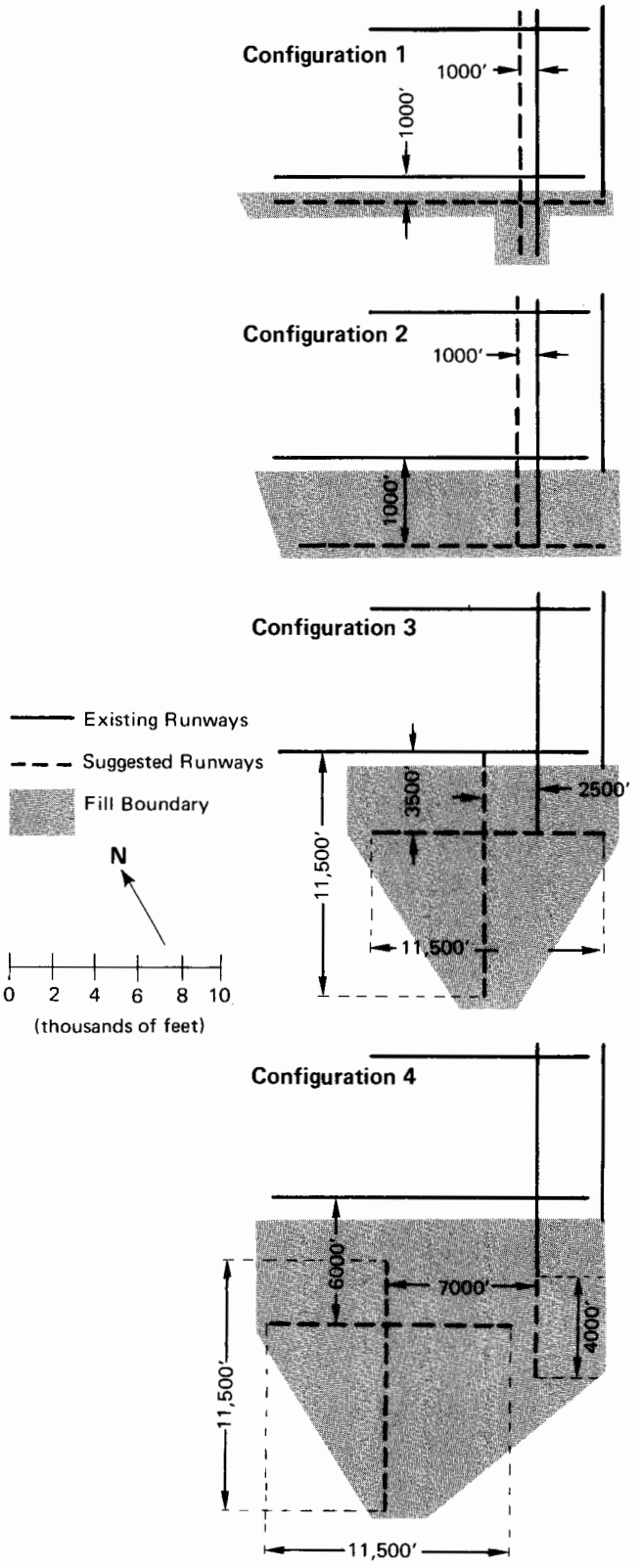


FIGURE 4-9 Fill requirements for proposed runway configurations.

retention time. Artificial re-aereation of Grassy Bay would increase the oxygen content of the water and improve its quality.

Bottom sediments that would have to be removed to provide an adequate base for runway construction could be transported to unproductive land areas on islands in the Bay, if this would enhance their productivity and quality.

Surface drainage from runways should be collected and treated for removal of contaminants before being discharged into the Bay.

Fuel used at Kennedy Airport should be transported entirely by pipeline to reduce the amount of barge traffic and fuel spills in Jamaica Bay.

There should be careful monitoring and pollution control at the airport to guard against an increased load on the Jamaica Bay system and surrounding areas as a result of increased operations and service facilities.

The bird-strike hazard could be reduced by filling in water areas between the runways, as shown on the diagrams for the four configurations (Figure 4-9). The success of this procedure would probably be greatest for Configuration 1, as it represents the least amount of intrusion into the Bay. This configuration would also require the least amount of fill and would result in the least amount of loss of water area. Filling in the water areas adjacent to the runways in Configuration 4 would probably provide the least amount of amelioration, as these runways would extend across the traditional flight paths of several large bird species. This would also result in the greatest loss of water area. Configurations 2 and 3 would be intermediate in both respects.

5 PUBLIC POLICY: NATIONAL ISSUES RAISED BY THE JAMAICA BAY STUDY

It is important that the air transportation problems of the New York Region be placed in a national perspective.

Already five of the nation's largest city airports have become saturated and the FAA has placed quotas on aircraft movements during peak-hour traffic. Three of these are in the New York area. An additional 14 airports are expected by federal officials to face similar congestion levels within the next five years.

Of the more than 150 million passengers enplaned in the nation last year, 50 percent traveled to these 19 airports, and about 20 percent were handled by the three New York area airports alone. Kennedy serves 40 percent of the nation's international passengers.

Like Kennedy, these airports are seeking to stretch their existing resources to increase capacity. But, for the most part, they are locked in by many constraining factors. Land areas are insufficient for major runway expansion and new facilities; unchecked urban sprawl has produced serious people–noise problems, resulting in demands for noise abatement; inadequate ground transportation facilities are choking passenger access; air-traffic-control systems are incapable of dealing with mixed traffic in the congested airspace, resulting in the likelihood of further restrictions. Finally, general opposition to city airport expansion is growing, based on both environmental and safety considerations.

These 19 busiest airports are, in fact, yesterday's airports. They were planned and developed by local governments and authorities to appeal to the affluent, to attract business and industry, and to provide a symbol of prestige for the community. They were located as close as possible to city residential and business areas, with highways as the main mode of access.

But times are changing, and rapidly. The cities have expanded to surround the airports with housing and other incompatible land uses. Demand for air travel has grown dramatically, spreading across a broad spectrum of income levels and personal and business activities. Air passengers come from more widely dispersed geographic areas inconveniently located with respect to city airports.

Kennedy Airport is a special example of a big city airport caught in the pressure of change. It was planned and built 30 years ago to service smaller and fewer aircraft. It was located in what was then an undeveloped open area, but which was convenient to the central city.

Now, people in desperate search for living space have moved up to its borders and ground access routes have become overcrowded with regular commercial and commuter traffic. At the same time, the larger jets have replaced smaller piston aircraft; domestic and international passenger and cargo volume has multiplied many times over; and Kennedy has become a very

congested and noisy airport, largely surrounded by a densely populated city.

Although crashes at Kennedy have been relatively few to date, more and larger planes requiring more and larger fuel storage and other support facilities increase the possibility of accident, while the growth of population in the airport environs greatly increases the number of people who might be affected by such an eventuality.

PONYA's proposal to expand Kennedy Airport into Jamaica Bay is, in effect, a continuation of the "central city" philosophy of airport siting and development. Even apart from the environmental impact upon the Bay, there is a larger policy issue of whether such an airport should be allowed to expand at all. Indeed, there may even be good reason to question whether it should not be phased out in the long run.

The very fact that Kennedy and other city airports are facing these difficulties signals a need for new directions in the development of air transport as a necessary public service. Some of the actions recommended for meeting these problems are: construction of new airports; maximization of use of existing airports; implementation of new technology in air traffic control, noise reduction and passenger access; and the development of new modes of air and ground transport.

However, unless we have planning, on a much more comprehensive scale than in the past, there is little hope of implementing them. For any of these recommendations to be put into effect, more coordination at all levels of government will be needed.

We will need a new and comprehensive national air transportation plan to meet future air transport needs and a coordinated program for funding and implementing it. It will also be necessary to devise intergovernmental mechanisms to resolve disputes relating to the location of airports and support facilities, the proper allocation of air service, and the protection of people and their environment.

We will need a comprehensive national ground transportation plan, with which air transport can be coordinated, to provide an integrated system approach for air passenger and cargo transport.

At the same time, a major effort should be undertaken to accelerate the adoption and installation of technological improvements, necessary for a safe and efficient air and ground transport system in the next decade.

At present, unfortunately, airport planning and development continue to be handled primarily by local authorities. Decisions concerning airline service, except for rates and routes, are mainly in the hands of private carriers. Furthermore, there is no clear allocation of responsibility for ground transit access to airports. In the absence of clearly designated national planning and decision-making authority, a range of forces—public and private and at regional, state, and local levels—has moved into the void.

In any case, planning for air transport needs will continue to be difficult and will not in itself resolve the competition among many various interests that will inevitably be involved. People will still not want airports in their backyards. Environmentalists will still be concerned with disruption of the ecology and the disturbance of natural resources. Airlines and airport managers will continue to be concerned with maintaining profits and protecting their investments. Regional and municipal planners will press for air service expansion to stimulate employment and business growth. Community leaders will protest the negative impacts of airports. Each interest will work its way to best serve its own cause.

The purpose of this chapter is to point up the relationship of the issues now apparent at Kennedy Airport to the problems of developing a better national air transport system. The underlying theme of our recommendations will be that, because air transport service is a national need, greater responsibility must be assumed by the federal government to guide the planning and development of airports and airline operations.

AIRPORT SITING AND DEVELOPMENT: KENNEDY AIRPORT, A CASE STUDY IN INTERGOVERNMENTAL DEADLOCK

The airport is a critical part of the air transport system. It collects and generates the traffic. Its size and location must relate to the actual and anticipated demand, to its accessibility on the ground and in the air, and to its effect on the human and natural environments that surround it. A new airport or the expansion of an existing one must also relate to a national air transportation system as well as to the requirements of the local region.

Equally important is the need for ultimate authority to see to it that plans are put into effect. The present Kennedy Airport situation is a good example of the consequences of the absence of such authority to implement plans to meet airport needs. The decision to build or not to build the runways or an additional airport in the New York region is widely dispersed among public authorities at all levels of government.

An example of the problems in airport siting and development is found in the history of proposals for a fourth jetport in the New York region. Nearly 15 years ago, PONYA, after making forecasts based on air travel

surveys, warned that the existing airport facilities in the New York region would not be able to handle the load expected in 1970.

In 1959, PONYA published a report that again predicted that demand would exceed capacity, and recommended that an additional airport be built. After an examination of 15 possible sites, it proposed that the fourth airport should be located in the Great Swamp area of Morris County, New Jersey. A year later, however, both houses of the New Jersey state legislature, spurred on by strong opposition from community groups and political leaders, expressed opposition to the Morris County site. An additional obstacle was interposed by a group of conservationists, which acquired a 1,000-acre site in the middle of the Great Swamp and conveyed it over to the federal government for a wildlife refuge.

In 1961, PONYA evaluated some 17 sites, and confirmed the Morris County location as the only one feasible. The FAA, after study, confirmed the need for an additional airport and recommended it be placed in the "northwest quadrant" of the New York region.

In 1963, the Governors of New Jersey and New York proposed sites within their respective states, but these were rejected by both PONYA and the FAA as unsuitable. The same year, the City of New York requested that PONYA evaluate a site adjacent to Staten Island. Both PONYA and the FAA found this suggestion unsuitable because of airspace congestion problems that would be created.

In 1964, the Aviation Development Council retained a consulting firm to make a detailed appraisal of the existing capacity of the region's three airports, and to update the demand forecast. It recommended immediate action to locate and develop a new major airport as the "most probable solution" to the problems of meeting their forecasted increased air traffic. Similar recommendations were made in 1965 by both the Tri-State Transportation Committee (created by the Governors of New Jersey, New York, and Connecticut) and the Air Line Pilots Association.

In 1966, PONYA restudied 22 possible jetport sites. Once more its choice was the Great Swamp. In 1967, the Department of Transportation of New Jersey recommended a new site at Solberg, in Hunterdon County. Also in 1967, the president of the New York City Council issued a report on the need for a fourth jetport to ensure New York's continued economic well-being. He urged that an existing airport in Calverton (Suffolk County, New York) be used as an international airport and that an airport at Solberg be developed to accommodate domestic flights.

In the same year, the federal Department of Transportation Systems Research and Development Service completed a study of "Alternative Approaches for Reducing Delays in Terminal Areas." Two new major airports were strongly recommended, an undesignated site west of the Hudson for domestic flights and Calverton for international flights. The 1969–1973 National Airport Plan of the Department of Transportation still carries a proposal for a fourth jetport in the New York region, to be located in New Jersey.

In 1969, the New York state legislature authorized the Governor to seek a site for a new international jetport in New York State; meanwhile, the Governor and the state legislature of New Jersey took a position unalterably opposing a new site in their state.

This history of failure to achieve agreement on the location of a fourth jetport for the New York region documents a basic weakness in the nation's airport planning policy. The critical decision to go forward with the siting of a major airport to serve an entire region as an integral part of a national system is left to local and state authorities. They are subject to pressure from local groups that may force them into inaction or the consideration of less suitable alternatives.

The state or local power to veto a proposed jetport site, coupled with the lack of any single authority to override these vetoes, has resulted in an impasse. Making no decision is, in itself, a kind of a decision. It may be that a fourth jetport was not a sensible recommendation 15 years ago, but we do not really know whether this is so because there has never been a comprehensive hearing or investigation by any responsible governmental agency to test adequately either need or feasibility. Meanwhile, a new airport for the New York region is still 10 to 15 years away. While a fourth jetport may not have been needed in the past, should one be needed in the future a new and effective decision-making process, which will result in action, is absolutely essential.

The problems related to the decision to expand Kennedy Airport into Jamaica Bay may be even more difficult than those associated with finding a fourth jetport.

The present airport is on land belonging to and leased from the City of New York. All or virtually all the land, both above and below water, on which the new runways would be built is also City-owned. As the Port Authority has no power to condemn City-owned land, an amendment to the present lease would be needed. This requires the consent of the Board of Estimate of the City. If such consent were withheld, the project would be blocked, and there is no authority at any level of government, under present law, that could compel approval.

If the Board of Estimate approves, the Mayor may

not veto the approval. Even without an actual veto, however, he may have the means of blocking the project if he disapproves of it, through his control of subordinates who serve at his pleasure. For example, he might be able to cause the Department of Ports and Terminals to block the project by refusing a work permit to fill in part of Jamaica Bay. He might also accept the legal argument being put forward by the Parks, Recreation and Cultural Affairs Administration to the effect that Jamaica Bay is held by the City in trust for park use and cannot legally be diverted for airport runways, and instruct the City Corporation Counsel to take such legal steps as would be necessary to prevent execution of the lease.

Even if the Mayor favored the proposal, the same argument as to the irrevocability of the commitment of the Bay for park use might be made by a citizen or taxpayer suing to prevent its diversion, and the project might be held back for years because of the pendency of such litigation.

New York State also has a critical role in regard to the future of the Bay and the added capacity of Kennedy. The Governor has a veto on new activities of the Port Authority, including any program of airport expansion. (The Governor of New Jersey has a similar veto.)

Under the state conservation law, the consent of the State Department of Environmental Conservation might be needed for approval of the placing of fill in Jamaica Bay to build the runways. There is some question, however, as to whether the statute requiring such consent applies to Jamaica Bay or to Port Authority projects. State approval would be needed, however, if the required fill is taken from under-water lands within the State, which seems to be the present intention of the Port Authority but might be avoided if it gave rise to difficulties.

The Metropolitan Transportation Authority, which, among other things, runs the New York City subways, is also involved. If, as in Configuration 4, discussed in Chapter 4, the runways ran across an existing subway line carried on a trestle across the Bay, the tracks would have to be placed underground or diverted elsewhere, requiring consent of the Metropolitan Transportation Authority.

As a practical matter, the Metropolitan Transportation Authority might also be involved in the provision of mass transportation between the City and the airport; a rail link to relieve existing acute ground congestion is already being contemplated; presumably, something of larger dimension might be needed for the increased traffic that the proposed runways are projected to serve. New state legislation would be needed to permit this; hence, the legislature and the governor (unless a veto were overridden) would have to agree.

Finally, if the runways were approved by New York City, but opposed by the state, the state legislature could assert its overall power over the City by amending the City Charter so as to remove authority in the City to enter into the lease of the necessary land, or could simply enact a law expressly forbidding the project.

We have recited a number of ways in which the proposed runways at Kennedy Airport could be blocked at the city and state government levels. (Some of the requirements for approval by federal agencies are discussed elsewhere in this report.) As stated above, we do not favor the proposed runways; it is striking, however, that, even if it were conclusively demonstrated that the runways were essential to the nation's air transportation system, and even if the project were approved by every federal official from the President and the Secretary of Transportation on down, under present law the federal government could not put it into effect if any state or local agency or official with veto power saw fit to oppose it. And the same has been true, and until the laws are changed will continue to be true, with respect to a fourth jetport for the New York area, and indeed with respect to any new airport, or expansion of an existing airport, anywhere in the country, no matter how compelling the need.

PONYA has been attempting to solve the region's airport-capacity problems for some 15 years, so far without success. It seems unlikely that such efforts will be successful until there is a national air transport policy and plan and mechanism to assist the people in the New York region in finding a solution.

AIR TRANSPORT OPERATIONS: IMPROVING THE SYSTEM

It is impossible to predict the future of air travel with confidence, because of the wide range of changes likely to take place in a national air transportation system. That system includes five principal elements, each of which will undoubtedly be going through a process of evolution: appropriate location of new airports; more effective use of those we have; a modern and effective air-traffic-control system; new types of aircraft; and adequate ground services for passengers and freight.

With respect to airport siting, the study group heard from FAA spokesmen and others and were impressed with the concept of new regional international and continental jetports as one part of the system, and older

"close-in" urban airports as another part, for intercity service.

It was suggested that large regional airports should be located on 20 to 30 thousand acres of land, reasonably convenient to population centers, and connected to them by high-speed rail transportation, the interstate highway system, and air taxi service. These airports would have unencroachable buffer zones for noise abatement and safety; omnidirectional air access; adequate runways and facilities to handle advanced aircraft technology; and a specialized ground system to handle both passengers and baggage.

A few such airports—Palmdale, California; Fort Worth–Dallas; and Mid-Continent–Kansas City—are presently being constructed, but for the most part, we are at the beginning stages in such a development and this is an ideal time for direct federal planning to start.

Given the enormous cost of the larger airports, consideration may have to be given to much larger direct federal funding than is now available, through loans, grants, and guarantees. In fact, in some cases, in the interest of regional economic development, the federal government may have to build, own, and operate such facilities where they might not otherwise be economically practicable at present.

As for existing local airports, there seem to be three choices: maintain them as domestic intercity airports for conventional aircraft use; use them as V/STOL ports for commuter and intercity use; convert them to sites for low-income housing or other public uses. Indeed, such a rationalization of airport use and planning for the future would seem to require federal powers, in view of the responsibility for safety and service that industry and government will have to share in the next 30 years.

An important part of such plans would be a method of joint planning and funding among FAA, mass transit, and the highway and rail agencies, to improve existing airport access and terminal congestion and prepare for future growth in passenger and cargo traffic. Transportation to and from the airport to passenger load centers and, in fact, to residential or other destinations, should be an intrinsic part of such an air transport system plan. Similarly, with the siting and operation of new airports, federal guidelines should be developed for including mass-transit access, and airport location near to the Interstate Highway System.

In any event, such a system of airports should involve not only intergovernmental planning and funding to a degree not yet attempted, but political decision-making, which has just begun to emerge at the national level. The challenge is to devise an effective governmental mechanism for such planning under our federal system.

One constructive step toward greater federal initiative in airport planning and siting was included in the Airport and Airways Development Act of 1970. The Secretary of Transportation is empowered to make grants up to 50 percent of the costs of airport projects he approves, and if he determines that a metropolitan area needs an additional airport consistent with the national plan, he can request the governing authorities of the area concerned to confer and agree upon a site for such an airport. But the statute provides no mechanism for resolving the stalemate when agreement cannot be reached.

With respect to the New York problem, we feel that, as a priority under the 1970 legislation, the Secretary should re-examine the need for a new airport to be located in the region and, if he determines that it is required, he should make definitive recommendations as to its location, size, and use, and timing of construction and operation.

Additionally, with respect to national air transport requirements, we suggest that the Secretary of Transportation initiate an immediate and comprehensive investigation into the need for additional airports in other regions of the country that are now congested or that may be expected to be congested within the next five years, and that, on the basis of such investigation, the Secretary make definitive recommendations as to the location of such new airports.

Further, we feel that the Secretary should now be authorized and funded by the Congress to acquire land by eminent domain or otherwise, and to use all powers necessary for the construction and development of required additional airport capacity, including access facilities, if within a reasonable period no responsible agency agrees to carry out his recommendations, or is incapable of doing so. In order to assist the Secretary in financing any airport capacity developed by the federal government, Congress could authorize the Secretary to use such funds as are necessary out of the amount allocated by the Airport and Airways Act to states in the region within which the new facilities are to be located.

It must be emphasized that such decisions by the federal government should be made with full attention to the concerns of local interests threatened by the construction of an airport in their vicinity, and particularly to the dangers to a wide range of environmental values inherent in almost any airport project.

Any decision-making process must require consultation and hearings for all interested parties and provide for full attention to environmental effects. We believe that the Intergovernmental Cooperation Act of 1969, (PL 90–577), and the accompanying A-95 Budget Bureau Procedures, together with the federal guidelines

under national environmental protection legislation, provide substantial opportunity for the views of state and local interests to be represented and considered with respect to airport siting and operation, where federal funds are used.

We recommend further that Congress assure that all rules and guidelines promulgated by the appropriate federal agencies involved in airport development be covered by the Federal Administrative Procedure Act, and that final decisions made by heads of such agencies be subject to right of direct judicial review in the federal courts, at the instance of concerned agencies of state or local government, or of private organizations or affected individuals. We feel that such review procedures are essential where the federal government is authorized to assert its responsibility over land usage such as airport siting and operations. At least as important as the provision of new airports is the more efficient utilization of existing facilities.

Federal aviation policy has been based on fostering of air travel and the economic well-being of airlines as the standards of progress. We now find ourselves confronted with congestion as a result of that policy. The FAA has been occupied with developing airports and operating traffic systems to move more planes in the airspace. Only recently has it begun to pay comparable attention to limitation of traffic in congested regions in the interest of safety. And it has yet to attend to a third obligation, to rationalize the use of the airspace in a region in order to achieve the most efficient use of existing capacity.

The CAB appears to have operated in a similar spirit of concentrating on stimulating industry growth. In awarding new routes, it has provided more service to more areas, but has yet to sufficiently limit operating rights and schedules in regions that have become overcrowded with competing service.

Moreover, the two federal regulatory agencies concerned with the air transport system have tended to operate independently of one another.

These shortcomings are undoubtedly the result of our early fundamental policy decisions to encourage airport and air service development through the incentive of private enterprise and local initiative. We believe, however, that the time has now come to build into the system some basic standards and constraints designed to meet broader national needs and to serve the public interest.

Existing statutory authority concerning the powers of both the FAA and the CAB would seem to give these agencies the necessary authority to restrict air activity as the situation warrants. However, both agencies have failed to explore the real possibilities of air service regulation. Only recently has the overcrowding problem been reflected in stricter regulation, such as the instrument-flight-rule peak-hour limitations imposed at Kennedy in the summer of 1969.

We recommend that the FAA and the CAB jointly make a full assessment of the air operations at commercial airports, as they relate to safety, quality of service, scheduling, demand, capacity, origins and destinations, and plans to meet any increased level of use. Specific recommendations should be made for making the most effective use of existing capacity, and rules promulgated for implementing those recommendations.

Where congestion is predicted, appropriate measures should be recommended, and put into effect now, before the airports in the concerned regions reach the saturation point.

As suggested in Chapter 1, increased landing fees may well contribute to flattening out the peak congestion, but they can also provide a new financial resource for improving safety and helping the communities that suffer most from the location and operations of the airport.

We would therefore suggest a federal program, to be administered by the FAA, to impose such additional charges in accordance with fair and appropriate schedules at all airports over which the FAA has jurisdiction.

We note that Section 307 of the Federal Aviation Act states:

> The [FAA] Administrator is authorized and directed to develop plans for and formulate policy with respect to the use of navigable airspace under such terms, conditions, and limitations as he may deem necessary *in order to insure the safety of aircraft and the efficient utilization of such airspace.* He may modify or revoke such assignment when required in the public interest. [Emphasis supplied.]

Since we are reaching what appears to be an inefficient utilization of the airspace, such action would seem appropriate.

If it is concluded that FAA does not already have the authority to impose such landing charges, it should seek that authority from Congress as soon as possible.

Discussion in Chapter 1 also highlighted the issues of duplicating schedules and underpricing passengers as a cause of airspace and airport congestion during peak hours. The CAB has inadvertently given rise to an inelastic system which has contributed to congestion and been harmful to the overall quality of service.

We believe that the CAB presently has the authority, under Section 401(e)(1) of the Federal Aviation Act, to remedy this situation, and to rationalize a system that may, in part, be contributing to the congestion crisis. In fact, we understand that a special study in this very area is now being completed. If there are

doubts as to the CAB's legal authority, statutory permission should be promptly requested of Congress.

It is interesting to note that while our own study was in progress last summer, the chairman of the CAB, Secor D. Browne, said that he would welcome airline proposals to limit flight frequencies. These would be aimed at restoring their "load factor," he said. Browne noted that diminishing flight frequencies "would not be detrimental to the public. The public is not well served by airlines in bad financial condition. It's in the public interest and everyone else's interest, if there is overcapacity, to have it brought more into balance with the levels of demand."

While this statement may have reflected the CAB's primary concern with the economic well-being of the air carriers, we think an equally good case can be made for the same conclusion on the basis of passenger safety and alleviation of airport congestion.

A modern and efficient air-traffic-control system is critically important. This was recognized as far back as March 1961, when President Kennedy ordered a scientific review of the nation's air-traffic-control system. Soon thereafter, the "Project Beacon" report was issued, setting out the guidelines for a National Airspace System, which it recommended should be in operation by 1970. According to a Report of the House Committee on Government Operations (Report No. 91–1308, 91st Congress, 2nd Session), no significant element of the systems recommended in the Project Beacon report is in operation today. Prototypes of equipment to be used have not yet even been developed, much less produced and installed. Contract delivery dates on vital elements of the system are years behind schedule and necessary decisions have not been made. In hearings before the Committee, the FAA admitted to a six-year slippage in the program schedule, and further conceded that the present air-traffic-control system is "under a severe strain."

Aircraft continue to operate under two different systems of flight rules, in many instances using the same airspace and with only the alertness of pilot vision to avoid air collisions. In a large number of airports across the nation, there are no traffic-control facilities at all.

In the last 10 years, domestic revenue passenger enplanements have increased from 50 million to 170 million. In the same period, "general aviation" aircraft movements have increased dramatically from 77,000 to 133,000.

There are approximately 10,000 airports in the nation. Some 600 of these serve regularly scheduled commercial traffic as well as general aviation. Of these 600 airports, only 330 have control towers, 121 have air surveillance radars, and 250 have instrument-landing systems.

We feel that all these 600 airports should have these basic air-traffic-control facilties as soon as possible in the interests of safety and efficiency of air transport.

We agree with the House Government Operations Committee Report that the Department of Transportation—at the Secretary level—must assume full responsibility for air-traffic-control development, and choose a viable system for implementation as soon as possible.

We further suggest that the Department of Transportation present to the Congress for action a full appraisal of the funding required to support its functions in this area. Current proposals of funding requirements appear to us to be insufficient to accomplish this important task. We seriously question whether the amount of $250 million per year recommended in the Transportation Department's recently announced 10-year plan is nearly adequate to meet the actual requirements of the task at hand.

Finally, we recommend that an advanced, adequately funded, research and development program be instituted for a fourth generation of air-traffic-control capability, including the use of satellites, inertial guidance, centralized data-processing equipment, and other system techniques.

It seems rather clear, on the basis of information brought to the attention of the study group, that no new and as-yet-untried technologies are required; what are needed at this juncture are firm decision-making by the Department of Transportation and the necessary appropriations by Congress.

The further development of VTOL or STOL (although perhaps some years away) for shorter air trips, intercity and intraregional, between airports, residential load centers, business districts, and transit terminals, appears to hold considerable promise for reducing congestion at conventional airports like Kennedy. This air mode could play a significant part in the total transportation system.

According to a planning study made for the CAB, technology exists to permit a commercial STOL craft to be operational today, and VTOL by 1980 or earlier. Such vehicles, says the report, "would be economical, convenient, quiet, high-speed and passenger appealing, and above all, would satisfy a vital need in the short-haul air transportation industry today, and for years to follow."

As Rene H. Miller and Robert W. Simpson have said:

> Can V/STOL penetrate the inter- and even intra-urban short-haul markets, thereby unclogging roads leading to the airport and clearing approach airspace for ever-growing numbers of long- and medium-haul flights?
>
> By and large, the answer has been *yes*. Today, most knowledgeable persons have concluded V/STOL systems are feasible and will play a future role in the Northwest Corridor and else-

where. They foresee decentralizing air travel from the major air terminals to multiple V/STOL ports. Decentralization will improve airport access and relieve ground-transportation links. It will reduce the number of operations at the major airports by removing a great deal of medium-haul traffic, and can bring the convenience of air travel to smaller communities not now served. The airport thus can become another node in a complete short-haul V/STOL network linking all the important population centers.

To date, however, planning and development of STOL and VTOL would seem to have proceeded far too slowly. To accelerate the development of these new aircrafts, the Secretary of Transportation might initiate demonstration VTOL and STOL programs in cities with air congestion, and Congress should provide funds for such development. Where commercial air carriers are reluctant to share in the development, such enterprises could be of a federal–state–local cooperative nature.

Our concern here is with the intercity "commuter-type" traffic, a very large share of which comes into the New York regional airports. A major issue is the separation of daily mass-transit travel from the longer-range transport. We think V/STOL may provide a clear possibility for short-haul intercity air transportation, but, without an extensive research and development program relative to its effectiveness and commercial feasibility, that possibility will not be open to the nation.

With respect to ground service at the airports, our study suggests that we may be faced with problems of congestion even greater than those in the air.

It is predicted that, by 1980, the number of passengers flowing through Kennedy Airport will double the present volume. Further, since passengers will, on the average, be disembarking from aircraft of considerably greater capacity, passenger flow may well be a series of large pulses.

Even with present capital expenditures, it is doubtful that Kennedy can double its terminal and ground-traffic facilities to accommodate this load. If it does, however, the most dramatic effect will be on the Van Wyck Expressway.

A conservative estimate suggests that, even assuming a proposed rail link from Manhattan to Kennedy is in operation, an enormous number of ground passengers will continue to proceed out of Kennedy onto Van Wyck during peak hours, which incidentally are also rush hours for commercial and commuting traffic. The average speed on the routes going into the metropolitan area could be reduced to 10 miles per hour or less. Without adequate ground access to and from the airport, passenger traffic to and from the airport at peak hours could come to a halt by 1980. Some effective form of mass transportation between the airport and Manhattan is absolutely essential.

Parking at Kennedy is already a major problem. Experience to date indicates that for every five passengers there are five visitors and two employees, nearly all of whom come by automobile. Available space for parking at Kennedy is close to saturation. For example, on a peak day in 1968, Kennedy processed 85,000 passengers, 85,000 visitors, and had 35,000 employees. Almost all passengers require ground transportation, a large portion of which is provided by the visitors, nearly all of whom come by car. A search is already under way by a number of airlines to find satellite terminals that provide customer parking and busing to the main terminal. The limited parking convenience that still exists at Kennedy will undergo further degradation proportional to the increasing passenger load.

During the next decade, with passenger load doubling and international traffic (which carries about twice the number of passengers per movement as domestic flights) increasing from about 50 percent to about 65 percent of the total, baggage facilities will undergo severe strain.

With still larger planes and more passenger traffic expected, major improvements in baggage-handling technique are essential. If the self-interest of the airlines proves insufficient to assure the necessary development, the federal government should insist upon it and, if necessary, fund it.

In short, there is little evidence that adequate steps are being taken to solve the ground passenger problem at Kennedy and elsewhere. This is true with respect to each major aspect of the problem—public transportation between the airport and the city; highways and parking facilities for those obliged to use private automobiles; and baggage-handling facilities that will enable passengers to collect their belongings and leave within a reasonable time after disembarking.

These aspects of air transport are also an intergovernmental responsibility. Therefore, we suggest that the federal government, in cooperation with appropriate state and local governmental agencies, make an evaluation of the congestion problem both at the terminals and with respect to ground access to the three major airports in the New York air region, and propose a plan for new systems that would reduce the congestion.

Similar evaluations must be made for other congested airports.

AIR TRANSPORT POLICY AND THE PROTECTION OF THE ENVIRONMENT

It is in the nature of land that it can serve several of man's needs at once. The national forests are managed

according to this principle. They provide a source of timber, a watershed, a habitat for animals, and preserve a wilderness for man. But only a few goals for a piece of land can be realized at once; many goals are incompatible.

To accept the fact of incompatibility requires that we accept restraint. The restraint that inhibits the building of a highway through a national park, and the restraint that inhibits the placement of the next generation of jetports in the immediate environs of cities, are essentially the same. Restraint almost always involves short-run sacrifice: extra effort to get to a valley over an old road and extra travel time to get to a jetport. The long-run reality, of course, is that the valley will be quieter and have cleaner air, and the 10-mile trip to one jetport through city traffic may take longer than a 50-mile trip via high-speed railway to the other.

In the case of Jamaica Bay, a jetport and a bird sanctuary are on neighboring land. They have been strangely compatible neighbors, thanks largely to the two miles of marsh and Bay water that separate them. At the present time, two forces are complicating this relationship. The jetport is seeking to expand across those two miles, and to use the intermediate area in technology-intensive ways, while recreation is beginning to compete for the same space. The airport expansion would diminish compatibility, while development of a recreation area can be designed to assure compatibility.

The question of the best long-term use of the Bay is perhaps one without a scientific answer. Realizing, of course, that it will be decided by political leaders and not by us, we nevertheless wish to give an answer, based upon our study and observations, that will reflect our point of view.

Airports are almost inherently large-scale despoilers of the environment. They occupy huge tracts of land, and they ruin the potential of surrounding areas for many other uses. They subject many of their neighbors to intolerable noise and contribute to the pollution of air and water. They also cause congestion of access highways. In short, they may sharply diminish the quality of life in their surroundings.

Yet, in the past, decisions on the location of airports have been made with little or no regard for any of these consequences. In the last few years, however, Congress has turned its attention seriously to the protection of the environment, and to the operation, development, and planning of our airport system, which is now very much a part of national policy, as well as to its impact upon state and local environments.

Federal legislation has required the states to set water- and air-quality standards and provide for their enforcement. Control of oil pollution and other hazardous polluting substances are a part of the program. Federal financial aid and coordination of federal agency activities to strengthen these programs at all levels are included in the legislation.

Significant legislation to protect and enhance the quality of the nation's environment was signed on January 1, 1970. Known as the National Environmental Policy Act of 1969 (P.L. 91–190), it established a series of specific policies and goals to be followed by all federal agencies in carrying out their programs and policies. In addition, it created a Council on Environmental Quality in the Executive Office of the President to review and monitor the effects of federal programs and the environmental and technological problems that face our society today and those that can be expected to face us in the future.

Particularly relevant to the development of an air transport policy for the future is the direct application of these environmental constraints to the Department of Transportation and to the nation's air system. Indeed, additional requirements are established under the Airport and Airway Development Act of 1970, the Intergovernmental Cooperation Act of 1968, the Demonstration Cities and Metropolitan Development Act of 1966, as well as such implementing actions of the executive branch as Executive Orders, the FAA's Interim Instructions for Processing Airport Development Actions Affecting the Environment, Bureau of the Budget Circular No. A-95, and the Guidelines of the Council on Environmental Quality.

In fact, we are rich in laws and regulations prescribing machinery and guidelines to ensure proper regard for environmental values when decisions for a new airport, the development of an existing one, or any other federally oriented programs, are to be made.

To begin with, the sponsoring agency must "afford public hearings for the purpose of considering the economic, social and environmental effects of the airport location and its consistency with the goals and objectives of such urban planning as has been carried out by the community."

The governor of the state, or, in some cases, a federal official, must certify in writing that "there is reasonable assurance that the project will be located, designed, constructed and operated so as to comply with applicable air and water quality standards."

Moreover, the Secretary of Transportation is required to consult with federal air and water pollution officials "with regard to the effect that any project involving airport location, a major runway extension or runway location may have on natural resources including, but not limited to, fish and wildlife, natural, scenic and recreation assets, water and air quality, and other fac-

tors affecting the environment, and shall authorize no such project found to have adverse effect unless the Secretary shall render a finding, in writing, following a full and complete review, which shall be a matter of public record, that no feasible and prudent alternative exists and that all possible steps have been taken to minimize such adverse effect."

Airport-development projects must also conform to the "national airport system plan," once it has been published by the Secretary of Transportation, and that plan is required by law to reflect environmental considerations. They must also be consistent with state, regional, and local comprehensive planning for the area.

If the project requires the use of any publicly owned land from a park, recreation area, wildlife or waterfowl refuge, or significant historical site, it may proceed only if the Secretary of Transportation determines both that there is no feasible and prudent alternative to the use of such land, and that the program includes all possible planning to minimize harm to the areas affected.

In addition, an environmental statement must be prepared and made available to the President, the Council on Environmental Quality, and the public, setting forth, among other matters, the following:

The probable impact of the proposed action on the environment, including impact on ecological systems such as wildlife, fish and marine life. Both primary and secondary significant consequences for the environment should be included in the analysis. For example, the implications, if any, of the action for population distribution or concentration should be estimated and an assessment made of the effect of any possible change in population patterns upon the resource base, including land use, water and public services, of the area in question.

Any probably adverse environmental effects which cannot be avoided, such as water or air pollution, damage to life systems, urban congestion, threats to health or other consequences adverse to . . . environmental goals.

Alternatives to the proposed action: the responsible agency (is required) to "study, develop, and describe appropriate alternatives to recommend sources of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources." A rigorous exploration and objective evaluation of alternative actions that might avoid some or all of the adverse environmental effects is essential. Sufficient analysis of such alternatives and their costs and impact on the environment should accompany the proposed action through the agency review process in order not to foreclose prematurely options which might have less detrimental effects.

The relationship between local short-term uses of man's environment and the maintenance and *enhancement of long-term productivity.* This, in essence, requires an assessment of the action for cumulative and long-term effects from the perspective that each generation is trustee of the environment for succeeding generations.

Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. This requires an identification of the extent to which the action curtails the range of beneficial uses of the environment.

And Federal Aviation Administration regulations further provide:

In particular, alternative actions that will minimize adverse impact are to be explored and both the long and short range implications to man, his physical and social surroundings, and to nature, should be evaluated in order to avoid to the fullest extent practicable undesirable consequences for the environment.

There can be no doubt that there is now in being a formidable array of legal requirements, all intended to ensure that airport-siting decisions in the future will be made with full attention and regard to environmental effects. The safeguards seem more than adequate—on paper. But paper requirements can be met by paper compliance.

Government agencies accustomed to viewing their mission narrowly may continue to pay only lip service to environmental requirements unless their pressing and often overriding importance becomes part of the consciousness of government officials at every level.

It will be necessary for the Environmental Quality Council, and the Office of Management and Budget, to take steps to assure adherence to the goals of these statutes and regulations by the Secretary of Transportation and all other officials concerned. Moreover, the Congress will have to exercise its responsibility for oversight of these matters.

However, it will be necessary to strike a sensible balance, and to devise procedures whereby environmental issues are explored fully but also efficiently and expeditiously. Environmental protection is not to be compromised, but the building of a better, stronger airport and airways system is a basic and urgent requirement of the people of this nation.

NATIONAL AIR TRANSPORT PLANNING

Steps have been taken in recent years to develop an effective national air transportation plan, but such plans as have been issued, and even the requirements for those to be prepared in the future pursuant to recent legislation, would still seem to fall short of the comprehensive planning that the nation urgently needs. We briefly discuss below existing plans and legislation relevant to them.

National Airport Plan

Pursuant to the Federal Airport Act of 1946, as amended, the FAA is directed to develop a national plan

for "a system of public airports adequate to anticipate and meet the needs of civil aeronautics. . . ." The latest revision of this plan, the 21st, was issued in 1968, and intended to cover Fiscal Years 1969–1973.

This plan does not pretend to be a comprehensive plan for air transportation in the United States, but is limited to estimates of needed additional airports and extensions of existing airports, classified by geographic location. While prepared in consultation with other agencies of the federal government, as well as state and local authorities, it appears to reflect little more than the gap between present capacity, on the one hand, and present and estimated future demand on the other. Availability of necessary local sponsorship and financing is simply assumed, as is the provision of necessary ground access facilities. Apparently no attention is paid to the possibility of mass ground transportation as an alternative to short-haul air passenger services; in fact, it is stated that "airport activity alone does not presently justify a 'special' rapid transit unit."

Illustrative are the detailed prescriptions for airports in the New York metropolitan area. One new air-carrier jetport is called for, its location designated as in New Jersey but with no further specificity. Fifty million dollars is set forth as the estimate for its total cost.

The National Aviation System Plan (Ten-Year Plan 1971–1980)

Issued in March 1970, this plan is drawn on the assumption that the Airport and Airway Development Act of 1970 would pass, as, in fact, it has, but it does not purport to resemble either the "national transportation policy" or the "national airport system plan" called for by the latter. As it is in large part a spending estimate, its objectives are apparently scaled down to conform to anticipated federal appropriations.

For example, the plan projects a total federal contribution of $2.5 billion over the 10-year period, for new and existing airport development. This is to represent 50 percent of total cost, estimated at $5 billion. This anticipated expenditure must be allocated between air-carrier airports and general-aviation airports, between improvement of existing airports and construction of new ones, and among airports of high, medium, and low density. A total of $2,391 million is allocated for 10 new, high-density airports (the federal component being half of this sum). It seems doubtful that this amount would be adequate, especially when compared with the over $200 million estimated cost for runway additions at Kennedy.

Recognized in the plan is its vulnerability to local governmental decision-making; although the plan calls for a badly needed airport, it will not be built if local funding is not provided or if local authorities cannot agree on a site. If, as may be assumed, at least one of the contemplated new airports is intended for the New York metropolitan area, events of the past demonstrate the likelihood that, without adequate new federal authority to select sites, this portion of the plan will not be implemented.

Assumed in the plan is the provision by local authorities of adequate ground access for passengers and freight. A more comprehensive plan should include provisions for these facilities. Furthermore, as in the case of the National Airport Plan, this plan appears to treat aviation in isolation from alternate modes of mass transportation.

While the plan is certainly a start toward the type of planning so urgently needed, so many of the factors that bear upon the dimensions of the need for airport expansion and the feasibility of the contemplated programs are beyond its scope, that it cannot be regarded as sufficiently comprehensive to meet today's or tomorrow's requirements.

The Airport and Airway Development Act of 1970

The most recent step toward true air transport system planning was taken in this statute, which requires the Secretary of Transportation to prepare two major plans.

The first of these, a "national transportation policy," is to be submitted to Congress for approval within a year of enactment of the statute (hence, by May 1971). In its preparation, the Secretary is required to consider the coordination of all modes of transportation and the integration of air transportation with the entire national transportation system.

The second, due in May 1972, and to be reviewed and revised as necessary thereafter, is a "national airport system plan" for at least a 10-year period. Consideration is required of "the relationship of each airport to the rest of the transportation system in the particular area, to the forecasted technological developments in aeronautics, and to developments forecasted in other modes of intercity transportation." Consultation with other federal agencies, especially in connection with environmental effects, is required.

References in the statute to consultation with state and local agencies are surprisingly limited. The Secretary of Transportation is obliged, "to the extent feasible," to consult "with planning agencies" and to "provide technical guidance to agencies engaged in the conduct of airport system planning and airport master planning to insure that the national airport system plan reflects the product of interstate, state and local airport

planning." Provisions for consultation concerning environmental changes refer only to federal agencies. There is nothing in the statute, however, that would prevent a Secretary so minded from engaging in fuller and more meaningful consultation with state and local officials, and, at least with respect to the environment, it is likely that the Council on Environmental Quality would seek to induce such consultation as is necessary for compliance with the provisions of the National Environmental Policy Act of 1969.

While a long step in the right direction, these provisions still fall short of what is needed. Consultation is vital, but conferences do not always resolve differences and, under present law, the Secretary will have no assurance that his plan can be effectuated. So long as a governor, a mayor, a county official, or even a village board can prevent the construction of a jetport vitally needed by a major metropolitan area, the best of theoretical plans may still remain nothing more than a sheaf of paper poignantly telling the story of what might have been.

A significant part of the Act is the establishment of a trust fund, similar to the Highway Trust Fund, composed of revenues from user taxes. No more than $840 million may be obligated by the Secretary over the next five years for airport construction and development; however, not less than $250 million a year is authorized "for the purpose of acquiring, establishing and improving air navigation facilities."

Considering that the trust fund is expected to run up to $1 billion or more a year in the next few years, a substantial amount will be available for air traffic control and navigation facilities. We feel that, at this stage of airway development, this is where the emphasis should be placed—not just for safety, but for providing a more rational use of existing airport capacity. At the same time, long-range planning for new airport capacity can go forward.

With an estimated tripling of revenue passenger-miles in the next decade and a further increase by 1990, planning should proceed as quickly as possible in view of the long lead time necessary to construct needed facilities. The Airport and Airways Act does not seem to change the existing system of air transport operation in any significant way. But it does place a positive responsibility upon the Secretary of Transportation to take an entirely new look at the whole structure of transportation in this country, particularly as air transport is interrelated with other transport modes.

In such a planning study, we suggest including the following items, which came to our attention during the Jamaica Bay Study:

First. We should be considering now the location and development of a limited number of large regional, intercontinental airports to meet the expected domestic and international travel demand. The necessary characteristics of these airports, as well as procedures for siting and funding them, are suggested above.

In addition, we recommend that the FAA and the CAB under a joint arrangement investigate the present use, and necessity for service, of all major public and private airports including the practicability of present routes, schedules, and aircraft; the environmental impact of present airports on their surrounding communities; and the long-range need for their continued utilization.

Second. A systems analysis of the location and use of existing and needed airports must be made to determine a region's requirements for facilities to serve commercial and general aviation. Federal funding on a formula basis should be re-examined in light of this systems study.

Third. Assessing the role of air transport as part of a total transportation system presents difficult problems. A plan should consider the coordination of air, rail, and other mass transit and highways, and should assess the priorities for their use and for governmental expenditures to assist them in achieving their purposes most effectively in the total system.

As we have suggested earlier, such a plan might include joint planning and funding between the FAA, mass transit and the highway and rail agencies, to improve existing airport access and terminal congestion and prepare for future growth in passenger and cargo traffic. With the siting and operation of new airports, guidelines should be developed for including mass transit access, and airport location near to the Interstate Highway System.

Fourth. The Secretary of Transportation should give special attention, as part of his study and recommendations concerning the planning process, to the environmental impact of airport noise.

Currently, large numbers of people near major airports are exposed to NEF levels above 30. We believe that national standards, methods of measurement, and guidelines for tolerable environment noise can be established and that a national commitment should be made to reduce aircraft noise in residential areas to a level of no greater than NEF 20. A firm technological base exists for production of engines for subsonic aircraft that will reduce the noise impact to levels very much lower than the present ones.

What is needed is a national decision to proceed, on the shortest possible time scale. We believe such a decision will enhance the future of commercial aviation.

We recognize that the FAA has for some time had

regulations prescribing aircraft landing and takeoff altitudes and use of runways that provide for minimization of noise impact [14 CFR Sec. 91.87 (d), (f) and (g)], as well as regulations applicable to specific airports (see 14 CFR Sec. 93.33 with respect to Kennedy). Such controls have been just sufficient to pre-empt the field, and to bar state and local governments from legislating to protect their citizens from the impact of airport noise without really contributing substantially to alleviation of the problem.

As the "quiet engine" program goes forward, we feel that the Department of Transportation has concurrent responsibility—particularly under the National Environmental Policy Act of 1969 (P.L. 91–190)—to impose stringent airport-noise standards and abatement procedures at all airports over which it has jurisdiction. Furthermore, consideration should also be given to requiring effective local zoning regulations, to ensure that noise-impacted areas are emphasized only for compatible uses, as a condition to granting assistance in airport projects undertaken under the new Airport and Airways Act of 1970 [Sec. 51 (b), P.L. 91–258].

CONCLUSION

The unhappy fact is that we have a system of airports and airline service that was designed for yesterday. Demand for air travel has spread across a broadening spectrum of income levels, making forecasts inherently uncertain. Airport facilities are struggling to cope with the larger aircraft. General aviation has become a very significant user of the air and ground space. Access to and from the airport has become a serious congestion problem.

The underlying theme of our conclusions is that, because safe and adequate air transport service is a national issue, far greater responsibility and authority must be assumed by the federal government for the planning, regulating, and developing of an effective, modern, national air transport system.

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FIGURE 3-3 Areas currently exposed to NEF 30 and 40. Scale: 1" = 1 Mile

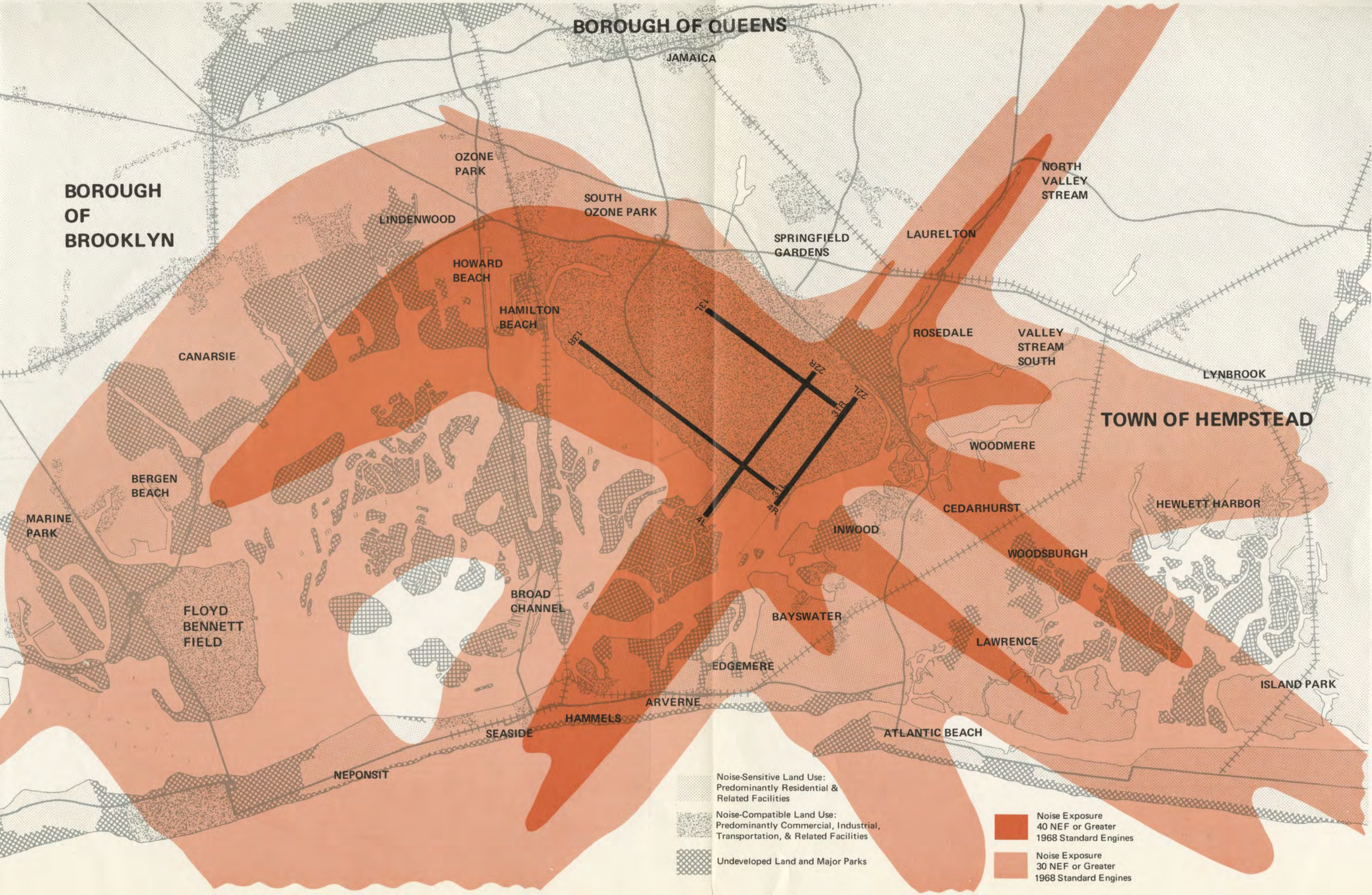

FIGURE 3-1 Jamaica Bay and Kennedy Airport environs. Scale: 1" = 1 Mile

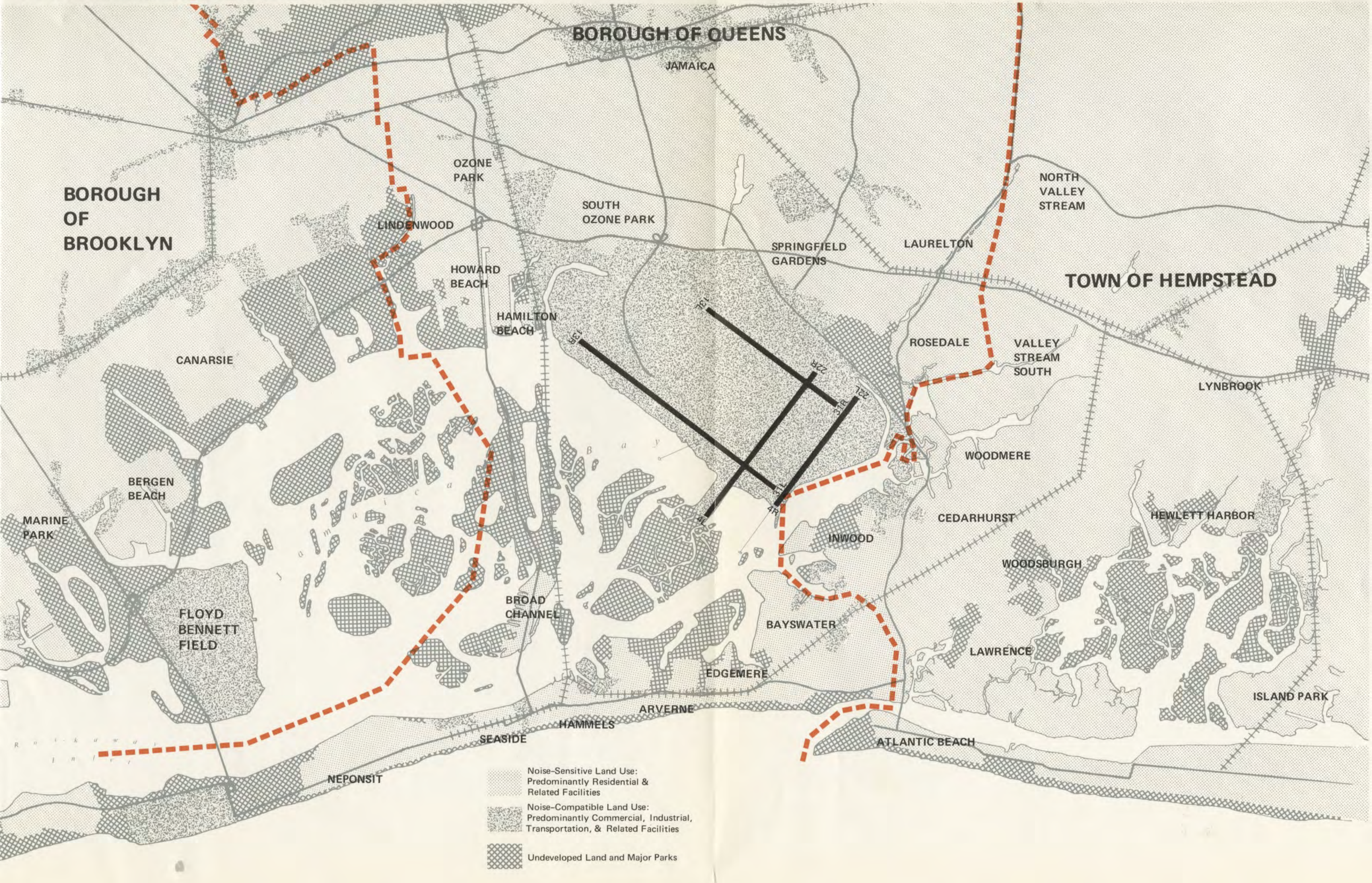

FIGURE 3-4 Public schools in high-noise areas of Kennedy Airport environs. Scale: 1" = 1 Mile

FIGURE 3-5 Hospitals and health care facilities in high-noise areas of Kennedy Airport environs. Scale: 1" = 1 Mile

FIGURE 3-6 Publicly assisted housing in high-noise areas of Kennedy Airport environs (projects built and occupied since 1959, currently in planning, or under construction). Scale: 1" = 1 Mile

Project	Key	Dwelling Units
157th Ave. 79th St.	1	576
Fairfield Towers	2	1,148
Linden Plaza	3	1,525
Louis H. Pink	4	1,500
Fresh Creek	5	2,500
Pennsylvania Ave. Area Wortman Ave.	6	336
Twin Pines (about ¼ of Spring Creek)	7	5,700
Seaside-Rockaway	8	1,416
Hammels-Rockaway	9	2,248
Bay Towers East and West	10	372
Arverne Urban Renewal Project A number of single projects	11	6,500
Nordeck Houses	12	342
Edgemere Houses	13	1,395
Norton Basin	14	1,400
B. 41st St. B Channel Dr.	15	712
Atlantic Gardens	16	700
Seaview Towers	17	400
Israel Sr. Citizens	18	409
Ocean Park Apts.	19	600
Roy Reuther	20	889
Total (New York)		30,668
Inwood Urban Renewal (Town of Hempstead)	21	281
TOTAL		30,949

Noise-Sensitive Land Use: Predominantly Residential & Related Facilities

Noise-Compatible Land Use: Predominantly Commercial, Industrial, Transportation, & Related Facilities

Undeveloped Land and Major Parks

Noise Exposure 40 NEF or Greater 1968 Standard Engines

Noise Exposure 30 NEF or Greater 1968 Standard Engines

Publicly-Assisted Housing Projects

FIGURE 3-7 Accumulated publicly assisted housing in Jamaica Bay environs. Scale: 1" = 1 Mile

FIGURE 4-1 Kennedy Airport and Jamaica Bay—existing major runways. Scale: 1" = 1 Mile

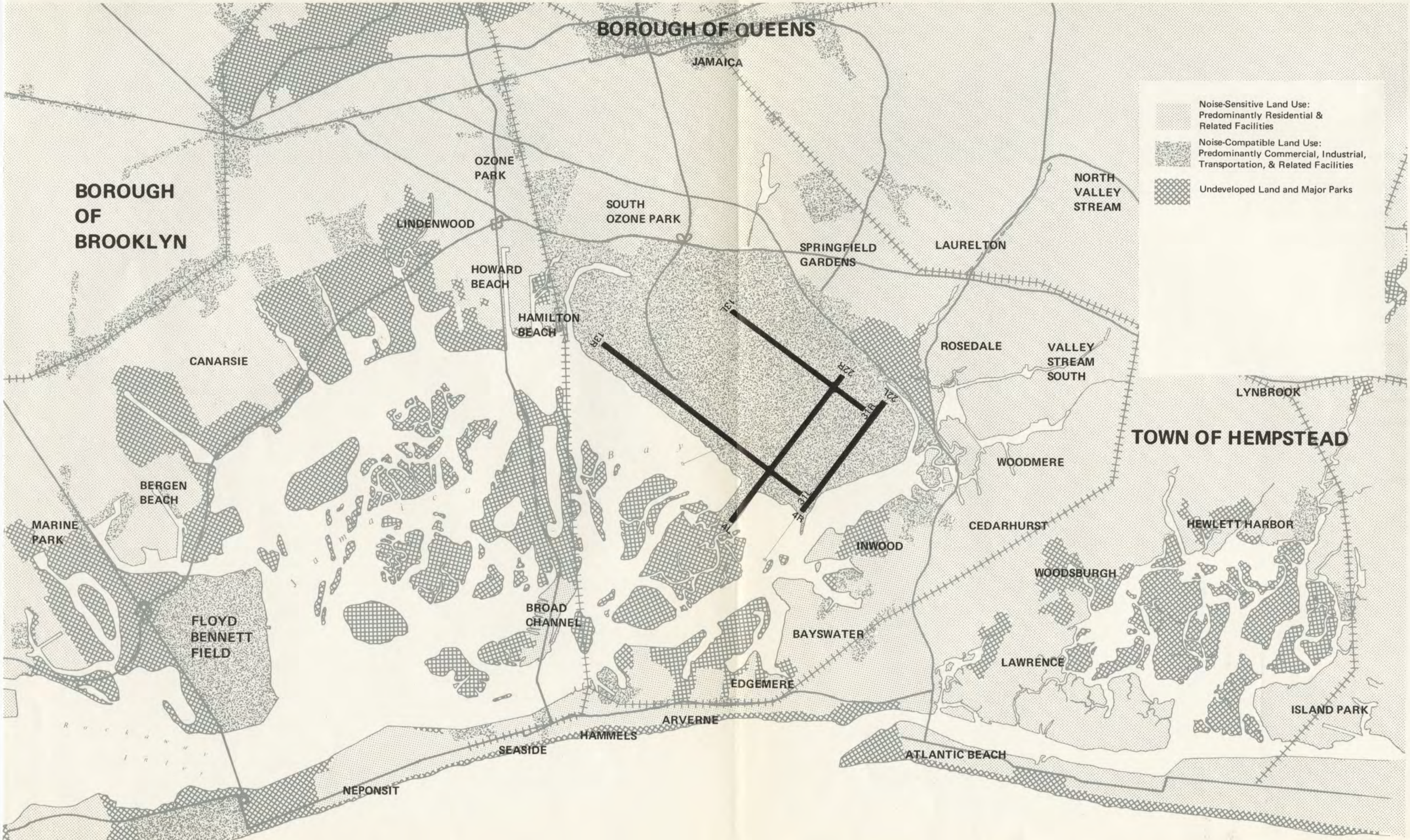

FIGURE 4-2 Kennedy Airport with Runway Configuration 1. Scale: 1" = 1 Mile

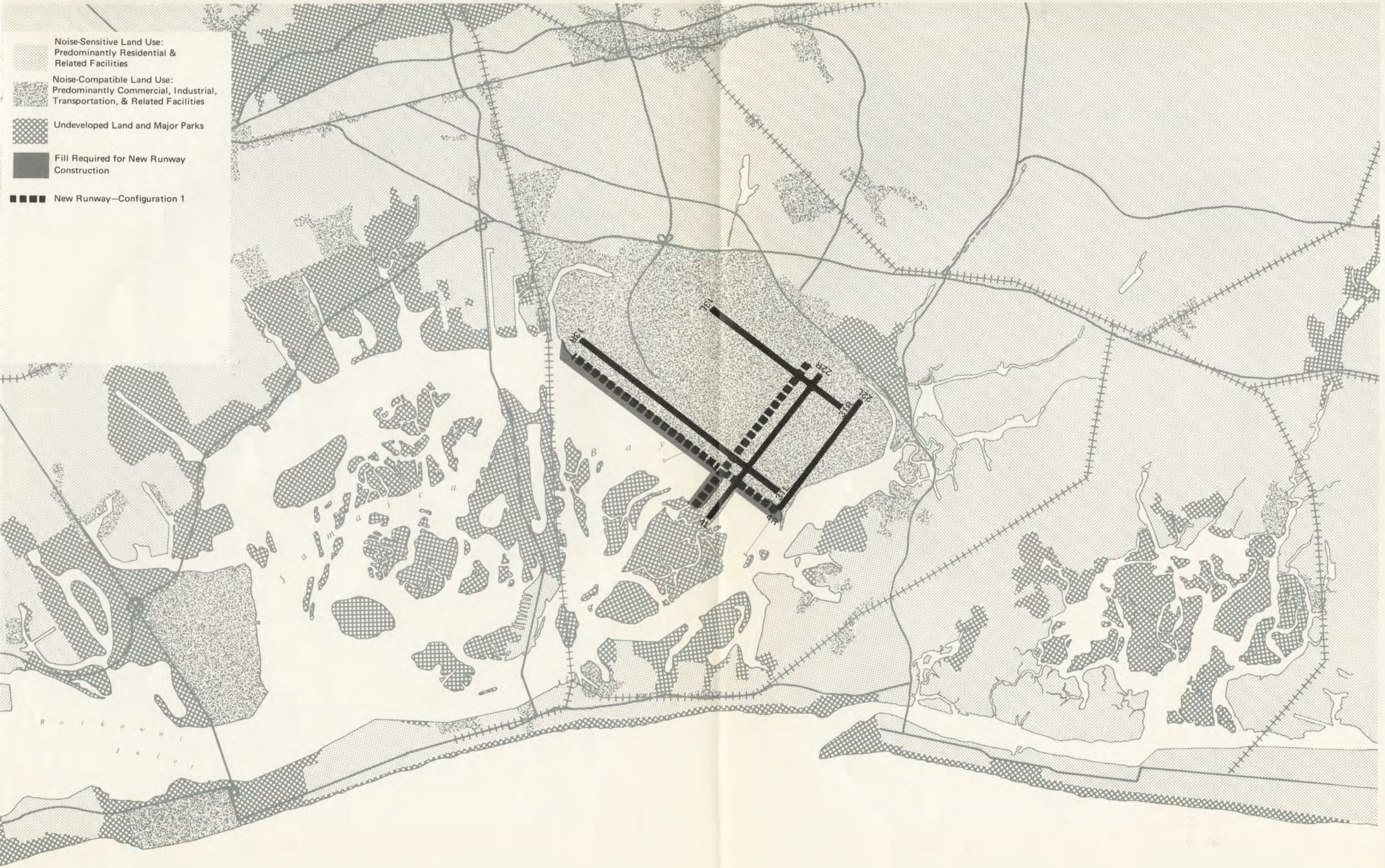

FIGURE 4-3 Kennedy Airport with Runway Configuration 2. Scale: 1" = 1 Mile

FIGURE 4-4 Kennedy Airport with Runway Configuration 3. Scale: 1" = 1 Mile

FIGURE 4-5 Kennedy Airport with Runway Configuration 4 (PONYA). Scale: 1" = 1 Mile

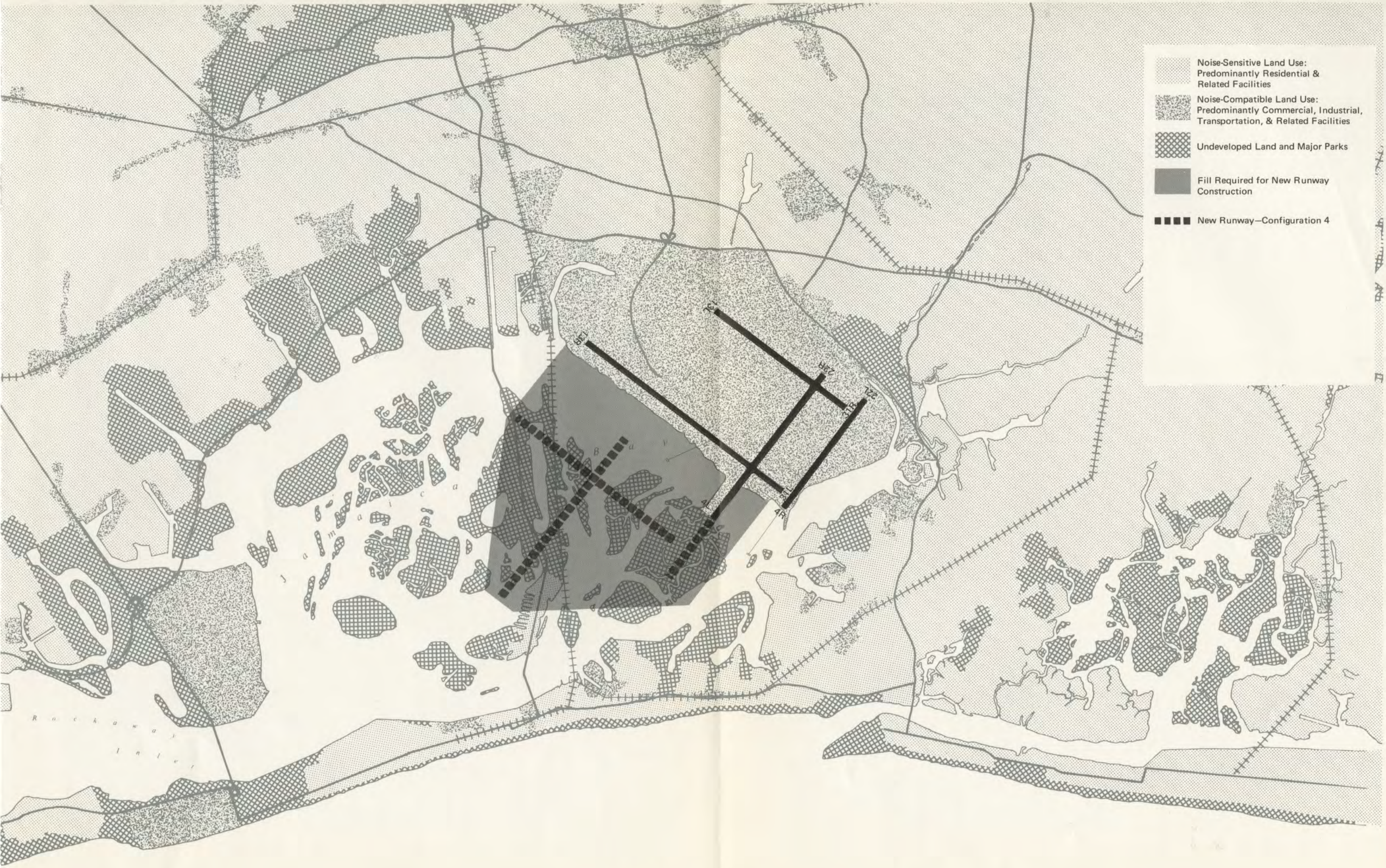

FIGURE 4-6 Comparison of noise-exposure contours under present conditions and with nacelle-treatment retrofit. Scale: 1" = 1 Mile

FIGURE 4-7 Comparison of noise-exposure contours under present conditions and with projected 1980 operations, reflecting improved (1970) engine technology and minimal runway additions. Scale: 1" = 1 Mile

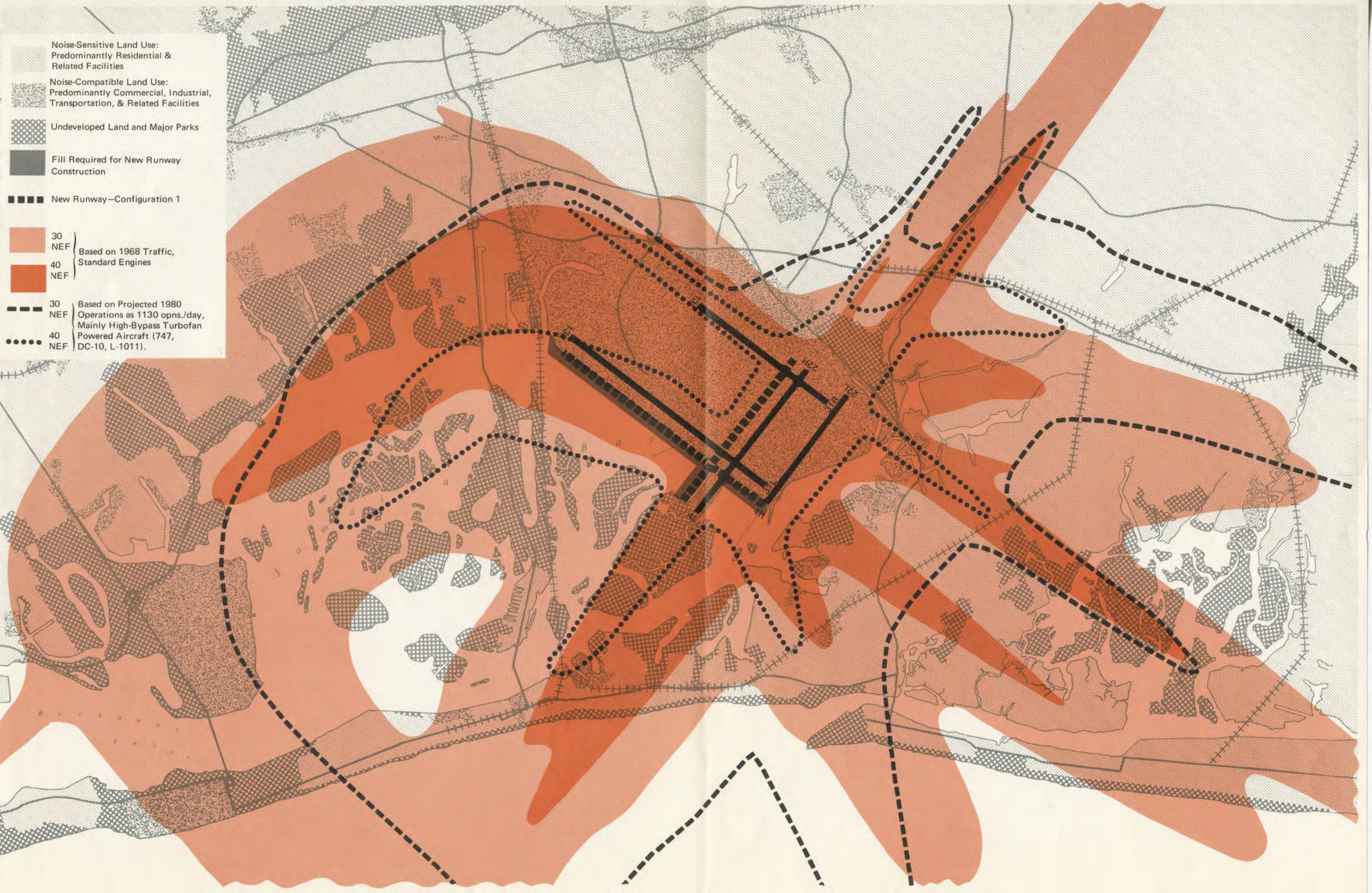

FIGURE 4-8 Comparison of noise-exposure contours under present conditions and with projected 1980 operations, reflecting improved (1970) engine technology and Runway Configuration 4 (PONYA). Scale: 1" = 1 Mile