PDHonline Course C750 (4 PDH)

Mr. Lincoln's Tunnel

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2020

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Mr. Lincoln's Tunnel

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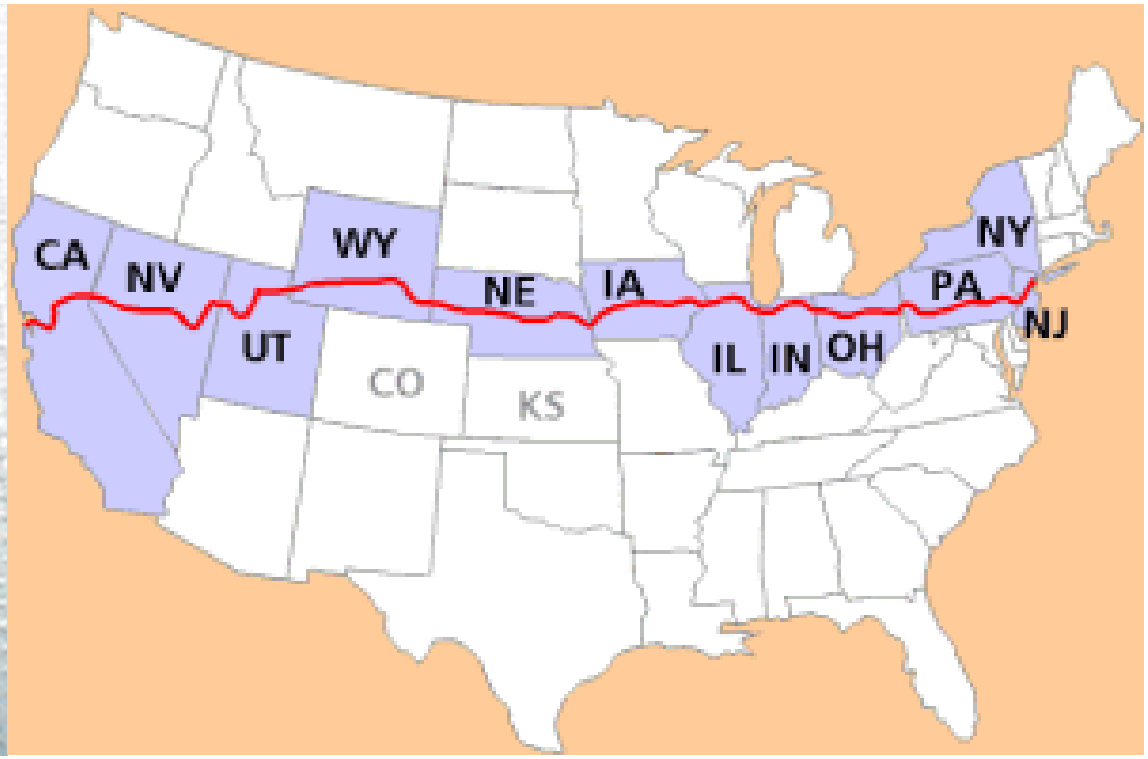
Part 1

Midtown-Hudson Tunnel

Namesake



In 1912, there were very few good roads in the *United States*. The relatively few miles of improved road were around towns and cities (a road was "improved" if it was graded). That year, *Carl Fisher* (developer of *Miami Beach* and the *Indianapolis Speedway*, among other things) conceived a trans-continental highway. He called it the "Coast-to-Coast Rock Highway." It would be finished in time for the 1915 *Panama-Pacific Exposition* and would run from the exposition's host city; *San Francisco*, to *New York City*. Two auto industry tycoons played major roles in the highway's development: *Frank Seiberling* - president of *Goodyear Tire & Rubber Co.*, and *Henry Joy* - president of the *Packard Motor Car Company.* It was Henry Joy who came up with the idea of naming the highway after POTUS *Abraham Lincoln.* On July 1st 1913, the *Lincoln Highway Association* was officially incorporated. The highway started in *Times Square*, NYC. It passed through *New Jersey, Pennsylvania, Ohio, Indiana, Illinois, Iowa, Nebraska, Wyoming, Utah, Nevada* and *California* (see map at right), ending in San Francisco's *Lincoln Park*. *Weehawken, NJ* became known as the "Gate to the Lincoln Highway" (see 1917 medal at left). For the Port of New York Authority's new "Midtown-Hudson Tunnel," whose western portal was in Weehawken, it only made sense to honor the fact that the late president and the highway which honored him also be named in his honor.

A Mighty Natural Barrier

"The Lincoln Tunnel has been built to meet the urgent needs of trans-Hudson vehicular traffic of the midtown Manhattan area and the adjacent New Jersey communities. The broad Hudson River, while it carries the water-borne commerce which has made this great Metropolitan area the trade center of the world, at the same time interposes a mighty natural barrier to the intercommunication and growth of the communities that line its shores. Their development is directly dependent on the adequate solution of the problems of vehicular transportation…"

RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* dedication ceremony booklet (December 21st 1937)

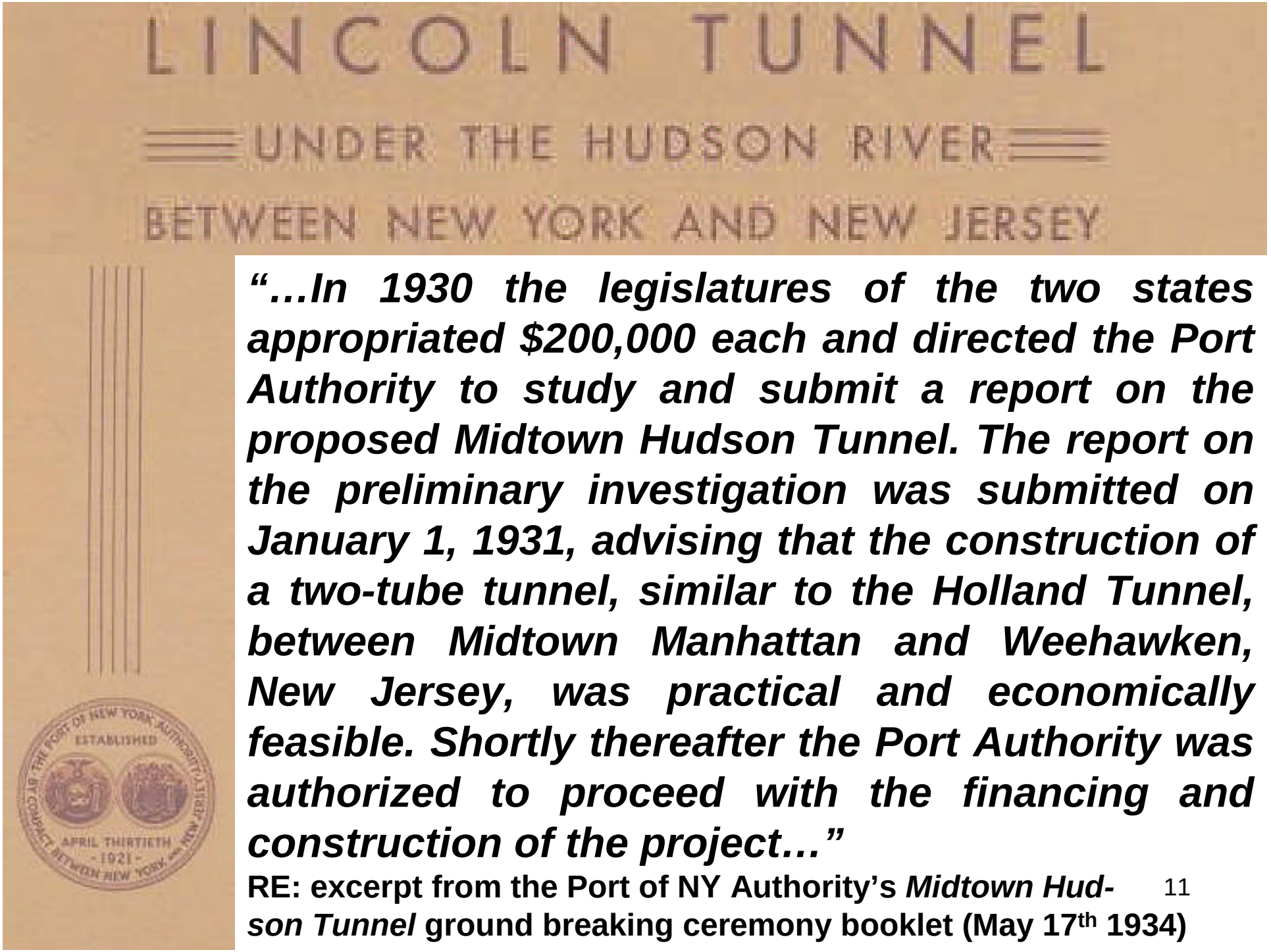
Reaching Capacity

"…The Holland Tunnel, completed in 1927, and the George Washington Bridge, opened for traffic in 1931, were built in answer to this pressing traffic need and together they have carried 155 million vehicles. Indeed, since the first of these crossings was put in service vehicular traffic across the Hudson River in the Metropolitan area has more than doubled in volume. However, neither the Holland Tunnel, three miles to the south and now carrying its capacity load, nor the George Washington Bridge, located seven miles to the north, can meet all traffic needs of midtown Manhattan and opposite New Jersey communities. Immediately after the Holland Tunnel was opened, the rapid growth of motor traffic made it evident that before many years another similar tunnel would be needed to serve the midtown area, and studies for the midtown tunnel were begun simultaneously by the joint Bridge and Tunnel Commissions, builders of the Holland Tunnel, and by the Port of New York Authority…"

RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* dedication ceremony booklet (December 21st 1937)

"As early as 1929, it was indicated that there would be a demand for additional Hudson River vehicular crossings to keep pace with the large increase in traffic between the many New Jersey and New York communities. During the past six years, trans-Hudson traffic has increased from 16,000,000 to 29,000,000 vehicles annually. The Holland Tunnel is now operating at better than seventy-five per cent of annual capacity and on Sundays and holidays, during periods of peak traffic, its capacity has been reached. During the last three years, it has averaged about 11,600,000 vehicles annually…"

RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* ground breaking ceremony booklet (May 17th 1934). By allowing for more car and bus traffic, the new midtown tunnel (along with the *Holland Tunnel* (1927) and the *George Washington Bridge* (1931) reduced dependency on commuter railroads and/or ferries and promoted the automobile as a central factor in the region's economic growth. It would also provide much needed employment for hundreds of men during the depression. The tunnel was designed by *Ole Singstad*.



"…In 1930 the legislatures of the two states appropriated $200,000 each and directed the Port Authority to study and submit a report on the proposed Midtown Hudson Tunnel. The report on the preliminary investigation was submitted on January 1, 1931, advising that the construction of a two-tube tunnel, similar to the Holland Tunnel, between Midtown Manhattan and Weehawken, New Jersey, was practical and economically feasible. Shortly thereafter the Port Authority was authorized to proceed with the financing and construction of the project…"

RE: excerpt from the Port of NY Authority's *Midtown Hudson Tunnel* ground breaking ceremony booklet (May 17th 1934)

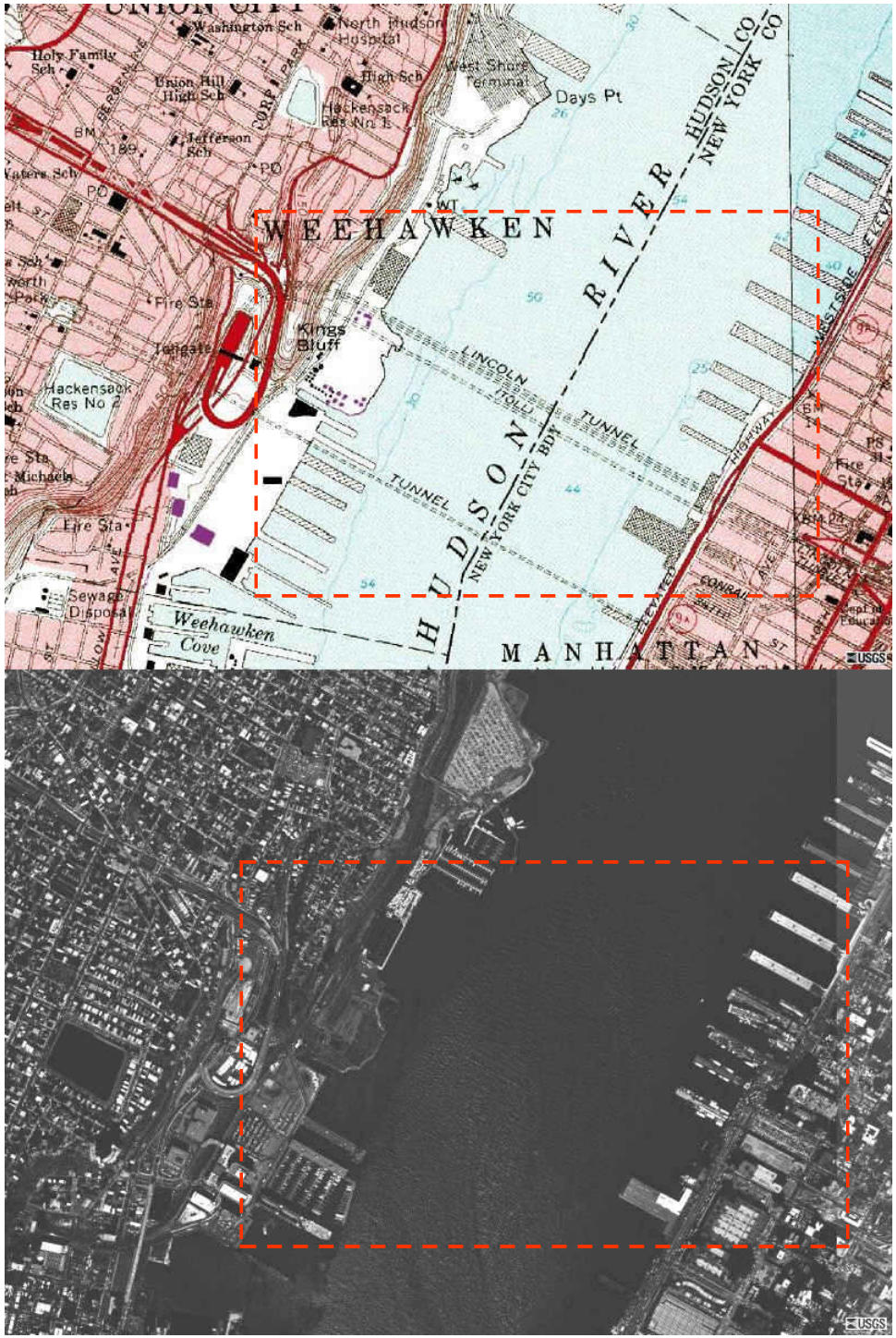
Old Man Depression

"…Early in 1931 the joint Bridge and Tunnel Commissions were merged with The Port of New York Authority and the Sates of New York and New Jersey authorized the reconstituted Authority to proceed with the construction of the new tunnel. However, by the end of 1931, when plans for the tunnel had been developed to the stage where construction could be started, the general economic situation had become such as to make it impracticable for the Authority to market its bonds, and activities were suspended…"

RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* dedication ceremony booklet (December 21st 1937)

"…In the summer of 1932 the federal government embarked upon its program for the relief of unemployment through the financing of projects of a self-liquidating character, and the Authority at once entered into negotiations for the advancement of federal funds for construction of the tunnel. In the course of these negotiations the Authority made a study which indicated the feasibility of building the tunnel in essentially two stages, the first of which would provide a single tube with approaches and facilities for two-way traffic operation. The initial investment would thus be reduced to accord with the then existing economic conditions…"

RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* dedication ceremony booklet (December 21st 1937)



"…When first opened, the Midtown Hudson Tunnel will consist of a single tube carrying two lanes of traffic in opposite directions, between West Thirty-Eighth Street, in New York City, and Weehawken, N.J. Eventually, a second tube will be pushed through alongside the first, and each will then become a one-way tunnel. Funds advanced by the Public Works Administration, under Administrator Harold L. Ickes, permitted the start of the ambitious project with the construction of the first tube, which in itself will help relieve traffic congestion at the George Washington Bridge to the north and the Holland Vehicular Tunnel to the south…"

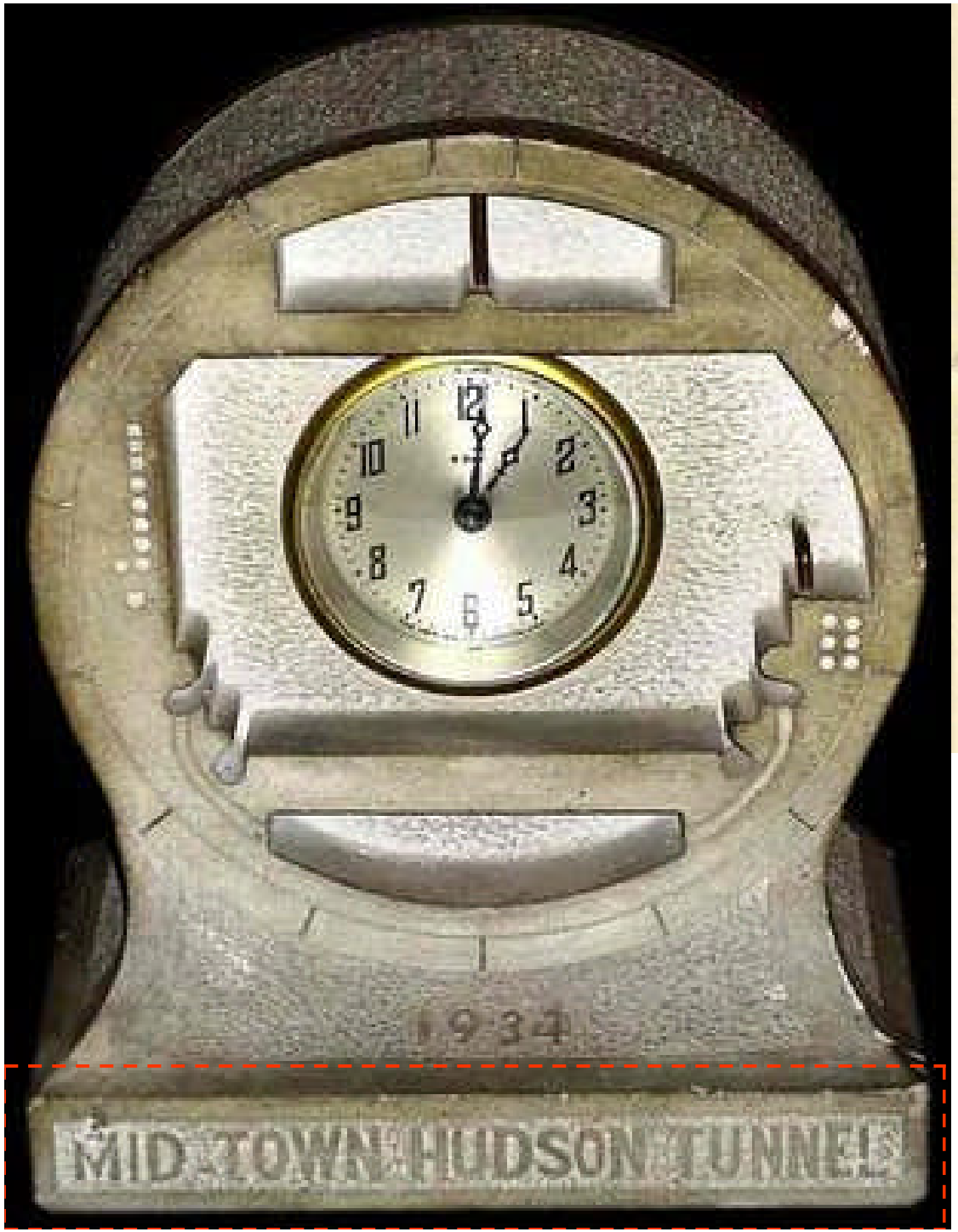
***Popular Science,* March 1936**

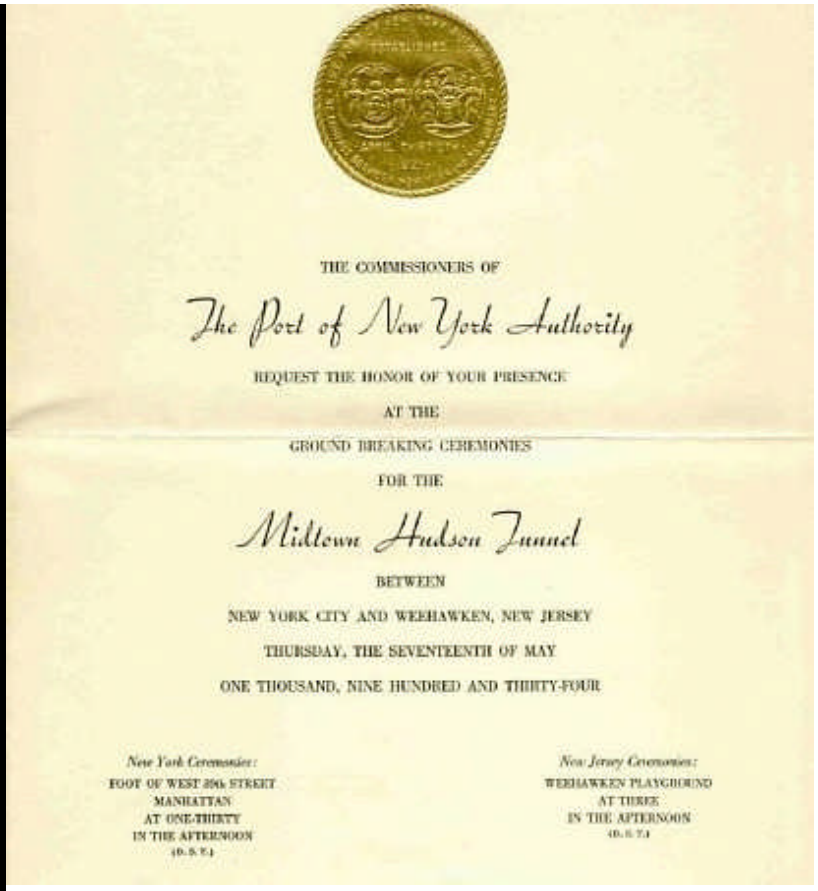
<u>Left</u>: topographical location map (top) and overhead photo (bottom)

"…An agreement for a federal credit of $37,500,000 for construction of the First Operating Unit was arranged through the Public Works Administration in September, 1933. Work was started promptly although official ground-breaking ceremonies were not held until May 17, 1934. Progress on shield tunneling was excellent and on August 2, 1935, the south tube was 'holed through' under the river. At the same time rock tunneling and construction of other parts of the project were going forward…"

RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* dedication ceremony booklet (December 21st 1937)

<u>Above</u>: caption: "May 17, 1934: The ground-breaking. It was a happy occasion. There isn't one in the scene not smiling"





THE COMMISSIONERS OF

The Port of New York Authority

REQUEST THE HONOR OF YOUR PRESENCE

AT THE

GROUND BREAKING CEREMONIES

FOR THE

Midtown Hudson Tunnel

BETWEEN

NEW YORK CITY AND WEEHAWKEN, NEW JERSEY

THURSDAY, THE SEVENTEENTH OF MAY

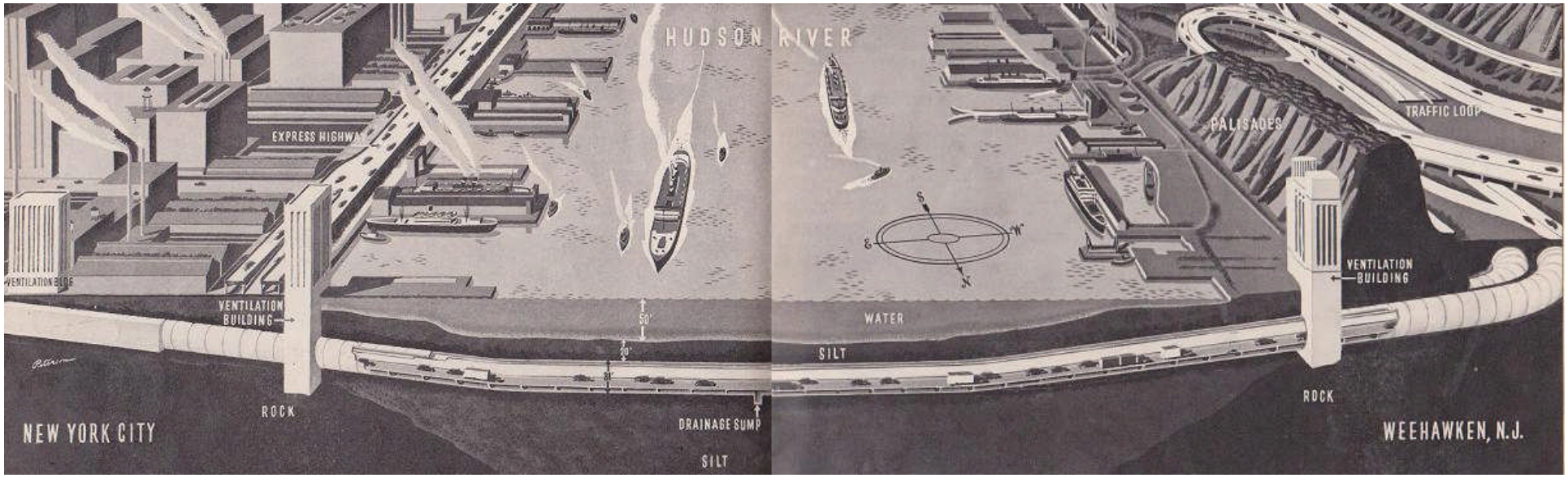
ONE THOUSAND, NINE HUNDRED AND THIRTY-FOUR

New York Ceremonies:
FOOT OF WEST 39th STREET
MANHATTAN
AT ONE-THIRTY
IN THE AFTERNOON
(D. S. T.)

New Jersey Ceremonies:
WEEHAWKEN PLAYGROUND
AT THREE
IN THE AFTERNOON
(D. S. T.)

<u>Above</u>: invitation to attend the Ground Breaking Ceremonies to be held on May 17th 1934

<u>Left</u>: cast concrete clock showing tunnel cross-section given out to VIPs at the Ground Breaking Ceremony held on May 17th 1934 (note it has the initial name: "Mid-Town Hudson Tunnel" inscribed at its base)



"Up to Nov. 13, 1927 all vehicular traffic between New York City and New Jersey had to use ferry boats across the Hudson River. Then the great Holland Tunnel, a miracle of engineering in its day, was opened to motorists. A million cars a month are now congesting this interstate tunnel. To relieve this traffic jam, one tube of a second tunnel under the Hudson was opened to the public Dec. 22. Called the Lincoln Tunnel, it runs from West 39th Street in Midtown Manhattan to Weehawken, N.J. By Dec. 22, 1938, 5,000,000 of the 35,000,000 cars that annually pass between Manhattan and New Jersey will have dived through it. In 1941, the second tube will receive traffic, thus doubling the tunnel's capacity. A record of speedy construction, the 8,215-ft. tube was started in March, 1934 with a PWA loan, was holed through Aug. 2, 1935, completed in 3¾ years. The Port of New York Authority repaid the loan, expects the tunnel to pay for itself in 40 years or less. Charge will be $0.50 per passenger car. Above you see a profile drawing of the $85,000,000 Lincoln Tunnel looking south down the Hudson as it will appear when both tubes are completed. At present, with only one tube completed, cars going both ways will use it. When the project is completed each tube will carry one way traffic only…"

***LIFE* magazine, December 27th 1937**

"…Early in 1935, business conditions had so far improved that it became practicable for the Authority to float a bond issue from the proceeds of which all federal government advances made up to that time ($12,300,000) were repaid, and funds in the amount of approximately $12,500,000 were made available to meet further construction costs of the First Operating Unit. The agreement with the federal government was modified to eliminate loan provisions and to make available instead a grant of $4,780,000…"

RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* dedication ceremony booklet (December 21st 1937)

<u>Above</u>: caption: "'Sand Hogs' bore through Hudson River Midtown Tunnel from Jersey side, 2/19/35"

Part 2

Weehawken or Bust

Phasing

"…Subsequently it was determined to carry out construction in two stages. The First Operating Unit, which is now being financed by the Federal Administration of Public Works, will consist only of the south tube and will provide for one lane of vehicular traffic in each direction…Contracts were awarded during the latter part of 1933 for the manufacture of the cast iron and cast steel tunnel segments ($2,358,150) and the steel nuts, bolts and washers ($177,700). The manufacture of these materials is well under way. Contract MHT-4, covering the boring ($6,452,000), by the shield driven method, of the under water portion of the tunnel and two ventilation shafts has been awarded. Specifications for other contracts are being expedited in accordance with a construction program which provides for the completion and operation of the first operating unit in 1938…"

RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* ground breaking ceremony Booklet (May 17th 1934)

<u>Above</u>: caption: "Midtown-Hudson Tunnel – Tunneling Operations"

"…'Here is how we go about burrowing underground, and under a river at that. Deep shafts are sunk on either side of the river and elevators are built into them. A huge circular shield of steel about twenty feet in diameter is then lowered into each shaft. Working toward each other from their opposite terminals, the shields are started forward, pushing through rock, mud and gravel under the mighty force of compressed air. A meeting-place for the two shields has been designated at a point midway under the river. As the shield pushes its hood through the course of the proposed tunnel, the passage is filled with debris which the sandhogs tackle with pick and shovel and load onto cars which carry it back to the elevators where it is removed to the surface. When the tunnel is being driven, big steel rings, made up of radial plates, are bolted into place to form the strong ribs of the tunnel. When this set of rings is finished, the shield is then moved forward again, and then more rings are bolted into place. This process continues until the tunnel is holed through.'…"

***Modern Mechanix and Invention,* June 1934**

Left: caption: "Artist's drawing: sinking of the preliminary shaft"

<u>Top Left</u>: caption: "North Tube, workers clearing bottom of rock tunnel at Weehawken, New Jersey, after completion of excavation"

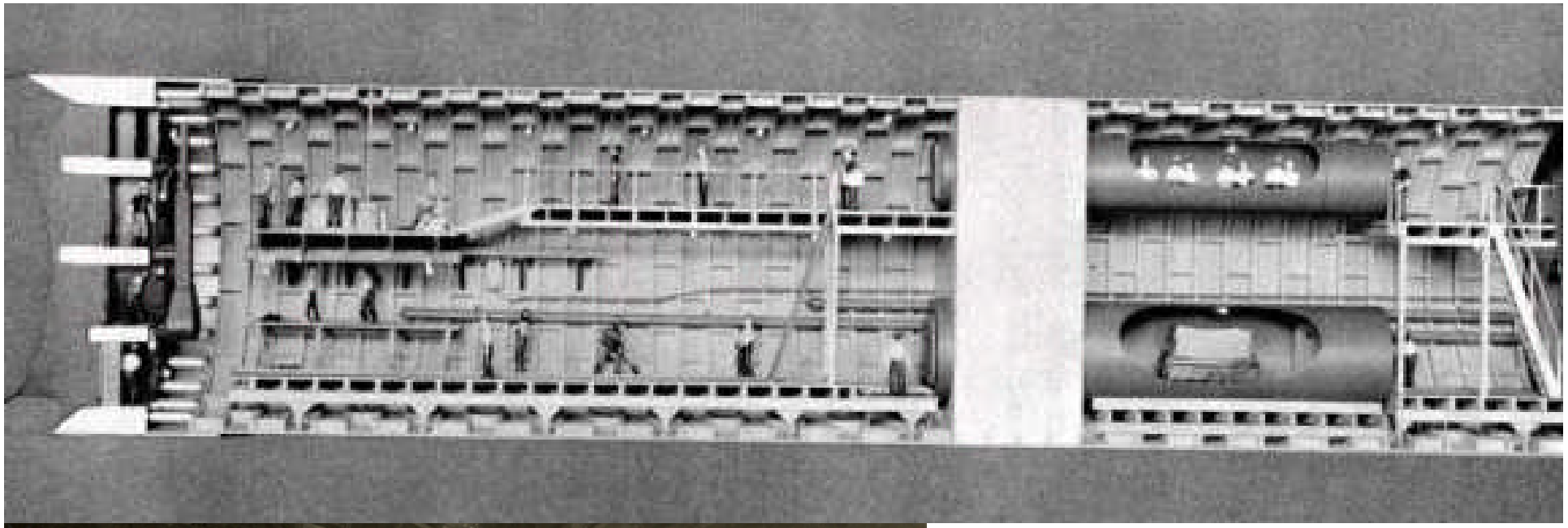
<u>Top Right</u>: caption: "Sandhogs shovel grout between iron lining rings. The iron segments were bolted together and sealed to prevent the tunnel from leaking water or collapsing."

<u>Left</u>: caption: "Hemp Grommets being dried after treatment in red lead and oil"

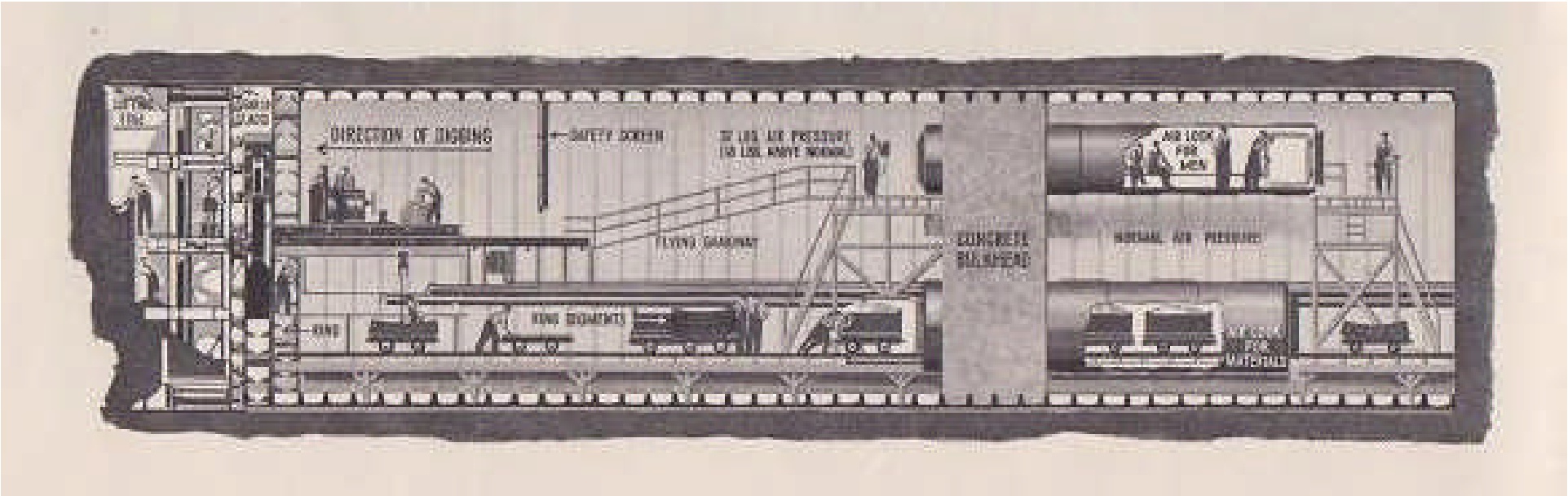
"…A circular metal shield, weighing 400 tons was advanced a few feet at a time by thirty hydraulic jacks of titanic power to punch a hole for the tunnel through the river bed, starting from the Jersey side. As it passed beneath a railroad, it added an amusing mishap to the annals of the tunnel, for its molelike trail upended the rails and a station platform as if an earthquake had hit them. Then, plunging down into the river ooze, it started its real work…"

***Popular Science,* March 1936**

<u>Above L&R</u>: caption: "Sandhogs shoveling river muck at face of shield"



<u>Above</u>: caption: "Tunnel Construction Model indicating driving of shield and air locks"
<u>Left</u>: caption: "Constructing concrete cradle for Shield, New York"



"…The diagram above shows how a tunnel is bored through rock and silt. Because work is carried on 20 ft. under the river bed, the sandhogs wage a continual battle to keep water from pouring into the tunnel. Only practical way of keeping it out is to use compressed air. Hence a massive concrete bulkhead is built near each end of the tube. Men passing through the bulkhead enter air locks in which air pressure is gradually raised to that prevailing on other side. At left is the working end of the shaft composed of a big circular shield and a row of hydraulic jacks. As the shield is jacked forward, silt is displaced and some is forced through shield apertures. After each shove a cast-iron ring forming outer jacket of the tunnel is brought in in segments and placed in position. Bull's eye of the two shields pushing from each end of the tube was a big steel caisson sunk in the New York edge of the Hudson River bed. When the shield reached this caisson they burned through its steel walls and the tunnel was holed through…"

LIFE magazine, December 27th 1937

<u>Above</u>: caption: "A great roadway for the motorist of 1938 begins to assume form in the mud and rock of the Hudson River bed: a view in the new Midtown Hudson Tunnel, which has advanced about 200-feet from the New Jersey side of the river and about 600-feet from the Weehawken Terminal Point. The daily movement toward the middle of the river is about twenty-five feet, and great rings of steel are set in place at regular distances for the frame of the tunnel."

<u>Top Left</u>: caption: “Making sure of their progress: a group of workmen placing and bolting a ring section on the roof of the tunnel”

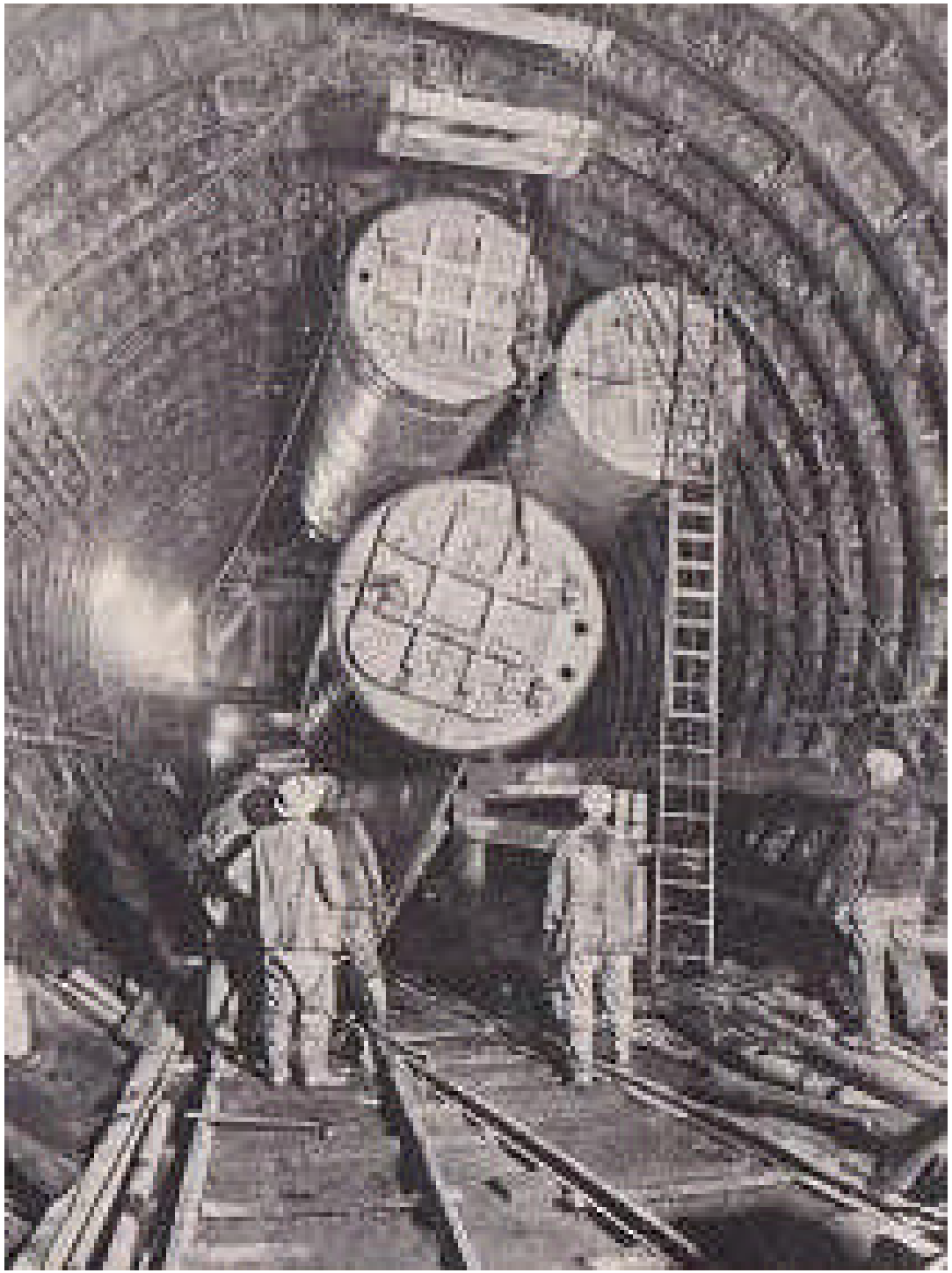
<u>Top Right</u>: caption: “Heavy labor far beneath the surface: a group of sandhogs digging out the mud as the shield is moved forward”

<u>Left</u>: caption: “In limited working space: the hydraulic jack control, with this operator in charge of the shield and ring sector hoist”

Buried Alive

“Think twice, you only live once”

RE: expression used by the “sandhogs” - the name for the tunnel construction workers. The sandhogs removed mud, blasted through rock and bolted together the rings that formed the lining of the tunnel. On a good day, the sandhogs progressed about 40-feet.



"…Air pressures up to forty-five pounds to the square inch keep water out of the shaft as sand hogs toiled within the thimblelike trailing edge of the shield, erecting iron walls that consolidated their hard-won gains at every push of the giant mole. Bubbles rising to the surface of the river told of their constant peril lest a minor air leak should suddenly develop into a major 'blow,' or escape of air, which might shoot them through the river bed or let the river in upon them…"

***Popular Science,* March 1936**

Left: caption: "Air Locks through which men and materials pass to enter or leave the compressed-air section of tunnel are placed in position in concrete bulkhead at back of the picture"

"…'The most common ailment from which the sandhog suffers is the 'bends.' This malady also affects deep-sea divers. It comes from a too sudden change in pressures. Either going from normal to under-pressure or vice versa has been too fast, and you get air-bubbles in your blood, preventing the normal flow. When the sandhog reports for work, he goes down the shaft and enters the air-lock. He sits there as the lock-tender works the pressure up to a point equal to that in the tunnel. The highest pressure he can work under is fifty pounds to the square inch. Under these conditions, he works for just half an hour, resting for the next five. After his time is up in the tunnel, the worker enters the airlock again where the pressure is reduced gradually until it is the same as that above ground.'…"

***Modern Mechanix and Invention*, June 1934**

"…The work of the sandhogs was dangerous, claustrophobic and tedious. Just entering and exiting the tunnel took a long time. Crews entered air locks, one at a time, after which the doors at each end were sealed. An air pipe started hissing, and the men's ears would pop as the air pressure climbed until it equaled that of the adjoining lock. The workers were then able to safely open the connecting door and crowd into the next section, where the entire ordeal would be repeated. Once at the forward end of the tunnel, the men had to work swiftly because they could handle the pressure only briefly. Compression and decompression had to be reached in safe, short increments…"

RE: excerpt from: *Perpetual Motion: The Illustrated History of the Port Authority of New York and New Jersey*

<u>Left</u>: a PNYA "Compressed Air Employee" badge worn by all Sandhogs working in the *Lincoln Tunnel*

<u>Above</u>: a group of Sandhogs take a break from their difficult and dangerous work

<u>Left</u>: according to this advertisement appearing in the January 17th 1938 issue of *TIME* magazine, the work of the Sandhogs and the drilling of the *Lincoln Tunnel* was made possible by printed forms from the *Hammermill Paper Company* of *Erie, PA.*

"Groping along like so many human moles, the Montague street tunnel crew pushed its way beneath the East river, separating Brooklyn and New York City. One moment the big cutting shield was boring steadily forward - the next, disaster struck with the fury of a tornado. The shield had cut through to the riverbed above! With terrific force the compressed air of the work chamber roared through the slit in the tunnel's weakened ceiling. Three workmen, stationed near the spot, were scooped up by the force of the giant blast and hurled upward. Like shells from a gun they shot through the rift in the ceiling - up through the waters of the East river - to catapult fifty feet into the air with a force that killed two of them instantly…"

***Modern Mechanix and Inventions*, June 1934**

"…Next to these 'blows,' as they are called, the dread of the tunnel digger is the premature dynamite blast. During the construction of New York City Water Tunnel No. 2, driven in parts from 500 to 700 feet underground, over fifty workers and technicians were killed and hundreds were wounded. Yet despite the almost constant threat of death, the workers swear fiercely by their hazardous calling. The heritage of danger is handed down from father to son…"

<u>Left</u>: caption: "Extreme air pressure allows tunnel builders to work only about one hour in five. A crew is shown coming off duty to rest five hours before re-entering the tunnel."

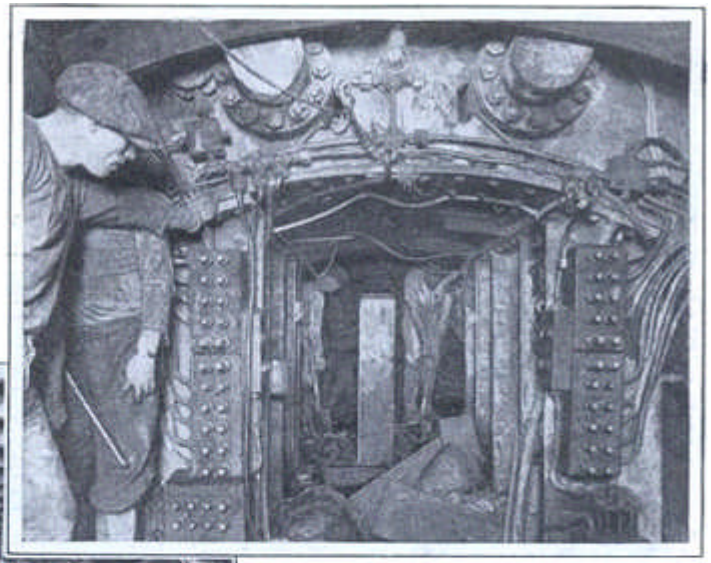
All in the Family

"…Take the Redwood brothers, for instance - Harry, Norman and Walter - three rugged, death – defying tunnel shooters whose sons are following in their footsteps even as they followed father, grandfather and great-grandfather before them. The tunnel-building Redwoods are a famous clan. Expert workmen, they are practically without a peer when it comes to sinking a foundation shaft or driving tunnels through mountains or river beds…Walter Redwood, who is forty-one, started his tunnel career at the age of thirteen in Birmingham, England, on a railroad bore. He was a dynamiter's helper and got five cents an hour for his services. 'In 1910 I came to New York City,' he says. 'There was a demand for tunnel experts in those days and in the following years I worked on practically every important tunnel job in New York City and the rivers which flank it.'…The average sandhog gets $7.50 an hour, or $15 for a two-hour day. The eldest of the Redwoods, Harry, has often been paid $100 a day for his services. But although the rewards are high, the penalties are even higher. Death lurks in the underground caverns and no man knows, going down to the airlock in the morning, whether or not he will return safely again that night…"

***Modern Mechanix and Inventions,* June 1934**

"…When a representative for Modern Mechanix and Inventions visited the Newark spot where the Passaic river bridge is being caissoned, he found eighteen members of the Redwood family working there. Walter, the youngest of the three veterans, finally revealed the history of his tunnel-digging family after considerable prompting had overcome his natural modesty. 'My great-grandfather, Robert Redwood, was first of the line of tunnel borers. We originated in England, you know. Then came my grandfather, also named Robert. He worked in the well-known and historic tunnel from England to Severn, under the water to Wales. My father, William, came by his tunnel-working inheritance quite naturally, and we have all followed suit. My mother's father was also a tunneler, by the way, and so were her eleven brothers. Our sisters are married to sandhogs, and our sons are in the same business. As a matter of fact, there hasn't been an outsider in our family for four generations. If you're not a sandhog, with a sandhog's blood in your veins, then you're not a Redwood. At least, not our Redwoods.'…"

Right: caption: "A rear view of the huge shield which is moved forward by a series of powerful hydraulic jacks"

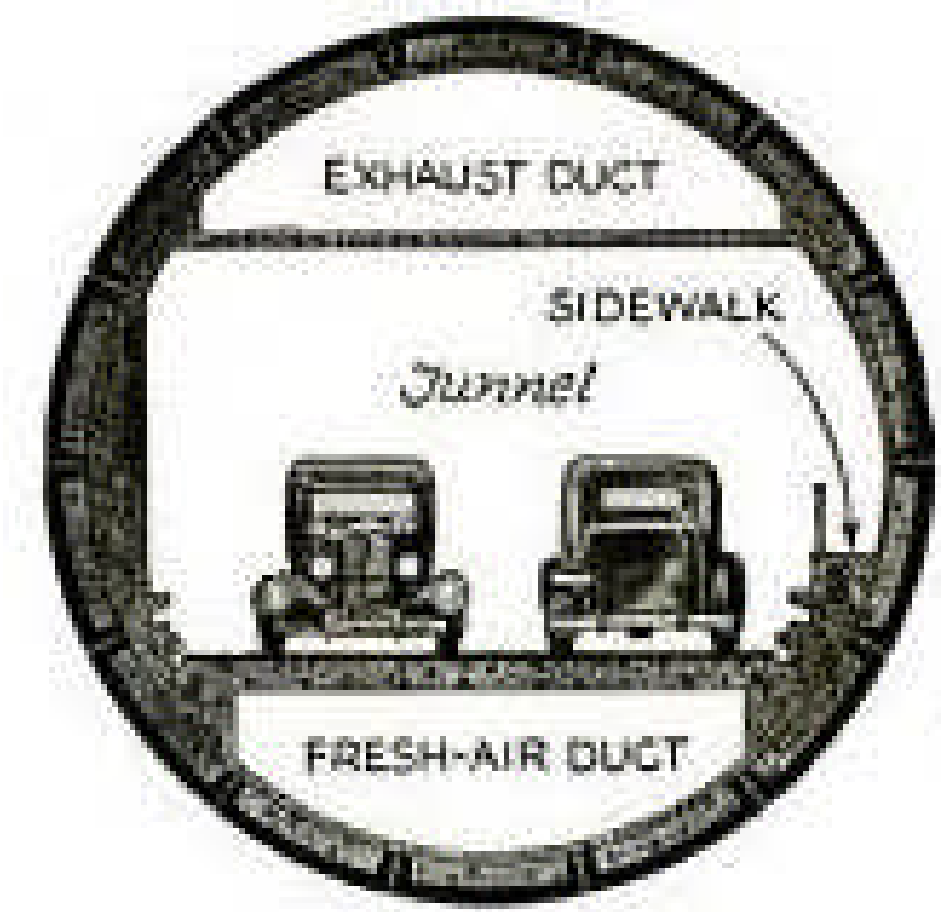


"…'This Newark contract is an air job, calling for work ninety feet under water. Because of the high air pressure under which we work, we put in one hour of actual work while we're off duty the next five. We work just two hours of a twelve-hour day under a pressure of thirty-four pounds to the square inch. This is about as perilous a job as I have ever worked on. We are working in a steel and concrete caisson, eighty by thirty feet. This caisson sinks with my crew of workers. That is, as we dig down and make room, the caisson wedges downward. Every pound of air that we put on takes 250 tons off the weight of the caisson. That is, each pound of compressed air lifts the equivalent of 250 tons weight in pushing the 'deck' or 'ceiling' of the caisson upwards. As soon as the air is dropped two or three pounds, the caisson drops right down. That is the terrific force of its weight. On this job I am in charge of the air-lock. I operate the compressed air instruments and you can easily understand what a slip or a flaw in judgment might mean…"

***Modern Mechanix and Invention,* June 1934**

Above: caption: "Above is shown a lock tender with his hand on the air valve which regulates the pressure in the air lock at the head of the stairway. Men enter this lock, where pressure is in-creased one pound per minute, to adjust their bodies to tunnel conditions."

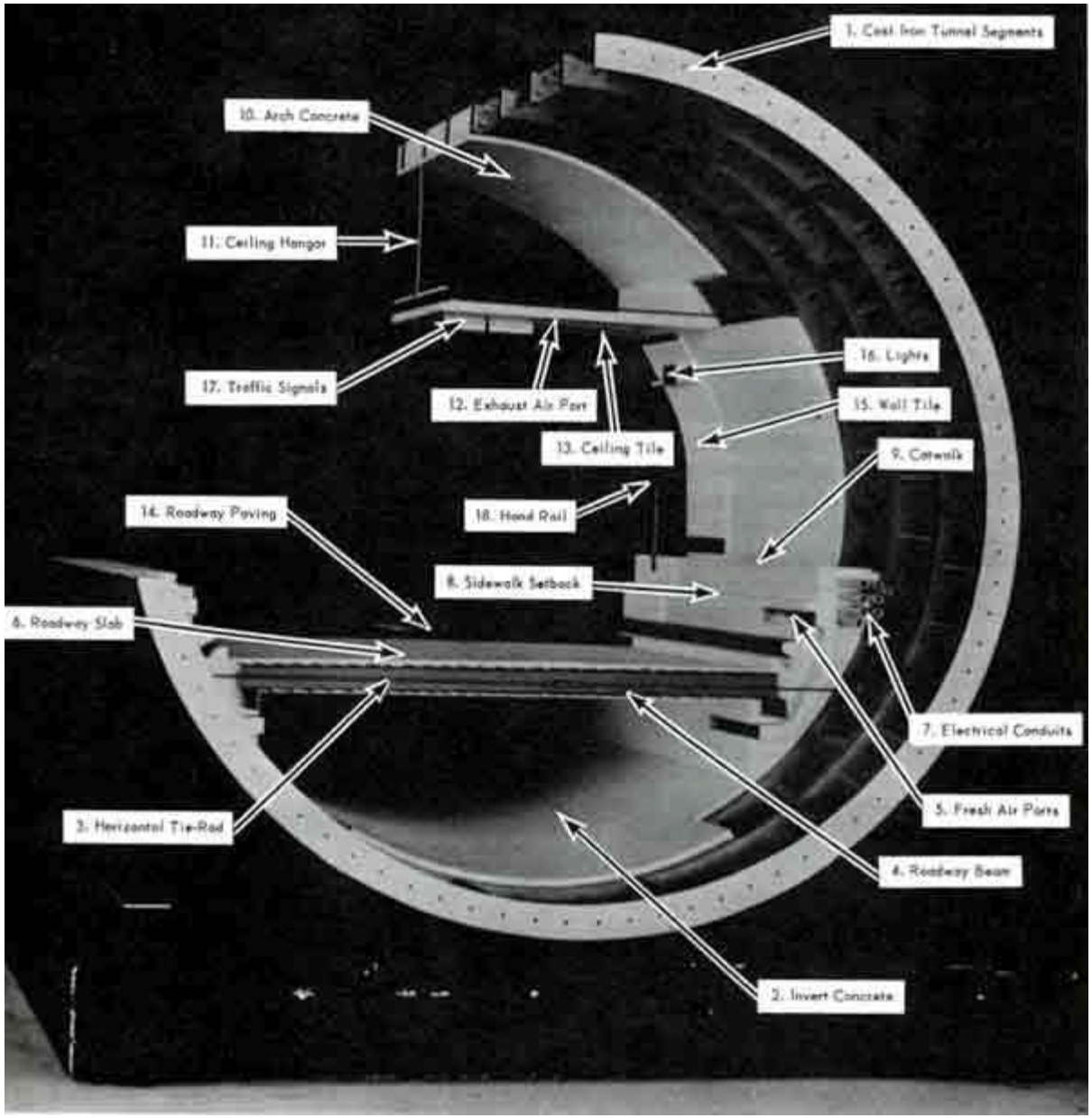
Holed Through



"…Completion of the ringed shell, as it was finally holed through into the connecting shaft from the New York end, enabled the abnormal pressure to be released. As this issue goes to press, workmen are placing the concrete that will line the finished tube, and erecting the roadway that will enable motorists to cover in a few minutes a journey that took sand hogs fourteen and a half months…"

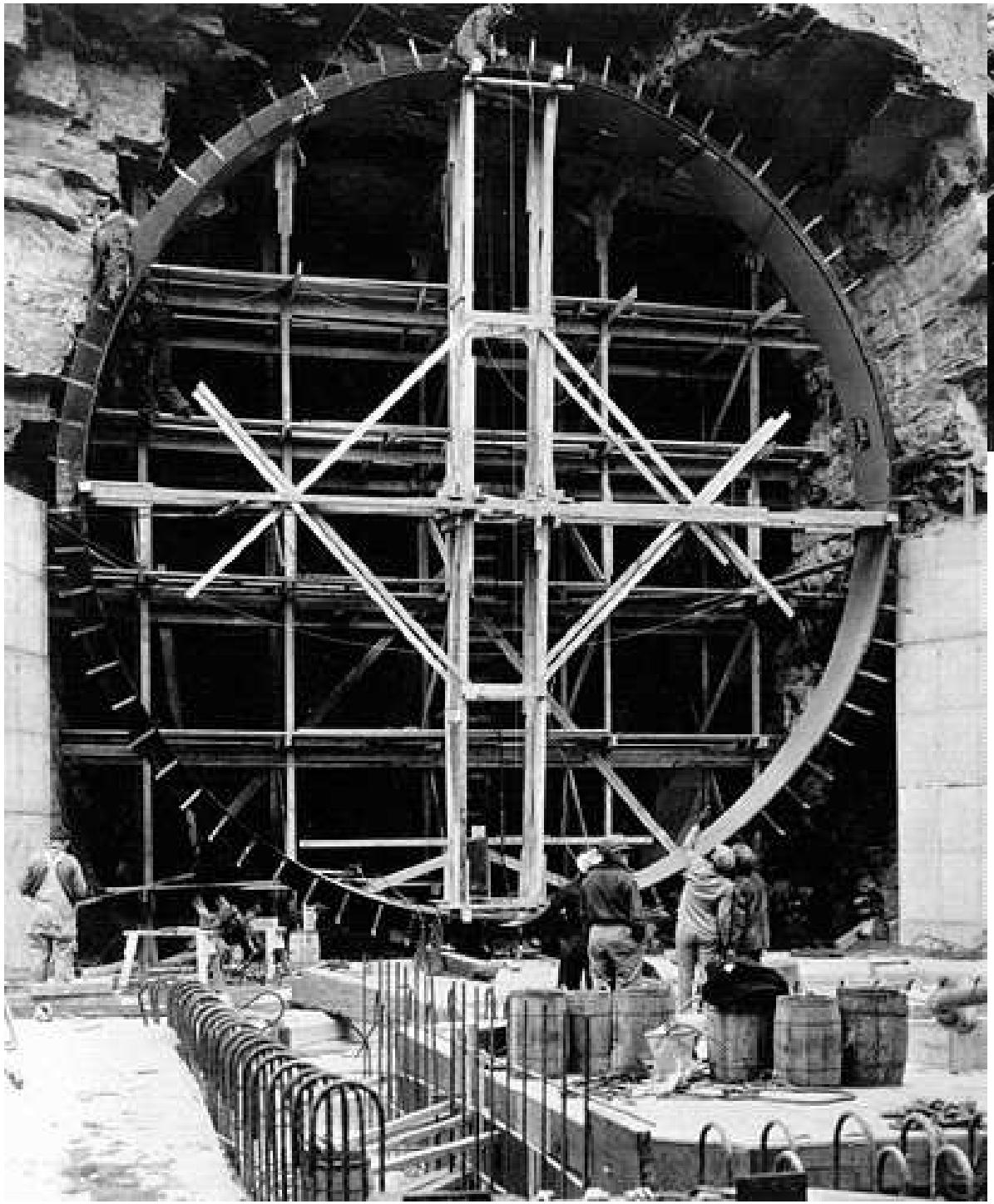
***Popular Science,* March 1936**

Left: caption: "Underwater Highway. Drawing shows cross-section of tunnel. Highway is laid in a tube thirty-one feet in diameter, made by bolting together curved iron segments to form rings."


1. Cast Iron Tunnel Segments
10. Arch Concrete
11. Ceiling Hanger
17. Traffic Signals
12. Exhaust Air Port
13. Ceiling Tile
16. Lights
15. Wall Tile
9. Catwalk
14. Roadway Paving
18. Hand Rail
8. Sidewalk Setback
6. Roadway Slab
7. Electrical Conduits
3. Horizontal Tie-Rod
5. Fresh Air Ports
4. Roadway Beam
2. Invert Concrete

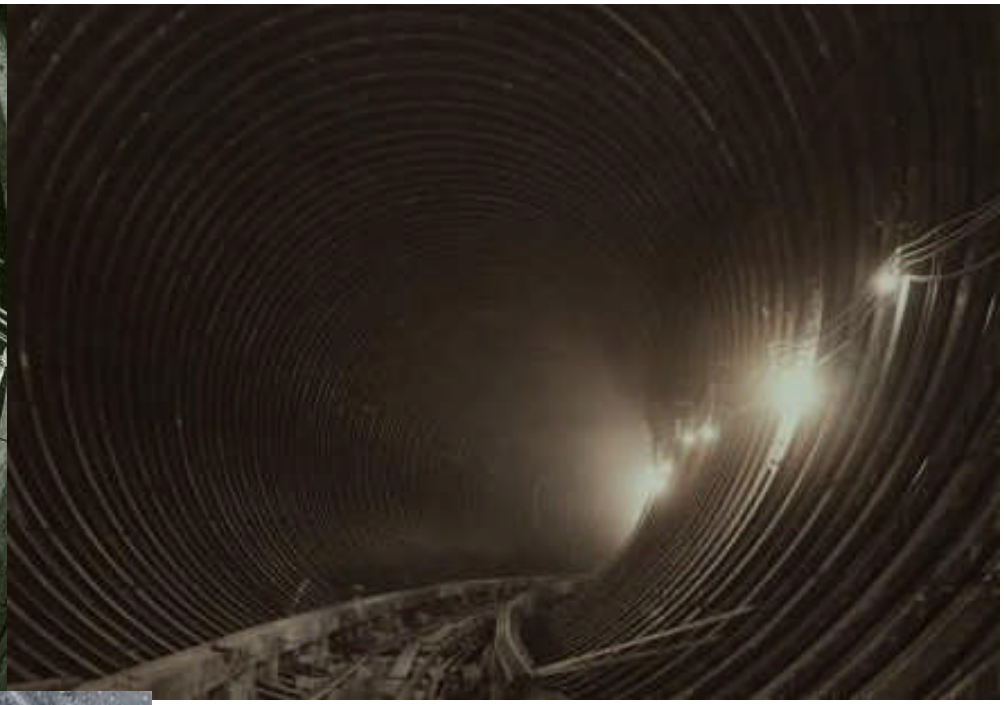
<u>Above</u>: caption: "It takes a two-man four-handed wrench to set nuts on the Lincoln Midtown Tunnel job"

<u>Left</u>: caption: "The Midtown Hudson Tunnel comes up for air on the New Jersey side"



<u>Above</u>: caption: “Bolting Tunnel Wall Forms in Place”

<u>Left</u>: caption: “Setting a form for the walls of the tunnel”



<u>Top Left</u>: caption: "Lincoln Tunnel construction 1936"

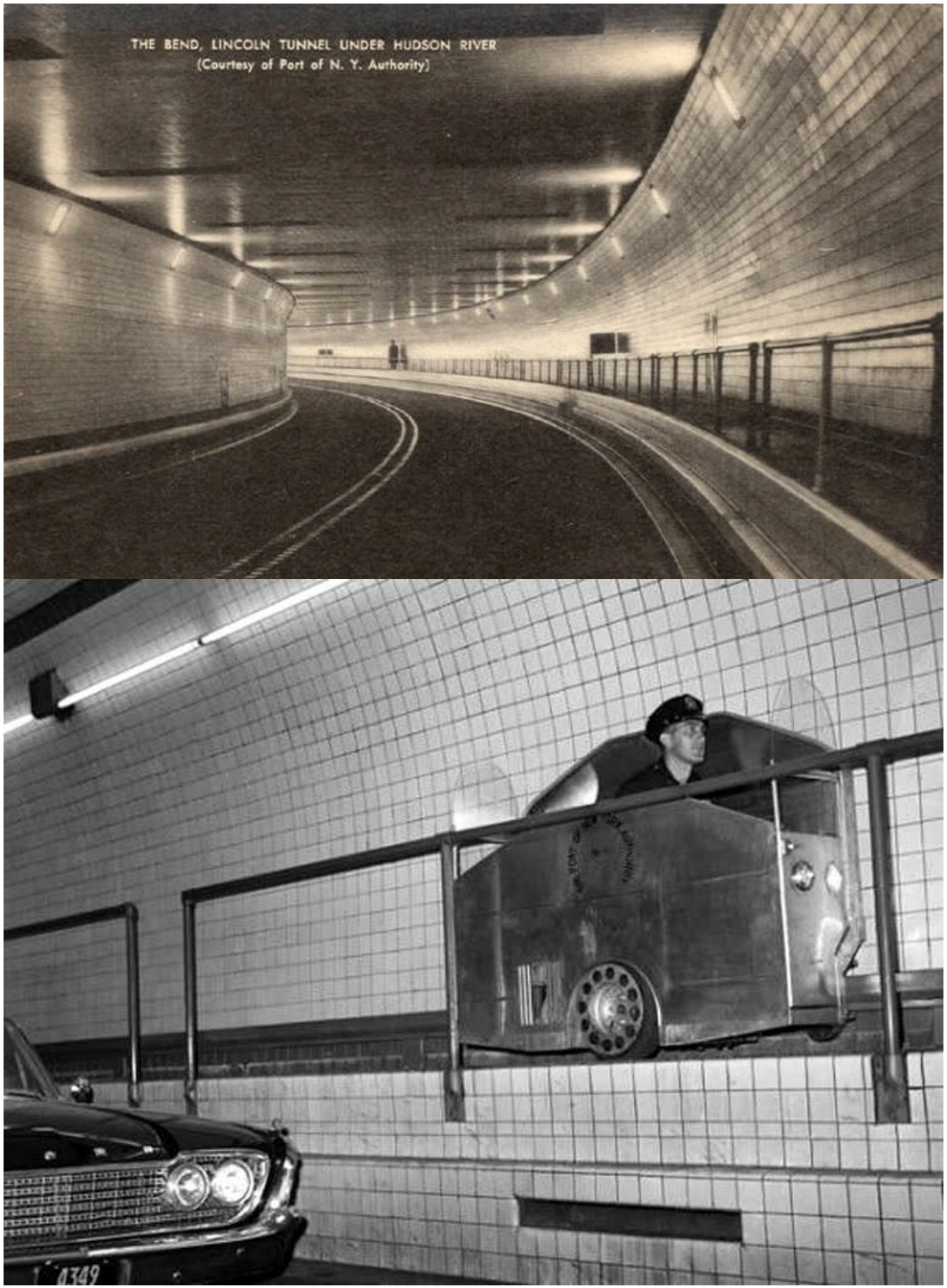
<u>Top Right</u>: caption: "Lincoln Tunnel – North Tube – Interior of completed structural steel shell of rock tunnel at Weehawken, N.J., before lining with concrete"

<u>Left</u>: caption: "Interior of Lincoln Tunnel under construction"

<u>Top Left</u>: caption: "The railroad track in the Lincoln Midtown Tunnel was taken up before the surface was laid for automobile traffic"

<u>Top Right</u>: caption: "Lincoln Tunnel – South Tube – Interior of tunnel showing first section of wall tiling in place"

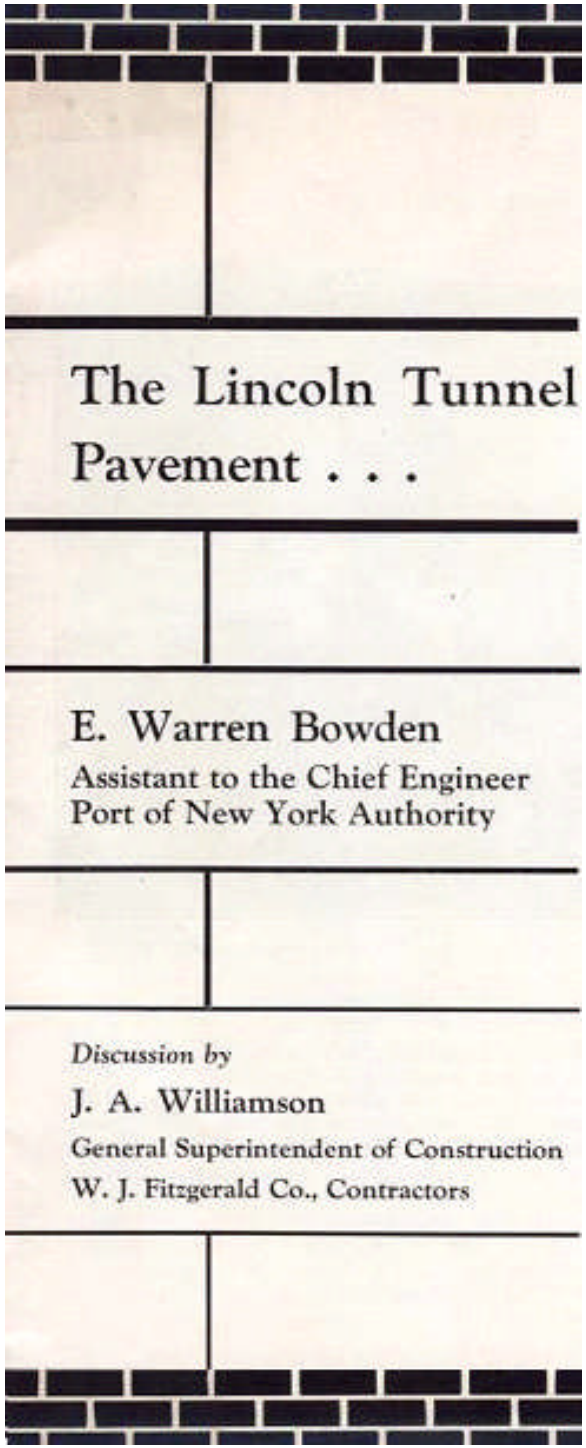
<u>Left</u>: caption; "Entering the N.J. portal of Lincoln Tunnel on way to New York"


THE BEND, LINCOLN TUNNEL UNDER HUDSON RIVER
(Courtesy of Port of N. Y. Authority)

Part 3

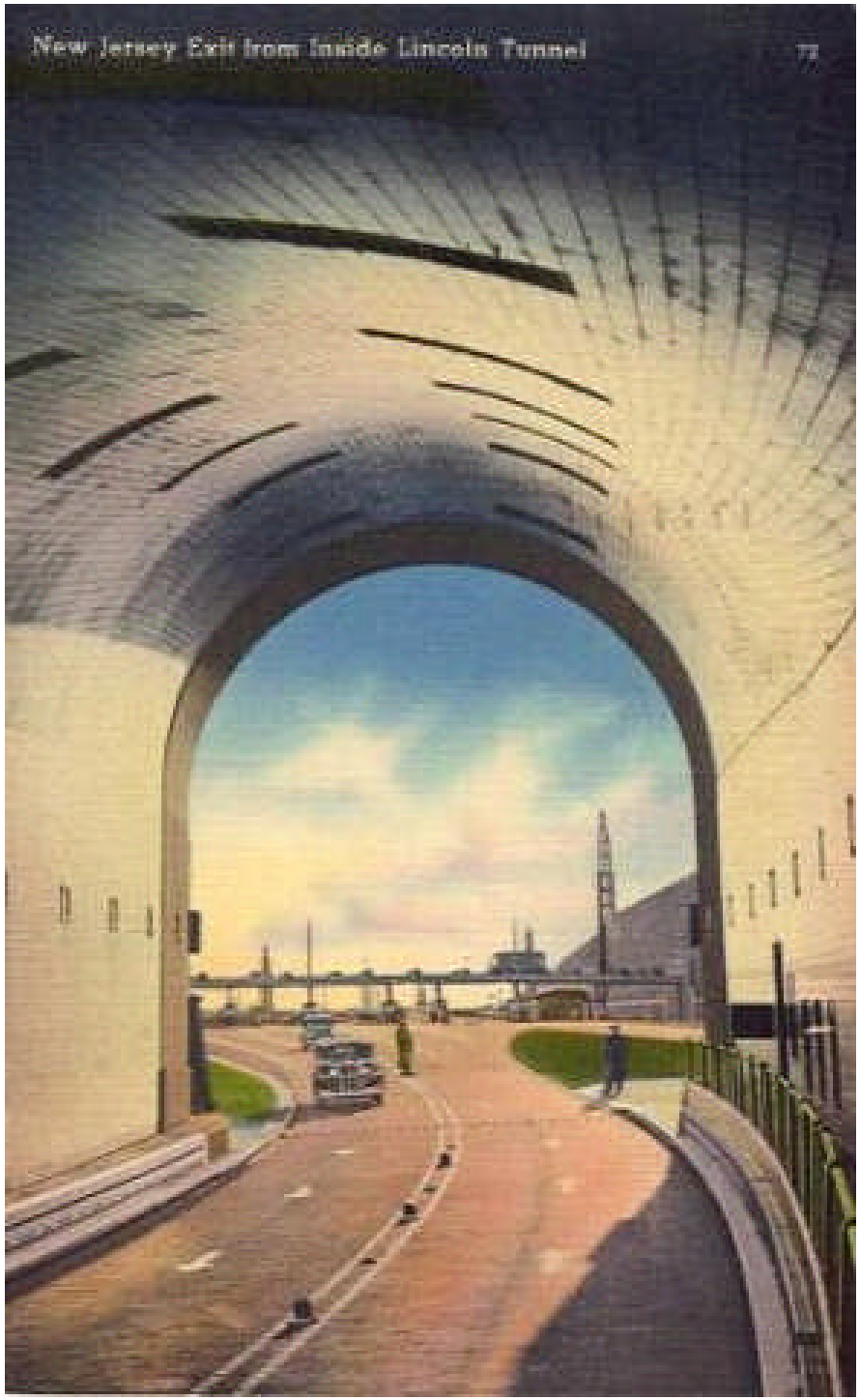
The Road More Traveled

Wearing Surface



"On December 22nd, just past, one of the most important stretches of brick pavement in the world, the Lincoln Tunnel at New York, was put in operation. Over this one and two-thirds mile length of two-lane roadway will pass more than four million vehicles during the first year of its use, a traffic later expected to become six or even seven million vehicles annually. No other stretch of brick surfaced roadway is so ideally situated to furnish an exact commentary on the development of present day paving brick to meet the requirements of modern traffic. Here an accurately counted never-ending stream of swiftly moving vehicles, confined to well defined traffic lanes and ranging from pleasure cars to 25-ton trucks will furnish a large scale demonstration of the qualities of paving brick…The importance of this project is such that every feature of its construction has been given the most careful consideration and, therefore, the choice of a de-aired vitrified brick pavement is an indication that to engineers intent on canvassing the entire field to find the product most suitable, vitrified brick appears to have valuable and outstanding characteristics for use in a modern vehicular facility…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**



"…At the time brick was chosen for the Lincoln Tunnel, there was no other important example of modern brick pavement in the Port area. The Holland Tunnel is paved with granite block and the George Washington Bridge with concrete. The decision to use a brick wearing surface was reached after careful studies and investigations had been made covering a dozen or more types of roadway surface, including concrete pavement, sheet concrete surface, armored concrete, cast iron paving units, steel plates or castings in treads, rubber pavement, granite block pavement, armored brick in wheel tracks and vitrified brick pavement. The decision was also based on the favorable impressions created by two sample sections of brick pavement laid in 1935 at the New Jersey entrance of the Holland Tunnel. The most important of these has carried over seven million cars to date…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

<u>Left</u>: caption: "New Jersey exit from inside Lincoln Tunnel"

"…A tunnel roadway pavement should have certain essential characteristics, in keeping with those required in any good roadway pavement, no matter where located, namely, it should be non-slippery, durable, smooth riding and noiseless. In addition, the specialized conditions of a heavily traveled tunnel roadway require that the pavement surface be such that it can easily be repaired or renewed with a minimum of interference with traffic. And lastly, it should be economical when considered in terms of maintenance and replacement over a period of years…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

Skidding Characteristics

"…In the first place, the pavement must be non-slippery because, even though superior in many other respects, if slippery when wet or when coated with the oil dripping from passing motors, it would be unsatisfactory for a tunnel roadway. The first requisite for successful operation of a tunnel is the confidence of the public in it as a safe as well as expeditious travel facility. The most dependable sources of information that we could find with regard to skidding characteristics were the reports of studies of coefficients of friction of pneumatic tires on several types of pavement as developed by investigations at the Engineering Experiment Stations of Iowa and Ohio State Universities. At Iowa, experiments covered both wet and dry road surface conditions and developed the fact that, when dry, the brick pavement on which the experiments were made had a somewhat higher coefficient of friction than the concrete pavement tested, while when wet, the coefficient of friction of the brick was slightly lower than that of concrete. The brick pavement was of the 'vertical fibre' type, filled by the squeegee method and had patches of filler on the surface…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

"…The Ohio experiments brought out clearly the relatively high co-efficients of friction developed by a 'vertical fibre' brick with no asphalt on top and the considerable loss of this valuable characteristic with increasing amounts of asphalt covering. It was quite clear to us that were it not for the recently developed method of completely removing excess asphalt joint material from the surface, consideration of brick for the tunnel pavement would have gone no further…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

"…To supplement the experimental data, the experience of those operating pavements of the type under consideration were sought. On Chestnut and Walnut Streets in Philadelphia where excellent brick pavements were in use, traffic officers and engineers reported no evidences of skidding on wet surfaces. The same statements were secured elsewhere. Our own observations on the operation of several million cars over the previously mentioned sample brick section laid at the New Jersey entrance ramp of the Holland Tunnel likewise attested quite satisfactory anti-skidding characteristics…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

Wear Resistance

"…As the second characteristic, the pavement must be durable under a traffic concentration more exacting than that usually found on open highways since a single traffic lane must carry from three to five million vehicles per year in sharply defined wheel tracks. The question was – how long could the various pavements be expected to remain in good condition. The answers were not easy to find because, although there is no dearth of testimony favorable to the several products, very little really scientific data is available. Granite block has served well in one location, concrete in another and brick in a third but in no case really comparable to our conditions have satisfactory data been determined for several kinds of pavement at once…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

"…It is true that we have the Connecticut Avenue experimental road in Chevy Chase, Maryland, built and maintained by the United States Bureau of Public Roads. The information secured, while valuable, is limited in its application to our problem chiefly because the traffic conditions there were not in any way analogous to those anticipated in the tunnel. In a single year the Lincoln Tunnel roadway will carry as many vehicles as the total carried during fifteen years of the experiment on Connecticut Avenue

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

<u>Above</u>: caption: "*Public Roads* has been exclusively an in-house research journal for engineers, scientists, and economists, fulfilling part of its original mission to publish the 'results or researches, experiments and studies of those connected with (the forerunner of the federal Highway Administration), and of highway officials of the various States'"

"…The accelerated traffic test made by the bureau on a circular brick test track at Arlington, Virginia, was also of much interest, but of very little help. One lane of our tunnel is estimated to carry in one year seventeen times the 326,500 tons total carried in the test. However, the test conditions were more severe than tunnel conditions, as, in all cases, trucks with solid rubber tires were used, and in 35 per cent of the trips the truck wheels were equipped with heavy non-skid chains…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

"…A considerable amount of information was furnished by organizations interested in the several pavement types as to the costs of maintenance. Here again it was practically impossible to secure really comparable data. From our own experience with the wearing qualities of concrete under actually measured traffic movement on the Port Authority bridges and from our knowledge of the wearing qualities of the granite block pavement in the Holland Tunnel under similar conditions, we were able to make what we felt to be a conservative forecast of useful life for these two types of pavement. Our test sections of brick pavement, although in use for only a short time, had carried about five million vehicles in a single traffic lane without any signs of wear on the part of the brick at the time the point was reached when a decision must be made as to the pavement to be chosen for the Lincoln Tunnel…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

Laboratory Investigation

"…Our final resort was to laboratory tests of the hardness, wear resistance and toughness of de-aired vitrified paving brick as compared to similar qualities of granite block. Granite was chosen as a standard of comparison because of its unquestionably high wearing qualities. In determining to make our own tests we had in mind recent developments in the process of brick manufacture, which had made possible an even more durable brick than any heretofore available…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

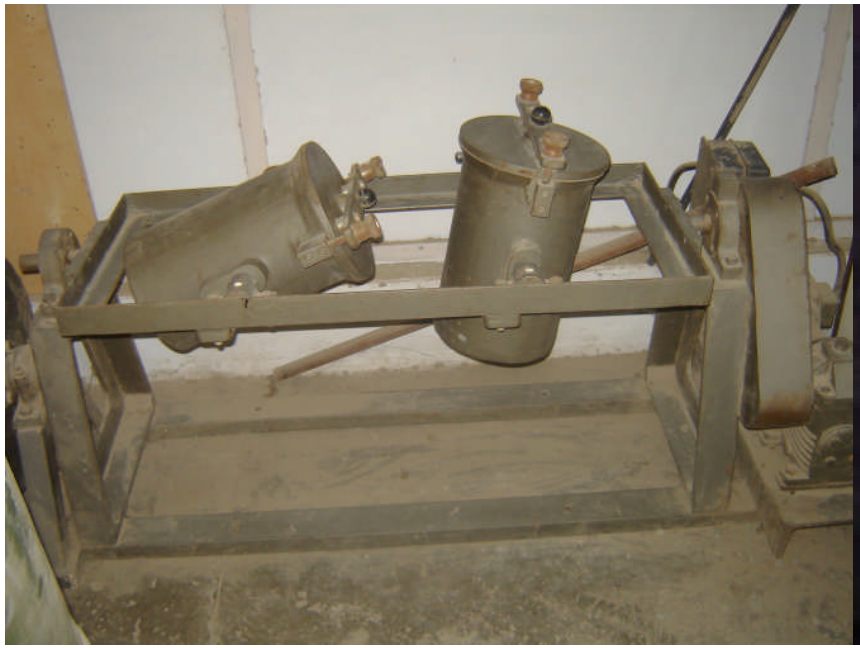
"…The laboratory tests were made under the supervision of Mr. G.M. Rapp, Assistant Engineer of the Port Authority, on samples of brick laid in the test section at the Holland Tunnel and manufactured by the Metropolitan Paving Brick Company. The conclusion reached was, briefly, that vitrified paving brick, manufactured by the de-aired process, can be produced equal in strength and durability qualities to the commercial, heavy traffic grade, granite block…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

"…The standard Dorry test for determining the surface hardness or resistance to abrasion consists of subjecting both end surfaces of small cylindrical specimens to the abrasion of quartz sand on a rotating disc machine. By this test, brick produced a coefficient of 19.09 as against 18.8 for granite block, showing the brick to be 10 per cent harder than the granite. A modification of the standard Dorry test was then run in order to more accurately simulate the actual service conditions of wear, and showed about 6 per cent less wear on the brick than on the granite…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

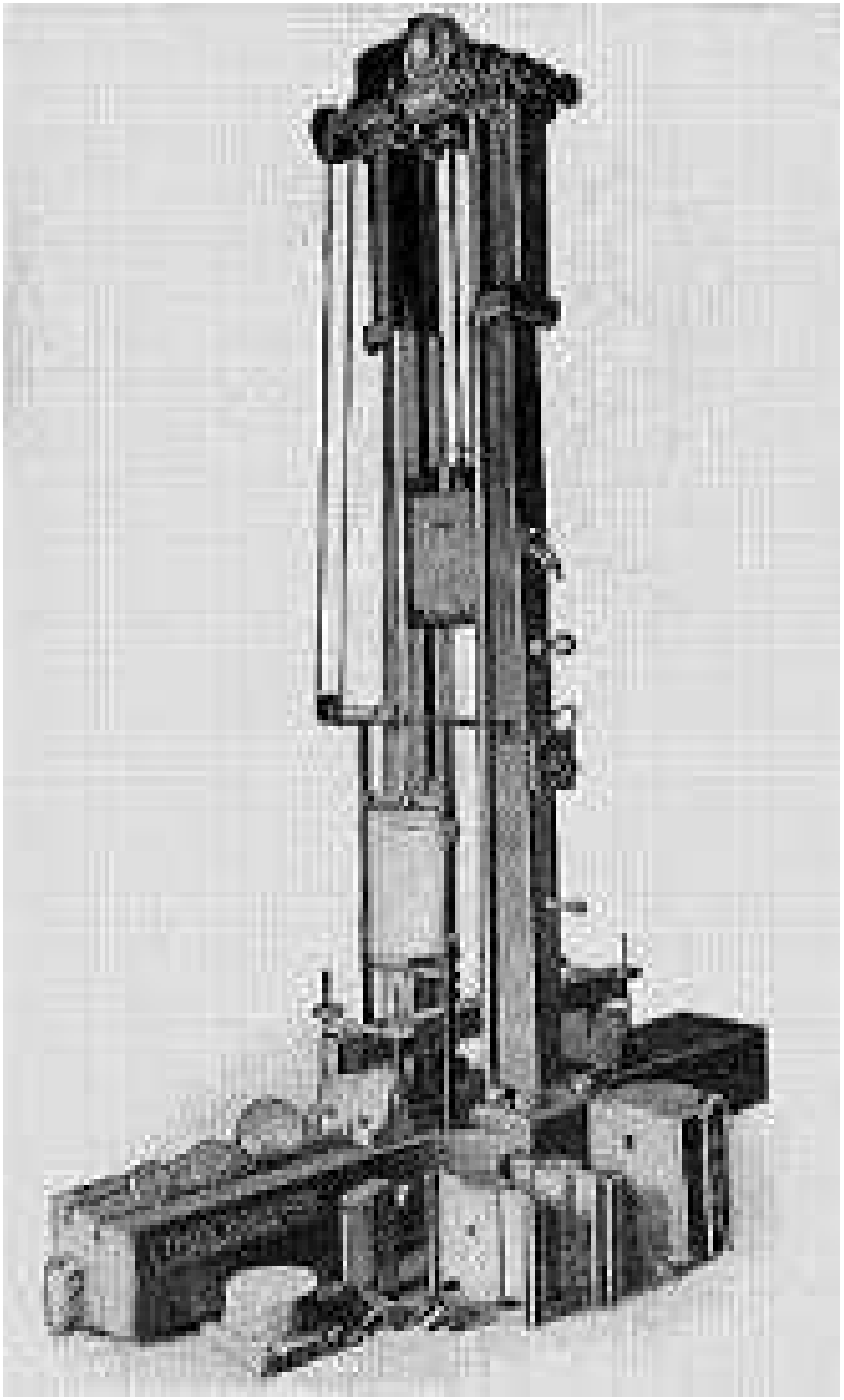
<u>Left</u>: caption: "Dorry Abrasion Testing Machine"



"…As a third test, samples of brick were subjected to abrasion in a Deval machine in accordance with standard methods. The test is designed to show the resistance to wear of rock aggregates used for road building and consists of subjecting a five kg. sample of coarsely broken fragments of the material to 10,000 revolutions in a steel cylinder inclined at 30 degrees with the horizontal and rotated about a horizontal axis. As applied to brick it differs from the rattler test by giving a truer picture of wear resistance itself, because the factors of toughness (or resistance to impact) and transverse strength are eliminated. It also tests the quality of surface wear predominating in the rattler test. The result of this test was to show for brick a French Coefficient of Wear of 12.1 as compared to 13.5 for granite block or in other words, the test showed the brick to be 10 per cent less resistant to wear…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

<u>Above Left</u>: caption: "Deval attrition testing machine (Deval attrition test). This equipment is used for testing the abrasion resistance of aggregates. The machine consists of a rotating frame to support two steel cylinders complete with covers and locking device. These cylinders are mounted on a shaft at an angle of 30 degrees with the axis of rotations of shaft. The shaft rotates at 30 – 33 rpm through a reduction gear operated by motor."



"…The apparent discrepancy between the results of this and the tests just described may be due to the fact that the interior structure of the brick, which is exposed to wear in the Deval test, is less hard than the surface, which is exposed in the Dorry test, or it may be due to the method of determining loss of weight by abrasion in the Deval test, since only detritus small enough to pass a 0.066 inch screen is recorded. Toughness or resistance to fracture was next considered and to determine it samples of brick were subjected to the standard drop impact test on a standard Page machine. This test records the height in centimeters of free fall of a 2 kg. hammer required to fracture a cylindrical specimen. Brick was found to have a coefficient of 19 as compared to 11.0 for granite block, indicating that the brick tested were considerably tougher than granite. In transverse strength the block was found to average 2,200 lbs. per sq. in. as against 2,700 lbs. per sq. in. for granite block, while for crushing strength the comparison was 23,100 lbs. per sq. in. for brick and 24,200 lbs. per sq. in. for granite block…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

<u>Left</u>: caption: "Impact Testing machine"

"…These tests certainly testified to the high qualities of paving brick now being manufactured and, although we realized that since the samples were taken from a lot furnished for a test road section, they would obviously be of relatively high quality, we were nevertheless satisfied that the question of durability had been satisfactorily answered…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

Other Factors

"…Our next two criteria – smooth riding qualities and noiselessness – were found to be fully met by brick pavement of the type used in the tunnel. Two factors, easy replaceability and cost, remained for consideration and of these the first named was felt to be at least as important as any other point considered. The requirement that the roadway surface be such that it can easily be repaired and returned immediately to service is peculiar to a tunnel roadway, where traffic operates twenty-four hours every day and where there can be no detours or extended closure of even a single lane without serious adverse effect on traffic and a resultant important loss of revenue. Certain types of surface, although satisfactory in other respects, would be quite undesirable from the replacement viewpoint. However, brick pavement with asphalt joints is admirably designed to meet this requirement. If and when repairs are necessary, it is possible to take up a short section of brick in a single lane and replace it immediately with a new brick surface. The whole operation can be performed during the night in the hours of least traffic and the pavement can be returned to operation immediately after the surface has been repaired…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

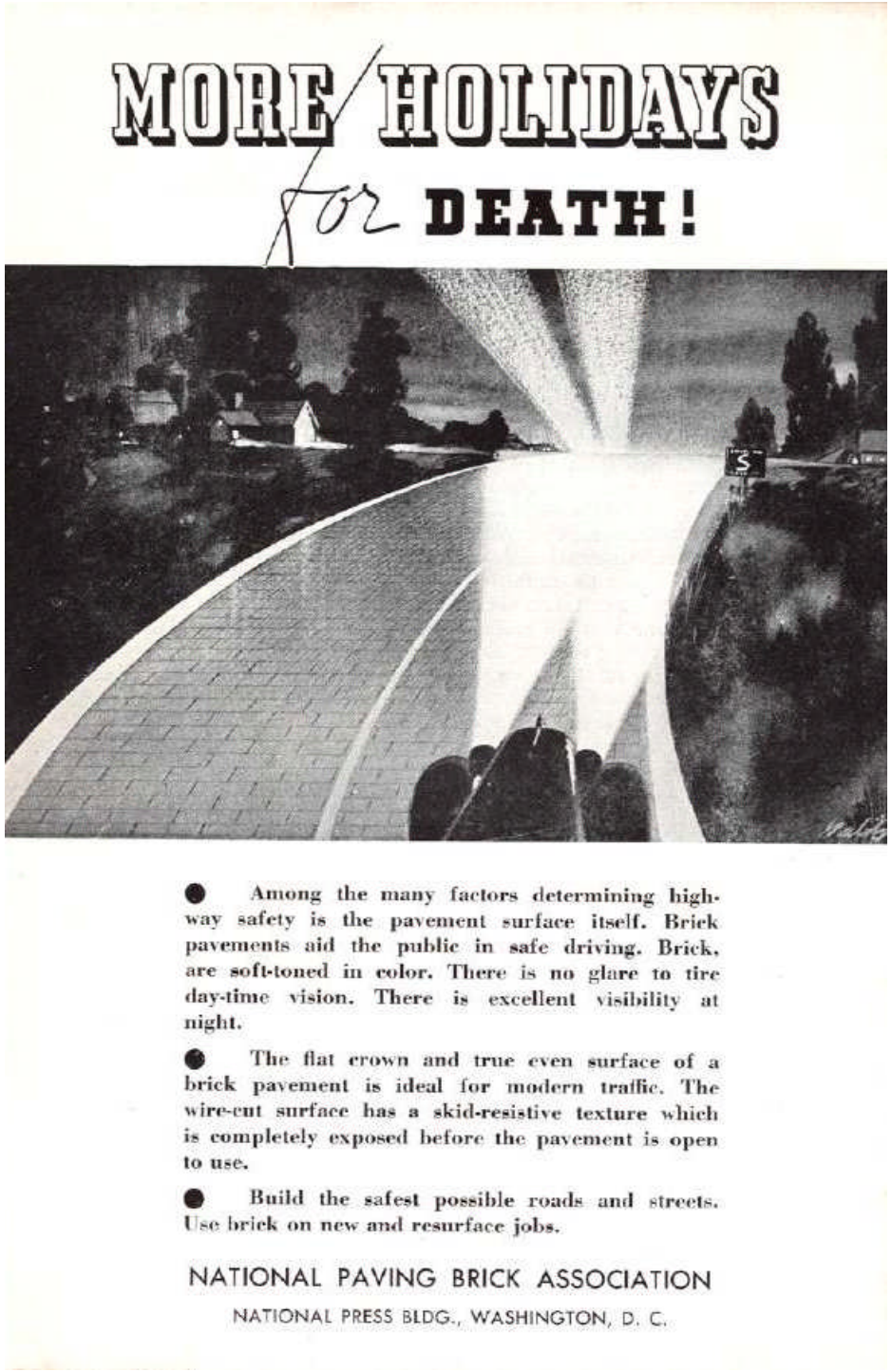
Ultimate Costs

"…The final factor in determining the choice of type of surface was the item of cost, and not only the initial cost but rather the ultimate cost as nearly as we were able to estimate it over a number of years. Thus all types of pavement were considered from the viewpoint of their ultimate utility. We have previously spoken of our studies to determine the probable length of useful life of the several pavement. It was necessary to make such an assumption in each case to determine the ultimate cost over a thirty year period, which was used for comparison. No matter what the length of useful life, every pavement sooner or later must undergo extensive repairs and replacements and to meet our requirements a block type of ultimate surface, which can be placed quickly and driven over as soon as placed, is indicated regardless of the initial pavement finish…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

"…Among the various materials proposed of meeting the pavement problem was the one of finishing the surface of the roadway slab initially as a concrete pavement and later placing over it a brick or granite pavement, or some other similar surface when necessary. This method of procedure offered economy in the initial investment but had certain very objectionable features from the practical viewpoint. In the first place, it would be necessary to provide adjustable curbs which would have to be moved to a higher elevation when the ultimate block surface was to be placed. Drainage details to accommodate the variable surface elevation would be awkward and difficulties would be found in relocating to new elevation the numerous manholes, air measurement boxes and other fixtures in the roadway pavement. Headroom, too, is an important factor and the inch or more added to the slab thickness to provide the concrete wearing surface would reduce the ultimate headroom by that amount unless taken initially from the lower air duct by lowering the entire roadway slab. In the latter case the restriction in duct area would cause a small but permanent annual increase in the cost of ventilation. In the end, this plan of procedure was rejected…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**



"…The estimated cost over a period of thirty years for each method of surface treatment included the initial cost, the cost of resurfacing, the cost of curb alteration where required by change in surface level, and interest on the investment. By this analysis it was found that among the reasonably acceptable plans, vitrified brick pavement resurfaced with brick would cost slightly more than an initial concrete pavement resurfaced with brick, but would cost considerably less than any other methods of treatment…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

Left: promotion for brick paving such as was used in the *Lincoln Tunnel* from the *National Paving Brick Association*

Specifications

"…Decision to use brick having been reached on the basis of the foregoing studies, specifications were prepared which called for a pavement of de-aired vertical fibre vitrified brick laid on a bituminous mastic cushion placed directly on the concrete base slabs, the joints between the brick to be filled with an asphalt filler. The brick were to be 3 in. thick and, of the various degrees of burning commonly classified as light, medium and dark, the medium and dark burned brick were to be preferred. The brick were to have lugs on one side and both ends. The standard rattler test was called for, the brick to show an abrasion loss of not more than 18 per cent…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

<u>Above</u>: caption: "Laying brick pavement"

"…The current A.S.T.M. specifications base acceptance only on visual inspection and on the rattler test for brick. In addition to this our specifications provided for tests for transverse strength and toughness. For the transverse test, lots of five brick were to be tested according to the requirements of the Standard Methods of Testing Brick (Designation: C 67-31) of the American Society of Testing Materials. It was required that the average transverse strength should be not less than 2,000 lbs. per sq. in. and that the minimum value for any brick of a test lot should be not less than 1,800 lbs. per sq. in…"

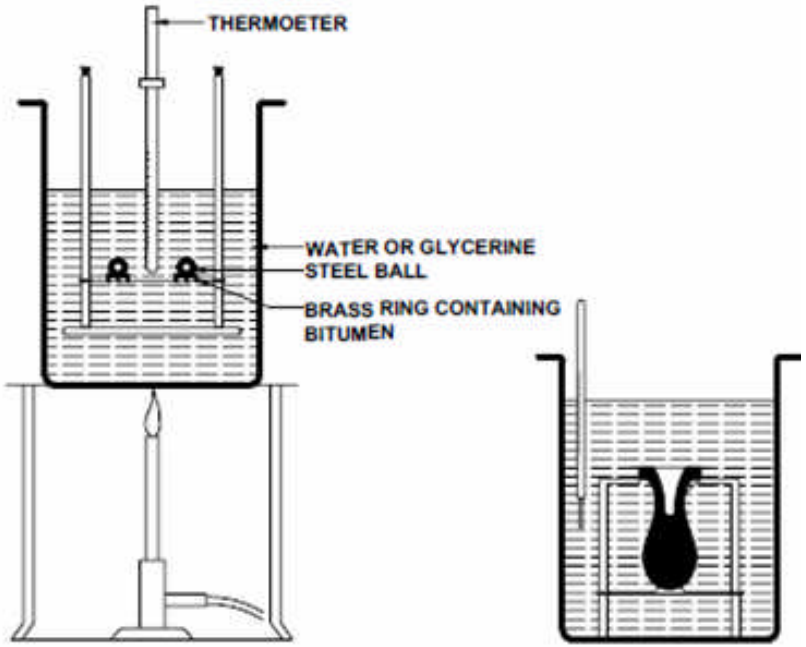
***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

"…For the toughness test a modification of the Page Impact Test was set up by our engineers. In practice it was found that the results obtained from the toughness test were so erratic with regard to the qualities otherwise apparent that rigid application of the test was waived. However, it will be described as a matter of information. The method of performance is as follows: - the brick to be tested is placed horizontally in flat position on knife edges or rollers spaced 7 in. apart. Over the center of the brick is suspended a solid spherical a solid spherical steel ball weighing 2½ lbs., which is allowed to drop freely on the center of the top surface of the brick from successive heights, starting at 1 ft. from the top surface of the brick and increasing by intervals of exactly 1 ft. until fracture. The height of drop in feet at fracture gives the toughness value of the brick. It was specified that of the ten bricks constituting a test lot, the average toughness value should be not less than 4.5, that no specimen should have a toughness value less than 3 and that only one specimen should have a value as low as 3…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**

"…The joint filler was specified to be a blended asphalt with or without the addition of inert mineral flour filler. A great deal of study was devoted to this material because we were very anxious to avoid bleeding of the material on to the brick surface. Our specifications required that the filler should show no signs of foaming when heated to 445-degrees F.; should have a minimum flash point of 500-degrees F,; a softening point, Ring and Ball Test, minimum of 215-degrees F. and a maximum of 230-degrees F,; penetration at 32-degrees F., a minimum of 15; a penetration at 77-degrees F., a minimum of 23 and a maximum of 32; and at 115-degrees F., a maximum of 45; ductility of 77-degrees F. was to be a minimum of 1.4 cm. Toughness at 32-degrees F. was to be a minimum of 8 cm., when tested according to A.S.T.M. Designation D2-18. The foregoing figures were for asphalt filler without the mineral flour. The softening point and the penetrations were slightly modified for asphalt filler with mineral flour…"

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**



The temperature at which bitumen softens is determined by the "Bitumen Softening Point Test" (a.k.a. "Ring and Ball Test" - above L&R). A brass ring containing bitumen is suspended in a liquid medium (water or glycerin) and a steel ball is placed on the disc of bitumen. The liquid medium is then heated at a specified rate. The temperature at which the softened bitumen touches the bottom plate placed at a specified distance below the ring is recorded as the softening point.

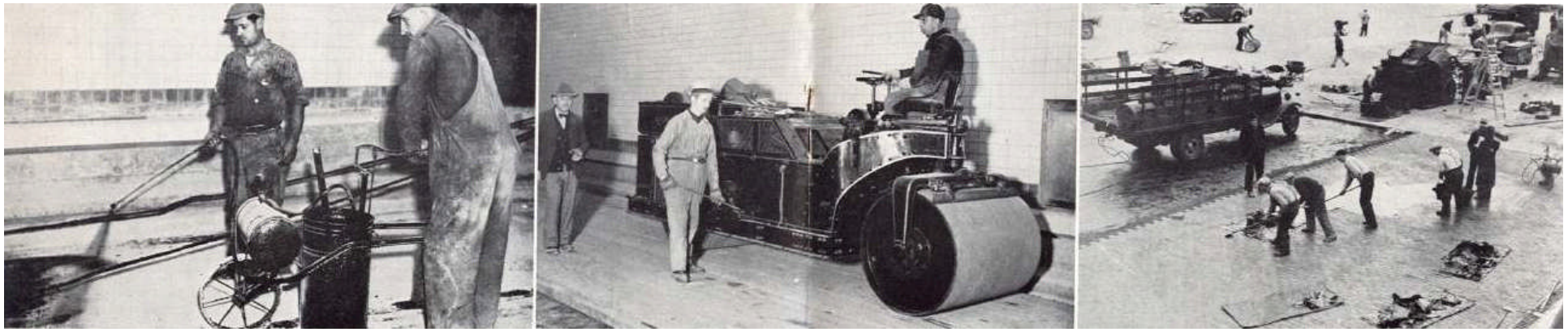
Above: caption: "(a) Diagram of Apparatus at Beginning of Test (b) Diagram Showing End of Test"

Left: caption: "Softening Point Ring and Ball Apparatus"

Construction

"…The paving contract was awarded to W.J. Fitzgerald Company in May, 1937. It provided for 26,100 sq. yds. within the tunnel proper, in the plazas near the portal, at the toll booth area of the Weehawken plaza and in a short underpass tunnel from the south end of the Weehawken plaza. The contractor bid $3.60 per sq. yd. For the brick pavement. Included in the contract were also white vitreous lane markers, illuminated lane markers and air measurement boxes to be installed in the pavement. The total cost of the contract was $135,000.00. Start of the field work was dependent upon the work of other contractors and it was not until the latter part of September that the contractor was ordered to begin his operations. The pavement was laid in one half the roadway at a time and progress was made at the rate of about 500 ft. of single lane per day. The contract was completed on December 21st, the date of the dedication ceremonies."

***E. Warren Bowden,* Assistant to the Chief Engineer – PNYA (January 1938)**



<u>Above Left-to-Right</u>: caption: “Pressure spraying base with bituminous prime coat before depositing mastic cushion material / Rolling brick on 1-inch surfaced boards with less than ten per cent renewal on entire job / Filler application and surface removal at Weehawken (N.J.) plaza, 180 by 286 feet”

<u>Above Left-to-Right</u>: caption: “Striking off asphaltic-sand mastic bed course with screed traveling on rollers and discs with compensating carriage / Close-up view of completed brick pavement showing clean wire-cut skid-resistant traffic surface / Kerosene fueled heating kettles in which ‘blended’ asphalt filler was heated to 450-degrees F”


NEW YORK

CONTRACTORS

OSBORNE DRILLING CORPORATION
Land and River Borings

KENNEDY-RIEGGER DRILLING CO., INC.
Land and River Borings

PHILIP J. HEALEY, INC.
Land Borings—New York Approach

SPRAGUE & HENWOOD, INC.
Land Borings—New Jersey Approach

STANDARD DRILLING COMPANY
Borings—New Jersey Approach and New York River Shaft

BETHLEHEM STEEL COMPANY
Manufacture of Cast Iron and Cast Steel Tunnel Lining for Both Tunnels

OLIVER IRON AND STEEL CORPORATION
Manufacture of Bolts, Nuts and Washers for Tunnel Lining, South Tunnel

MASON & HANGER CO., INC.
Shield Driven Tunnels and Shafts for Both Tunnels and Rock Section of North Tunnel

UNDERPINNING & FOUNDATION CO., INC.
Rock Section in New Jersey—South Tunnel

GEORGE M. BREWSTER & SON, INC.
Steel Bent Sections of Both Tunnels in New Jersey, and Plaza Connections and Approach between Hudson County Boulevard East and Pleasant Avenue in Weehawken

CORNELL CONTRACTING CORPORATION
Steel Bent Section, Plaza and Approaches of South Tunnel in New York

GEORGE SCHOR
Demolition on New York Approach

BUFFALO FORGE COMPANY
Mechanical Equipment for Ventilation of South Tunnel

CAULDWELL-WINGATE COMPANY
New York River Ventilation Building

GEORGE COLON CONTRACTING CORP.
New York Land Ventilation Building

GEORGE SIEGLER COMPANY
Ventilation Building, Field Office Building, Toll Booths and Floodlight Towers in New Jersey

MACBETH-EVANS GLASS COMPANY
Manufacture of Ceiling Tile

J. LIVINGSTON & COMPANY
Electrical Equipment and Installation

DEL TURCO BROS., INC.
Side Wall Tile and Other Tunnel Finish

THE P. J. CARLIN CONSTRUCTION CO.
New York Approach Finish of South Tunnel

W. J. FITZGERALD
Tunnel and Plaza Brick Paving

A. DIERKS & COMPANY, INC.
Pumping Equipment

JOSEPH P. SCANLON, INC.
Marginal Roadways in Union City

BEACH ELECTRIC COMPANY, INC.
Toll Signaling and Recording Equipment

CLINTON ASPHALT COMPANY
Widening and Paving 19th Street, Weehawken

TAYLOR-FICHTER STEEL CONSTRUCTION CO., INC.
Structural Steel for Steel Viaduct Section in Weehawken

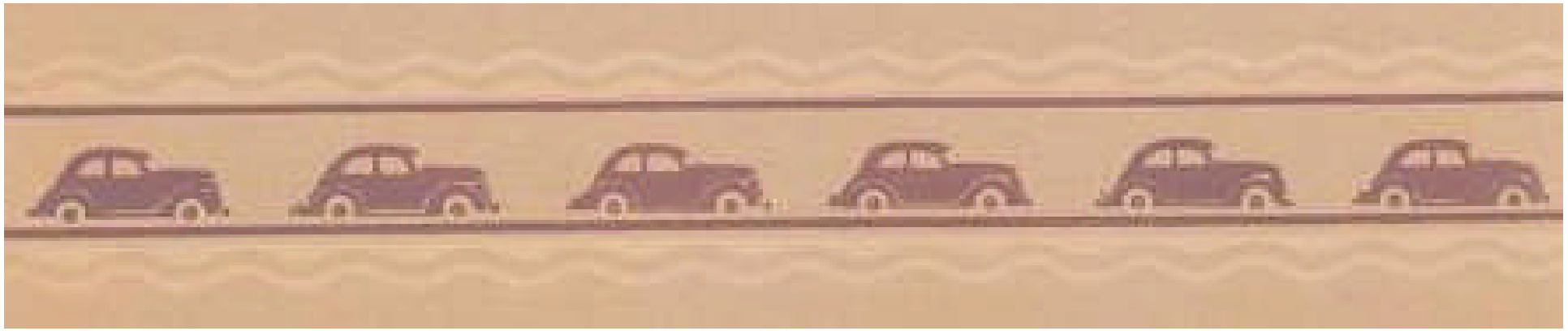
POIRIER & McLANE CORPORATION
Concrete Viaducts and Concrete Deck and Piers for Steel Viaduct Section in Weehawken

L. P. O'CONNOR, INC.
Excavation and Foundations for Viaduct Sections in Weehawken

Part 4

On the Jersey Side

Second Tube



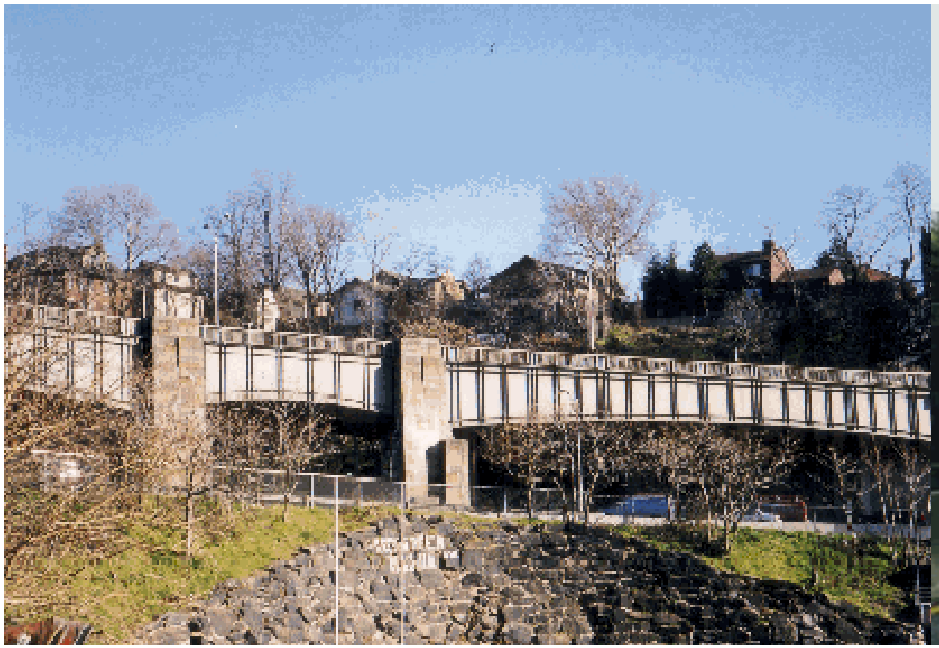
"…In November of last year, general business conditions were such as to justify the Authority in going forward with construction of the second tube and the remainder of the work on connections. Bonds in the amount of $10,000,000 were issued in December to initiate second tube financing. Other issues have been made as required by progress of construction on the entire project. Thus bonds aggregating approximately $62,600,000 for Lincoln Tunnel purposes are now in the hands of the public. While the Authority proposes to complete the financing of the project in this same manner, the federal government, through the Public Works Administration, has cooperated with the Authority by establishing a credit against which it may borrow for Lincoln Tunnel construction purposes if necessary, and also by agreeing to make an additional grant (not to exceed $3,100,000) contingent upon the amount of labor which may be taken from relief rolls…"

RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* dedication ceremony booklet (December 21st 1937)

Access

"…The plaza for entrance and exit will be between 38th and 39th Streets and between 9th and 10th Avenues in New York; and adjacent to Park Avenue, south of King's Bluff, in New Jersey. From these plazas there will be appropriate connections to the various streets and highways so as to make access to the tunnel easy from all directions…In Man-hattan, a new street eight blocks long will be opened between Ninth and Tenth Avenues as part of the approach system. On the New Jersey side connections will ultimately be made with all the main highways both east and west of the Palisades. Practically all grade crossings and left turns will be eliminated…"

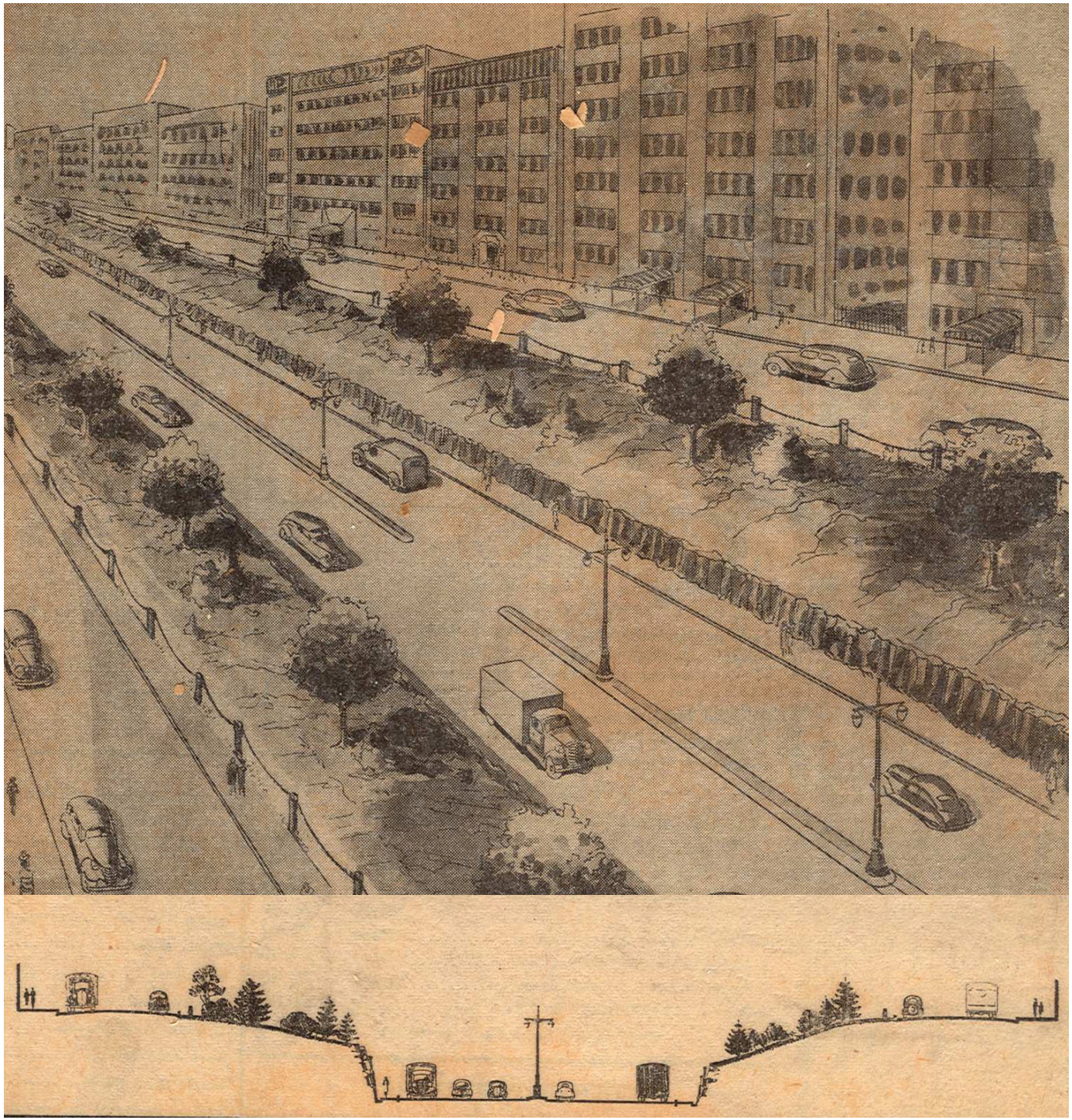
RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* ground breaking ceremony booklet (May 17th 1934). Plans for the *Hudson-Midtown Tunnel* and its approaches were first announced in 1930, when the PNYA proposed a $62 million, twin-tube tunnel under the *Hudson River* between *West 38th Street* in *Manhattan* and *Weehawken, New Jersey*. On the western shore of the Hudson, the tunnel was to connect to *New Jersey State Route 3* (NJ 3).



The original midtown tunnel proposal included a land tunnel extension from the toll plaza west through *Bergen Hill*, ending at *Tonnelle Avenue* (*US 1/9*) in *North Bergen*. Instead of constructing the land tunnel, the PNYA constructed a 360-degree, elevated "helix" that brought the six-lane highway from atop the palisades of *Weehawken* down to the tunnel's toll plaza. The 2.6-mile-long connecting freeway through *North Bergen, Union City* and Weehawken (designated *NJ 3*) was opened by the PNYA in December 1937. With its six 11-foot wide lanes, lack of shoulders and inadequate acceleration and deceleration lanes, the road reflects pre-Interstate highway design standards including Robert Moses' trademark stone-arch overpasses.

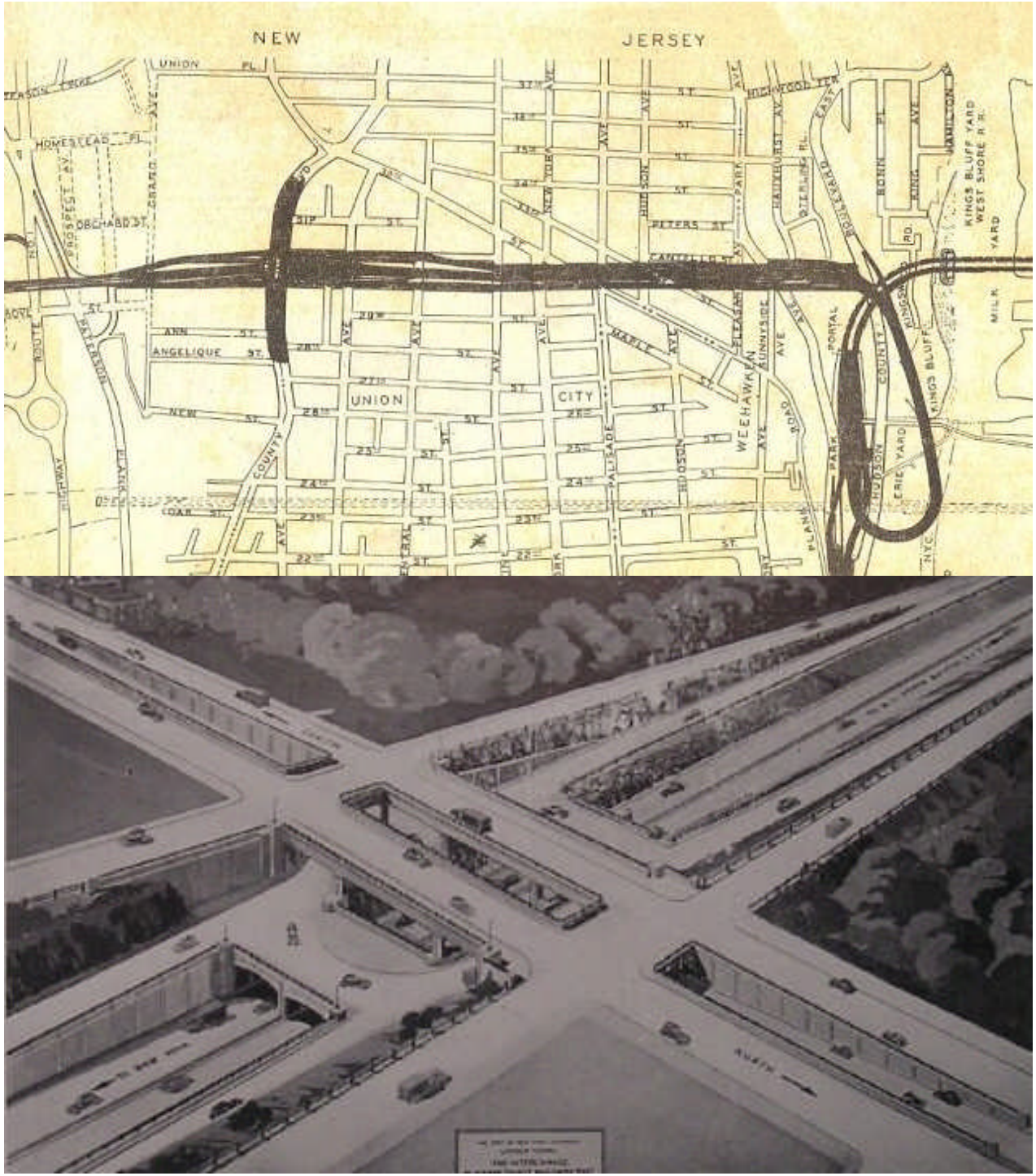
Left: caption: "Lincoln Tunnel Approach Viaduct (a.k.a. NJ 495), locally known as "The Helix." Upon exiting the tunnel, NJ 495 makes a helical incline to the top of the Weehawken Palisades."

Right: caption: "Westbound NJ 495 in Union City, NJ"



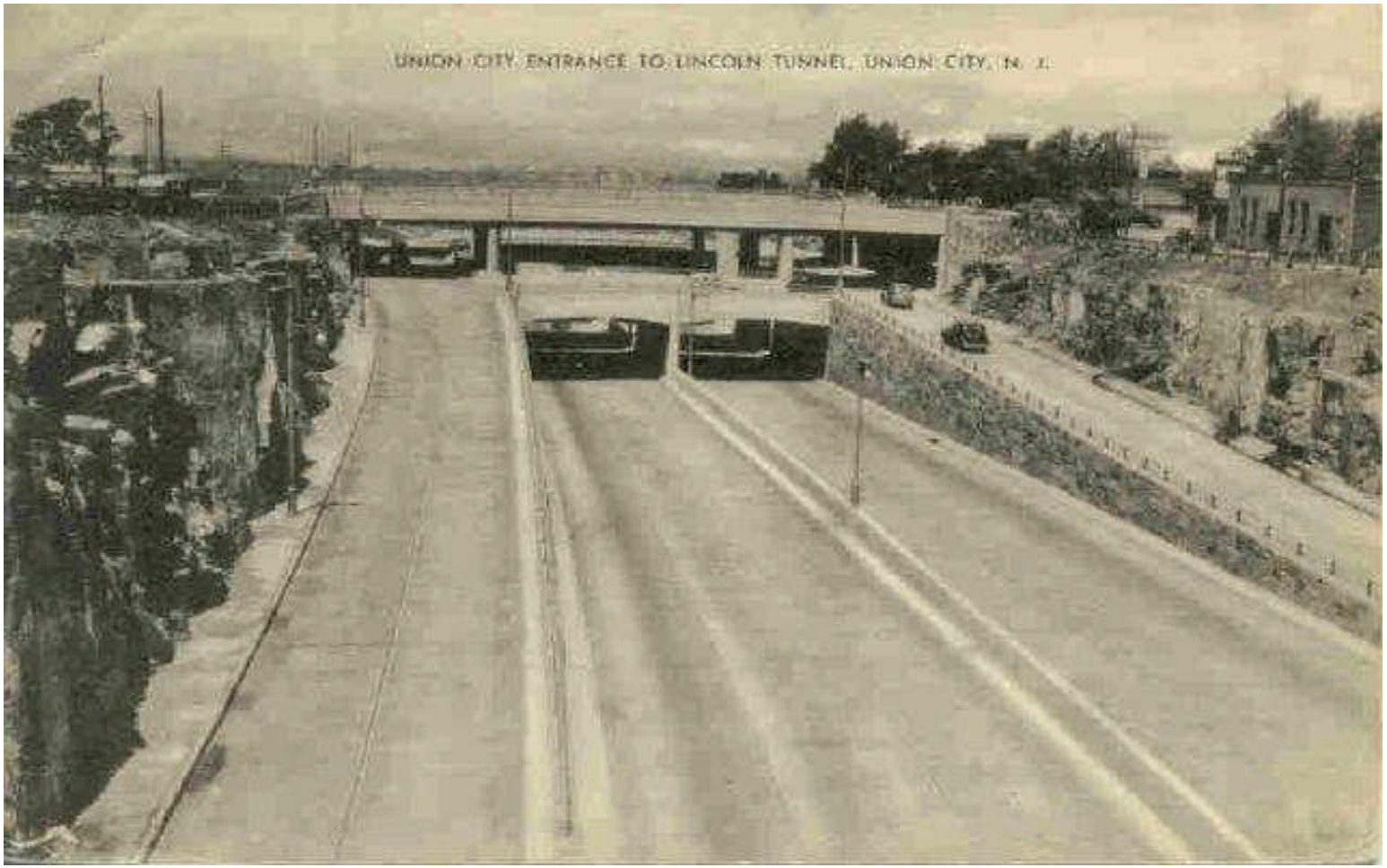
<u>Top</u>: caption: "Here is how Kay envisions the Weehawken-Midtown Tunnel approach. The drawing, which shows a section of the highway, lays stress on the highway development from the real estate angle. Here you will see the beautiful apartment houses that will in all likelihood rise on both sides of the highway. Residents of these modern apartments will look down upon a scene of beauty and charm in the parkways flanking the highway."

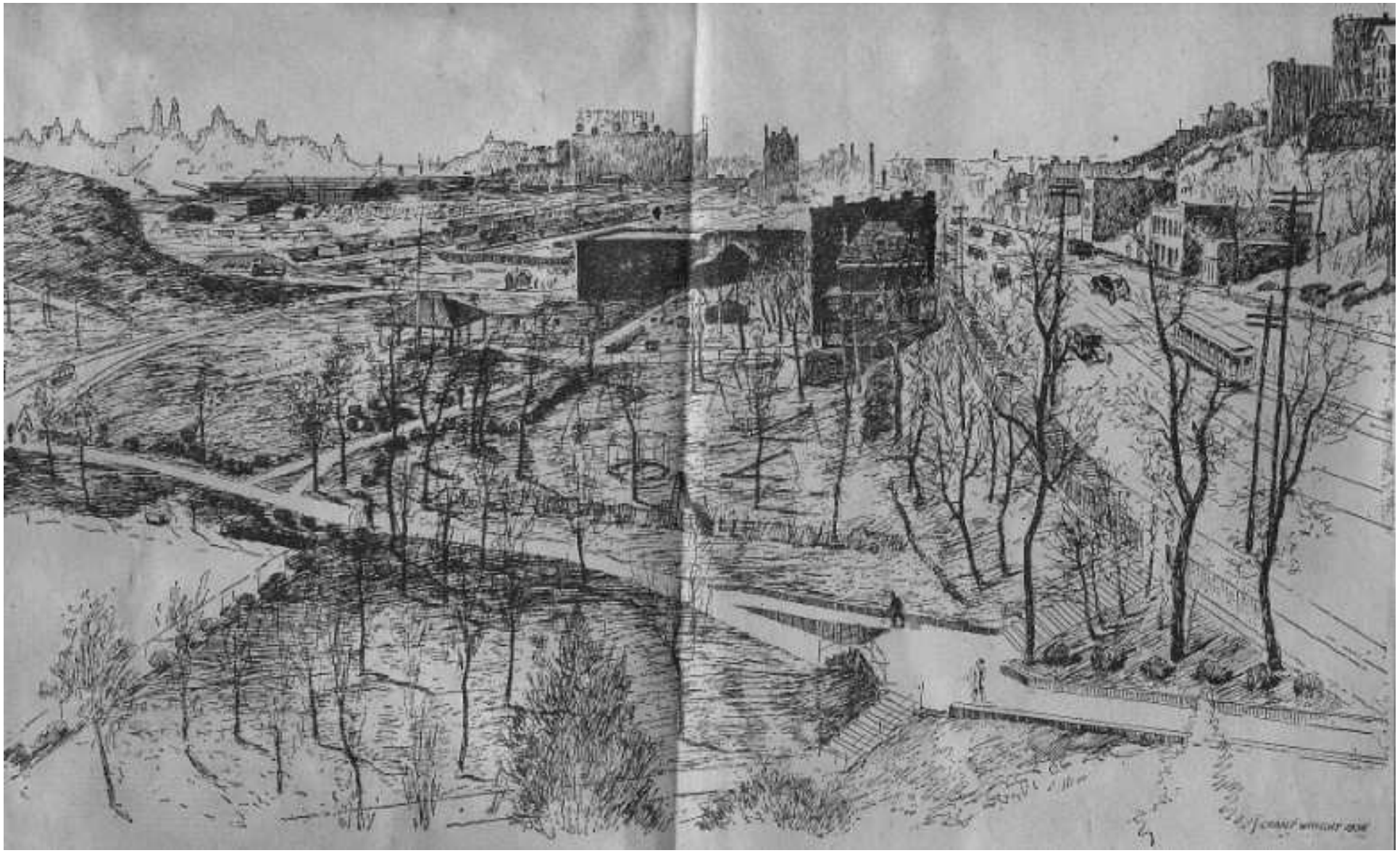
<u>Bottom</u>: caption: "A cross-section view of the depressed highway approach to the Weehawken-Midtown Tunnel, flanked by parkways rising to the level of the marginal highways on each side."



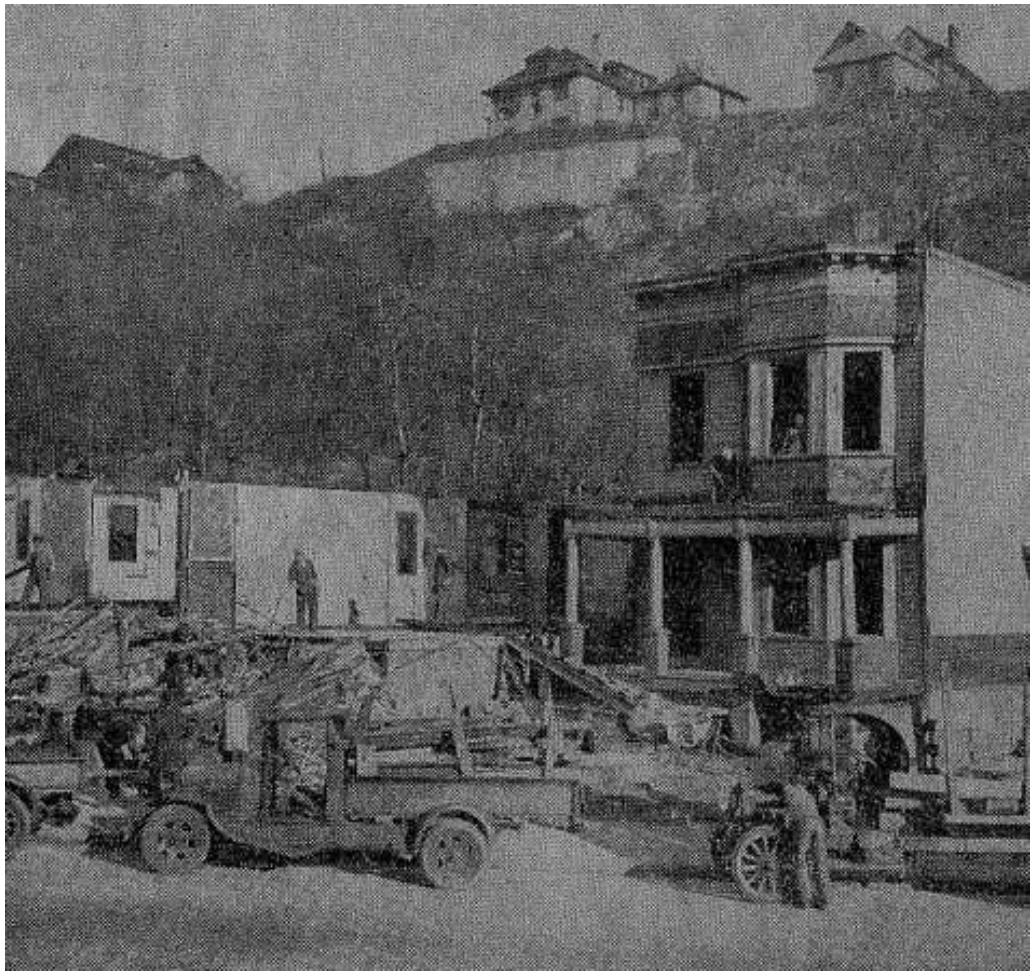
<u>Top</u>: caption: "The above diagram shows how the depressed highway of the Weehawken-Midtown Tunnel will cut through Union City and Weehawken. From the tunnel mouth in Weehawken the highway forms a loop around Boulevard East and swings up to begin its course across Union City at Pleasant av. The three sections forming the black area indicate the depressed highway and marginal surface highways. Where they pass New York av. At 32nd st., a plaza will be built, and continuing to the Hudson Boulevard, further developments will be made. The depressed highway will go under the Boulevard and remain depressed until it reaches Route 1 in North Bergen." (*Hudson Dispatch*, April 23rd 1937)

<u>Bottom</u>: caption: " A Triple 'Layer-Cake' of Cross-Overs. A Lincoln Tunnel approach in Northern Hudson County."

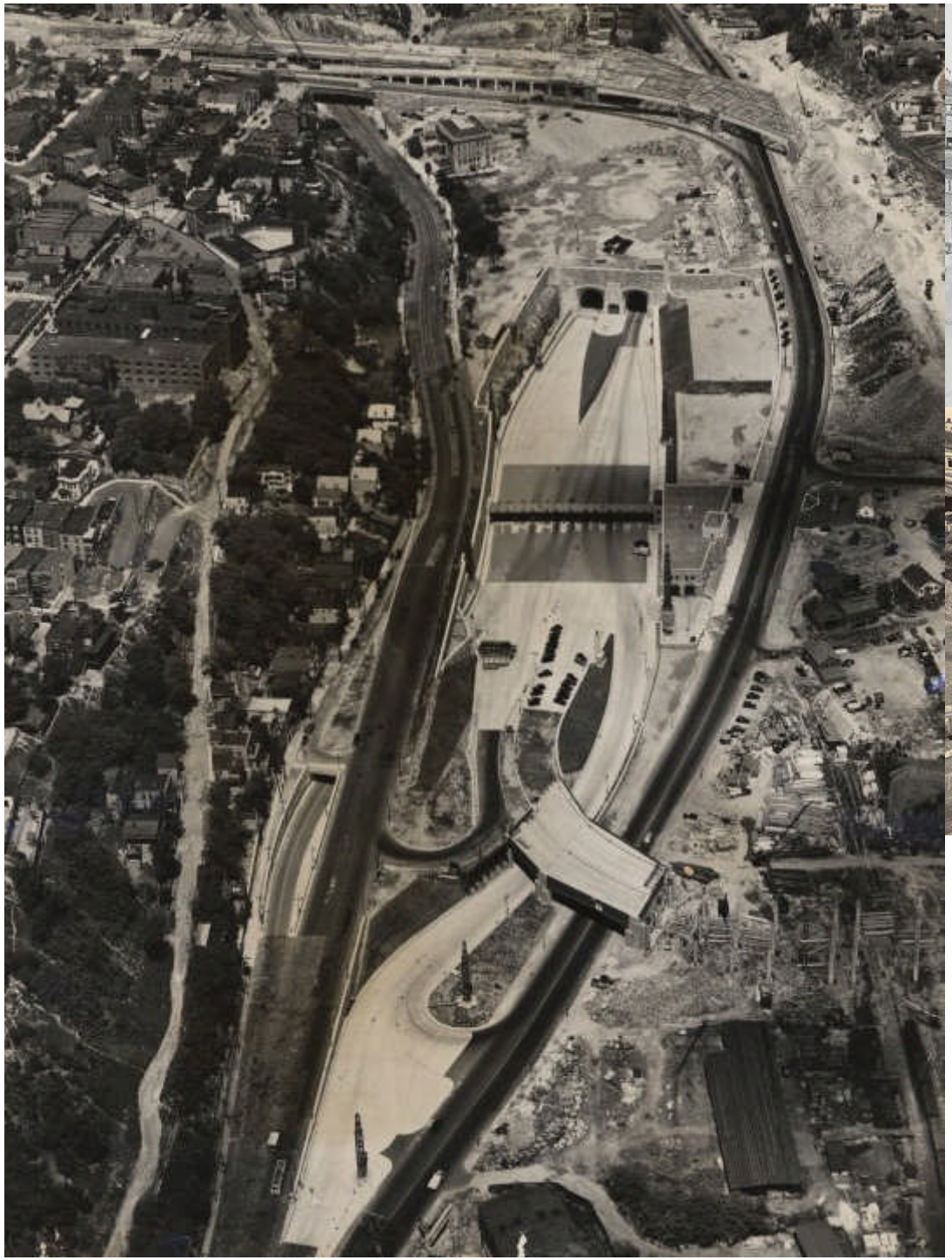

UNION CITY ENTRANCE TO LINCOLN TUNNEL, UNION CITY, N. J.

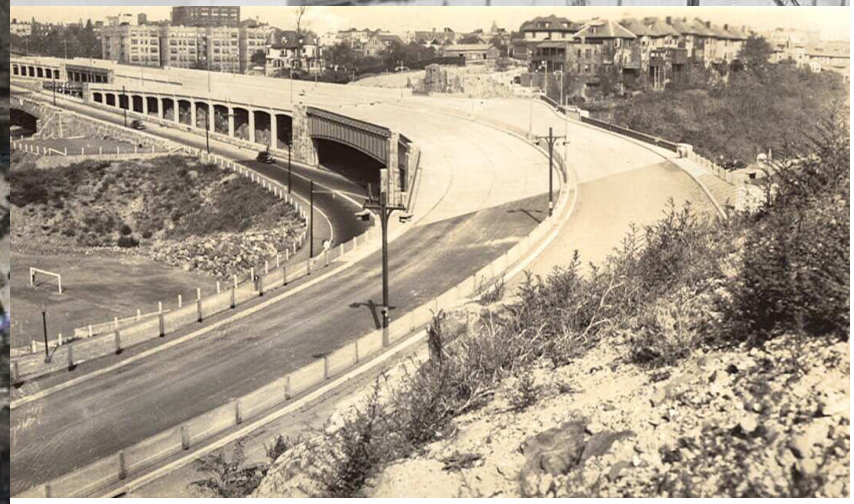


<u>Above</u>: caption: “This sketch by Grant Wright shows the area of the Weehawken side of the Lincoln Tunnel before construction began”



<u>Left</u>: caption: "November 1935: The job of wrecking is under way. Here is almost completed the task of tearing down 24 frame houses in the 'Valley' on Boulevard East, Weehawken, in preparation for building the approaches to the tunnel. One of the buildings is in process of demolition. Another is being readied for the spike and rope. This is in vicinity of new playground. King's Bluff is in background. This is a section in what was once Weehawken's 'Valley Park,' years ago the scene of busy industries and shad fishing. The setting is looking east toward the famous 'Bluff' where the Kings and other famous families lived in 19th Century exclusiveness. The houses to go were among the township's oldest privately owned dwellings."

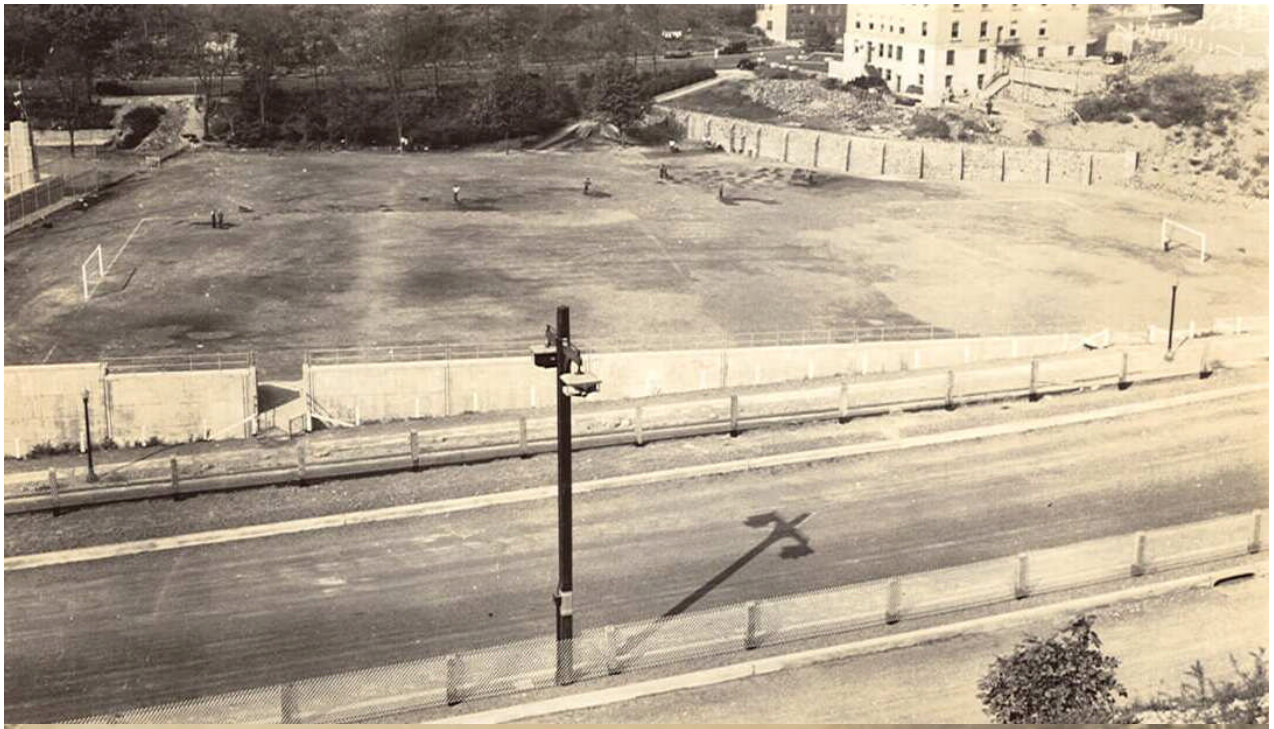




<u>Above Top</u>: caption: "The Helix being constructed; looking west along express highway from top of King's Bluff"

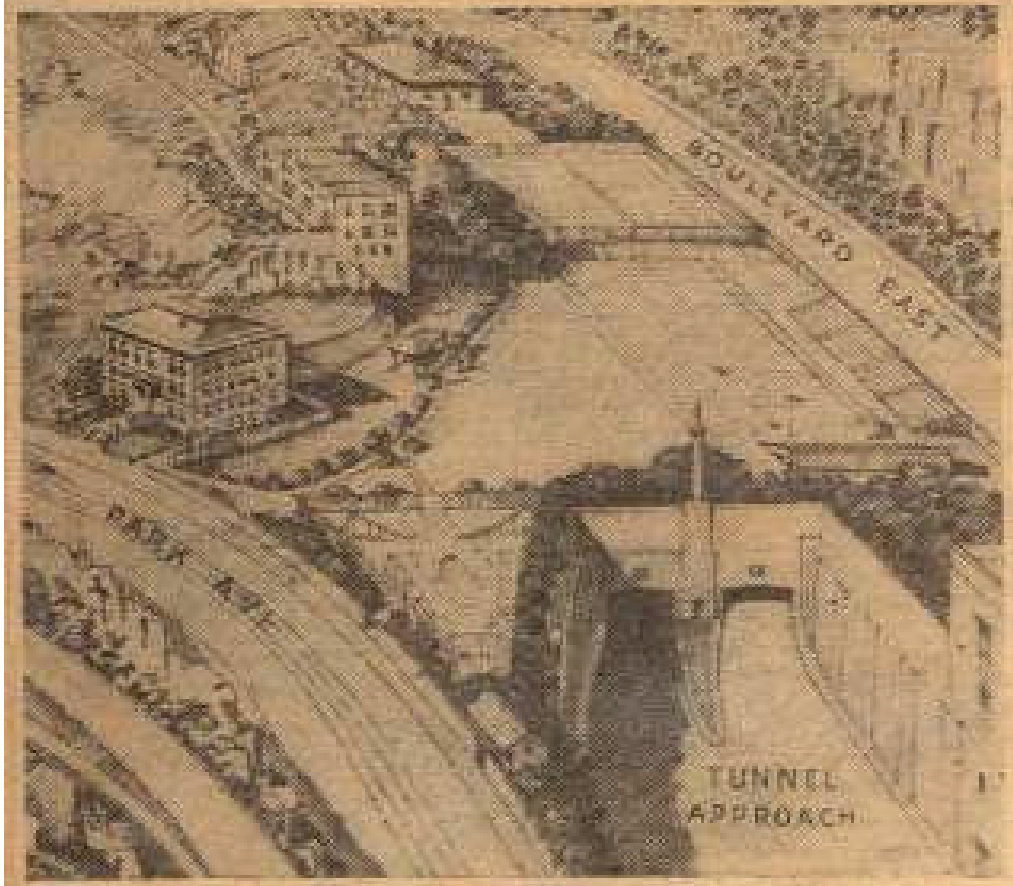
<u>Above Bottom</u>: caption: "The Helix after its opening in October 1938 - with no traffic"

<u>Left</u>: caption: "Aerial view of the Helix being constructed, 1938"



<u>Above</u>: caption: “Installation of the bridge carrying the Lincoln Tunnel approach over Park Avenue. Placing 55-ton steel to complete the ramp on Park Av.”

<u>Above</u>: caption: "Initial Arrangement of New Jersey Approach. Weehawken toll plaza with its initial to Hudson County Boulevard East and Park Avenue as completed to form part of the First Operating Unit of Lincoln Tunnel. The uncompleted structure at Hudson County Boulevard East will form part of the viaduct loop which is now under construct-lon." (as of December 1937)



SKETCH OF THE NEW WEEHAWKEN PLAN.

The tunnel entrance and exit are at the lower right, and the Municipal Building at the left. Boulevard East is drawn in accordance with the new proposal. The approach plaza and hairpin loop across Park Avenue are not included in this sketch.

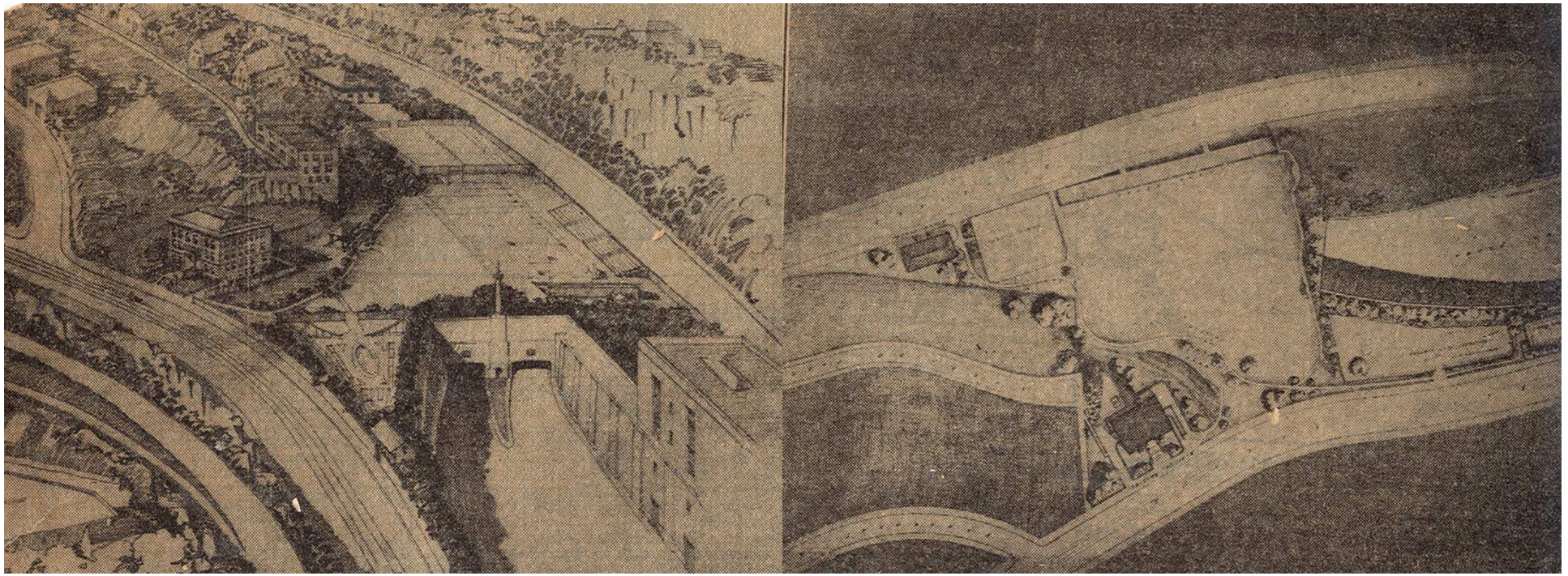
WEEHAWKEN GETS NEW TUNNEL PLAN

148th Proposal of Port Board Is Offered to Satisfy Taxpayers' Demands.

BOULEVARD EAST SHIFTED

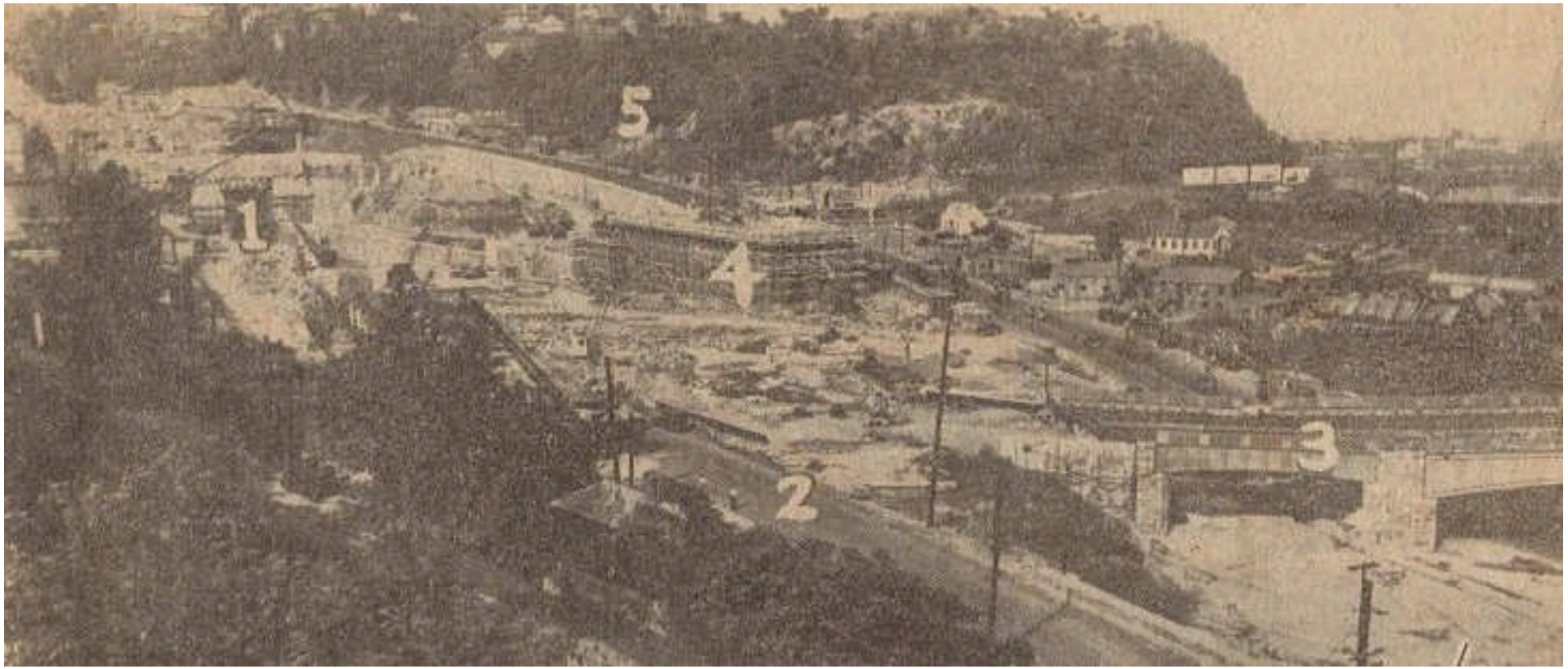
Further Playground Development Is Provided—Assessment Problem Is Unsettled.

A new plan for the approach to the Midtown Vehicular Tunnel in Weehawken, N. J., was proposed last week by the Port of New York Authority at a public meeting called by Mayor John Meister of Weehawken. The plan was the 148th mapped by the Authority in an effort to meet its own requirements and to satisfy the demands of Weehawken taxpayers and township officials.

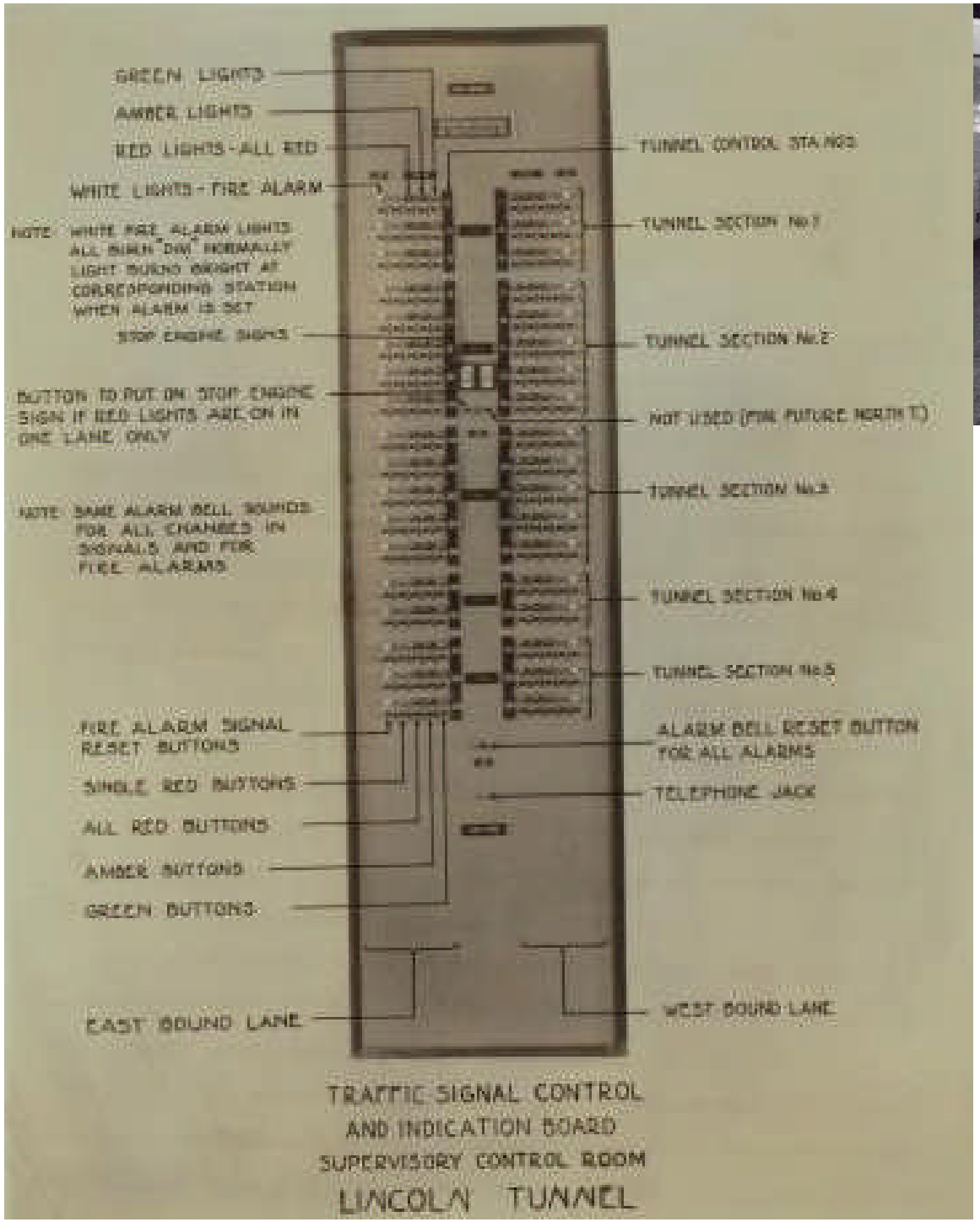


<u>Left</u>: caption: The above sketch discloses latest proposed plan for location of entrance and exit to new Mid-Town Tunnel at its Weehawken end. Road to right is Boulevard East (Valley Road) and at left Park avenue. Picture is drawn looking north from Eighteenth street with new town play field directly above tunnel entrance."

<u>Right</u>: caption: "Air View of Weehawken Tube Plaza"



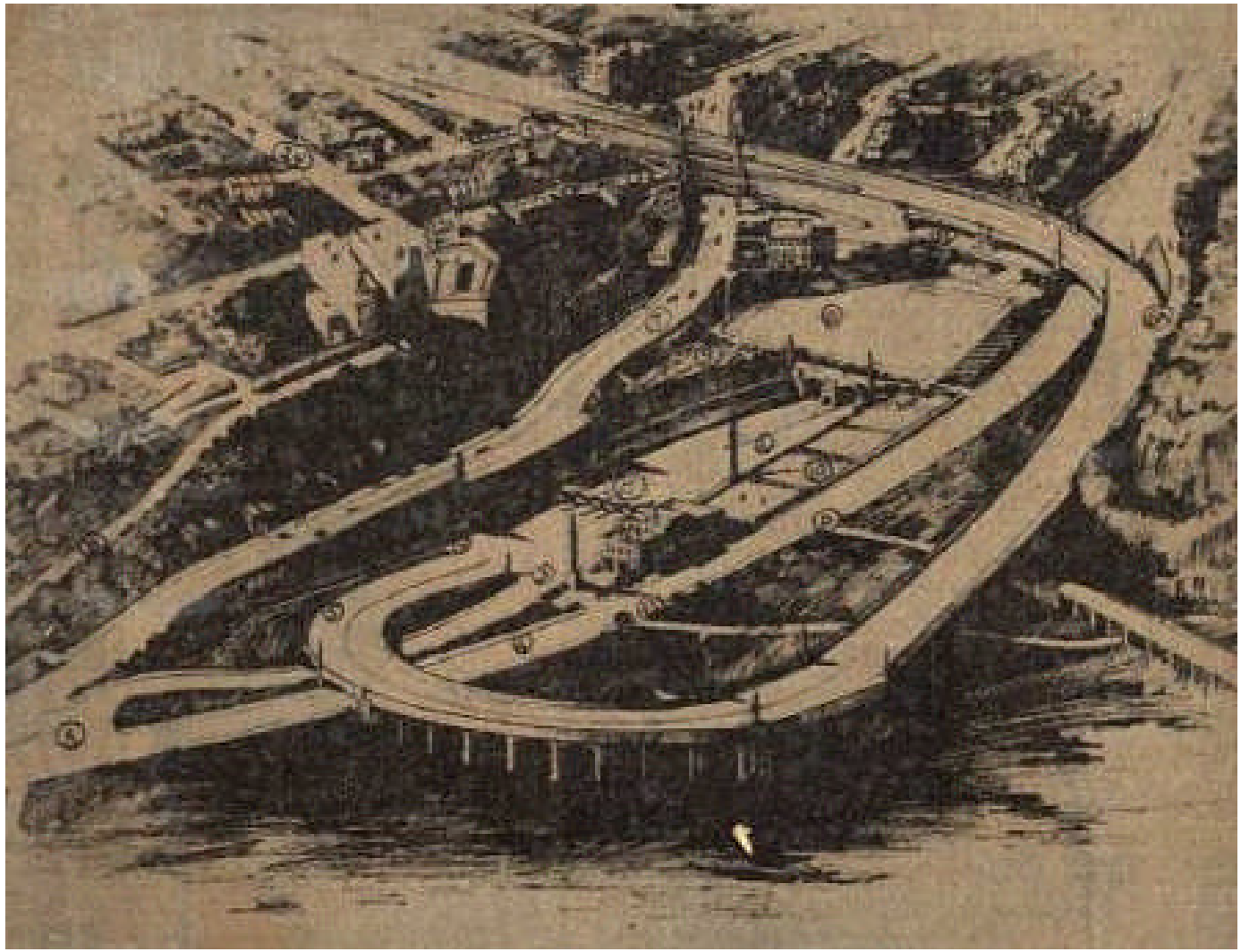
<u>Above</u>: caption: "Just as time marches on, so does construction work on the Weehawken Midtown Tunnel. Here is a view taken of the latest advancements made on the approaches. No. 1 shows the mouth of the tube crossing from the western to the eastern side of the Hudson River. No. 2 is Park av., widened. No. 3 is the first completed section of the overpass crossing Boulevard East. The pass will be built farther south and will circle back north alongside King's Bluff and west into Union City. The stretch of dirt road in the foreground is Hackensack av., better known as the 'High Road,' which will also be rebuilt. No. 4 is the administration building now in process of construction. This will house the business department of the Port of New York Authority who will concentrate on tunnel work. No. 5 is where the overpass will circle around and back into Union City. Workmen are busy constructing concrete pylons and blasting away the rock hills just north of the town hall." (*Hudson Dispatch*, August 19th 1937)



<u>Above</u>: caption: "Officer controlling traffic in the Traffic Control Building at the New Jersey Plaza"

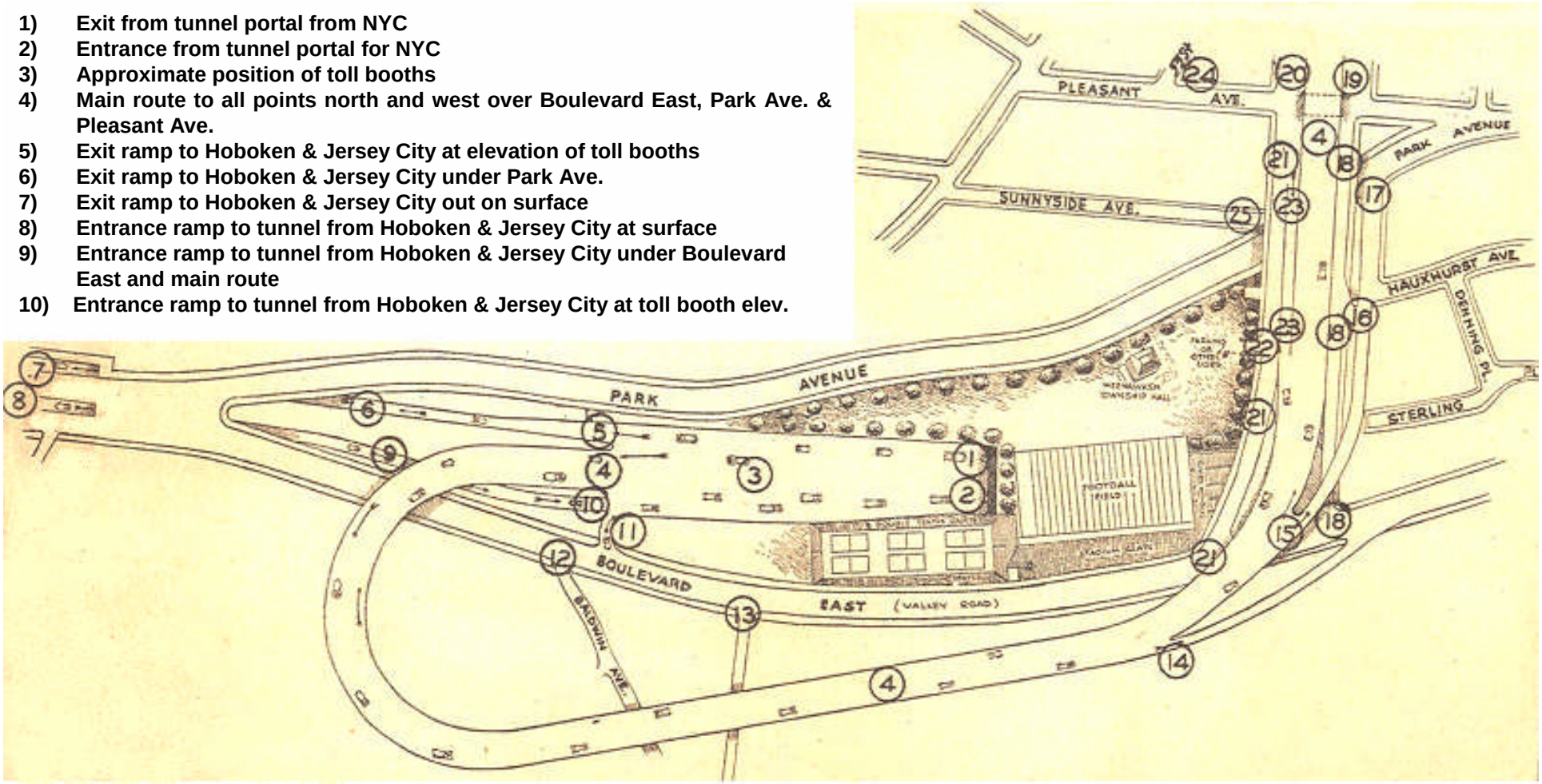
<u>Left</u>: caption: "Traffic signal control and indication board – Supervisory control room"

<u>Above</u>: caption: "Ultimate Arrangement of New Jersey Approach. Weehawken toll plaza with its connections to Hudson County Boulevard East and Park Avenue, the viaduct loop structure, and the open-cut express highway through Union City. The latter will provide connection with Hudson County Boulevard and state highway routes in North Bergen. The toll plaza is practically complete, while the viaduct structure and depressed highway are now under construction." (as of December 1937)



<u>Above</u>: caption: "Picture shows two tunnels. Only one, however, will be opened for traffic in 1938. Should conditions warrant, the second tube will be constructed. (1) Entrance and exit to the tunnel; (2) Port Authority Administration Building; (3) road from Hoboken; (4) road to Hoboken; (5) main 'loop' route to Union City; (6) new Boulevard East; (6a) ramp to Boulevard East, going north; (7) Park Avenue with Municipal Building above; (8) main ball field and stadium; (9) children's playgrounds; (10) tennis and handball courts; (11) parking space; (12) Sunnyside Avenue; (13) Pleasant Avenue; (14) Hackensack plankroad. (A) The present intersection of Park and Willow Avenues; (B) the new Highroad, or Paterson plankroad extension; (C) Baldwin Avenue; (D) Electric Ferries; (E) fare booths."

1) Exit from tunnel portal from NYC
2) Entrance from tunnel portal for NYC
3) Approximate position of toll booths
4) Main route to all points north and west over Boulevard East, Park Ave. & Pleasant Ave.
5) Exit ramp to Hoboken & Jersey City at elevation of toll booths
6) Exit ramp to Hoboken & Jersey City under Park Ave.
7) Exit ramp to Hoboken & Jersey City out on surface
8) Entrance ramp to tunnel from Hoboken & Jersey City at surface
9) Entrance ramp to tunnel from Hoboken & Jersey City under Boulevard East and main route
10) Entrance ramp to tunnel from Hoboken & Jersey City at toll booth elev.



11) Entrance ramp to tunnel from Boulevard East (Valley Rd. section)
12) Relocation of connection between Boulevard East & Baldwin Ave.
13) Relocation of connection to Electric Ferry
14) Exit ramp from main route to Boulevard East (Valley Rd. section), for Weehawken Heights & points north
15) Exit ramp from main route to Hauxhurst Ave., Park Ave. & local points in Weehawken & Union City
16) Exit ramp at Hauxhurst Ave., showing connection with Marginal St.
17) Exit ramp at Park Ave. present grade
18) Marginal St. connecting East & West Boulevards
19) Connection of Marginal St. with main route for west bound traffic
20) Connection of main route traffic to Marginal St. which connects West & East Boulevards
21) Marginal St. connecting Boulevard West with Boulevard East
22) Marginal St. connection with Weehawken municipal center
23) Entrance ramp to main route for tunnel-bound traffic
24) Entrance to main route for tunnel bound traffic from Park Ave., which becomes Pleasant Ave. traffic when all right hand turns are necessary. Park Ave. traffic may also enter tunnel at point 8
25) Sunnyside Ave. to become entrance to Marginal highway

SATURDAY, OCTOBER 8, 1938

Weehawken Loop of Lincoln Tunnel Open to Traffic Next Saturday Noon

Panoramic View of Lincoln Tunnel Entrance and Loop

Approach Roadway Link as Far as Pleasant Av., Union City, Ready Considerably Ahead of Schedule — Depressed Highway to Be Opened Next Summer

DOES AWAY WITH TRIP TO 19TH ST.

The loop roadway approach to the Lincoln Tunnel in Weehawken will be opened to traffic next Saturday at noon, the Port of New York Authority announces. No formal ceremonies have been planned.

This construction, a notable departure from methods hitherto adopted for the handling of vehicular traffic, is a major phase in the construction of adequate approaches to the Lincoln Tunnel in New Jersey.

A curving concrete and steel structure dedicated solely to tunnel purposes will carry vehicles between the tunnel portal in Weehawken and Pleasant av., Union City. Its completion at this time is considerably ahead of schedule, and will be followed next summer by the opening of the depressed express highway through the Palisades connecting with State Highways 1 and 3. The depressed roadway will be a continuation of the loop roadway.

The latter is an outstand[ing] ... example of construction where[by] ... increasing of distance lessen[s] ... grade of a roadway, so that ... latter can be negotiated ... high gear. It is understood ... the only construction of this ... kind ... later east of the Rockies.

Opened to Pleasant Av.

Starting at the southerly ... the Weehawken Plaza, the ... swings left as a viaduct over ... yard East and runs along ... "shelf" cut into the western ... of King's Bluff. It then re-... Boulevard East and passes ... of the Weehawken Township ... It ends at Pleasant av., ... dividing line between Weeh... and Union City, at which p... finally has reached the plat... the Palisades.

The rather short section be... Park av., Weehawken, and ... ant av., will not be opened ... time. Ramp connections wi... loop at Park av., will be us... clusively for the present. ... ramps connect with ... streets flanking the main ap... to the tunnel.

The loop is about 4,000 fe... There are three traffic la... each direction. A wall will ... rate eastbound and west... traffic and act as a curtain ... posing automobile lights. ... convenience of traffic d... along the north bank of the ... son River, the loop will ... Boulevard East by merging ... bound lanes.

The temporary connection ... is use between the tunnel ... and Park av. will be discon... and similar service will be ... formed north of the forecast... All other permanent conn... with existing highways ... maintained.

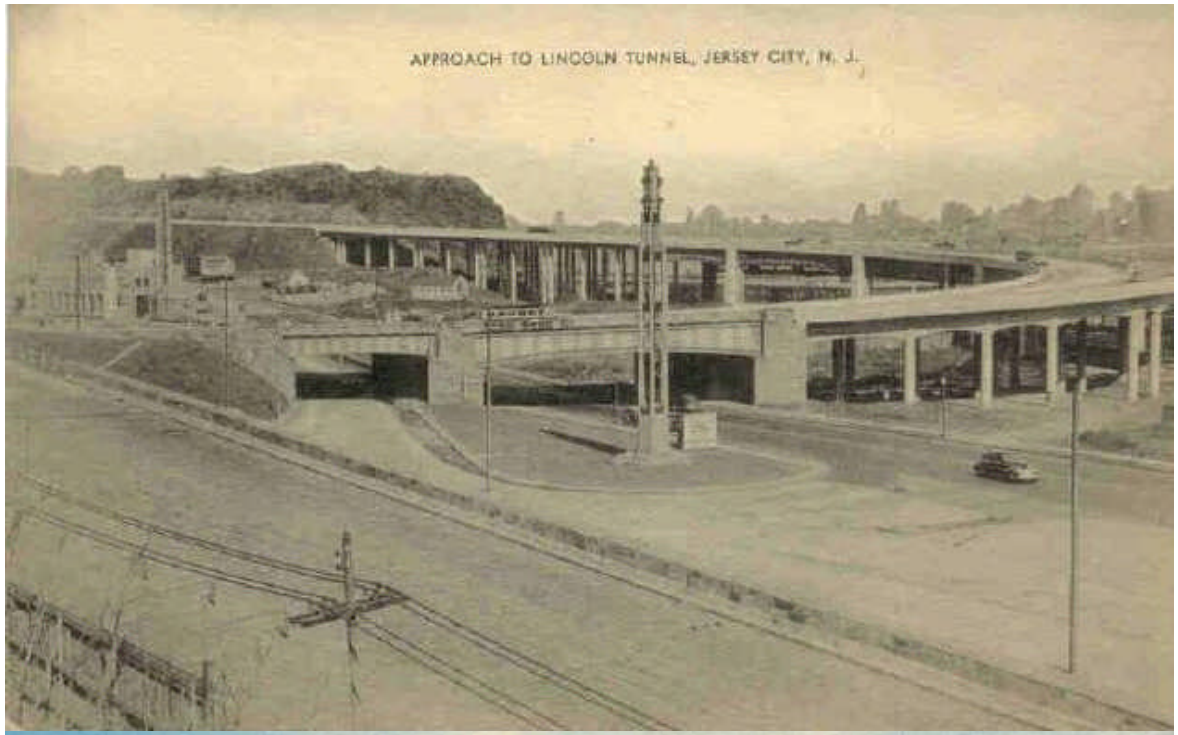
Ends Trip to 19th St.

"The opening of the lo... helix," as our chief engineer ... fers to call it, will remove ... appeared to be a rather ... travel for eastbound traf... 19th st, in South Weehawken," ... Frank C. Ferguson, chairm... the Port of New York Au... "Now, the outbound traffic ... accom... dated on a three-la... speed roadway with a four ... compensated grade, tunn...

(Turn to Page 8, Column ...

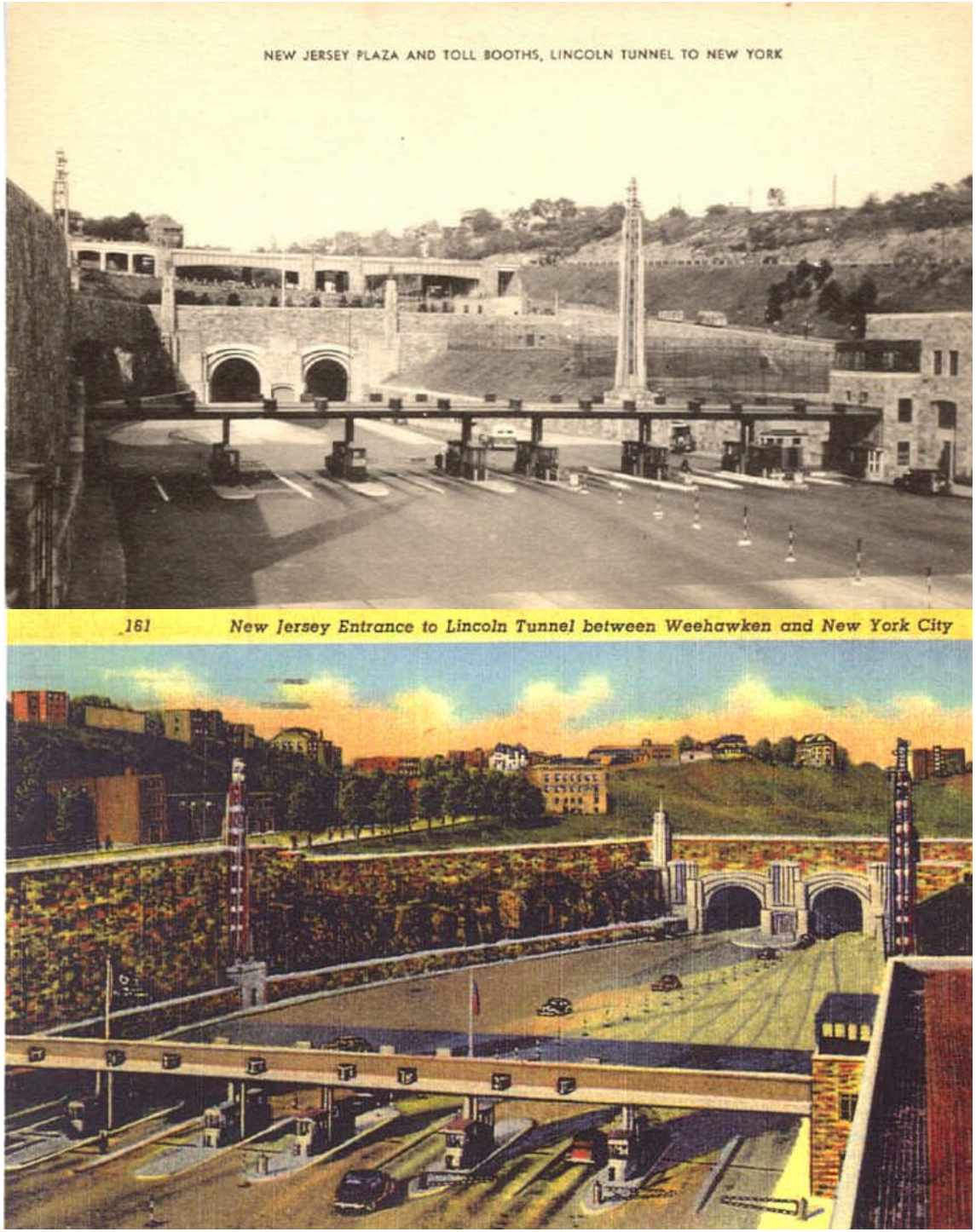
"Three years of digging, blasting, shoveling, sketching and leveling having ended the loop of the Lincoln Tunnel in Weehawken will open for traffic at noon today…gradually science performed one of its finest face-lifting jobs and today there stands in Weehawken one of the most praiseworthy masterpieces of architecture in the United States. Graceful roadways mounted on concrete pylons sweep in from Union City to curve over Boulevard East and then sweep down to the tunnel plaza. Starting at the southerly end of the plaza, the loop turns left as a viaduct over Boulevard East and runs along a rock hewn space in King's woods. The road re-crosses Boulevard East to pass in the rear of the municipal building and out into Union City. However, there is a marginal highway on either side of the two main highways, one leading to Park av. in Weehawken and the other to Boulevard East…"

***Hudson Dispatch,* Saturday, October 15th 1938**



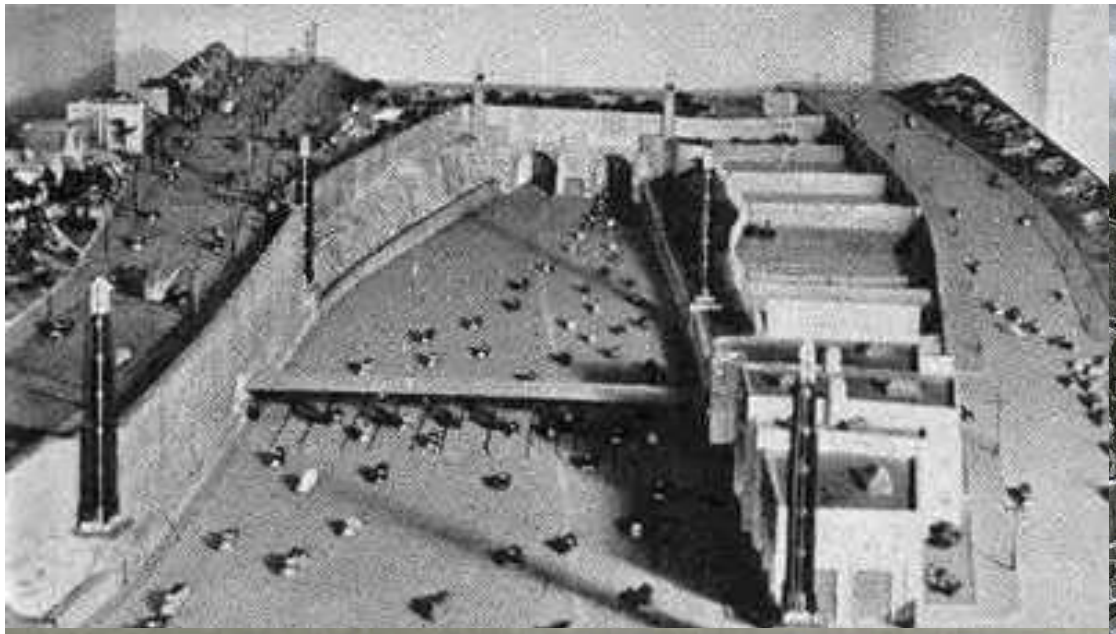
"…When the helix opened in 1938, a year after the opening of the Lincoln Tunnel, it was hailed as an engineering marvel. The Hudson Dispatch called it 'one of the most praiseworthy masterpieces of architecture in the United States.' Drivers no longer had to join local traffic in downtown Weehawken on their way to and from the Lincoln Tunnel. The massive helix provided three traffic lanes in each direction, connecting to Weehawken's Pleasant Avenue. In 1939, a depressed express highway (now Route 495) opened, connecting the helix through Union City to Interstate Routes 1 and 3…"

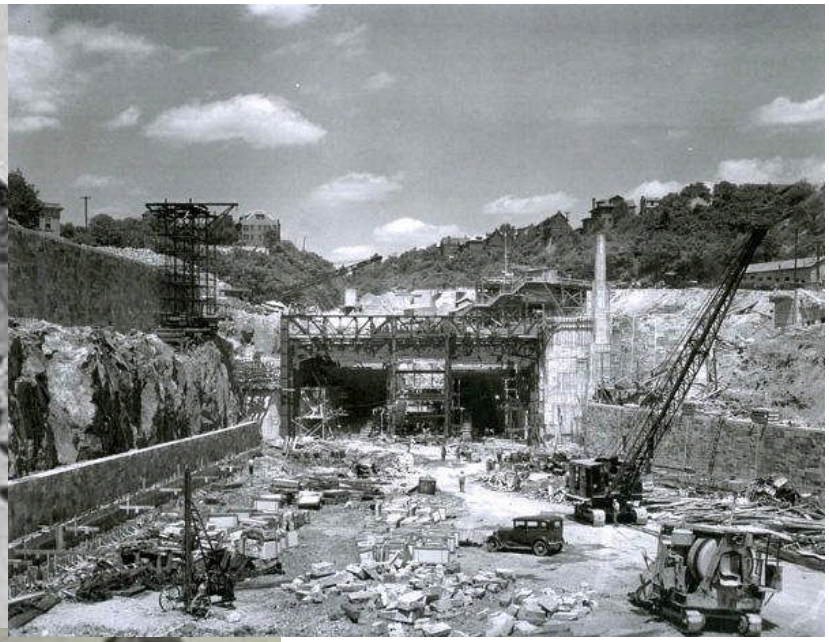
***Metrofocus*, July 2012**



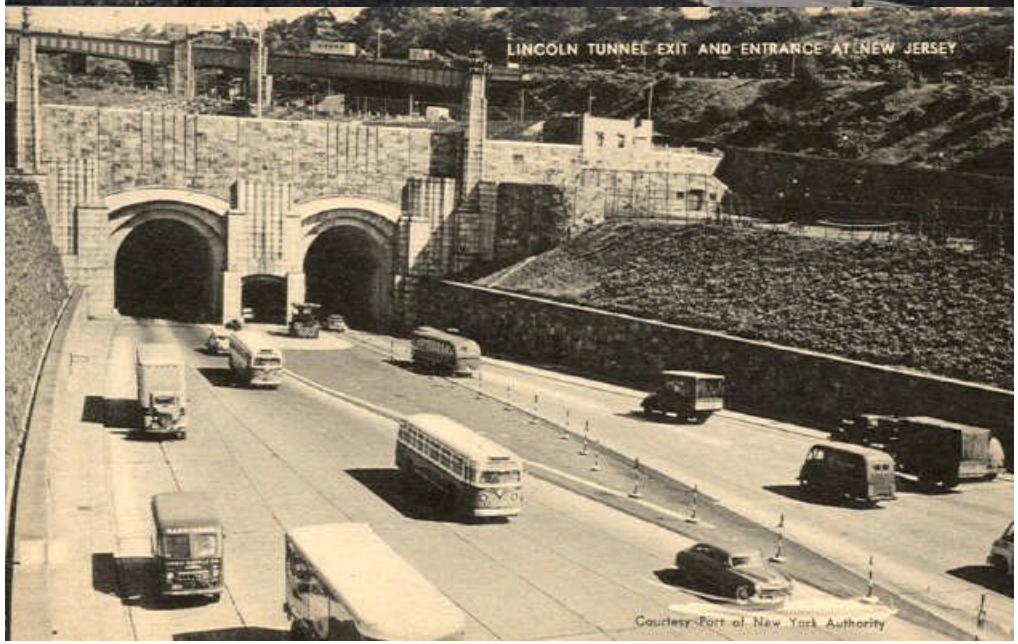
"…When the Port of New York Authority told the township of Weehawken that the loop would not be an eyesore to the community, such as was left in Jersey City in the form of the Holland Tunnel approaches, it meant just what it had promised. The Connecticut granite walls, blended in brown, red and gray, look like autumn foliage in color. The concrete work leaves nothing to be desired as there is not an unfinished piece in the entire construction. Unlike other concrete finishes, the loop presents a novel feature in that the supports of the girders look to be of white marble instead of concrete…"

***Hudson Dispatch,* Saturday, October 15th 1938**





<u>Top Left</u>: caption: "Model of New Jersey Toll Plaza"
<u>Top Right</u>: caption: "New Jersey entrance of the Lincoln Tunnel 1937"
<u>Left</u>: caption: "New Jersey Toll Plaza"

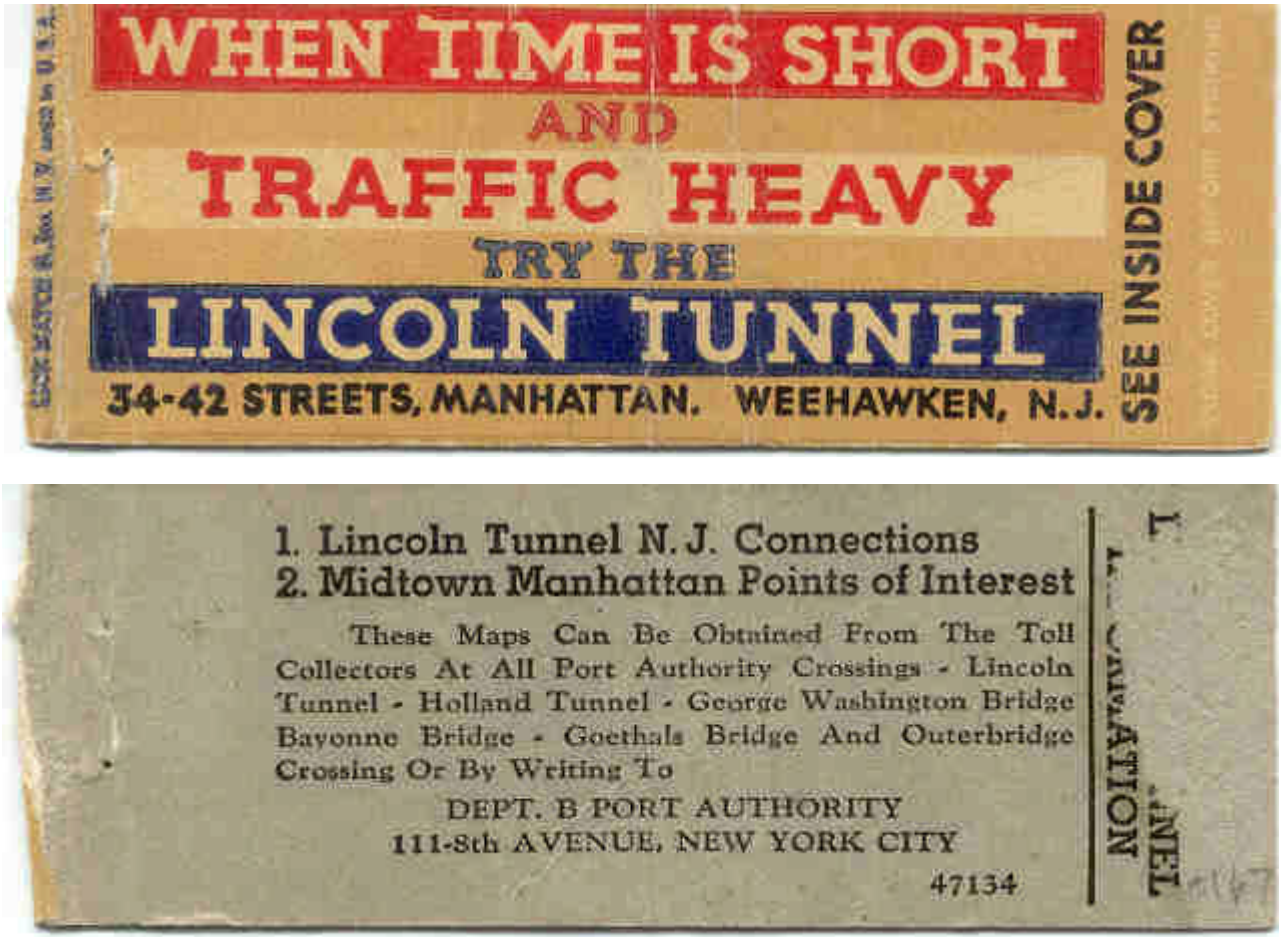


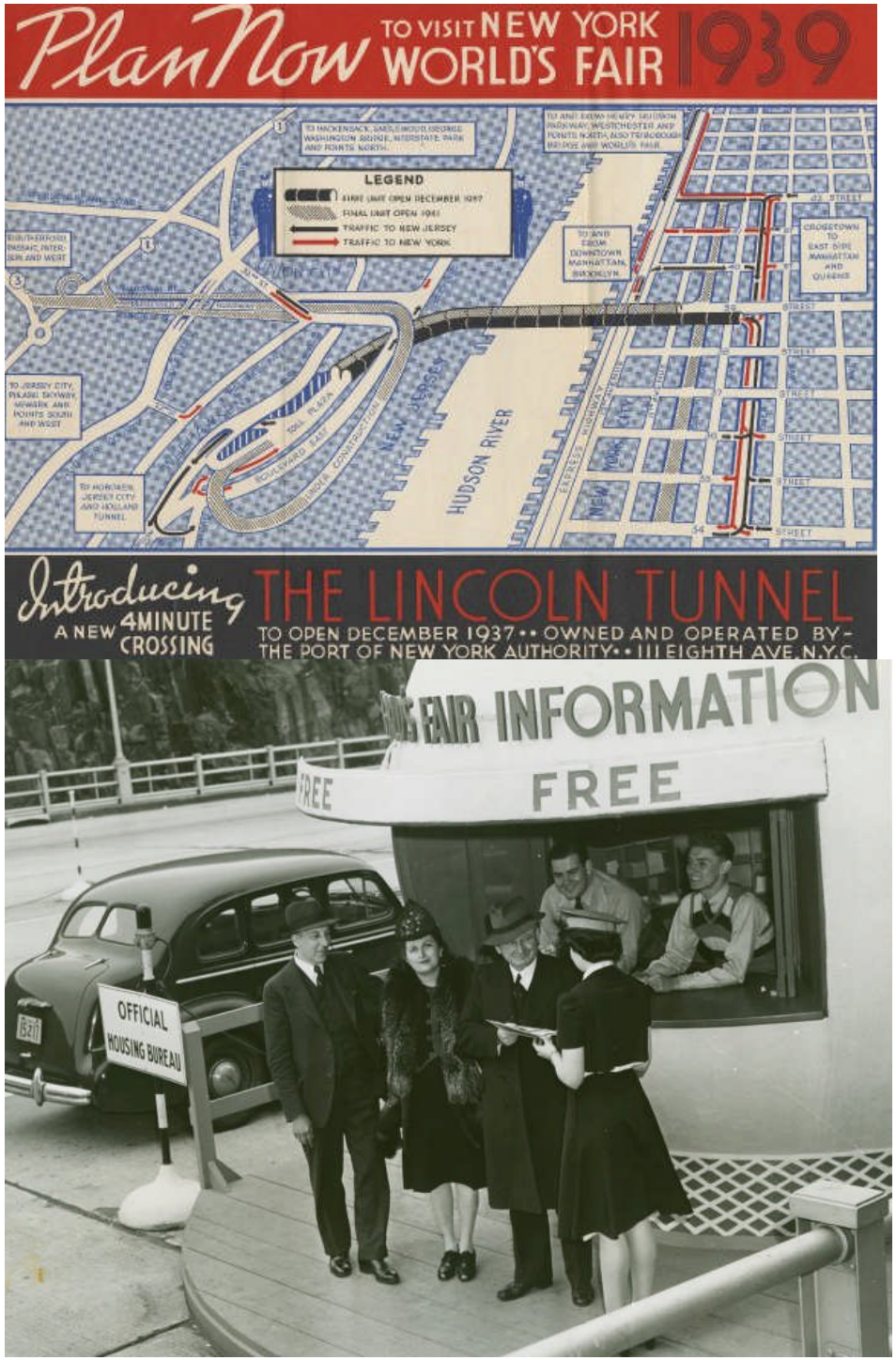
"Every year, 40 million vehicles use the Lincoln Tunnel to travel between New Jersey and New York City, where the tunnel empties onto West 39th Street. To get into the city, the vast majority of drivers use a single entry point called the helix. This 4,000-ft, sloping roadway loop connects traffic from Route 495 to the tunnel entrance. When congestion clogs the city-bound lanes, one can at least enjoy an expansive view to the east of the Hudson River and Manhattan skyline…"
***Metrofocus*, July 2012**

"We used to bet a dime on whether we'd pass one, two or three vehicles while driving through the tunnel!"

Austin Tobin, **PNYA Executive Director**

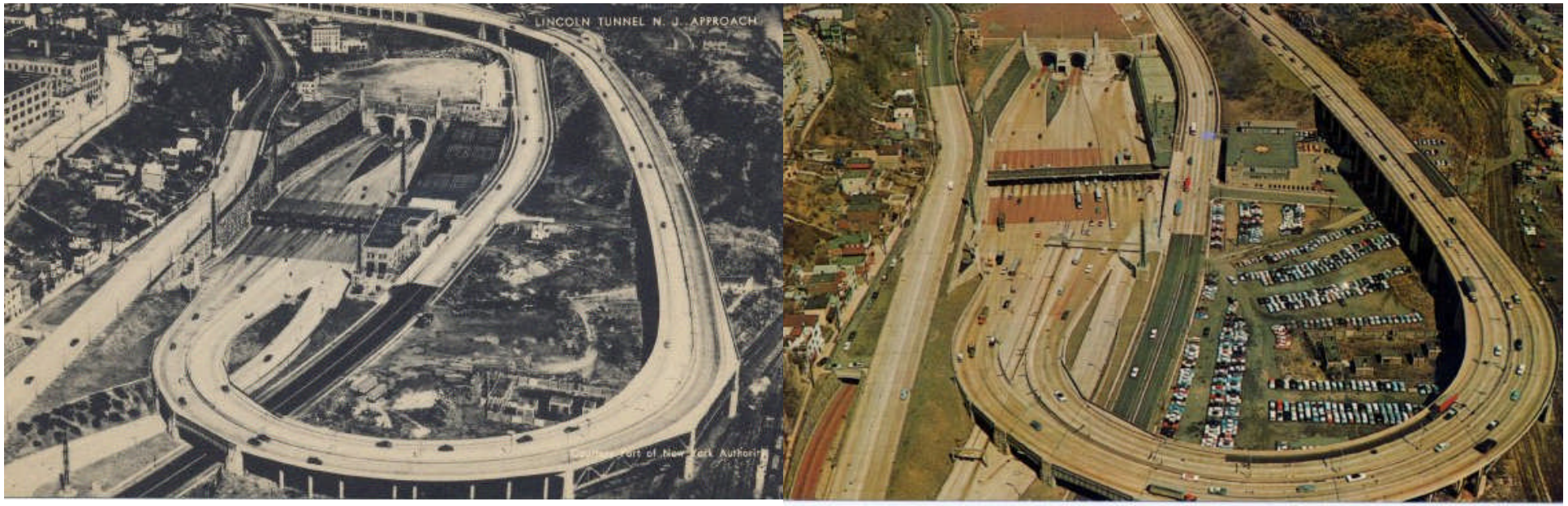
<u>Left</u>: matchbooks promoting use of the PNYA's *Lincoln Tunnel* to the public. The first tube (present-day center tube) of the Lincoln Tunnel was opened on December 22nd 1937. With only one lane of traffic in each direction in its first year of operation, a less-than-spectacular 1.8 million vehicles used the new tunnel. A second tube was opened north of the original tube in 1945, after years of WWII-related delays. This allowed for two lanes of eastbound and westbound traffic.


WHEN TIME IS SHORT
AND
TRAFFIC HEAVY
TRY THE
LINCOLN TUNNEL
34-42 STREETS, MANHATTAN. WEEHAWKEN, N.J.
SEE INSIDE COVER
1. Lincoln Tunnel N.J. Connections
2. Midtown Manhattan Points of Interest
These Maps Can Be Obtained From The Toll Collectors At All Port Authority Crossings - Lincoln Tunnel - Holland Tunnel - George Washington Bridge Bayonne Bridge - Goethals Bridge And Outerbridge Crossing Or By Writing To
DEPT. B PORT AUTHORITY
111-8th AVENUE, NEW YORK CITY
47134



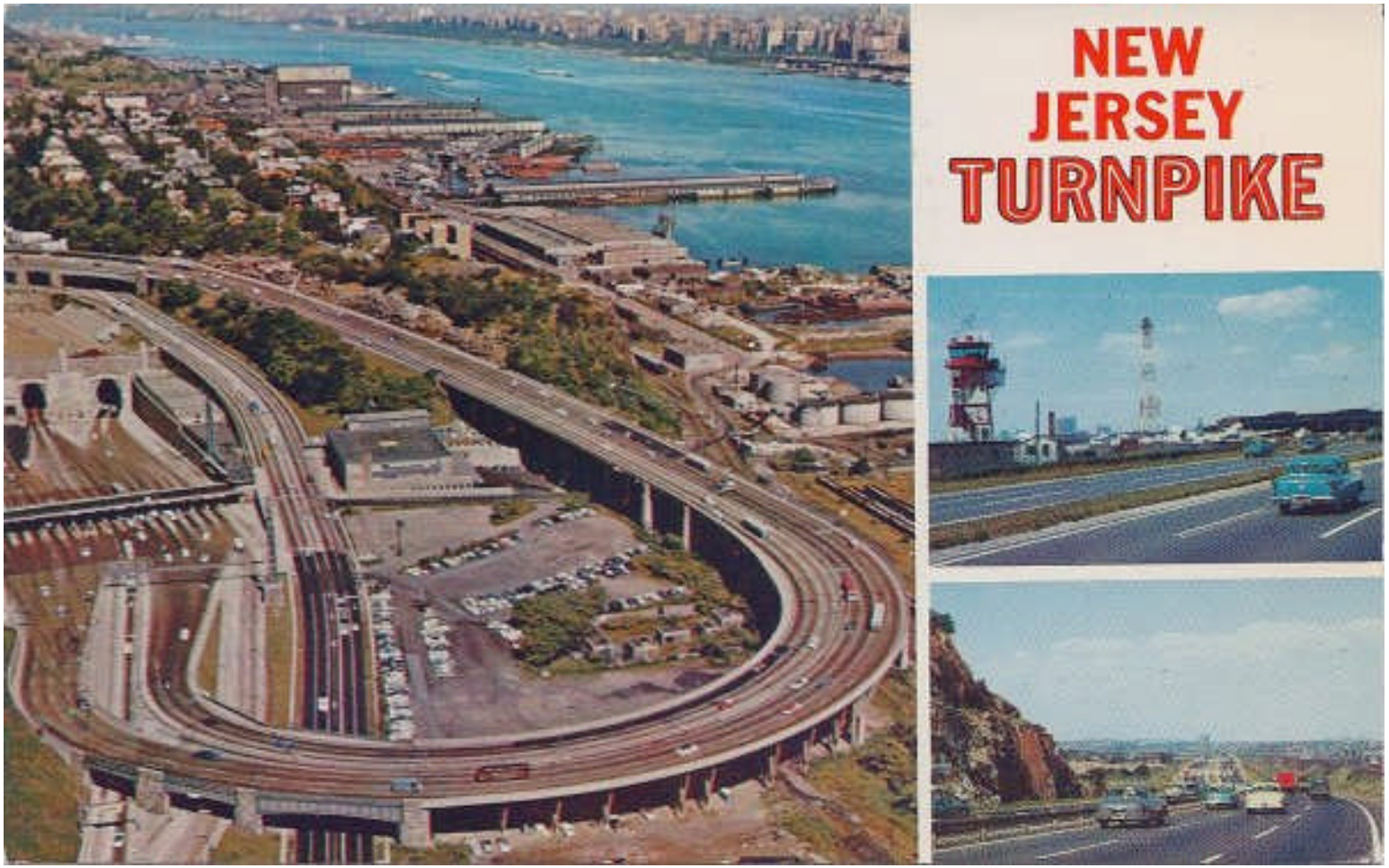
<u>Top</u>: caption: "In this promotion for the 1939 World's Fair in Queens, the helix can be seen as 'under construction,' leading out to present-day Route 495"

<u>Bottom</u>: caption: "Information Booths - Attendant helping men and woman at booth shaped like Perisphere outside of Lincoln Tunnel"



In 1952, the PA and the *New Jersey Turnpike Authority* (NJTA) extended the Lincoln Tunnel western approach for 0.9 mile west to *EXIT 16* of the recently opened *New Jersey Turnpike* in *Secaucus*. The extension provided for grade-separated interchanges for *US 1/9* and *NJ 3*, as well as for a toll plaza. The *Lincoln Tunnel Approach* became part of the Interstate highway system in 1956. In 1971, the *Mid-Manhattan Expressway* that was to connect the two *I-495* sections in *New Jersey* and *New York* (the Lincoln Tunnel Approach and the *Long Island Expressway*) was canceled. It was not until 1989 that the Lincoln Tunnel Approach was re-designated *NJ 495*.

<u>Left</u>: caption: "Helix in the 1940s"
<u>Right</u>: caption: "Helix in the 1960s"


NEW
JERSEY
TURNPIKE

<u>Top Left</u>: caption: "New Jersey Approach and Entrance to the Lincoln Tunnel looking North (October 1991)"

<u>Top Right</u>: caption: "Lincoln Tunnel Entrance showing Approaches from the South, view looking South (October 1991)"

<u>Left</u>: caption: "New Jersey Toll Plaza Entrance to the Lincoln Tunnel looking Northeast (Oct. 1991)"

New York Approach

<u>Above</u>: caption: "Initial Arrangement of New York Approach. Plaza and approaches for the First Operating Unit of Lincoln Tunnel, as now completed. The new approach (named Dyer Avenue in memory of a former Chairman of the Port of New York Authority, Gen. George R. Dyer) extends from West 34th Street to West 42nd Street, midway between Ninth Avenue and Tenth Avenue. It has been constructed for use of tunnel exclusively." (as of December 1937)

<u>Above</u>: caption: "Ultimate Arrangement of New York Approach. How the plazas and approaches for both tubes of Lincoln Tunnel, as well as plazas of the proposed Crosstown City Tunnel, will appear when completed. The new approaches (named Dyer Avenue and Galvin Avenue in memory of former Chairmen of the Port of New York Authority) extend from West 34th Street to West 42nd Street, midway between existing avenues. They are planned for use of tunnel traffic exclusively." (as of December 1937)

<u>Top</u>: caption: "Opening ceremonies Lincoln Tunnel, New York entrance, December 21, 1937"

<u>Bottom</u>: caption: "Photo shows the Art Deco-style Manhattan portal of the Lincoln Tunnel and the east ventilation tower"

Part 5

Similar, But Different

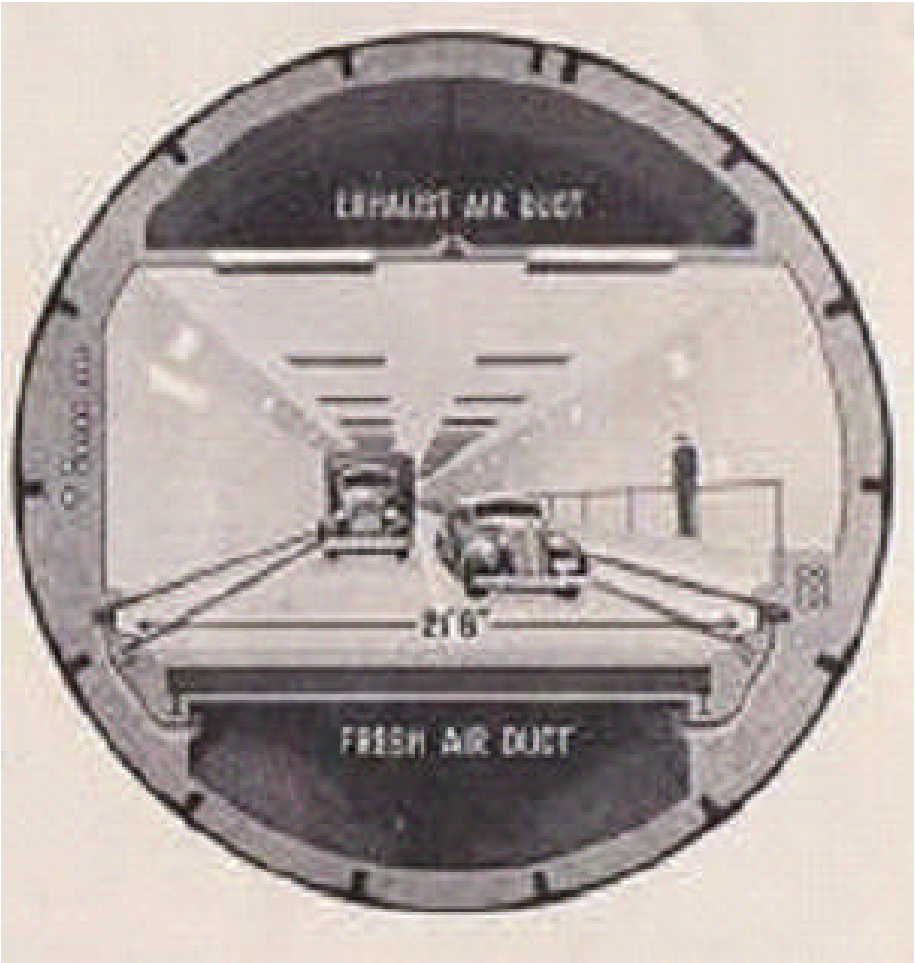
"…The tunnel will closely resemble the Holland Tunnel, excepting for a slight increase in size, to correspond with trends in vehicle design. The roadway will be 21½ feet wide, or a foot and one half wider than that of the Holland Tunnel. Three ventilation buildings, designed so that they can be enlarged for the second tube if necessary, will be constructed. One will be on the New Jersey side at the foot of the Palisades and the two on the New York side will be at the corner of 39th Street and 11th Avenue and at the bulkhead line. The tunnel will be some 8,000 feet long, of which 4,600 feet will be under the river…"

RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* ground breaking ceremony booklet (May 17th 1934)

"…Facts and figures revealed by Wharton Green, resident project engineer, show the magnitude of the undertaking. The new tunnel, passing from New York beneath the Hudson River and piercing the solid rock of the Palisades on the New Jersey shore, will measure about 8,000 feet between portals. Its thirty-one-foot diameter will permit a roadway a foot and a half wider than that of the Holland Tunnel. More than 170,000 cubic yards of rock, earth, and silt have been displaced, and 2,300 rings erected, to construct this huge shaft since ground was broken in May, 1934…"

***Popular Science,* March 1936**

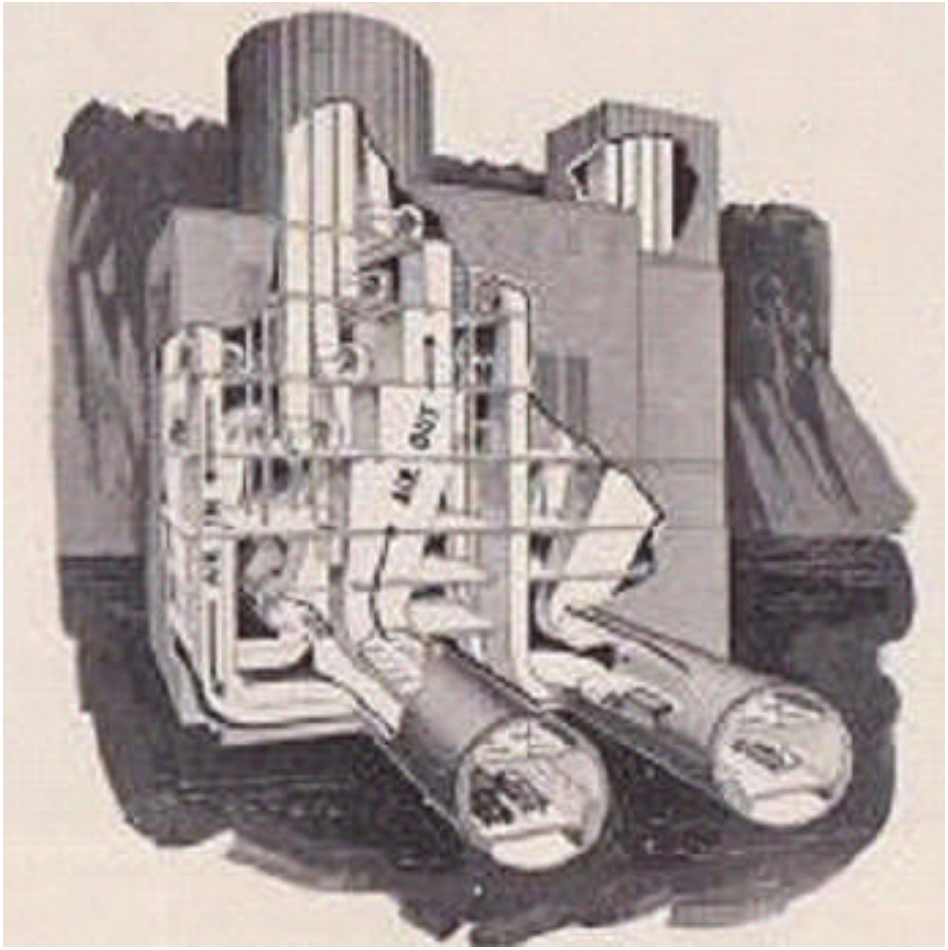
<u>Above</u>: caption: "Cut-away view of the bed of the Hudson River, with the new tunnel plunging under it to link the midtown section of New York City with New Jersey"



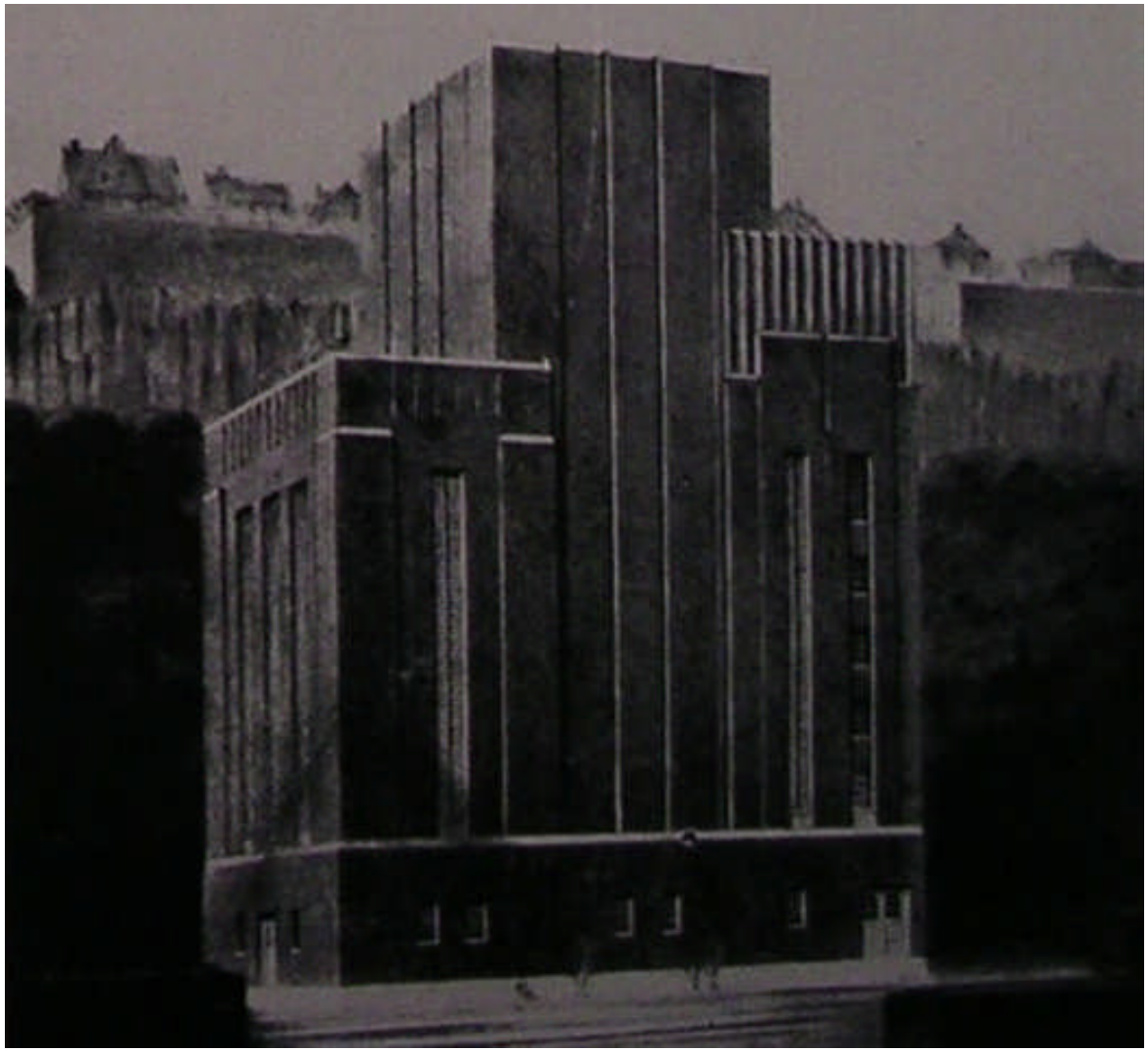
"…When both units of the Lincoln Tunnel shall be ready for use they will accommodate 13,000,000 motor vehicles, the estimated annual capacity. To insure an adequate fresh air supply, three ventilation buildings have been provided…"

Port of New York Authority

Left: caption: "Completed tube looks like this in cross section. Fresh air is pumped into duct at bottom, passes into tunnel through slits in curb. Vitiated air is drawn through ceiling and sucked out by top duct. Conduits on either side are for water, telephone, electricity. Trucks of over five tons and other vehicles unable to maintain a 20 m.p.h. speed are banned from the tunnel."



<u>Left</u>: caption: "Ventilation building provides the tunnel with complete protection from poisonous fumes which are continuously emitted by automobiles. Giant fans located on different floors blow fresh air into the tube continuously. Exhaust fans create a semi-vacuum to draw out bad air. Since harmful gases are lighter than air, they naturally rise in the tunnel and in the vertical shafts where they are blown out at the top of the building. Control room for power, lighting and traffic signals in on top floor."



<u>Left</u>: in 1921, *Charles Watson Murdock*, who was then employed as an engineer by the *New York State Bridge and Tunnel Commission* and the *New Jersey Interstate Bridge and Tunnel Commission*, was assigned by *Clifford Holland* to work on the design and testing of the tunnel's ventilation system. Murdock conducted and supervised ventilation tests at the *University of Illinois* and at *Bruceton, PA*. and was later chosen to oversee the installation of the ventilation system on the *Lincoln Tunnel*. Fifty-six fans performed the air-handling duties and twenty men (in three shifts) monitored the carbon monoxide levels in the tunnel. In 1939, the year after the Lincoln Tunnel first opened, Murdock's presentation: "Ventilating the Lincoln Vehicular Tunnel" was made before the *American Society of Heating and Ventilating Engineers*, setting the standard for similar tunnels around the world.

<u>Top Left</u>: caption: "Excavation at Site of New Jersey Ventilation Shaft looking Northeast"

<u>Top Right</u>: caption: "Excavation for New York Land Ventilation Building, Looking East"

<u>Left</u>: caption: "Removing Temporary Segments and Grout to Permit Air Duct Construction at New Jersey Ventilation Shaft, Looking North-east"

<u>Left</u>: caption: “Forms and Reinforcing for Air Ducts and Ventilation Shaft, Weehawken, New Jersey”

<u>Above</u>: caption: "View of Manhattan Ventilation Building from New Jersey"

<u>Left</u>: caption: "Manhattan Ventilation Building: 11th Avenue – W. 39th Street (1937)"

ENGINEERING

O. H. AMMANN, Director of Engineering

J. C. EVANS, Chief Engineer

EDW. W. STEARNS, Assistant Chief Engineer

RALPH SMILLIE
Engineer of Design (Tunnel Crossings)

ALLSTON DANA
Engineer of Design (Bridge Crossings)

CHAS. E. GEEM
Engineer of Construction

W. E. THOMPSON
Tunnel Engineer

GEORGE L. LUCAS
Engineer of Inspection

R. F. SCHAEFER
Assistant Engineer of Design

CHAS. W. MURDOCK
Mechanical Engineer

J. N. DODD
Electrical Engineer

CHARLES L. CRANDALL
Resident Engineer

THOMAS DARROW
Resident Engineer

A. B. LINCOLN
Resident Engineer

E. WARREN BOWDEN
Assistant to Chief Engineer

L. L. BERWIND
Assistant to Chief Engineer

CONSULTING ENGINEERS

JAMES FORGIE
Consulting Engineer

OLE SINGSTAD
Consulting Engineer on Tunnels

ROBERT RIDGWAY
Consulting Engineer

MORGAN F. LARSON
Advisory Engineer on Terminals and Highways

PROF. GEORGE H. BROWN
Consulting Engineer

LEWIS B. STILLWELL
Consulting Electrical Engineer

ARCHITECT

AYMAR EMBURY II

CONSULTING GEOLOGIST

PROF. CHAS. P. BERKEY

A Major Advance

"'Holed Through' months ahead of schedule and seventy-five percent completed at this writing, the new Midtown Hudson Tunnel linking New York City and New Jersey reflects the striking progress that has been made in engineering methods in the last few years. Mechanical innovations employed to speed the construction of New York's latest vehicular tube are declared to mark a major advance in the art of tunneling…"

***Popular Science,* March 1936**

"…A new invention, a mighty hydraulic wrench, helped sandhogs toiling far below the bed of the Hudson River to shatter long standing records in erecting the twenty-two-ton iron rings that form the backbone of the tunnel. Each of these rings is composed of fourteen curved segments, bolted together, and the assembled ring is bolted to the last preceding one as the tunnel progresses. Formerly, two husky workers strained at the end of a five-foot wrench to pull each of the nuts tight. The new hydraulic wrench eliminated the manual labor…"

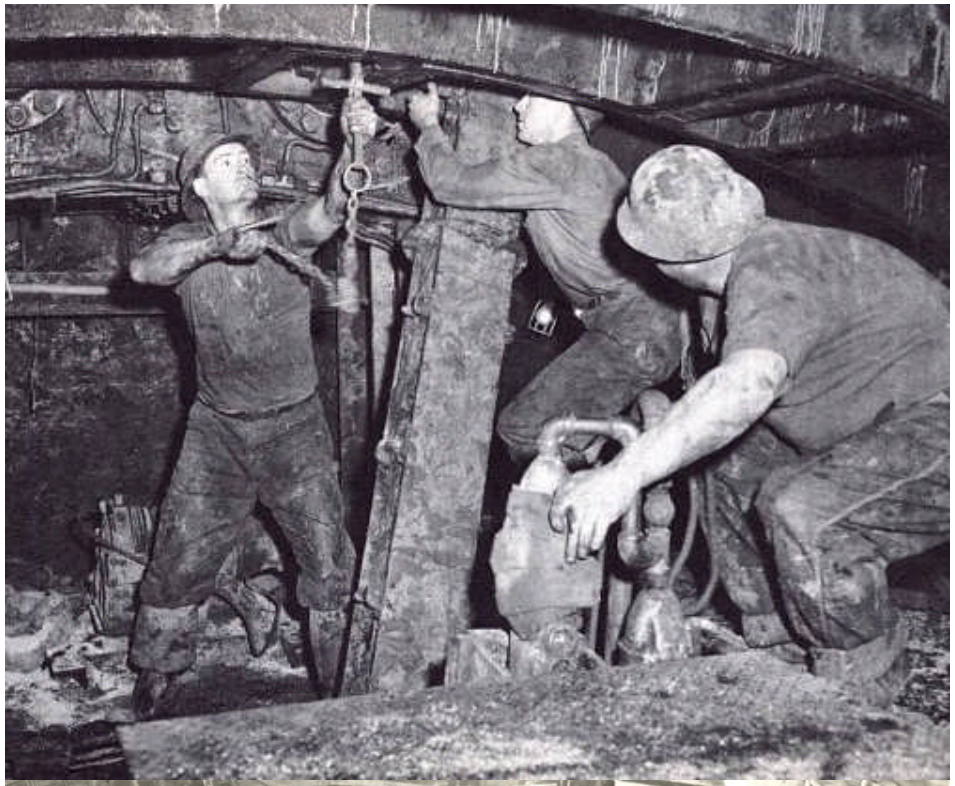
***Popular Science,* March 1936**

"…Resembling the minute hand of a monster clock, it rode around a circular track within the tunnel, while its metal hand grasped each nut and speedily whirled it home to just the proper tension. With this potent aid, sandhogs were able to erect as much as forty-five feet of tunnel wall – eighteen rings – in a single day, as compared with a max-imum of twenty-four feet when the work was done by hand…"

***Popular Science,* March 1936**

<u>Top</u>: caption: "Hydraulically-oper-ated bolt tightener in use"

<u>Bottom</u>: caption: "Sandhogs tighten a bolt in a tunnel-lining ring with ratchet wrench (Queens Midtown Tunnel)"



"…Thanks to this device and to a host of other, if less spectacular, refinements in mechanical technique – including an improved type of erector arm to lift the heavy segments into place, and high-speed muck conveyors that disposed of the river-bed ooze through which the tunnel was pushed – its construction is expected to set a speed record for undertakings of its type. Its scheduled opening date of January 1, 1938, may be materially advanced…"

***Popular Science,* March 1936**

<u>Top</u>: caption: "Sandhogs place locking ring segment in place to complete a ring prior to making another push of the shield. Note the erector arm in the center of the photo."

<u>Bottom</u>: caption: "Removing muck from tunnel with shovel operated by compressed-air"

Glass Ceiling

"…Motorists will then have a first-hand opportunity to inspect a real novelty in tunnel design – a roof of glass. Eight thousand panes of cream-colored glass will line the top of the tube and form the largest glass ceiling in the world. The novel lining is expected to save large sums that otherwise would have to be expended periodically for cleaning and repainting a bare concrete ceiling, like that of the Holland Tunnel which connects the two states a little farther down the river…"
***Popular Science,* March 1936**

"…Although the walls of this earlier tunnel were tiled, its ceiling was merely of painted concrete, since it was feared that the constant jarring of traffic would shake tiles loose and cause them to fall out. The problem has now been solved by the invention of ingenious metal grippers, that hold a tile or a pane of glass with equal facility, securing it firmly to the concrete base. In the Midtown tube, these frames will hold glass panes because these have been found cheaper than ceramic tile. The glass will have a stippled surface, designed to minimize glare and to improve the efficiency of the tunnel lighting system…"

***Popular Science,* March 1936**

Left: caption: "The Lincoln Midtown Tunnel as it neared completion"

Right: caption: "This is the interior of the new Lincoln Tunnel which will be opened to traffic December 21 connections New Jersey and Manhattan. This picture was taken as one of the first cars to test the runway passed through."


DON'T
SOUND
HORN

Dedication

"…Even as these ceremonies of dedication are taking place, the companion north tube is burrowing its way through the bed of the river, and drilling rigs and steam shovels are cutting a highway approach across the Palisades. Excellent progress is being made so that the entire New Jersey approach may be completed and opened to traffic by the summer of 1939. The north tube with its New York approach will complete the project and is expected to be opened in 1940…"

RE: excerpt from the Port of New York Authority's *Midtown Hudson Tunnel* dedication ceremony booklet (December 21st 1937)

PRINCIPAL DATA

Length of first (south) tube, portal to portal	8215 feet
Length of second (north) tube, portal to portal	7400 feet
Length of each tube under river,	about 4600 feet
External diameter of cast iron and cast steel shell	31 feet
Maximum depth, surface of river to top of tunnel	75 feet
Maximum depth of roadway below surface of river	97 feet
Minimum covering of mud and silt above tops of tubes	20 feet
Distance between tubes under river, center to center	75 feet
Width of roadway	21½ feet
Cast iron and cast steel in shell, both tubes	101,000 tons
Concrete in tunnel between portals, both tubes	114,000 cu. yds.
Glass ceiling tile, both tubes	1,390,000 tile
Glazed wall tile, both tubes	2,590,000 tile
Ventilation buildings	3
Fresh air fans for both tubes	26
Exhaust fans for both tubes	30
Maximum amount of fresh air to be supplied to both tubes,	3,460,000 cu. ft. per minute

THE PORT OF NEW YORK AUTHORITY

DEDICATION OF LINCOLN TUNNEL

Tuesday, December 21, 1937

Admit One

Not Transferable

NEW YORK PLAZA
11:00 A. M.
ENTRANCE
40TH STREET, BETWEEN
NINTH AND TENTH AVENUES

NEW JERSEY PLAZA
12:00 NOON
ENTRANCE
HUDSON COUNTY BOULEVARD EAST
WEEHAWKEN, N. J.

LUNCHEON
1:00 P. M.
HOTEL ASTOR
BROADWAY AT 44TH STREET
MANHATTAN

NO AUTOMOBILES ALLOWED THROUGH TUNNEL. PORT AUTHORITY TRANSPORTATION PROVIDED BETWEEN NEW YORK AND NEW JERSEY CEREMONIES AND TO THE LUNCHEON.

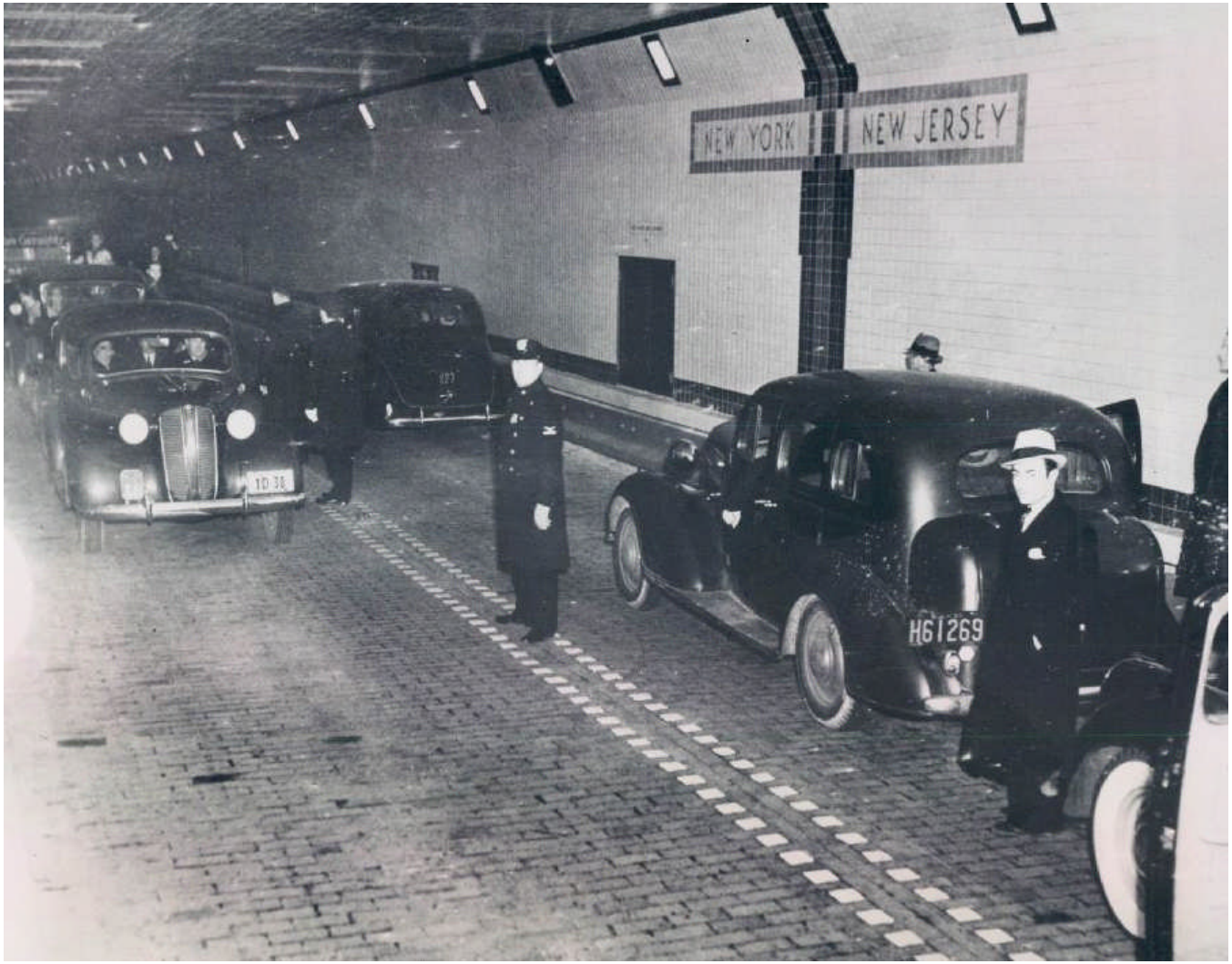
Lincoln Tunnel Dedication Medal

PRESENT THIS PORTION OF THE TICKET AT LUNCHEON TO RECEIVE THE DEDICATION MEDAL.

<u>Above</u>: caption: “Gold colored medal with a profile of Abraham Lincoln and the wording ‘For a further unification of the people’ on the front side. The reverse shows the entrance to the original two tubes of the tunnel and has the wording ‘Lincoln Tunnel Dedicated 1937. Built and owned by the Port of New York Authority.’”

Above: caption: "Former President Herbert Hoover, Mayor F.H. LaGuardia, representatives of the states of New York and New Jersey, officials of the Port of New York Authority and other dignitaries take part in ceremonies on the brick paved south tube that was opened to traffic December 22, 1937"

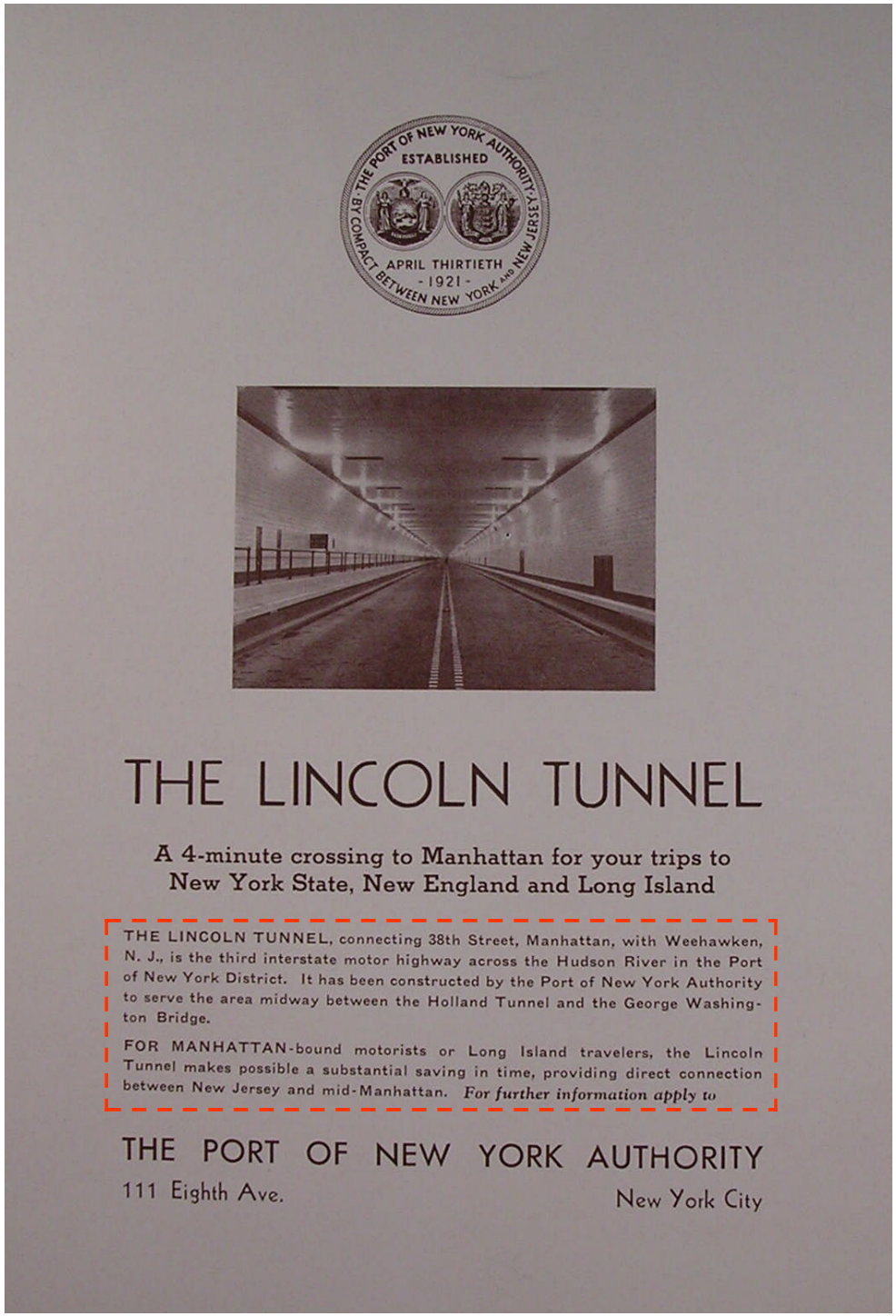
Left: commemoratives of the dedication of the *Lincoln Tunnel*


NEW YORK
NEW JERSEY
H61269

<u>Top</u>: caption: "Gigantic Tunnel is Opened, New York City - Manhattan Island is lined again with the mainland, this time by the magnificent $85,000,000 Lincoln Tunnel crossing under the Hudson to Jersey from mid-town New York. Brilliant ceremonies mark the opening of one tube of the tremendous project."

<u>Bottom</u>: caption: "Weehawken Mayor Meister and NYC Mayor Laguardia meet in the Lincoln Tunnel on opening day"

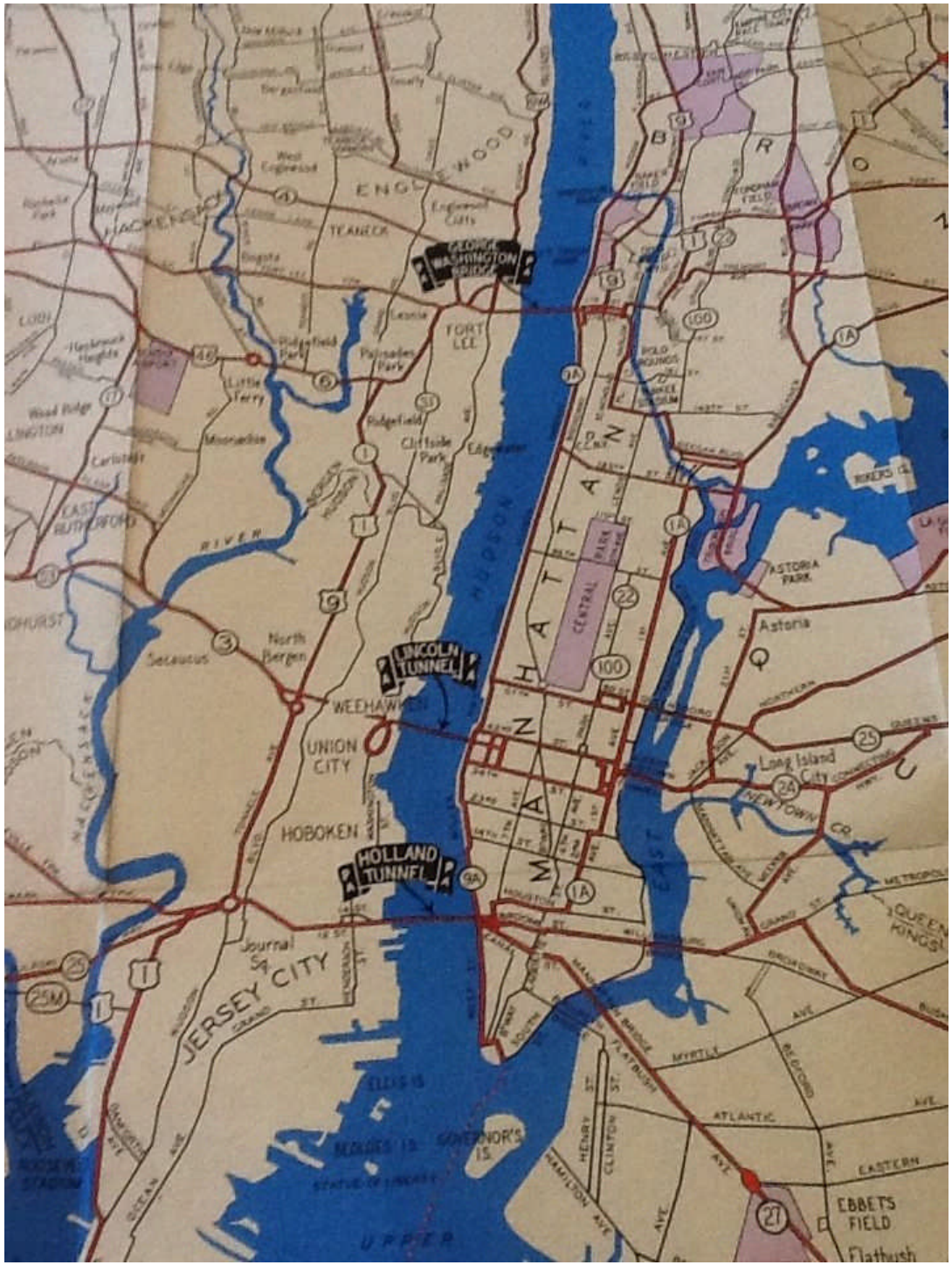
A Dream Come True



"With the completion of the Lincoln Tunnel and its wonderful system of approaches to and from the main arteries of travel in New Jersey, the latest extraordinary engineering achievement of the Port of New York Authority became a reality…"

Port of New York Authority

Left: caption: "The Lincoln Tunnel, connecting 38th Street, Manhattan, with Weehawken, N.J., is the third interstate motor highway across the Hudson River in the Port of New York District. It has been constructed by the Port of New York Authority to serve the area midway between the Holland Tunnel and the George Washington Bridge. For Manhattan-bound motorists or Long Island travelers, the Lincoln Tunnel makes possible a substantial saving in time, providing direct connection between New Jersey and mid-Manhattan."



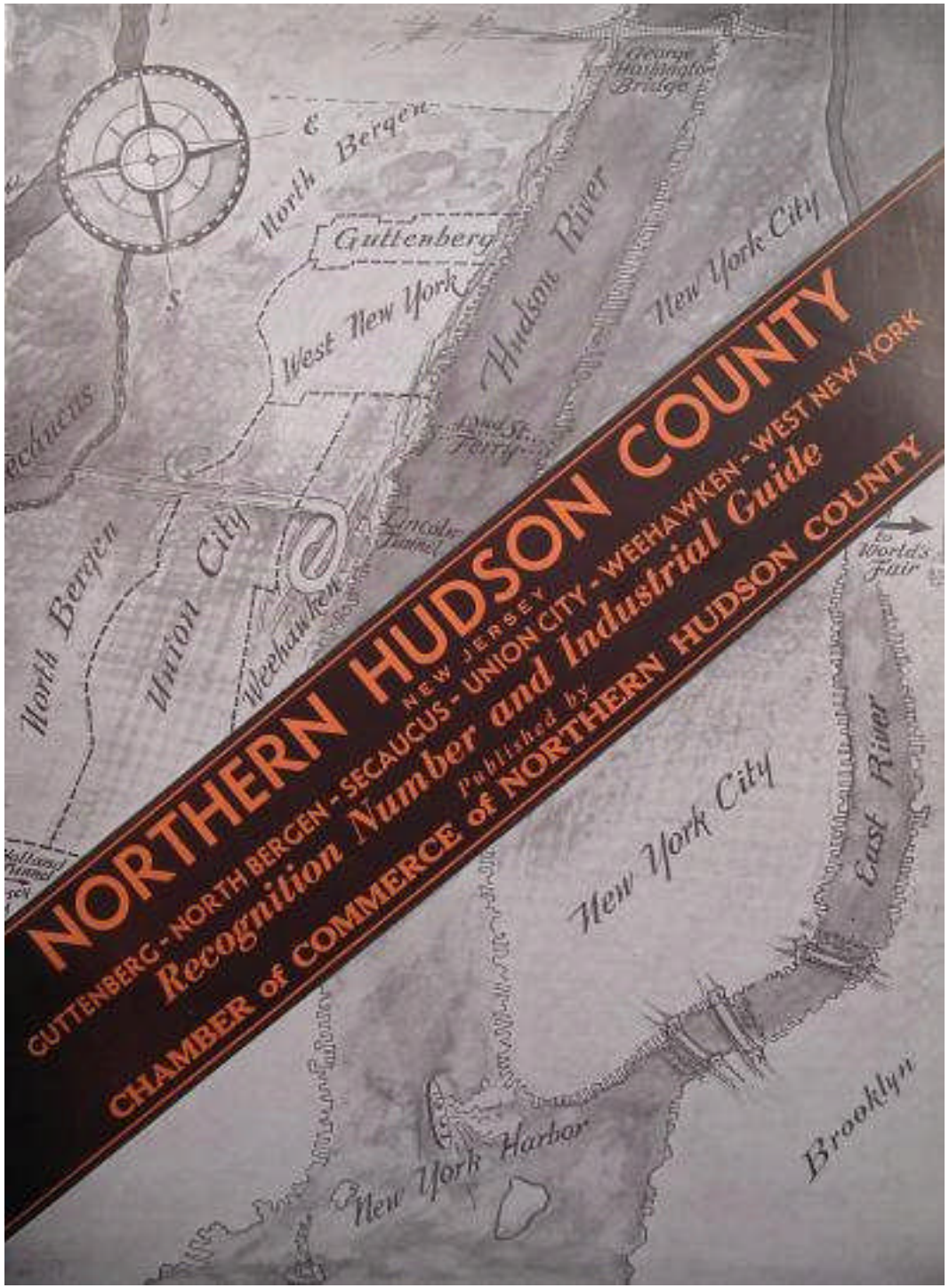
"…Within the span of a single generation means have been provided for shorter and more convenient travel between New Jersey and New York. What had been merely a thought, a vision, in the minds of even our earliest settlers over two hundred years ago, is now a completed masterpiece of engineering skill – not building, but built! – conceived, constructed and in actual use. All accomplished within the span of a single generation!..."

Port of New York Authority

<u>Left</u>: caption: "1949 PNYA map showing Hudson River crossings"

"…And so, a $100,000,000 project intended to solve an interstate rapid transit problem of the most vital importance to Northern Hudson County – so important that it has been in the minds of men for over two hundred years – is now in operation without a cent of cost to any taxpayer; for it is a self-liquidating undertaking, the cost of which is defrayed out of toll payments by the users, to whom again it means a saving in time and expense…For splendid team-work and unselfish cooperation between officials of the Port of New York Authority and the Chamber of Commerce of Northern Hudson County, without which a project of such magnitude could not have been put through successfully, this splendid engineering achievement will stand as a permanent monument…"

Port of New York Authority

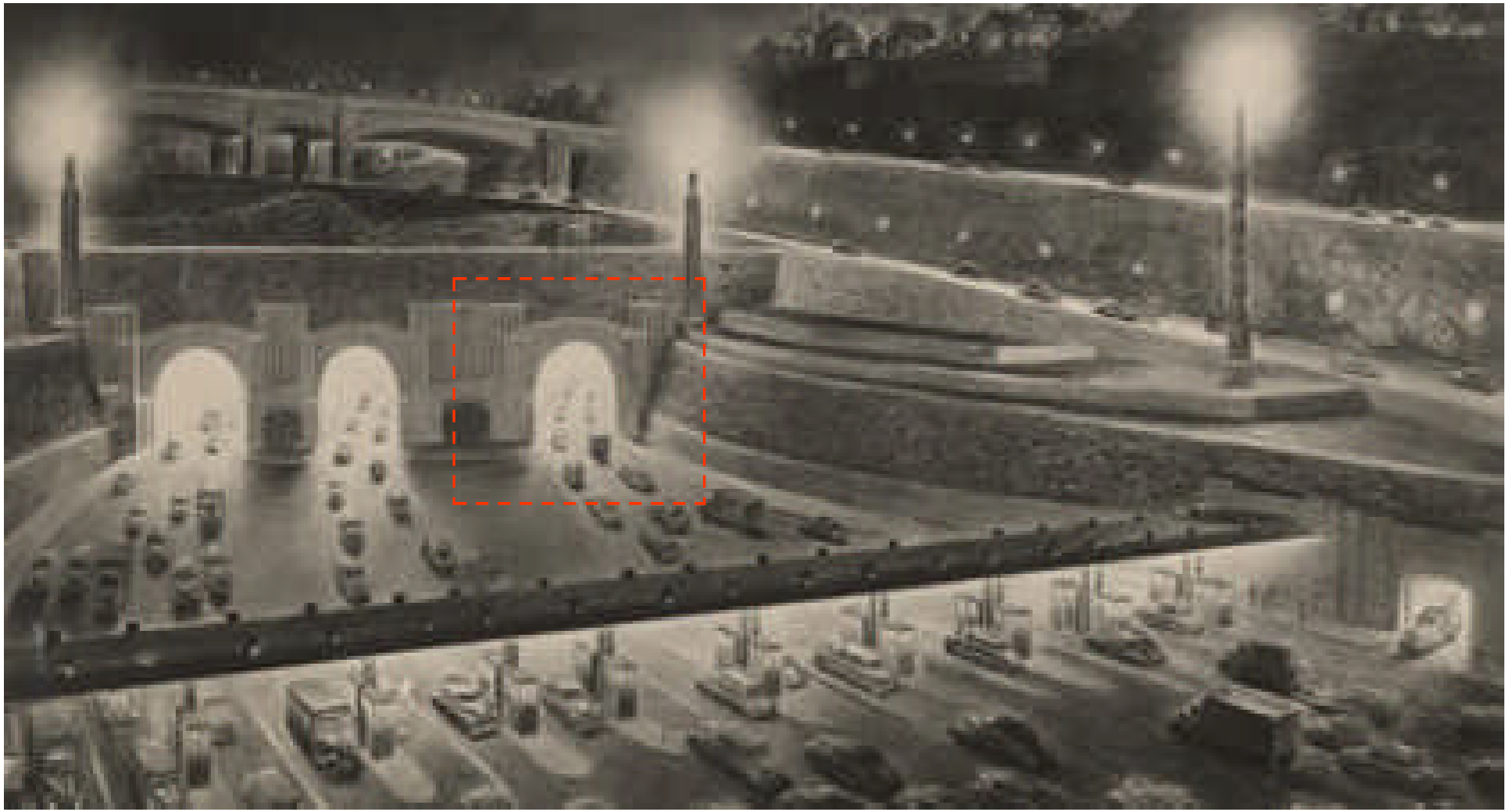


"…It is not generally understood that other interests affecting the welfare of the Port of New York are the direct concern of the Port of New York Authority also and they are of almost equal importance. For instance, it is not widely known that the Port of New York Authority is in a certain sense, a sort of 'watch dog' safeguarding the interests of the Port of New York as against rival seaports, striving to obtain some of its legitimate commerce through subversive methods. It has consistently fought for the basic principle on which the Port of New York Authority is founded, namely, that all sections of the Port of New York must be considered as a unit. Northern Hudson County is one of these sections. Our local shippers are well aware of the tremendous advantage to them of adherence to this principle…"

Port of New York Authority

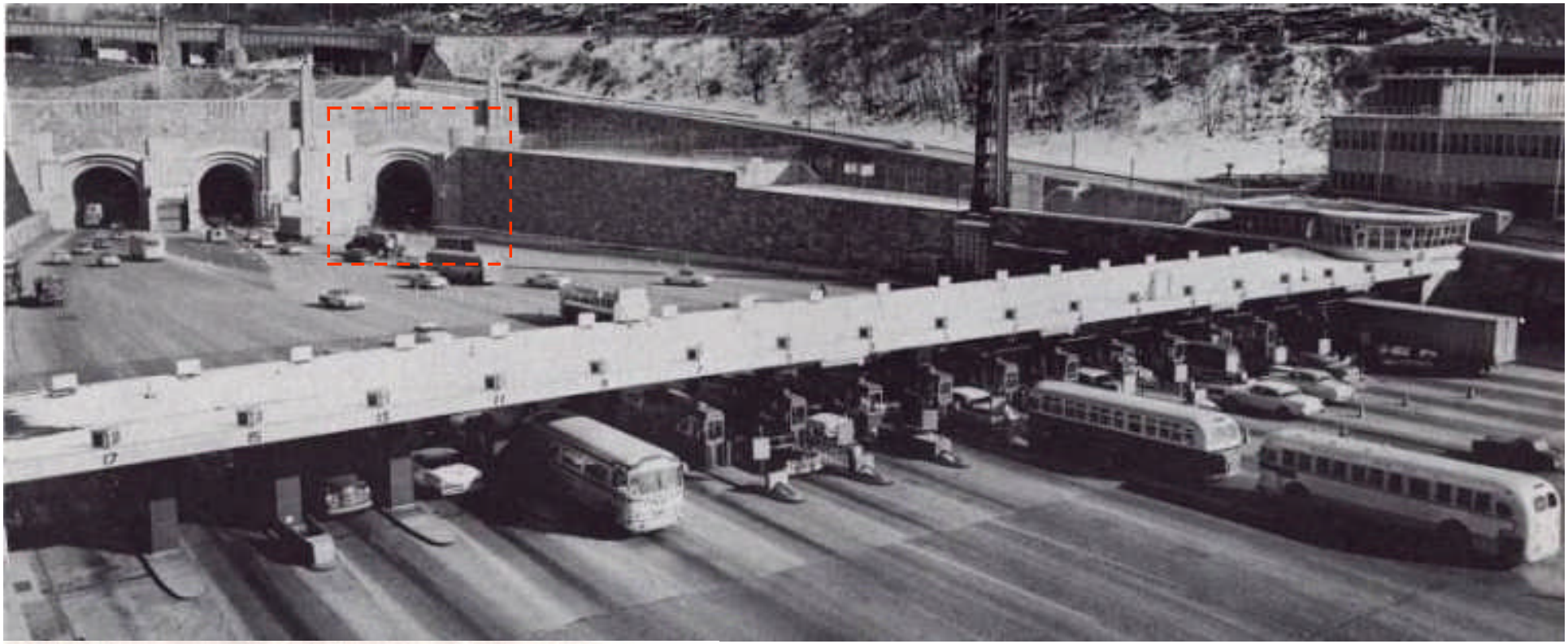
Part 6

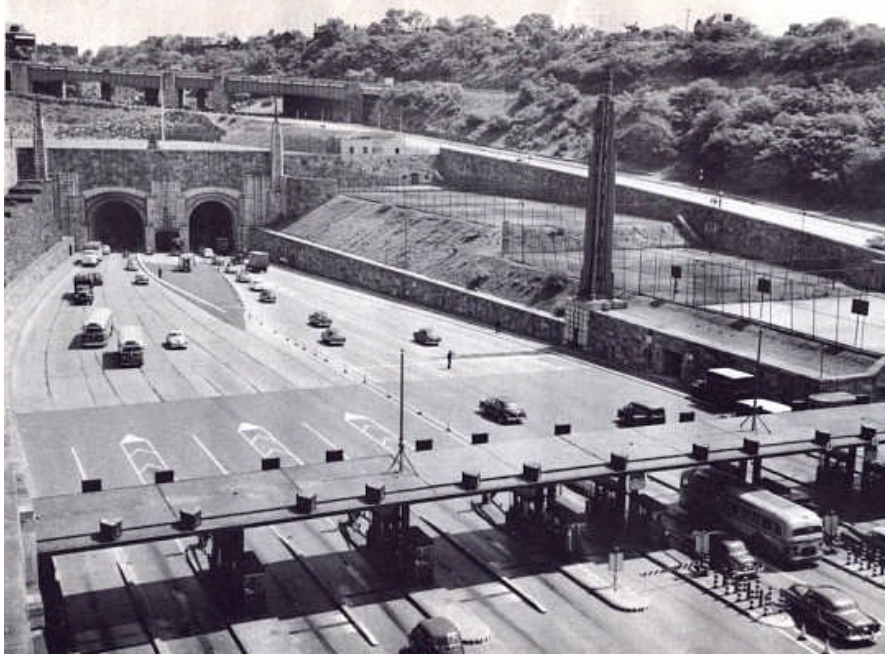
Third Tube



Trans-Hudson traffic continued to accelerate after WWII, prompting consideration of a new twin-tube tunnel between *14th Street* in *Manhattan* and *Hoboken, New Jersey*. Instead, the PNYA decided (in 1951) to construct a third tube for the *Lincoln Tunnel*. This project, which included the approach roads in Manhattan and Weehawken, and the "peripheral parking area" outlined in the *Joint Study of Arterial Facilities* (1955), was completed in 1957 at a cost of $85 million.

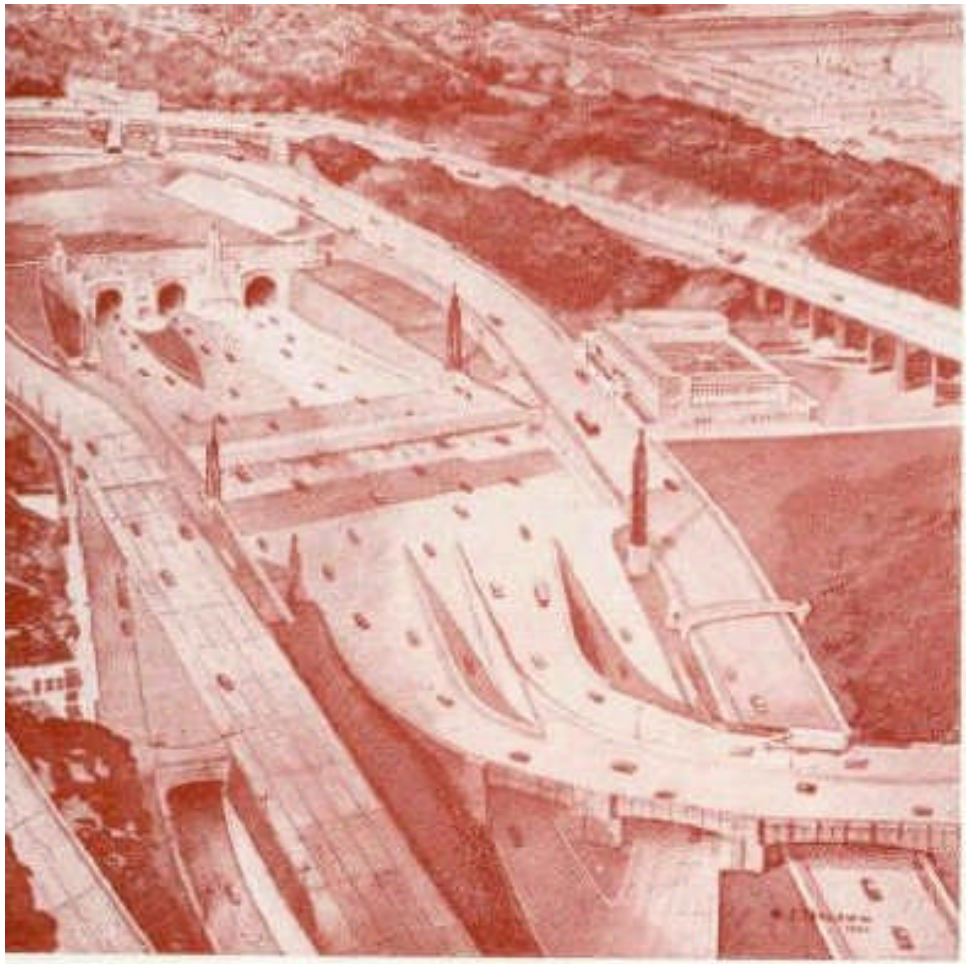
<u>Above</u>: rendering of reconfigured Weehawken toll plaza with addition of a third tube

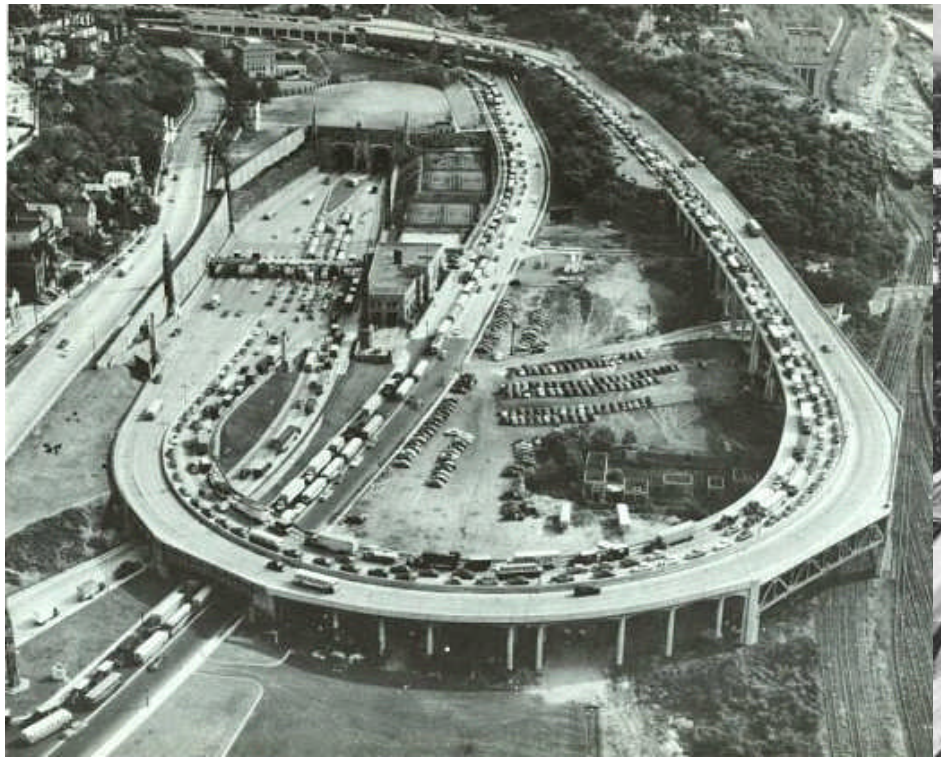




<u>Left</u>: caption: "Toll booths and New Jersey Plaza prior to the start of construction of the Third Tube Project"

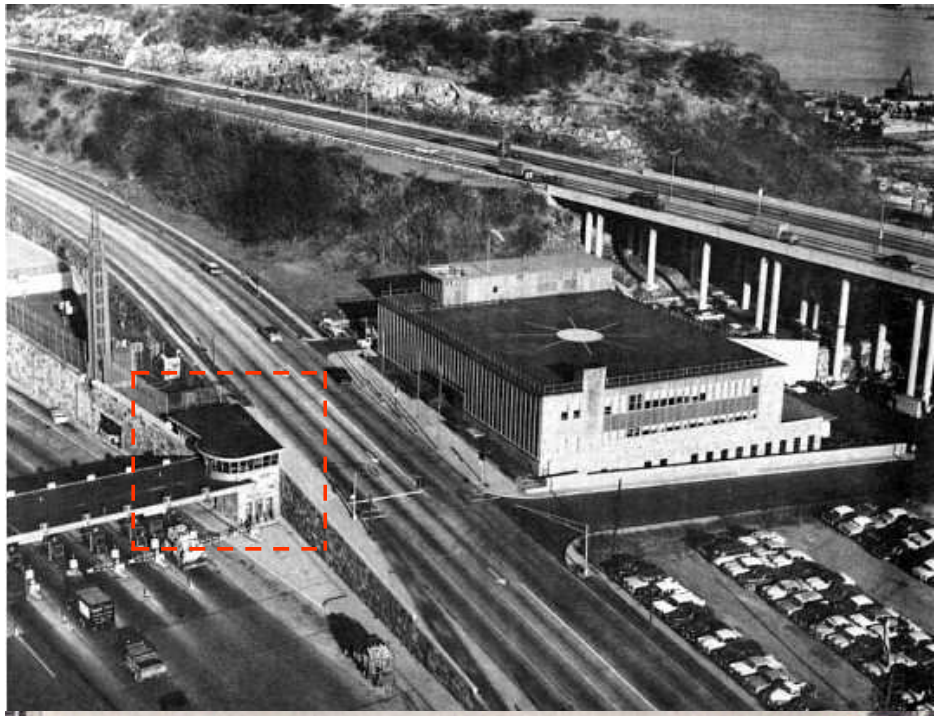
<u>Above</u>: caption: "Toll booths and New Jersey Plaza after completion of the Third Tube Project"





<u>Left</u>: caption: “New Jersey Plaza and Helix prior to start of construction of the Third Tube Project”

<u>Right</u>: caption: “New Jersey Plaza and Helix after completion of the Third Tube Project. Note third portal, new administration building, widened tolls area, new center ramp, widened westbound helix.”

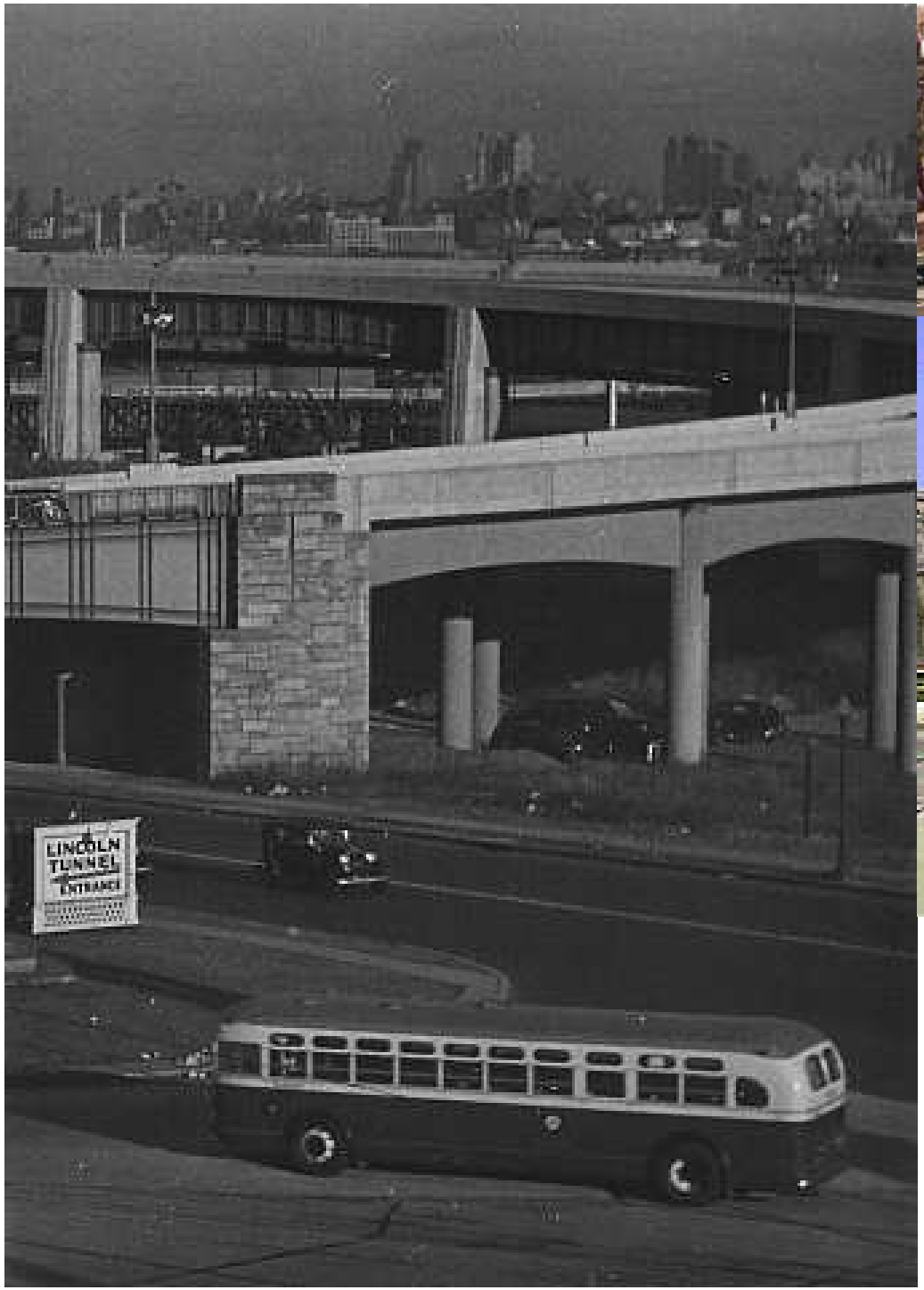


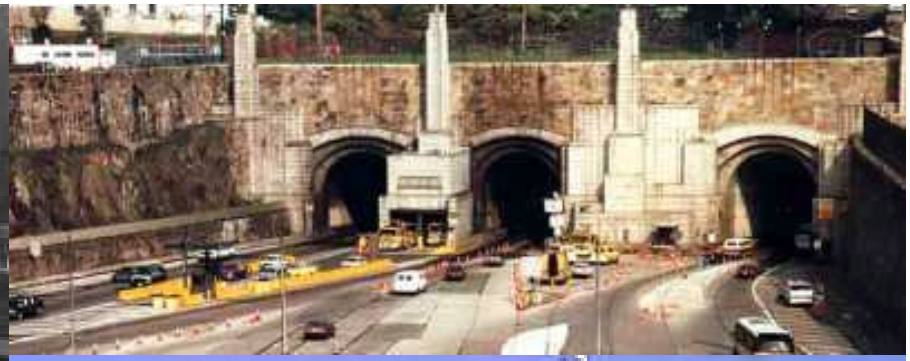
<u>Top</u>: caption: "Administration Building at corner of Hudson County Boulevard East and Baldwin Avenue in Wee-hawken"

<u>Bottom</u>: caption: "Traffic Control Building on New Jersey Plaza" (highlighted in top photograph)

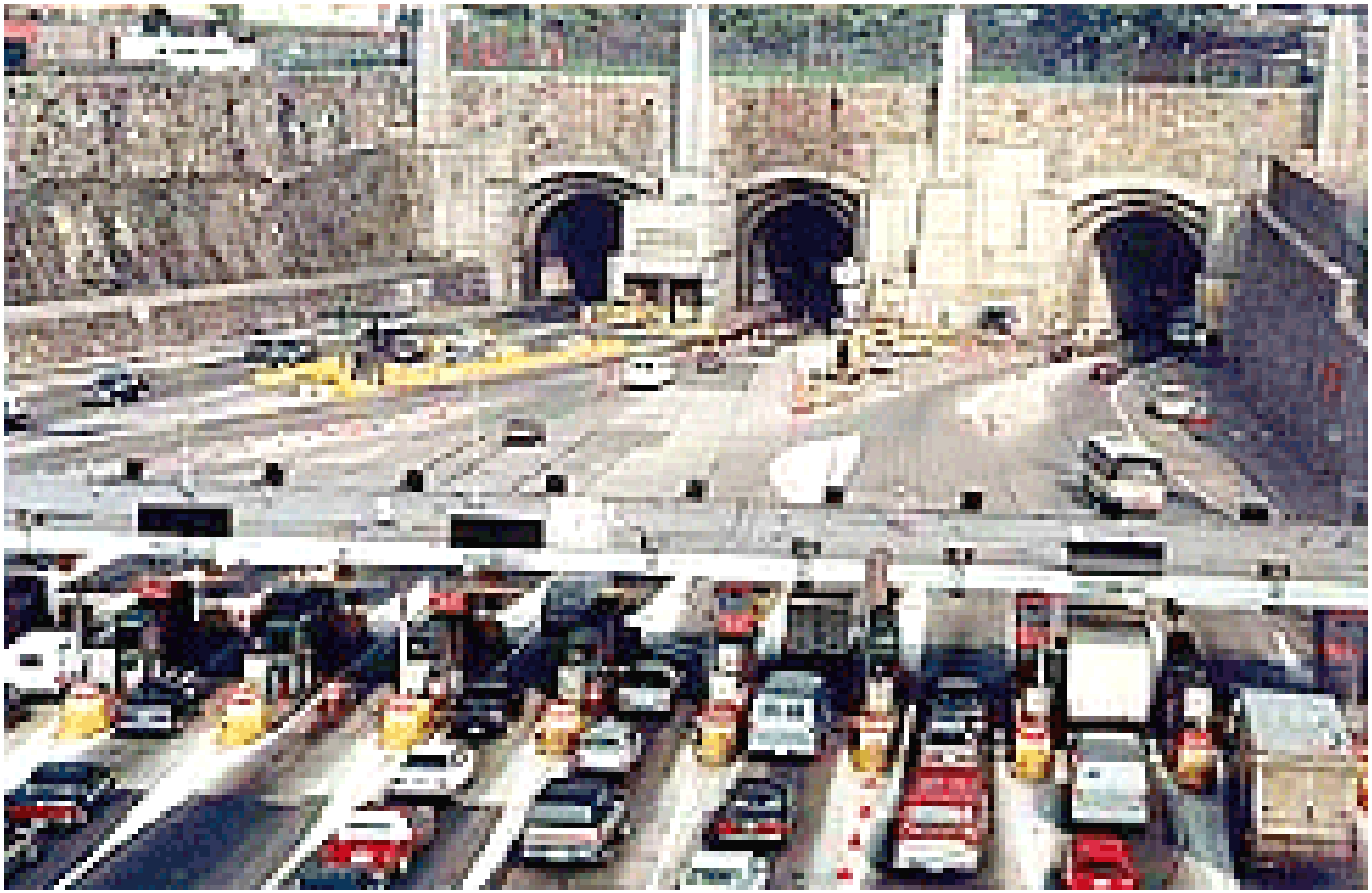
<u>Above</u>: caption: "That great curving ramp, called a helix by the engineers who built it, leads down into three of the world's most expensive holes in the ground: The triple-tube Lincoln Tunnel from New Jersey to New York City. Eighteen traffic lanes pass under the toll booths on the plaza at lower left, and they merge into six as they enter the tunnel. Beyond the Hudson River, the lights of the metropolis glamorize the night. The tallest building (upper left) is the Empire State. Each day, nearly 40,000 automobiles go underground here at Weehawken, N.J. and emerge after a five minute trip on the west side of Manhattan between 38th and 39th Streets. And an equal number escape the jammed streets of the crowded island and sweep back up the helix. The impatient drivers take little note of the design which their headlights emphasize, but they are part of an accidental pattern of beauty. And even these weary travelers must find subconscious satisfaction in traversing this mighty spiral, upward and outward from deep beneath the river."

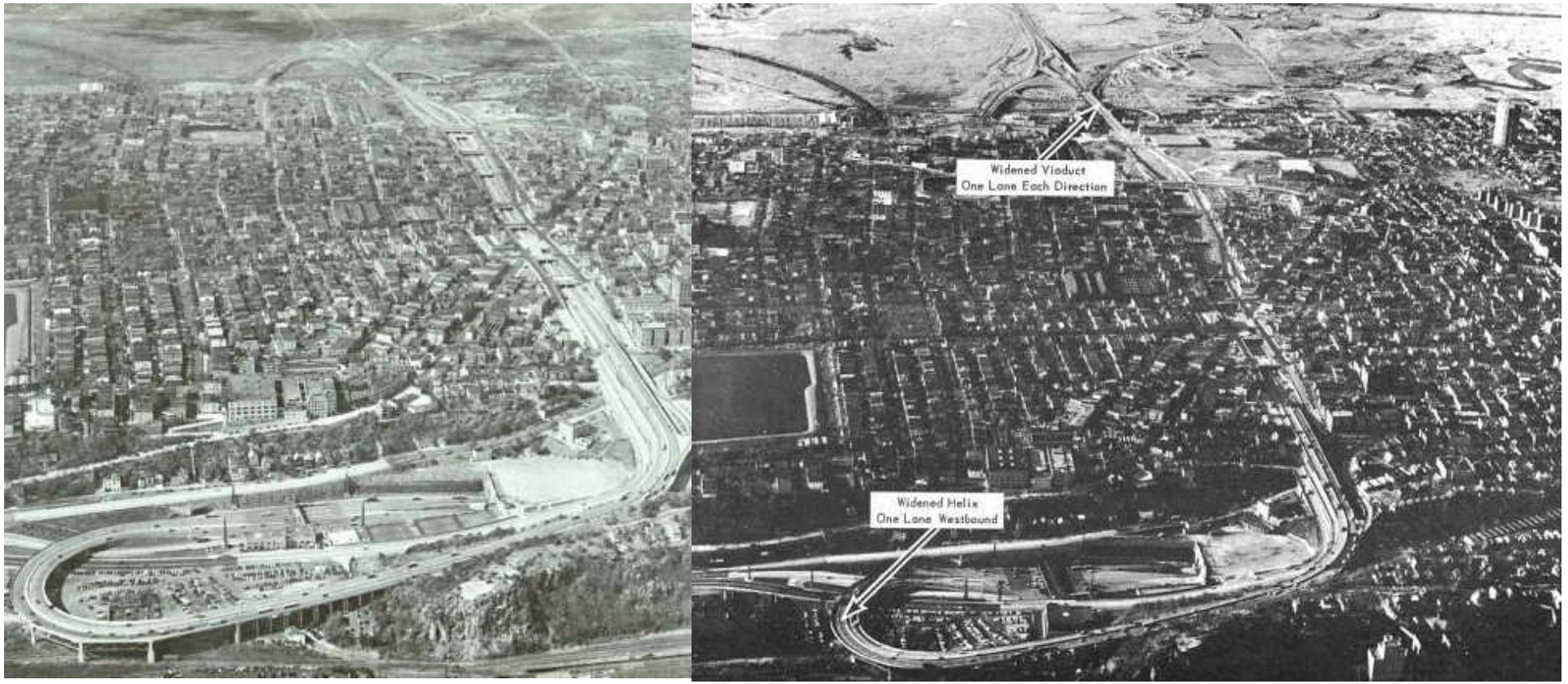
***Saturday Evening Post*, September 1958**



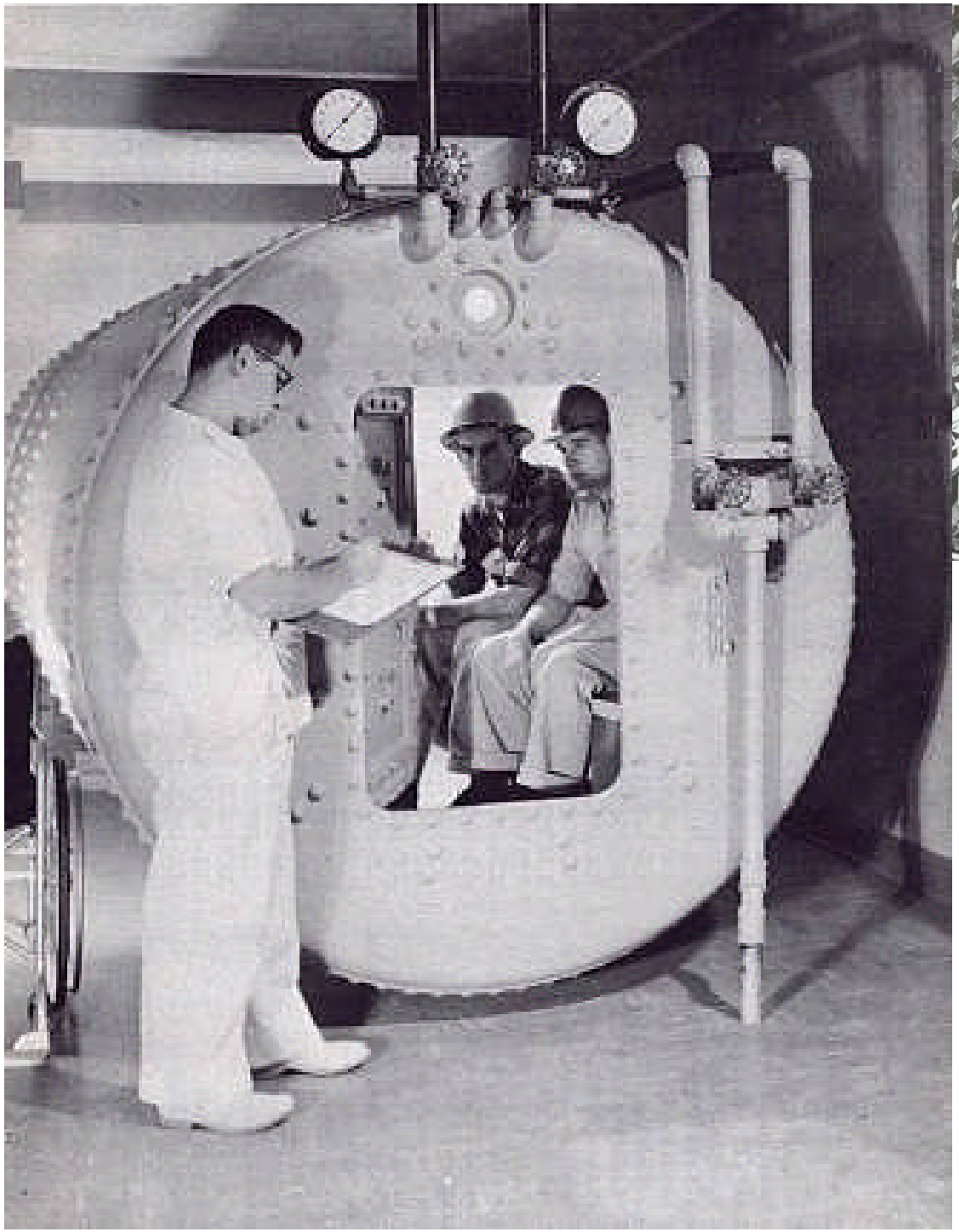


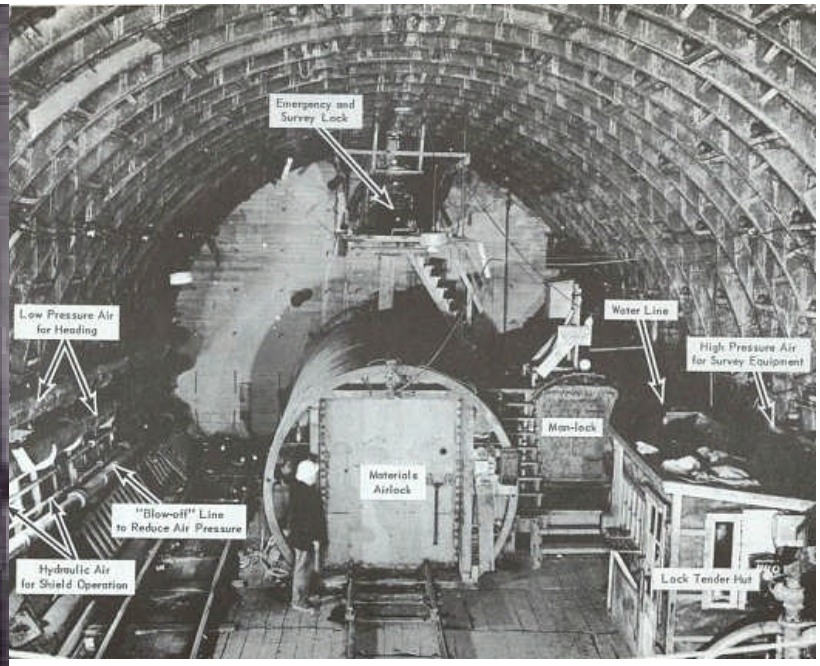
<u>Above T&B</u>: caption: "Three-portal Weehawken entrance of the Lincoln Tunnel and the toll plaza"
<u>Left</u>: caption: "Bus on its way from Weehawken to New York City" 171





<u>Left</u>: caption: "New Jersey Approaches prior to start of construction of the Third Tube Project"
<u>Right</u>: caption: "New Jersey Approaches after completion of the Third Tube Project"





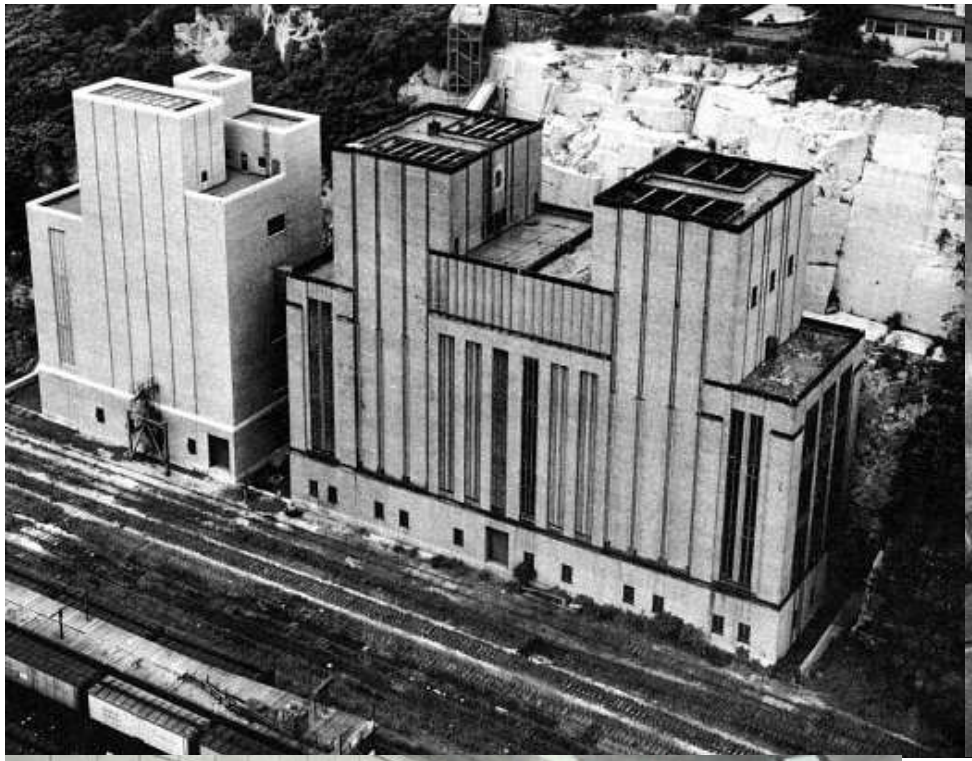
<u>Above</u>: caption: "Air locks and equipment on free air side of concrete bulkhead where men are working driving the tunnel"

<u>Left</u>: caption: "Decompression Chamber in New Jersey Medical Clinic"

<u>Left</u>: caption: "Third tube of the Lincoln Tunnel under construction"

<u>Above</u>: caption: "Last Bolt Ceremony. Left to right are Port Authority Chief Engineer Kyle, Governor Meyner of New Jersey, Mayor Krause of Weehawken, Port Authority Chairman Lowe, Governor Averell Harriman of New York. The governors are tightening the last bolt."

<u>Above</u>: caption: “Lincoln Tunnel Third Tube Dedication Ceremony on New Jersey Plaza, June 1958”



<u>Top Left</u>: caption: "New Jersey Ventilation Buildings with new Third Tube building on the left"

<u>Top Right</u>: caption: "Four-speed motor installed for Third Tube ventilation"

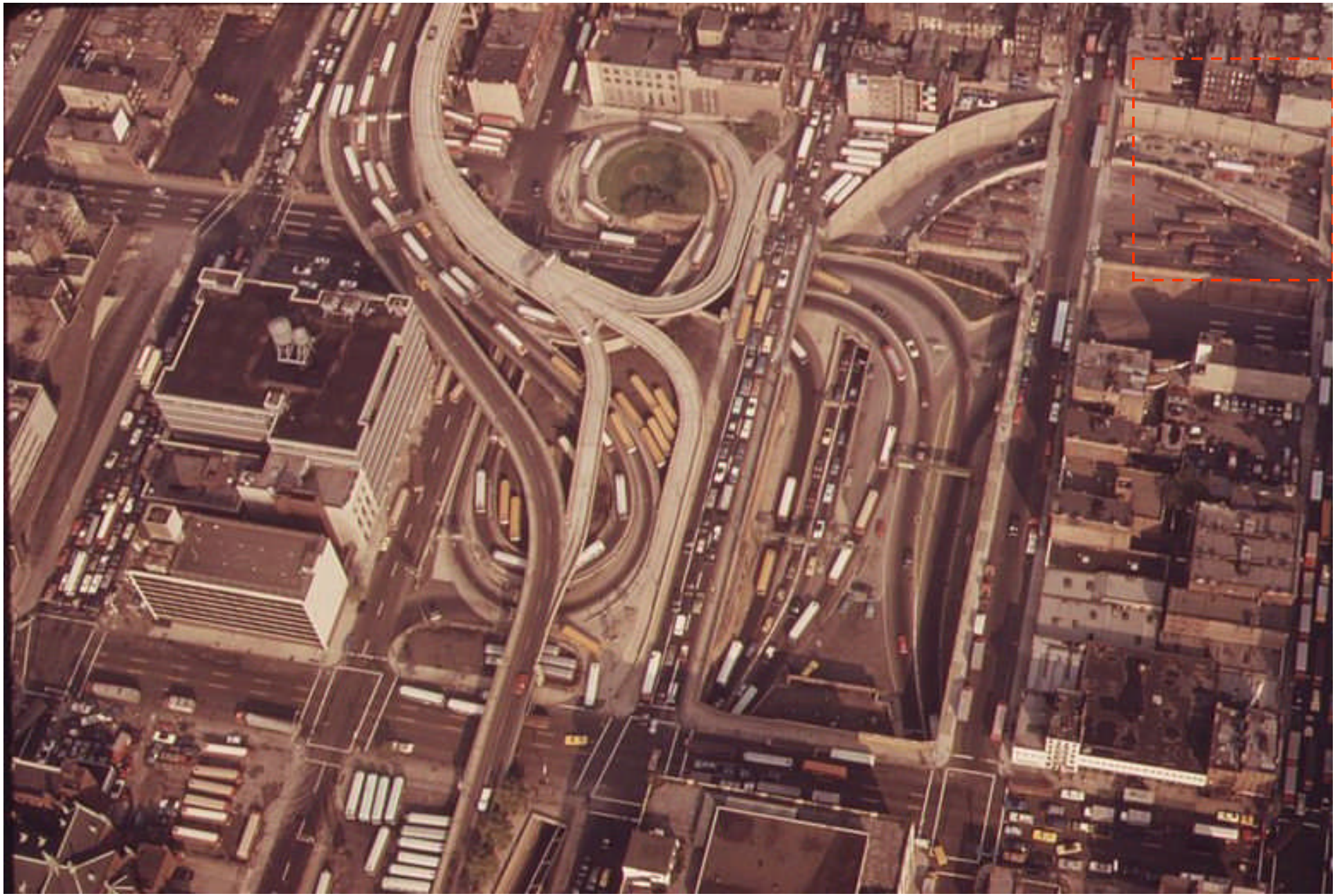
<u>Left</u>: caption: "Supervisory Control Room in New Jersey Ventilation Building upon completion of Third Tube construction"

Part 7

Planning for the Future

The Lincoln Tunnel Expressway

At about the time the third tube of the *Lincoln Tunnel* was completed, the four-lane, $10 million *Lincoln Tunnel Expressway* was completed. The expressway (which runs north-south between the *Manhattan* plaza of the tunnel and *West 30th Street*) connects with all three tubes of the tunnel. In constructing the approach highway, PNYA engineers had to build a bridge under an existing bridge, provide two twin tunnels and five viaducts, depress and elevate part of the roadbed as necessary and develop an intricate network of entrance and exit ramps at intermediate points. Also, as part of the expressway's design, ramps were constructed to the *Port Authority Bus Terminal*. The Lincoln Tunnel Expressway was to be integrated into the *Mid-Manhattan Expressway*, a crosstown route leading to the *Queens-Midtown Tunnel*.



<u>Above</u>: caption: “Manhattan entrance to the Lincoln Tunnel”

<u>Above</u>: caption: "New York Emergency Garage with Third Tube Portal on left and Center Tube Portal on right"

<u>Left</u>: caption: "Emergency Jeep and Emergency Tractor"

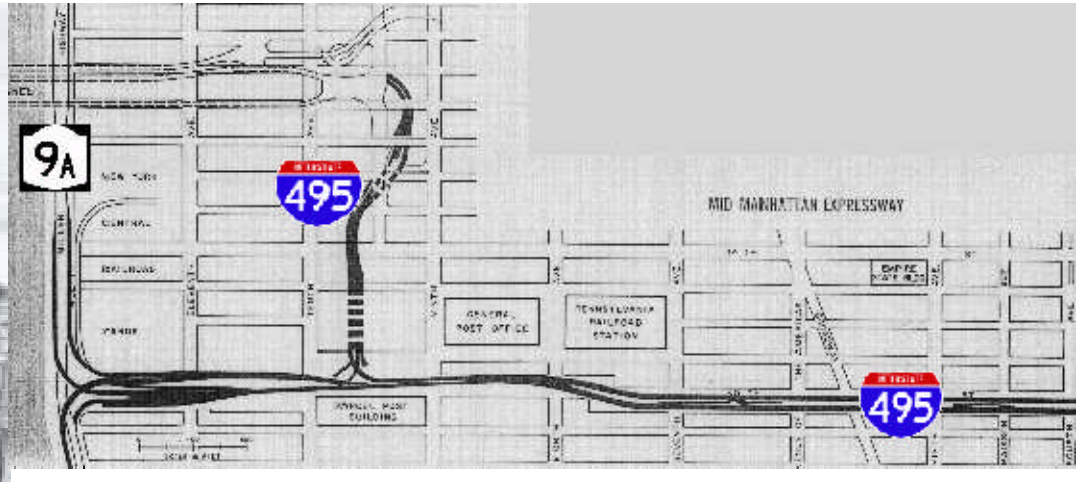
Mid-Manhattan Expressway

"Mid-Manhattan Crosstown Highway: This is a proposed express connection between the Queens-Midtown and Lincoln tunnels to serve crosstown traffic from the tunnels, through traffic between Long Island and New Jersey, and local crosstown Manhattan traffic. The Commission agrees in principle to the desirability of exits and entrances in the center of the island in a Manhattan crosstown express route. This is an essential part of the highway pattern that has not been built because of the difficulties of financing the project. However, it would appear that the travel time savings that it would afford to very large volumes of traffic, would warrant an expenditure of the amount required for its construction. Consideration should be given to the financing of this improvement as a toll facility. Engineers for the Borough President of Manhattan have estimated that its cost as a tunnel would be approximately $40,000,000."

RE: excerpt from NYC's Master Plan, 1941. First proposed in 1926 by the *Regional Plan Association* (RPA), the *Mid-Manhattan Expressway* was adopted as part of the RPA's 1929 master arterial plan entitled: "Plan of New York and Its Environs." NYC construction coordinator *Robert Moses* envisioned the Mid-Manhattan Expressway to be an elevated, limited-access link between the *Queens-Midtown* and *Lincoln Tunnel/s*. After receiving the I-495 designation in October 1958, this crosstown artery was to have connected the I-495 segment in *New Jersey* with the *Long Island Expressway* in *Queens*.

"An elevated expressway, from its connection with the West Side Highway, would start as a depressed highway in the center of a widened 30th Street to 10th Avenue. At this point, it would swing to the north side of 30th Street to make connections between 10th and 9th Avenues with the Lincoln Tunnel Third Tube approaches now under construction. After underpassing 9th Avenue, the six-lane expressway would rise to over-pass 8th Avenue and continue across Manhattan as an elevated structure. Between 8th and 7th Avenues the roadway would recross 30th Street and occupy a one-hundred-foot right-of-way immediately south of 30th Street. After overpassing 2nd Avenue, the expressway would swing north to follow the 30th Street alignment as a four-lane elevated expressway to connections with the East River (FDR) Drive. At 1st and 2nd Avenues, ramps would be constructed to provide access to and from the Queens-Midtown Tunnel via 1st and 2nd Avenues and the existing tunnel approach roadways. Access to the expressway would be provided in each direction in the section between 5th and 7th Avenues. If the expressway were constructed, it is estimated that it would be used to its estimated capacity of 24,000,000 vehicles a year. It is estimated that the cost of the elevated expressway alone would be $77,000,000, of which $33,500,000 represents real estate."

RE: excerpt from the *Joint Study of Arterial Facilities*, published by the *Triborough Bridge and Tunnel Authority* and the PNYA in 1955



"Can you imagine an elevated expressway at 30th Street just so Long Island guys could get to New Jersey?"

Robert A.M. Stern, **Architect**

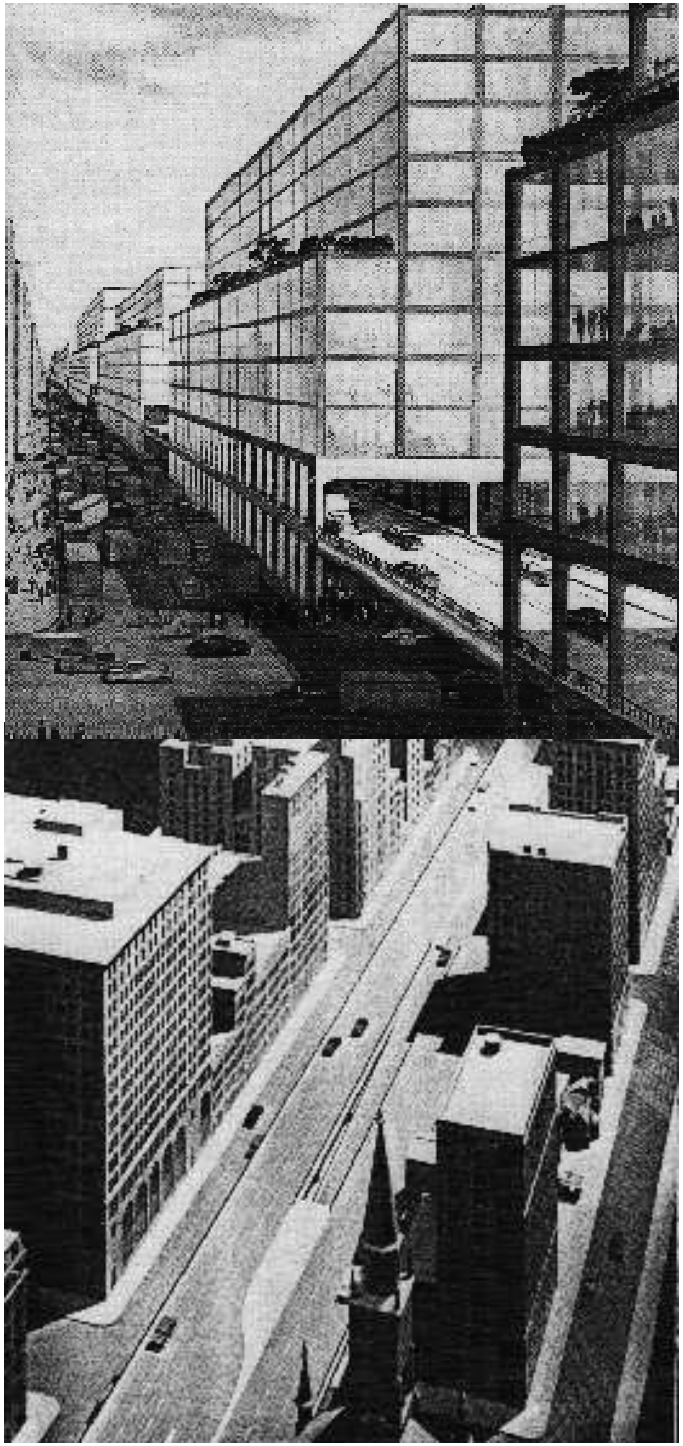
<u>Above</u>: caption: "This 1963 map from Future Arterial Program for New York City shows the proposed Mid-Manhattan Expressway, with connections to the Lincoln Tunnel and the West Side Highway (NY 9A) to the west."

<u>Left</u>: caption: "Mid-Manhattan Expressway (proposed), looking east, ca. 1959"

According to the Joint Study, the chief argument against the *Mid-Manhattan Expressway Tunnel* was its cost. This would have ranged from $119 million for a no-exit, express link between the *Lincoln Tunnel* and *Queens-Midtown Tunnel*, to $145 million for a tunnel link that would have provided entrances and exits at *Fifth Avenue.* To accommodate future traffic along the Mid-Manhattan corridor, Moses proposed construction of a $120 million third tube to the Queens-Midtown Tunnel. The third tube, which would allow four lanes of traffic in one direction during rush-hour periods, was to be constructed in conjunction with the expressway. Through a succession of NYC mayors (starting with *Fiorello LaGuardia*), Moses found support for his Mid-Manhattan Expressway. He also received the support of most of the NYC press (especially *The New York Times*) and the *Bureau of Public Roads.*

"As a newspaper we have previously endorsed those cross-town expressways (the Mid-Manhattan and Lower Manhattan), and we stand by that earlier endorsement. But we must admit to a growing disenchantment with great urban highway and expressway schemes."

RE: excerpt from a *New York Times* editorial. By the early 1960s, public sentiment had begun to shift in favor of mass transit and against Robert Moses' various transportation infrastructure schemes for NYC and its environs. In large part, this was due to the construction of the infamous *Cross-Bronx Expressway* which decimated many vital, thriving Bronx neighborhoods.



A novel feature of the *Mid-Manhattan Expressway* was the allowance for development both above and below the expressway. The two, three-lane roadways (ten stories above street level) would be separated by a median in which elevators (serving the development above the expressway) would be located. Below the expressway, space for commercial development and parking were to be provided. According to the Joint Study, the proposed development would have added $14 million to the cost of the expressway.

<u>Left T&B</u>: caption: "Artist's conceptions of the elevated Mid-Manhattan Expressway. The top conception shows the expressway tunneling under skyscrapers that would have been constructed through the sale of air rights.

Mid-Manhattan Tunnel (?)

"It would be necessary to build two separate tubes under adjacent crosstown streets. A two-lane eastbound tube could pass under 29th Street; a two-lane tube westbound under 30th Street. Ventilation buildings would be located in the block between 29th and 30th Streets fronting on the west side of 8th Avenue and the east side of Lexington Avenue. The least costly type of construction for such a tunnel would be the steel-bent and concrete subway-type, installed by cut-and-cover method. The tunnel providing only two lanes in each direction would, of course, have only two-thirds the capacity of a six-lane expressway. Provision of more than two lanes in each tube is not feasible due to limitations imposed by building foundations on either side of 29th and 30th Streets and extremely high costs. Limited street access in Midtown could be provided in the vicinity of 5th Avenue at a cost that would depend on the degree to which the interchange was developed."

RE: excerpt from the *Joint Study of Arterial Facilities* (1955). As early as 1937, the RPA advocated construction of a four-lane, twin-tube tunnel under *36th Street* and *37th Street/s*.

"A route crossing midtown Manhattan, connecting the East River (FDR) Drive and the West Side Highway, as well and the Lincoln and Queens-Midtown tunnels, has long been proposed. It is intended to remove from city streets traffic that wishes to cross from one side of the island to the other. This facility, currently a segment of the Federal Interstate highway system, would penetrate the area of highest-cost real estate and greatest commercial density in the nation. Clearly, this should receive the most intensive study and design evaluations to assess whether such a road-way can be satisfactorily adapted to the very dense and complicated environment. Also, the potential effect on the delicate transit balance in the midtown area must be carefully weighed, particularly in view of the proposed East River subway tunnel. In such an evaluation, radical departures from the present design concept should be examined."

RE: excerpt from *Transportation 1985: A Regional Plan* (1966 report of the *Tri-State Transportation Commission*). In August 1969, the *NYC Planning Commission* recommended against building the *Mid-Manhattan* and *Lower Manhattan Expressway/s* and on March 24th 1971, NYS Governor *Nelson Rockefeller* terminated plans for the Mid-Manhattan Expressway.

<u>Left</u>: caption: "Model of the proposed Mid-Manhattan Expressway along 30th Street. The model, which was built in 1966, shows the Empire State Building on the right and the proposed Madison Square Garden (which opened in 1968) on the left."

<u>Above</u>: In 1958, the *I-495* designation was given to the proposed *Mid-Manhattan Expressway*. The expressway was removed from official plans in 1971, but remnants of Robert Moses' grand plan (in the form of I-495 signs) survived long after in *Manhattan*. These two I-495 signs were located on *East 34th Street* (ca. 1998).

A Very Remote If

"If (and it is a very remote 'if') the Mid-Manhattan Expressway (I-495) were ever constructed, it would be connected to deficient river crossings with vertical and horizontal roadway clearance problems for interstate trucking. Also, these river crossings currently carry traffic loads above their original design capacity, and therefore could not carry additional traffic. The Queens-Midtown and Lincoln Tunnels, which are maintained by MTA Bridges and Tunnels and by the Port Authority of New York and New Jersey respectively, would need to be upgraded and expanded. Add to this the cost of tunneling expressways through some of the most expensive real estate in the nation, blasting through solid bedrock while not disturbing building foundations, subway and utility lines, and you have a project that would make the Boston Central Artery project appear simple and cheap by comparison."

Ralph Herman

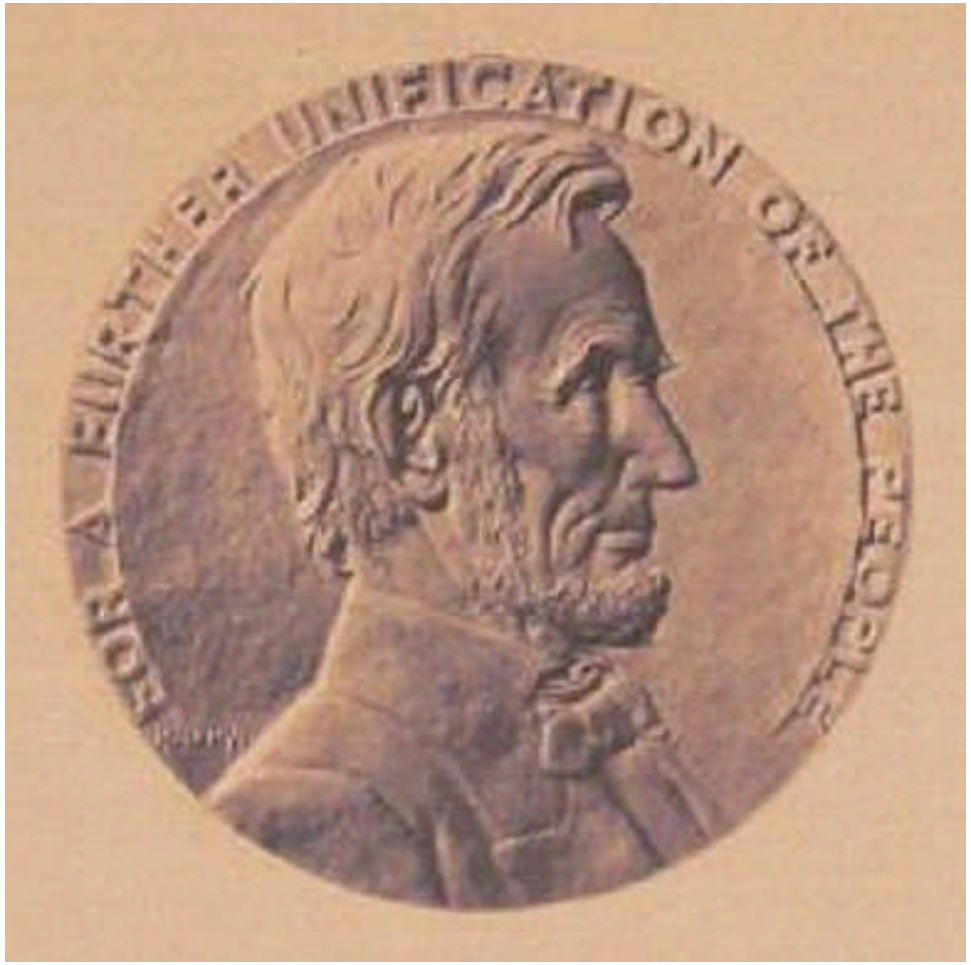
RE: discussions begun in 1998 on reviving plans for I-495 across Midtown Manhattan

"Certainly, the added cost of tunneled roads is still going to be sufficiently significant to preclude their widespread use. However, for road links that would handle and serve large amounts of traffic, they can be justified. Such an underground tunnel would certainly be justified for the Mid-Manhattan Expressway between the Lincoln and Queens-Midtown underwater tunnels. To supplement the Mid-Manhattan Expressway, new tubes will certainly have to be constructed across the Hudson and East rivers. With regard to these potential projects, bored tunneling was cited at an April 1997 Regional Planning Association panel as providing the advantage of far less surface disruption than cut-and-cover tunnels, thus having the advantage of being far more politically feasible. Moreover, bored tunneling would offer more latitude in determining a road link's exact alignment, providing greater flexibility in avoiding building foundations, subways and utility lines. An express tunnel directly connecting New Jersey with Queens without access to Manhattan would be a logical thing, even if in conjunction with a more local crosstown Manhattan tunnel with exits serving the East Side and the West Side. However, because of the construction and maintenance expenses involved, it would have to be built as a toll facility."

Douglas A. Willinger

RE: in 1999, Willinger (of the *Takoma Park Highway Design Studio*) made the case for a *Mid-Manhattan Expressway Tunnel*. Also in 1999, a research paper entitled: "How To Build Our Way Out of Congestion" (published by the *Reason Public Policy Institute*) advocated a proposed Mid-Manhattan Expressway Tunnel. The proposed tunnel (based on Paris' "Metroroutes") would allow buses and most fire equipment access, but not heavy trucks or long-distance coaches. Nevertheless, smaller vehicles constituting +90% of rush-hour traffic flows would be permitted.

For A Further Unification of the People


FOR A FURTHER UNIFICATION OF THE PEOPLE