

The
NEW JERSEY HISTORIC BRIDGE SURVEY

Prepared by
A. G. Lichtenstein & Associates, Inc.

For
**The New Jersey Department of Transportation
Bureau of Environmental Analysis**

and
**The Federal Highway Administration
New Jersey Division**

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Mary Elizabeth McCahon, Project Manager
September, 1994

NEW JERSEY HISTORIC BRIDGE SURVEY

I. NEW JERSEY HISTORIC BRIDGE SURVEY METHODOLOGY

DEFINITION OF SURVEY OBJECTIVES AND PARAMETERS

The 1991-1993 New Jersey Survey of Historic Bridges was undertaken by Lichtenstein & Associates for the New Jersey Department of Transportation Bureau of Environmental Analysis in response to the Surface Transportation and Uniform Relocation Assistance Act of 1987 (STURAA). It was agreed among the New Jersey Department of Transportation (NJDOT), Federal Highway Administration (FHWA), and the New Jersey Department of Environmental Protection and Energy Historic Preservation Office representing the State Historic Preservation Officer (SHPO) that the project would be inclusive and would inventory all bridges (defined as structures with a clear span of 20' or greater) built before 1946 that are under the National Bridge Inspection Standards (NBIS) jurisdiction of the state. This includes state and county bridges. Since many railroad bridges are under state jurisdiction, it was agreed that only spans that either carry or cross a road would be included in the survey. Bridges included in the 1991 NJ Transit Historic Railroad Bridge Survey were excluded from this survey.

The primary goal, mandated by STURAA, was to evaluate the National Register eligibility status of the pre-1946 bridges in the state. To achieve that goal, each bridge would have to be field inspected, photographed, and assessed as to its engineering and historic significance during phase I. Phase II augmented the initial fieldwork with research in primary and secondary sources. The findings would then be compiled and recorded on a standardized survey form, and the data would then be evaluated against the National Register of Historic Places criteria for evaluation to determine which structures appeared to meet the criteria. The National Register-eligibility recommendations would be forwarded to the Bureau of Environmental Analysis and New Jersey Federal Highway Administration, to become a significant component in the Section 106 and Section 4(f) review processes.

The field inspection did not evaluate condition and functional adequacy. The survey was from the historical, not structural, perspective.

Other project requirements were specified in the Bureau of Environmental Analysis' Scope of Work dated May, 1990.

MOBILIZATION

To facilitate easy retrieval of the survey findings, it was specified in the Scope of Work that all data would be compiled in "dbase III+" software running under MS-DOS 3.3. The survey of the approximately 2,300 bridges to be examined was organized and executed on a county-by-county basis. Drawing on its computerization of the data contained on the state's "Structure Inventory and Appraisal" records that are part of the National Bridge Inspection Standards, NJDOT's Bridge Division provided a computer file that contained all the pre-1946 bridges in the state's inventory. That dbase III+ file included data such as location, structure number, length, width, owner, material, year built, and route number. The large file was then divided into smaller county files that served as the (1) initial list of bridges to be surveyed in each county and (2) the source of data to be verified or corrected during the fieldwork phase of the survey.

A list of bridge types, designs, and primary materials found in New Jersey (Figure 2) was developed to ensure that physical descriptions on the survey forms and entries into dbase III+ files would be standardized. This would facilitate sorting and evaluating survey findings. All entries would be in caps with no hyphens.

Most bridge overall length and out-to-out width measurements used on the survey forms were taken from the SI&A database and were not measured in the field.

SURVEY FORM

It was necessary to develop a survey form that would convey information in a clear, complete, and concise manner. Several NJDOT departments that would be using the survey findings were interviewed about the types of information they would find most useful, and then drafts of potential survey form were prepared and submitted to those departments for their review and comments. The adopted survey form sought to convey relevant information in an easily retrievable format on one page (Figure 1).

When necessary, a second page, or long form, with an expanded physical description, statement of historical and technological significance, boundary description, and a selected bibliography was completed. Long forms were prepared for bridges that (1) appear to be eligible either individually or as a contributing resource in a potential historic district, (2) were of questionable eligibility which needed research to resolve, or (3) are in a listed National Register Historic District but were not rated and were evaluated as being contributing resources.

No long forms were prepared for bridges whose eligibility had previously been evaluated. Those included bridges for which the SHPO previously has rendered a Finding, are already listed in the National Register individually or as contributing resources within historic

districts, multiple-property resource, have been determined by the National Park Service, or were recommended as being noncontributing to listed National Register historic districts.

The informational categories on the New Jersey Historic Bridge Survey Form (Figure 1)

Figure 1.

**NEW JERSEY DEPARTMENT OF TRANSPORTATION... A.G. LICHTENSTEIN
BUREAU OF ENVIRONMENTAL ANALYSIS & ASSOCIATES, INC.**

NEW JERSEY HISTORIC BRIDGE SURVEY

| | | | |
|------------------------------------|---------|----------|---------|
| STRUCTURE # | COUNTY | OWNER | ROUTE |
| MILEPOINT | | TOWNSHIP | |
| FACILITY CARRIED | | | |
| NAME/FEATURE INTERSECTED | | | |
| TYPE | | DESIGN | |
| MATERIAL | # SPANS | LENGTH | WIDTH |
| DATE OF CONSTRUCTION (ALTERATIONS) | | | SOURCE |
| DESIGNER/PATENT | | | BUILDER |

SETTING/CONTEXT

CURRENT NATIONAL REGISTER STATUS

NATIONAL REGISTER RECOMMENDATION
SUMMARY

PHOTO INDEXREVIEWED BY DATE QUAD

FIGURE 2.

BRIDGE TYPES

DECK TRUSS

PONY TRUSS

THRU TRUSS

CANTILEVER TRUSS

DECK GIRDER

THRU GIRDER

LATTICE GIRDER

MULTI GIRDER

ARCH

STEEL ARCH

3 HINGE ARCH

TIED ARCH

DECK ARCH

BRICK ARCH

OPEN SPANDREL ARCH

OPEN SPANDREL RIBBED ARCH

STONE ARCH

T BEAM

SINGLE LEAF BASCULE

DOUBLE LEAF BASCULE

ROLLING LIFT

VERTICAL LIFT

SWING SPAN

CABLE LIFT BASCULE

BOX BEAM

RIGID FRAME

BAILEY

SLAB

SUSPENSION

STRINGER

TUNNEL

OTHER

BRIDGE DESIGN

PRATT HALF HIP

PRATT

WARREN

K

HOWE

LENTICULAR

CAMELBACK

PARKER

BALTIMORE

HYBRID

DOUBLE INTERSECTION

TRIPLE INTERSECTION

SCHERZER

STRAUSS OVERHEAD

STRAUSS UNDERNEATH

HEEL TRUNNION

ELLIPTICAL

PARABOLIC

BARREL

ARCH

RIM BEARING

CENTER BEARING

ENCASED
PARTIALLY ENCASED
LAMINATED
TRUNNION
JACK ARCH (BRICK)
JACK ARCH (CONCRETE)
TUNNEL
CONTINUOUS
OPEN WEB
MATERIAL
STONE
BRICK
WOOD
CONCRETE
STEEL
WROUGHT IRON
METAL
REINFORCED CONCRETE

are described as follows:

Structure Number. Each bridge under state jurisdiction has been assigned a unique 7-digit number. The first 2 digits are a county code, and the 5-digit suffix is a sequential route code for state bridges and often a variation of the old county numbering system for country-owned spans. All NJDOT records relevant to a particular bridge are filed by this unique number, so the survey followed a like program. Thus the structure number was established as item 1.

County. The county in which the bridge is located, or, in the instance of a joint-county span, which county assumes responsibility for it. This data was derived from the SI&A files.

Owner. Governmental entity, agency, or corporation that owns the bridge. Private refers to a private owner or bridge commission. Railroad is a generic entry indicating that a railroad company owns it but not necessarily which one. DOT refers to a state-owned bridge.

Route. NJDOT has numerical codes for all roadways in the state. 90 followed by the 2-digit county code designates a county route. The information is used as an aid in locating the structure. The data was derived from the SI&A files.

Milepoint. State highways are measured west to east or south to north from the (1) state line or (2) origination of the route. Milepoints (referred to as mileposts on railroads) are measured to the nearest hundredth of a mile.

Township. Local civil division in which the bridge is located.

Facility Carried. Name of feature the bridge carries. If the feature has a name and a county route designation, the county route designation is included in parenthesis after the name of the feature.

Name/Feature Intersected. Name of features carried and crossed.

Type. A standardized entry based on a list of all bridge types found in the state (Figure 2).

Design. A standardized entry based on a list of bridge type designs found in the state (Figure 2). Design assists with better identifying bridges with similar physical characteristics, such as the various trusses or concrete reinforcing systems.

Material. A standardized entry based on a list of the material of the primary members (Figure 2). Spans are typed by primary material. When it is not known for certain if a span is steel or cast or wrought iron, metal is used.

Spans. Total number of spans.

Length. The backwall to backwall overall length of the bridge.

Width. The fascia to fascia width of the bridge.

Date of Construction: Alteration. Date of erection and, when applicable, date of significant alteration(s) that affect the appearance of the span. Circa dates are entered with the ca. after the year.

Source. Source upon which date of construction/alteration(s) is/are based. In some instances it also references the source of historical data. In addition to the self-explanatory entries, "STYLE" is the convention used when the date is based on the physical evidence of the structure itself. "NJDOT" refers to the date provided in the NJDOT SI&A database. That date was used when it was confirmed by physical evidence and research.

Designer/Patent. Identifies who designed the bridge or patented the design or construction details. "NJ HWY DEPT BRIDGE DIV" is the convention used to identify bridges designed by the state highway department bridge engineers. Unknown was entered when research failed to identify the designer/patent. If no designer/patent was researched, then the category was left blank.

Builder. Identifies the person or company that actually built the span. When no research was conducted to identify the builder, the category was left blank. If research was conducted and no builder was identified, then "unknown" was entered.

The following sections of the survey form were developed to record the qualitative data about the bridge that supports the National Register recommendation. The fields of "Setting/Context" and "Summary" were limited to 500 characters each. When additional space was needed, a second page was attached to the survey form.

Setting/Context. Surroundings and historic contexts are an important part of the National Register evaluation process. Frequently a bridge is found to be eligible because it is located in an identified potential or listed historic district. For example, it might contribute to a historic context of industrial development or community planning. It could also be in an area that once had historic significance but has been so altered that the significance has been lost. The bridge might be newer than its historic setting and therefore not contribute to it. Or, the span could be isolated in a setting surrounded by woods or fields. This category was defined to explain and assess the environment of the span as a means of better supporting the National Register recommendation. Because of space limitations, sometimes historical data, especially information about the road itself, was included in this category.

Current National Register Status specifies whether a bridge is listed, has been determined eligible, or has not been evaluated by the SHPO as to its National Register eligibility. Files and records at both HPO and BEA were searched to determine which bridges had been evaluated and which bridges had not.

Current National Register status was entered several ways. If there had been no record of previous SHPO review of the bridge "Previously Not Evaluated" was entered.

If a structure was individually listed or located in a historic district, "Listed" was entered, followed by the name under which it was listed and the date of the listing. For bridges located in historic districts, the nomination was reviewed to determine if the bridge was rated as contributing, noncontributing, or if it was not rated.

Because the contributing or noncontributing rating of structures in National Register historic districts was a procedural requirement implemented well after the National Register was established in 1966, it was necessary to review all existing district, thematic, and multiple property nominations in the National Register file at HPO to determine (1) if any bridges are within the district boundary described in item 10 of the nomination, (2) if those bridges were rated, and (3) if they were not, what themes and period(s) of significance were developed in the nomination. The bridge was then evaluated against those items to determine if it was a contributing resource. When there was no clear or complete definition of period of significance or area(s) of significance in the nomination, the perceived emphasis of the nomination served as the basis for the recommendation, and the bridge was evaluated in a manner consistent with current National Register procedures and policy as outlined by the National Park Service in National Register Bulletin 16 (U. S. Department of the Interior National Park Service Interagency Resource Division, September 30, 1986).

When a bridge had been reviewed by the SHPO and an opinion rendered on its eligibility, the eligible or not eligible opinion was entered, followed by "SHPO Finding" and the date of the letter or other documentation that conveys the opinion. Findings are not formal Determinations of Eligibility (DOE) issued by the National Park Service. When a formal DOE had been issued, the eligible or not eligible determination was entered, followed by "DOE" and the date of the letter of the determination.

National Register Recommendation is the professional opinion of the survey compilers and reviewers of whether the structure appears to meet the criteria for inclusion in the National Register of Historic Places. It is a studied and carefully considered opinion based on all the information gathered statewide during the field work, research, and review phases of the survey. The recommendation reflects the perspective of historians and engineers (the evaluation process is described in detail in Criteria for Determining Significance starting on page 10).

Summary is a narrative that briefly describes the bridge and significant alterations and justifies and explains the National Register recommendation. It is the "heart" of the

assessment and serves as a summation of the engineering and historical significance of the structure and its setting/context.

Photo enumerates the roll and negative number of the images of the this bridge. The negatives will be retained by BEA.

Reviewed By records who did the fieldwork and who was the principal investigator that went over the field workers report. By having a series of reviews of the survey findings by both engineers experienced with old bridges and historians, a fair and thorough evaluation was made.

Date is the month and year the bridge was field inspected and photographed. A second date records when the structure was reevaluated or the survey form was revised.

Quad identifies which USGS quadrangle map in which the bridge is located. Dates of the maps vary.

Each survey form is accompanied by black-and-white photographs. At least two photographs were taken of each bridge, showing an elevation and a through view. In rare instances field conditions precluded obtaining an elevation view. A copy of the section of the quad map with the bridge marked on it is also attached to the form.

EXECUTION OF SURVEY

The field inspections were conducted on a county-by-county basis in cooperation with the county engineer or his designate. At the commencement of the survey, each county engineer was contacted by BEA and asked for his cooperation with identifying, locating, and documenting bridges under his jurisdiction. Lichtenstein then met with engineers before starting field work in each county. The county engineer was given the dbase III+-generated list of bridges and asked to (1) make sure all the pre-1946 bridges in the county were on the list and (2) delete those bridges on the list that had been replaced or have post-1945 superstructures. The list marked by the county engineer was retained as the record for deleting from the survey bridges initially identified incorrectly as predating 1946 but in fact do not. The county engineers often provided maps that proved helpful in locating bridges, and they permitted researchers to use their files to document the historical significance and history of alterations of the spans. The state records maintained by the structures and right-of-way sections of the Department of Transportation served as the basis for data for state bridges.

Bridges to be surveyed were plotted on county maps. A survey form for each bridge to be inspected was generated from the software programs used for the project, and a file folder was made for each structure.

Field inspection was performed by teams made up of one engineer and one historian experienced in surveying old bridges. Each structure was visited, field notes and photographs of the bridge and its setting were taken, and an initial assessment of the National Register-eligibility was made. Attention was given to inspecting for alterations and interesting, unusual, or innovative construction details. Questions generated by the items observed during the field inspection were noted so that they could be followed up during the research phase.

After the field inspections, the research phase of the survey commenced. A variety of primary and secondary sources, including the records of the county engineer, local history collections at local or county libraries and historical societies, and the plan files maintained by NJDOT, were utilized to establish the historical and technological significance. County records often contained plans that named the designer of the bridge and its date as well as the builder or fabricator.

The physical and historical data was summarized and entered in the dbase III+ record maintained for each bridge. This "first draft" of the survey was then reviewed by the principal investigator and project manager for completeness and accuracy. When more research or an additional inspection was needed to clarify significance, such tasks were done. At this step similar resources were evaluated as a group. The best examples of the type were identified and used as for comparison throughout the evaluation process.

Once in-house review of the draft survey forms was completed by the consultant, the draft forms were submitted to BEA and FHWA for their review and comments. The consultant then revised the forms to address review comments and did what research and fieldwork was required to resolve any questions. The revised, or final draft survey forms were then returned to BEA. Revisions were made as requested.

Simultaneous with the fieldwork and research to complete the survey forms was preparation of a historical overview on the history of road transportation and bridge building in New Jersey. The overview, which is based in part of the survey findings and the research done to establish the significance of the individual bridges in the survey population, would be used as two of the historic contexts for evaluation. It would also serve as a contribution to updating the existing body of work addressing transportation and bridges in the state.

Narratives outlining how transportation networks affected the development of each of the twenty-one counties were prepared. The narratives provide an overview of bridge building within the county with emphasis on the local effort and a summary of their significant bridges. They provide specific contextual information about individual counties and are intended to augment the transportation and bridge technology contexts that reflect the statewide perspective.

II. CRITERIA FOR DETERMINING SIGNIFICANCE

The primary objective of the survey was to judge each bridge against the National Register of Historic Places criteria for evaluation as enumerated in 36 CFR 60.4. The National Register criteria are broad, and there are numerous areas of significance related to those criteria, like transportation, community planning and development, engineering, or landscape architecture. In response to the broad intent of the criteria, it was decided that each bridge would be evaluated against the criteria on its own merits rather than against predetermined, project-oriented criteria or historic contexts. This approach would accommodate the subtle yet often crucial distinctions of significance among large numbers of similar resources with a common history; what distinguishes apparently eligible resources of a like type from those that are not. Such minute distinctions have historically been a part of the National Register eligibility evaluation process.

The National Register of Historic Places criteria for evaluation are

The quality of significance in American history, architecture, archeology, engineering and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and:

- A. that are associated with events that have made a significant contribution to the broad patterns of our history; or
- B. that are associated with the lives of person significant in our past; or
- C. that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose component may lack individual distinction; or
- D. that have yielded or may be likely to yield information important in prehistory or history.

Criteria considerations: Ordinarily cemeteries, birthplaces, or graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years shall not be considered eligible for the National Register. However, such properties will qualify if they are integral parts of districts that do not meet the criteria or they fall within the following categories:

- a. a religious property deriving primary significance from architectural or artistic distinction or historical importance; or
- b. a building or structure removed from its original location but which is significant primarily for architectural value or which is the surviving structure most importantly associated with a historic person or event; or
- c. a birthplace or grave of a historical figure of outstanding importance if there is no other appropriate site or building directly associated with his or her productive life; or
- d. a cemetery that derives its primary significance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or
- e. a reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or
- f. a property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own historical significance; or
- g. a property achieving significance within the past 50 years if it is of exceptional importance.

INTEGRITY

One of the most important considerations in the evaluation of National Register status is integrity. A synonym for state of completeness or preservation, integrity refers to the retention of original fabric and/or historic appearance. It does not refer to its state of repair or its structural or functional adequacy. Integrity is defined in the criteria for evaluation as an integral part of the assessment of the significance of a structure. Integrity must be present in "location, design, setting, materials, workmanship, feeling and association" for a resource to be evaluated as eligible. In other words, a structure must appear much as it did when it achieved its significance in order to meet the National Register criteria. The issue of integrity is applied to structures that are individually evaluated as well as to those that are located in historic districts.

The integrity necessary for a resource to contribute to a historic district is commonly interpreted differently from the integrity needed for individual eligibility. This is because a district as a whole can meet the criteria for significance and integrity even though some of the components are altered somewhat (criterion C). For example, a stone arch bridge

which has been widened on one side bridge might not be individually eligible, but if it has enough integrity and is from the period and area(s) of significance of the district, the bridge might contribute to the historic character of the district and thus be evaluated as a contributing resource. On the other hand, a Pratt pony truss bridge that has been altered by the addition of welded members and connections at the panel points and no longer appears or functions as it did when the district achieved its significance would be evaluated as noncontributing.

APPLICATION OF CRITERIA FOR EVALUATION

The following are explanations of how the individual criterion were applied in the evaluation of the historic bridges in New Jersey. The interpretations were applied to all bridge types in the survey with exceptions noted, such as not placing a great deal of emphasis on a common alteration to a particular structure type.

Criterion A addresses a variety of events or pattern of events that made an important contribution to the historical and physical development of a locality, region, or the state. This could range from the development of a settlement as a regional trading or industrial center or the influence of a medical treatment facility that was developed in accordance with a then-current theory of treatment. For bridges, criterion A could include a significant transportation route, like the Delaware Lackawanna and Western Railroad's 1909-1911 New Jersey Cutoff or the Ben Franklin Bridge, which greatly affected post 1925 development in the greater Camden area.

All bridges have a history. They were built by a railroad, a county, the state, or a private commission, and were thus related to larger historic contexts such as development of improvement of rail rights-of-way or expanding the state highway system with the then-prevailing bridge technology. Criterion A was therefore interpreted and applied to differentiate between history, which tends to be common to like features such as all railroads having an impact on the subsequent development on the areas through which they passed or 1930s dualized state highways facilitating the suburbanization of the northern part of the state, and distinguishable events that made a significant contribution to historical development. Thus representative examples of common bridge types with no distinctive or unusual historical background or setting were evaluated as not meeting criterion A.

Criterion B addresses historic association with great persons from the past. Birthplaces, graves, and memorial structures associated with persons significant in our past are excluded from National Register eligibility under criterion B. This criterion is not commonly applied to bridges, as the works of noted engineers and builders are usually better represented under criterion C. Both Francis C. Lowthorp, designer of the early cast and wrought iron pony truss bridges in Hunterdon County, William Cowin of Lambertville, the fabricator, are famous in the annals of metal truss bridge technology in the country, but it

is the technological value of their three surviving ca. 1870 bridges in Hunterdon County that is noteworthy.

Criterion C addresses the distinctive characteristics of a type, period, or method of construction or represents the work of a master or the significance of a historic district and is thus the most broadly applicable criterion to bridges. The criterion affords recognition of the evolution of bridge building technology as well as the setting of the structure or the importance of the engineer who designed it or fabricator/contractor who erected it. Bridges were carefully assessed in both the field work and research phases of the survey to see if they possess the technological and/or historical significance to meet criterion C. Bridges with unusual construction details or are rare survivors of a bridge type that was significant in the development of bridge technology, were the work of noted engineers, or were particularly good examples of their type were evaluated as eligible under criterion C.

Criterion C was applied to common resource types, like steel stringers or reinforced concrete deck arch spans, on a local, regional, and statewide basis to ensure that best and/or most distinctive examples were identified as being significant. The parameters of the distribution were based, in part, on common topographical, economic, historic, and development factors as well as political boundaries. Thus several counties that share like topography and historical development might be considered on a regional basis for comparison.

Bi-county bridges were also looked at from the perspective of both entities.

Thus, a bi-county thru truss bridge was evaluated on a regional basis because (1) the decision as to which joint-county crossings are under the jurisdiction of which county is arbitrary, and (2) both counties were historically responsible for the span. Comparing the bridge only to the universe in the county who has modern jurisdiction over it is not an accurate measure of its history nor its technological significance.

Criterion D is generally interpreted to refer to archaeological resources. The survey dealt only with above-ground resources, although reference to National Register-listed archaeological sites was noted when such data was known.

DISTRICTS

Another component in assessing National Register eligibility is evaluating the setting to determine if it meets the criteria as a potential historic district. Identification and assessment of potential historic districts was an important component of the fieldwork phases of the survey. If the surroundings appeared to meet the National Register historic district criteria, then the bridge was evaluated in relationship to the period and areas of significance of the potential district. Rights of way as well as clustered developments were evaluated for historic district potential.

There are three ways a resource located within a listed or potential historic district can be considered a contributing and thus National Register-eligible structure.

Firstly, the bridge was present in the district during the years that the district achieved its significance. The period of significance, which usually must be greater than 50 years in age, is determined by historical research and the physical development of a district. To be evaluated as a contributing resource within a historic district a structure must have been built within that period of significance, like the handsome brick-arch span designed for or by the Olmsted Brothers as part of the original landscaping plan for Branch Brook Park in Newark. Conversely, a late-1920s encased stringer bridge built in a historic district that achieved its significance prior to World War I would be rated as noncontributing regardless of its state of preservation because it is outside the period of significance of the district.

Second, the structure needs to support the historic themes or areas of significance for which the district is being recognized. It must add to the historic architectural qualities, historic associations, or archaeological values for which a district is significant. Thus, unless a structure is related to one of the themes or areas of significance for which the district is eligible, it is evaluated as noncontributing. Many of the historically significant early-20th century municipal parks contain bridges that were designed to be landscape amenities integral to the overall design. Such spans were evaluated as contributing because they are part of the landscape architecture significance of the parks.

Third, some structures located in historic districts meet the National Register criteria on their own and are thus eligible independent of their setting and associations. Provisions for such individually significant structures located in historic districts are made in the programmatic procedures of the National Register. Bridges like the 1886 Nevius Street double-intersection Pratt thru truss bridge at Raritan, that are located in listed or potential or listed National Register historic districts were evaluated from both perspectives; as contributing resources and as meeting the criteria on their own merits. The conclusion of the evaluation is specified on the individual survey forms.

Emphasis was placed on looking at entire roads as potential historic districts to ascertain if they possessed sufficient integrity and significance to meet criteria A and/or C. Did its development make a significant contribution to the broad patterns of our history, and thus meet criterion A, or was it part of the overall history of the ongoing development of roadways in the state? Did the road possess engineering significance or was it a typical solution to common traffic bridge engineering problem? Does it possess the integrity of original design, setting and feeling?

Because of the importance the criteria for evaluation places on integrity, it was an overriding consideration in the fieldwork and research phases of the survey as well as the evaluation to determine the National Register recommendation. To arrive at an accurate assessment, alterations were studied to determine (1) if they were historic or not (executed within the past 50 years), (2) changed the design or how a bridge functions, or (3)

compromised the technological and/or historical significance of the structure. These issues figured greatly in the assessment of the historical and technological significance of each bridge.

It was possible to state accurately how many of each resource type there are in the state because of the inclusive nature of the survey, which studied most of the pre-1946 bridges in the state, and the ability to tabulate the survey findings. As a result, the unique, rare, or infrequent criterion was applied on a county, regional, and statewide perspective.

Unique, rare, or infrequent survivors of a type or construction detail were evaluated as having engineering significance. Bridge types like a pin-connected deck truss, double intersection Pratt, or Whipple, thru truss, or Fink-like span were often evaluated as significant because they are no longer common. Yet, they represent the development of metal truss bridge technology in this country. Likewise, unusual construction details, like a Melan-type steel and concrete arch bridge or idiosyncratic truss bridge designs were evaluated as significant because they reflect the era of experimentation in the establishment of different bridge technologies.

Certain allowances in integrity were made for bridges that are a unique or rare example of their type and or/design. When a resource type or detail becomes so infrequent or rare that losing one or two examples will mean that it is no longer represented, then the integrity question is secondary to recognizing a disappearing historic artifact.

Priority was placed on recognizing the better or best examples of a resource type or construction detail when a sufficient population was identified. The survey findings were analyzed to identify which examples of types and designs best represented the population and distinguished some examples as being noteworthy and historic. Better or best was often meant being the larger, more complicated, or least altered example of a type or a structure that exhibits several distinctive details or notable historical association(s).

No numerical quota for how many of a given type or design would be evaluated as eligible was established. If nearly identical examples were of equally well preserved, like the ca. 1890 open or lattice web wrought iron deck truss bridges, or 1880s Pratt thru truss bridges built by the King Bridge and Manufacturing Company, all were evaluated as eligible. Likewise, all but one of the open-spandrel concrete arch bridges built by the State 1929-1941 and surviving in unaltered condition were recommended as eligible because of their technological and associative significance.

When a bridge type and design is common, like single-span reinforced concrete elliptical arch spans built after 1906, some noteworthy feature, like a particularly well-detailed, custom balustrade or original light standards and luminaires, was required to merit an eligibility recommendation. This policy was applied to all bridge types and designs, both fixed and movable.

Bridges that are documented as to designer, builder, and/or fabricator were evaluated as more significant than those that are undocumented. Such information establishes the historical, and frequently, technological significance of the span. This consideration was used especially for metal truss bridges, where knowing the fabricator contributed greatly to the historical significance of the span under criterion C. It was also used with early-20th century concrete arch bridges, where the reinforcing system is often the technologically significant feature of the span. Other spans were evaluated as significant because they were the work of noted bridge engineers or engineering firms.

Priority was given to acknowledging on a statewide basis the oldest extant examples of a type, design or detail in an effort to set the engineering history in the state context. These examples were regarded as more significant than later examples.

Identifying the early application of a particular technology was an objective of the survey, and tabulation of the findings made it possible to determine which structures truly marked transitions from one technology to another. Thus, a seemingly undistinguished appearing span might be technologically significant.

Again, this criterion was applied on a local, regional, and statewide basis in order to achieve a balanced perspective.

Movable spans that survive in complete condition were evaluated as having greater historical and technological significance than examples that have altered movable leaves, machinery, and/or operators houses. This became an important consideration with well-represented 20th-century movable bridge types. It was a less weighty issue with rare types. In-kind replacement of open gear sets was not regarded as an alteration.

Stone and concrete (plain and reinforced) arch bridges that have been widened on both sides were usually not evaluated as significant because they have lost integrity of design through alterations. To accommodate the widening(s), the original span would have lost its original/early parapets, and the fasciae are no longer visible.

Some modifications common to a particular bridge type or design were not considered as alterations that detracted from the potential significance of a span because the changes were necessary to (1) address inherent weaknesses in the original design, (2) were necessary replacements to keep the bridge operational, (3) were such minor changes that they did not affect the overall appearance or design of the span, (4) were sensitive alterations that were done in a manner which did not detract from the original design, or (5) are reversible alterations that did not involve the removal of original fabric. These common modifications include replacement of stringers and decks or wearing surfaces on metal truss bridges, deck replacements, the additions of outriggers to pony truss spans, and the replacement of sources of power, brakes, locks, and control panels on movable bridges. Other common alterations to which no diminishing of integrity was associated include removal of original railings on metal truss bridges, the addition of beam guide rail when it was attached in a manner so as not to irreversibly impact the historic fabric, minor

strengthening to metal truss bridges, especially strengthening the end panel floor beam hangers of thru trusses, small welded repairs to metal truss bridges, relocation, and repointing to masonry work when done in a reasonably sensitive manner. In kind replacement was not considered to adversely affect the technological and historical significance of a bridge.

Alterations that were considered as drastic enough to make a bridge not eligible include removal of original concrete balustrades/parapets, widening on both sides so that the original structure is undiscernible in elevations, replacement of the major portions of the operating mechanisms on a movable bridge, and welded additions to pin-connected metal truss bridges that change it from a pinned to a rigidly connected structure. A higher degree of alteration was acceptable as significance in other areas increased, especially for very old or very rare structures.

III. DEVELOPMENT OF TRANSPORTATION NETWORKS IN NEW JERSEY FROM THE COLONIAL ERA UNTIL 1946

INTRODUCTION

Bridges are integral parts of transportation networks that carry people, vehicles, and material over natural and manmade barriers. They are first and foremost practical and utilitarian structures that function within larger transportation systems that support the social and economic life of the state. Because bridges have shaped and now reflect the historical development of New Jersey, it is important to place the state's bridges within the larger framework of the historic contexts of the state's transportation networks in order to appreciate the contributions they have made.

Within the epoch of New Jersey's transportation history from the 17th century to 1945, two periods stand out as extraordinary for their rapid pace of change and growth. The first, running from about 1800 to 1860, saw internal improvements and technological advances such as turnpikes, canals, and railroads. They were all aimed at greater capacity, speed, directness, flexibility, and regularity of service than could be achieved by earlier modes of river navigation and overland travel. Historian George Rogers Taylor has quite correctly called 1800-1860 the "transportation revolution." The second extraordinary period of transportation growth occurred from 1919 to 1936, and was, in terms of historian Bruce Seely, "the golden age of highway building." During this period, New Jersey's road and highway bridges were substantially modernized to handle modern load requirements and increased volume of vehicular traffic. The result was to shift emphasis from railroads to highways.

While the transportation revolution for 1800 to 1860 and the golden age of highway building from 1919 until 1936 were perhaps the most critical times of New Jersey's, and, for that matter much of the nation's, transportation development, the overall picture is much more complex. Granted, turnpikes, canals, and railroads, and later the integrated highway systems were significant technological breakthroughs, but their application or development throughout the state was uneven and was dependent upon whether their construction was appropriate to the given location. In South Jersey, for instance, few railroads were built until after 1860 because they were not necessary in a sparsely populated region with small-scale agriculture and industry.

Similarly, new transportation systems did not immediately replace older ones. Rather, the new ones were integrated into the existing networks. For many years railroads and highways transferred traffic to ferries where wide rivers and harbors, like the Hudson and Delaware rivers, were unbridgeable. Likewise, highway traffic competed with railroads through the 1920s, 1930s, and 1940s for freight traffic.

Finally, New Jersey's transportation networks are perhaps best described by their specific roles in the movement of materials and people. Much of the state's history has been influenced by the east-west trade; the transportation of eastbound agricultural staples and natural resources from Eastern Pennsylvania and the trans-Allegheny west, and of westbound merchandise and manufactured goods from eastern urban centers. The economic potential presented by western resources, like coal and grain, and western markets was the driving force behind the construction of routes across New Jersey from New York City as early as the 18th century. Additionally, New Jersey's strategic position between New York and Philadelphia ensured that it would be the transportation hub of the east coast, and that it would be one of the most highly trafficked states in the union. Accommodating the volume of traffic on the routes between New York City and Philadelphia has given New Jersey a character uniquely its own, and historically has placed it in the forefront of transportation developments.

For purposes of organization and clarity the following history of New Jersey's transportation networks has been divided into sections: (1) New Jersey's transportation network prior to 1801; (2) turnpikes; (3) canals; (4) railroads; and (5) highways and byways. This is not to suggest a simple progression from one transportation network to the next, but to highlight the impact of each transportation system. Most of all, it is to suggest that New Jersey's transportation networks are best read as a series of cumulative developments that have left a direct strong imprint on the cultural landscape in the form of rights-of-way, road surfaces, railroad tracks, artificial water features, and, perhaps most visibly, bridges. Indirectly their influence is discernible on residential settlement patterns and the location of industrial and commercial centers.

NEW JERSEY'S TRANSPORTATION NETWORK PRIOR TO 1801

During the first two decades of the 17th century Dutch explorers were among the first Europeans to set foot in New Jersey. To Europeans, New Jersey was a wilderness having no transportation networks except the natural navigable rivers and the footpaths used by Native Americans to travel between villages. Over the next one hundred and fifty years, thousands of colonists, mostly from Great Britain and to a lesser degree from other Northern European countries such as Holland and Sweden, emigrated to New Jersey, and in the process they transformed the landscape by clearing the land, establishing cultivated farms, and building towns. The transportation system that developed integrated river navigation with overland roads and established Philadelphia and New York City as urban commercial hubs. By 1800 hundreds of boats plied the Delaware, Raritan, and Hudson rivers and their tributaries moving people and freight from the interior to New Jersey's borders. Stage coaches raced across the state on highways between Philadelphia and New York, and a network of crude local roads connected farms with market towns.

New Jersey's transportation network was initially an outgrowth of natural geography. Of all the North American colonies, New Jersey was unique for its position between two large

navigable waterways, the Hudson River and New York Harbor to the northeast, and the Delaware River and Bay to the west. The rivers offered natural transportation corridors deep into the interior of the state, and the bays provided large sheltered harbors. The Dutch were the first to recognize the advantages offered by the rivers and in the 1620s founded trading posts in order to barter with Native Americans. The most important trading post was New Amsterdam on Manhattan Island, which eventually grew into New York City (Lane, p.19).

The Dutch found it difficult to maintain their New Netherlands colony against other European rivals, and in 1664 the British seized control of the Dutch possessions. Britain's conquest was a turning point in New Jersey's transportation history because it inaugurated a period of steady population growth and the beginning of permanent agricultural settlements. The British colonists' agricultural economy relied upon schooners, flatboats, and a large variety of other specialized craft to move bulk goods such as lumber and grain to market. Consequently, in the third quarter of the 17th century two distinct population centers formed: one running north to south along the Delaware River, and concentrated at the towns of Salem, Gloucester, and Burlington; and the other bordering New York Harbor and Raritan Bay at Hackensack, Newark, Elizabethtown, and Perth Amboy (Lane, pp. 31, 59).

Overshadowing the establishment of New Jersey towns in the last quarter of the 17th century was the growing economic and political influence of New York City and Philadelphia. By 1700 the two cities controlled a large part of the coastwise and transatlantic trade with the result that much of the exported produce and imported goods of New Jersey first passed through those cities' merchant houses.

As population increased and arable land adjacent to navigable streams was taken up throughout the early 18th century, New Jersey colonists moved inland to found new farming communities such as Freehold, Princeton, Orange, Westfield, and Somerville. They pushed back the frontier settling much of the land except the inhospitable coastal pine barrens and the mountainous northwest. At first they followed the trails established many centuries earlier by Native American tribes, but soon set about the task of widening the trails for carts and of clearing new roads and paths. The winding roads established the rights-of-way of many of today's secondary routes such as the Tuckahoe-Mount Pleasant Road in Cape May County and the Old Middlebush Road in Somerset County to name but a few. The common roads, built to serve local resources and the local distribution of goods, were a significant transportation accomplishment of the pre-1800 period (Lane, pp. 40-41).

Beginning in the late 17th century, the colonial government ordered local communities to lay out and build so-called King's Highways, major through roads between the colony's most important towns. The term King's Highway was loosely used for any road sanctioned by the legislature, and, for instance, King's Highways ran from New Brunswick to Perth Amboy, Trenton to Elizabethtown, from Navesink to Perth Amboy, and from Burlington to Cooper's Ferry and on to Salem (Cawley and Cawley: 1981, p. 13). Townships struggled

to raise the volunteer labor necessary to build the roads and to keep up with the never-ending task of filling holes, repairing wagon ruts, and replacing washed-out bridges. Even when farmers assembled with hoes, rakes, and shovels, the results were rarely long lasting. Furthermore, hauling goods to market was a necessary, but slack-season job for most farmers, and they rarely deemed it worth their while to go to the great expense of maintaining well-graded and hard-surfaced roads for through traffic, much to the frustration of travelers (Lane, p. 41; Taylor, pp. 15-16).

Not surprisingly, New Jersey's most heavily traveled overland through routes were those that served to connect Philadelphia and New York City. Only thirty miles separated the Delaware River from the Raritan Bay (New Brunswick), and in 1740 passenger traffic had reached such a level that stage lines began to keep regular schedules. The first stages traveled between Burlington City and Perth Amboy, but the level of business prompted rivals. On the Delaware River, Bordentown and Trenton emerged as important transfer points between river boats and stage wagons, with Trenton gaining increased favor because of its location at the head of navigation on the river.

At the eastern terminus of the overland roads, travelers had several options including ferries to New York at New Brunswick, Amboy, Woodbridge, and Elizabethtown. Tides and unfavorable winds made crossing New York Harbor the greatest element of uncertainty in the trip, and after 1760 the trend was toward those routes that had a minimum of water transportation. In 1766 the completion of a new road from Newark to the Paulus Hook Ferry in Hudson County (NJ 7) offered the shortest and most dependable means of crossing the Harbor. Shortly thereafter the Old York Road (NJ 28 and portions of various county and local routes in Somerset and Hunterdon counties) by way of Paulus Hook, Newark, Elizabethtown, Plainfield, Somerville, and Lambertville on the Delaware River became an increasingly popular stage road servicing interior counties (Lane, pp. 16-18, 38-39, 77-93).

The constant desire to minimize water travel on the Philadelphia to New York route was a sign of the growing importance of overland travel in New Jersey's transportation history. This important route, then as now, was a barometer of changing transportation needs and trends. Prior to 1800 the rivers and bays had been the most convenient, and in many cases, the only means of travel. Increasingly, however, merchants and travelers saw New Jersey's rivers as barriers to be spanned by bridges rather than crossed by ferry boats. Between 1800 and 1900 technological changes such as turnpikes, canals, and especially railroads broke maritime commerce's lock on the coastwise movement of freight and bulk commodities. River traffic, despite the application of steam power and the deepening of watercourses, was increasingly relegated to minor, locally-important, specialized roles, and more often than not eventually bypassed altogether. After 1800 it was this increasing shift from maritime to overland travel that heralded the construction of more numerous and longer span bridges in New Jersey.

TURNPIKES

Turnpikes started the early-19th century transportation revolution in New Jersey. The first two decades of the nineteenth century were the turnpike era in the state. Between 1801 and 1820 forty-seven turnpikes were chartered amounting to over 500 miles of turnpike road mostly in the northern and central portions of the state (Gordon pp. 17-18). Turnpikes were the first attempt to build highways that offered travelers relatively direct and well-maintained roadways between major towns and markets. They were also the first highways to make use of improved building technologies such as stone-surfaced Telford roads and stone-founded and earth-surfaced Macadam roads. Most of all, turnpikes, although soon overshadowed by canals and railroads, demonstrated the economic potential of a network of state roads, and figuratively and literally laid the groundwork for the future state highway system.

In 1801, the New Jersey legislature, following the lead of Pennsylvania, New York, and the New England states, adopted the concept that toll roads were essential to the state's development. The turnpike movement had an important historic context within the political debates of the time. It was in part a result of the pressing need to facilitate communication and trade between the states that had a short 17 years earlier gained their independence from Great Britain. Fear of a naval blockade by a hostile European power encouraged the young republic's military leaders to seek an alternative transportation system to coastal shipping. The failure of local governments to maintain major through roads exasperated growth-minded politicians such as Secretary of the Treasury Albert Gallatin, but the undertaking of large transportation projects by the federal and state governments was strongly opposed by the majority who wished to place strict limits on governmental prerogatives.

Given that public financing was politically unfeasible, state governments turned to private corporations to raise the necessary capital for improved highways. Turnpike companies issued stock, took over existing roads, and charged tolls under charters granted by legislatures, and, in return, the turnpike companies pledged to offer more direct, wider, and better maintained roads. The success of Pennsylvania's Lancaster Turnpike (1792) inaugurated intense public interest in the creation of toll roads. The turnpike companies ushered in a new era of American capitalism, and industrialization, and they set the organizational pattern for canal and railroad companies that followed. They also signaled the beginning of intense rivalries between the businessmen of Baltimore, Philadelphia, and New York to capture the east-west trade routes (Taylor, pp. 17-26; US Dept. of Transportation, pp. 8-13).

The objective of most New Jersey turnpikes was facilitating the movement of freight, especially the products of farms and mines, to large towns and urban areas. The greatest turnpike building efforts took place in the north and central portions of the state where poor water transportation and hillier terrain limited hauling. New York capitalists, determined to be the principal market for northern New Jersey's iron ore, beef, and wool, financed the

turnpikes and opened up significant new routes between Newark Bay and the upper Delaware Valley. The Morris Turnpike (1801) was the earliest New Jersey turnpike and connected Newark with Morristown where it later met up with the Union Turnpike (1804) which continued to Milford, Pennsylvania. The Morris Turnpike returned a handsome annual dividend of over four per cent in its first decade, and investors soon built several competing turnpikes, including the Washington Turnpike (1806) from Morristown to Phillipsburg, the Jersey Turnpike from New Brunswick to Phillipsburg (1806), and the Paterson and Hamburg Turnpike (1806) from Paterson to Milford. The turnpikes formed the nucleus of modern through traffic patterns in northern New Jersey, and firmly established Phillipsburg/Easton and Milford as the western terminals of cross state travel (Gordon. p. 17, Lane. pp. 145-147).

The Philadelphia to New York corridor attracted the special attention of New Jersey turnpike builders because of the potential profits from improving an already heavily travelled route. The Trenton and New Brunswick Straight Turnpike Company (1804-1806), as its name implied, followed a straight-line route across New Jersey's midsection along the current route of US 1. As anticipated, it turned out to be the busiest turnpike in the nation, specializing in stage traffic that carried both passengers and mail. Unlike most other turnpikes, however, the Trenton and New Brunswick did not carry much heavy freight because it was still more economical to ship by coastwise boat between Philadelphia and New York (Lane, pp. 150-151).

In many ways the early success of New Jersey's turnpikes contributed to their demise. The short-term enthusiasm for the most heavily traveled routes encouraged the creation of turnpikes in sparsely settled regions where anticipated usage and revenues never materialized. Most turnpike companies went into debt in order to build improved roadways and bridges, and toll revenues failed to provide for adequate maintenance. The public became disgruntled at the turnpikes' deteriorating condition, and raising tolls simply drove travel on to nearby public highways or "shun-pikes" that looped around toll gates. Finally, beginning in the 1830s, even the strongest turnpike companies faced stiff competition from canals and railroads that could carry heavy commodities at a fraction of the cost along the very trade routes that the turnpikes had helped establish (Lane, pp. 160-161).

An exception to the statewide decline of the turnpike was southern New Jersey where turnpike building was renewed briefly in the 1850s with the establishment of over 20 toll roads. The southern New Jersey turnpikes were part of a general economic revival in what was one of the least populated and economically underdeveloped parts of the state. In the 1850s glass production increased, farmers found improved means of growing vegetables and fruits in the sandy soil, and a small but affluent group of tourists began to vacation at the shore. The new turnpikes radiated from trade centers such as Camden, Mount Holly, Burlington, Bordentown, and Trenton, and were the first significant improvements to highways in South Jersey. Many of the turnpikes were plank roads, roadways surfaced with sawn timber. Portions of several modern routes follow the rights-of-way of the turnpikes including the western portions of the White Horse Pike (US 30), Camden to Salem (NJ 45),

Mullica Hill to Bridgeton (NJ 77), Woodbury to Millville (NJ 47), and numerous other county routes. Construction of turnpikes ended abruptly with the Panic of 1857, and after the Civil War in 1865 the extension of railways into southern New Jersey contributed to the failure of numerous turnpike companies (Wilson, pp. 765-770; Lane, pp. 163-167).

Between 1830 and 1870 distressed turnpike companies petitioned the state legislature for relief. The companies usually returned the roads to local authorities without compensation or, in a few cases, sold their rights-of-way to railroad companies. In 1870, only a handful of turnpikes remained, and most of these no longer operated on major through routes, but on short sections near cities and towns. In the last quarter of the 19th century, public sentiment turned against the surviving toll roads on the argument that they should be made free to all and that they unfairly taxed local farmers and commuters. In 1878 and 1884 the legislature passed acts allowing county governments to purchase turnpikes at the lowest possible price, and in 1897 began offering state aid to counties that had not yet availed themselves of the benefits of the previous acts. In 1902 fewer than 50 miles of turnpike road remained in the state, mostly in Gloucester County, and this was soon incorporated into the public highway system. Few bridges built by private turnpike companies remain in New Jersey largely because the turnpikes followed or established major through routes and reverted to county, and eventually state control. In the early 20th century the turnpike roads and bridge were among the first to be rebuilt in the highway improvement campaigns (Durrenberger, pp. 159-163; Wilson, pp. 772-775; Lane, pp. 168-169).

CANALS

In the 1820s the nation turned enthusiastically to canal construction as another means of improving overland transportation, especially for moving heavy bulk goods such as grain and coal. The success of New York's Erie Canal (1817-1825) encouraged numerous imitators, and between 1820 and 1840 American canal companies constructed over 3200 miles of canals nationwide. The canals opened new markets and trade routes and spurred industrial expansion. They also required financing and organization on a scale uncommon in the United States, and were the training grounds of a new generation of civil engineers (Taylor, pp. 32-48).

New Jersey's two foremost canals were the Morris Canal (1825-1831) and the Delaware and Raritan Canal (1830-1834). Merchant capitalists financed the canals primarily to transport coal from the Pennsylvania coal fields to the markets of New York City and New England. The access to cheap coal was one factor leading to the industrial growth of Newark, and the revival of the languishing iron industry in Morris, Warren, and other northwestern counties. The canals also led to the wide spread adoption of coal for home heating fuel. Although the canals prospered for less than four decades before being eclipsed by railroads, they had a permanent impact on the state's development.

The 90-mile Morris Canal crossed the northern part of the state from the Delaware River near Phillipsburg (Warren County) to Newark (Essex County) on Newark Bay. Its main trade was the anthracite coal hauled to the Delaware River via Pennsylvania's Lehigh Coal & Navigation Company Canal, built 1826-1829, and entered the Delaware River at Easton. The Morris Canal brought to prominence the trade route leading directly west of Newark into the Appalachian Mountains, which in later years was followed by railroads and state highways. The canal was designed primarily to improve the woefully inadequate intraregional transportation systems of northern New Jersey, and in a large part due to its success, the region enjoyed a period of economic prosperity from 1830 to 1860.

In its traverse across the state, the Morris Canal was among the most ambitious and celebrated civil engineering achievements of its day. It lifted canal boats to a height of 913 feet above sea level and required 23 locks and 23 inclined planes to accomplish the task. The canal also had numerous aqueducts including a notable single 80'-span stone arch bridge over the Passaic River at Little Falls, and a 236' six span timber bridge over the Pompton River in Wayne Township. As a result of the canal passing through previously thinly populated territory, canal towns such as Port Warren, Port Morris, Port Murray, and Port Colden came into being, and still exist to this day (Gordon, pp. 23-26; Veit, p. 35).

The 44-mile Delaware and Raritan Canal was built between 1832-1834 from New Brunswick on the Raritan River through Millstone, Rocky Hill, Princeton, to Trenton, and then south along the Delaware River to Bordentown. The Delaware & Raritan Canal followed an already well-established route along the New York City to Philadelphia corridor, and its main contribution to the history of New Jersey transportation was providing an additional route for movement of Pennsylvania coal from the Delaware River to New York City. The canal made easy transfers with both the Delaware Division canal coming down the west bank of the Delaware River from the Lehigh Valley coal fields, and with the Schuylkill Navigation Canal from the Reading, Pennsylvania, coal fields.

Unlike the Morris Canal, the Delaware and Raritan Canal had few difficult engineering problems to overcome. It possessed a relatively level ascent and required only 14 locks and no inclined planes. On the course of the main canal were 17 stone arch aqueducts spanning streams and 27 pivot bridges for at-grade crossings of roadways over the canal. An innovative feature was the 21-mile long gravity feeder from Raven Rock (Hunterdon County) to Trenton that supplied the main canal with water from the Delaware River and was also used for transportation (Gordon, pp. 26-28, Veit, p. 8).

The profits from coal hauling allowed New Jersey's two canals to outlive many other east-coast canals that relied upon a more diversified trade. In the 1860s both canals reached their peak haulage with the Morris Canal moving over 450,000 tons of coal and the Delaware and Raritan Canal moving over 2,300,000 tons (Viet, p. 80). Prior to the 1870s the canals worked in concert with railroads, and it was only after this date that they were eclipsed by rail.

From 1830 to 1871 the Delaware and Raritan Canal enjoyed the joint financial backing of the Camden and Amboy Railroad, which rather than a powerful competitor had been a benevolent senior partner. The canal and railroad had been built at the same time, and, in order to gain monopoly charters on the Philadelphia to New York City route from the Legislature, had agreed to pool their monetary resources (Veit, pp. 22-23). The arrangement had worked well with the canal specializing in coal and bulk freight and the railroad in lucrative passenger and light freight traffic. But that changed in 1871 when the joint operating company's monopoly expired which cleared the way for other lines to develop and acquire cross-state routes. The powerful Pennsylvania Railroad leased the Camden & Amboy Railroad to gain access to its New York route, and part of the deal was the Delaware & Raritan Canal.

In 1876 the Philadelphia and Reading Railroad, a coal-hauling line, built its own line across New Jersey, breaking the monopoly and eliminating its own need for coal barges. The Morris Canal suffered similarly from the consolidation of major railroads when in 1875 the Lehigh Valley Railroad leased the Eastern and Amboy Railroad giving it a direct route across central New Jersey. Shortly thereafter the railroad disposed of the services of the canal which was soon limited to moving small amounts of lime, fertilizer, and farm products.

In 1922 the decline of the Morris Canal led to its abandonment and take over by the State of New Jersey. It was largely drained as a result of the 1924-1928 abandonment project. Some portions remain, like the reservoirs, for purposes of water supply and flood control, but the inclined planes are gone and many portions of the canal ditch filled, or as in the case of Newark and Paterson, covered by highways and city streets (Veit, pp. 55-56). While the right-of-way of the Morris Canal is listed in the National Register of Historic Places, it is more a memory than a tangible artifact in the transportation landscape of the state.

In 1934 the Delaware and Raritan Canal followed the Morris Canal into state receivership. The Delaware and Raritan Canal and canal feeder have suffered less drastically from alterations, and much of their right-of-way has been incorporated into state and municipal parks and as part of the regional water supply system (Veit, p. 83). In Trenton portions of the right-of-way have been covered by the Trenton Freeway (US 1) and office complexes. Several historically significant early-1830s stone arch aqueducts are extant, such as the ones crossing Moores Creek (1110158) and Jacobs Creek (1110152) in Mercer County. One swing span highway bridge (3000168) built in 1920 at the end of the canal's operative period survives in Somerset County. Other roadway bridges spanning the canal are not associated with the canal's period of historic significance.

PATTERNS OF RAILROAD DEVELOPMENT IN NEW JERSEY 1832-1945

Less than fifty years ago New Jersey's railroads reached into every corner of the state to carry passengers and freight both short and long distances. The railroads predated the modern highway system and were the first fast, inexpensive, and all-season mode of overland transportation. New Jersey's railroad networks, like earlier turnpikes, began in the 1830s as a collection of non-unified short lines designed primarily to serve local purposes. By the end of the 19th century, however, the railroads had grown into an integrated network of competing through lines that connected New Jersey with the entire nation. The railroads ushered in the industrial age, provided for the expansion of commercial farming, stimulated a thriving tourist industry, and profoundly changed the character of New Jersey.

In 1832 the Camden and Amboy Railroad became New Jersey's first operating railroad under a state charter that gave it exclusive rights to New York-Philadelphia through traffic for the next forty years. The first line went from South Amboy to Bordentown, and a year later connections were made from Bordentown to Camden. The effect of the Camden and Amboy on New Jersey's trade patterns was immediate and dramatic. In its first full year of operation it carried over 110,000 passengers, took over federal mail contracts, and almost immediately bankrupted the old turnpike stage lines along the same route. The Camden and Amboy's monopoly made it unusually prosperous and powerful even during a time when most American railroads received some form of government assistance. The profits gave the company immense financial might and also fed a political machine that ruled state government for over thirty years. The Camden and Amboy used its influence to fend off all rivals, buy lucrative connecting steamship lines, and build numerous branch lines, such as the 1850s Belvidere and Delaware Railroad.

An unintended consequence of the Camden and Amboy, however, was to stimulate agriculture along the length of its lines. In 1835 farmers shipped 1,500 tons of products to the Philadelphia and New York markets, and in 1860 an amazing 83,000 tons. Communities, such as Hightstown and Jamesburg, realizing that railroads meant economic prosperity, competed against each other to raise the necessary capital to build local lines that connected with the Camden and Amboy main line in their towns (Lane pp. 293-296).

During the thirty years before the Civil War other railroads built lines, but none enjoyed the spectacular success of the Camden and Amboy. In northern New Jersey, railroads like the 1835-1838 Morris and Essex from Newark to Morristown and the 1829-1834 Paterson and Hudson River Railroad from Paterson to Jersey City, tended to follow already established highway routes radiating from New York Harbor. They were often simply an upgraded form of highway that used horses to pull cars on wood rails with iron straps (Lane, pp. 373-398).

In southern New Jersey public interest for railroads ran high prior to the Civil War, but local businessmen were not capable of raising the necessary funds for construction. A notable exception was the Camden and Atlantic Railroad (1853), which ran sixty miles from Camden to what was to become Atlantic City. It was the first railway expressly for the

purpose of carrying vacationers to the shore, and as such was considered by many a financial folly. The railroad's passenger business expanded more quickly than expected but not enough to cover expenses. In 1857 the Camden and Atlantic filed for bankruptcy, but only after proving the potential of the shore route. After 1870 the rail line would become profitable and an important component of New Jersey's transportation network (Cook and Coxey, p. 5.; Lane, pp. 398-406).

Like the Camden and Atlantic, most of New Jersey's railroads passed through financially troubled beginnings and only began to gain some measure of security in the decade after the Civil War. The railroads' problems were not so much the result of poor planning but the fact that they required large outlays of capital well beyond the amounts usually available to investors. The lines relied upon passenger and freight fares, which rarely met operating expenses let alone provided funds for maintenance and upgrade. Furthermore, the early 19th century economy was characterized by intense competition between the businessmen of neighboring cities who worked against each other to capture the trade of the backcountry. Although New York City was clearly on its way to becoming one of the largest ports in the world, many northern New Jersey cities still hoped to gain an upper hand on their bustling metropolitan neighbor with the result being that New Jersey businessmen backed locally-owned and operated railroads rather than pooling their resources with regional, interstate interests. To make raising capital even more difficult, the State Legislature, with the willing support of the joint operating company that controlled the Camden and Amboy Railroad and the Delaware & Raritan Canal, refused to grant charters to out-of-state partnerships on the grounds that "foreigners" should not be allowed control of valuable public corporations.

The Civil War (1861-1865) was a turning point in the history of railroading. The need for through movements of troops and military supplies attracted attention to the disadvantages of numerous short line railroads with varied gauges and lack of connections in major cities. At the same time, continued technological improvements in locomotive design produced increased speed and powerful equipment capable of long distance movement of heavy freight. The Pennsylvania coal trade appeared especially lucrative if through lines could be completed that effectively underpriced the canals, which were the only transportation routes offering through service from the Delaware River to New York Harbor. Additionally, the Midwest had become an important grower of grain and other food stuffs, and a large outlet for eastern manufactured goods. The market for goods and commodities was expanding prodigiously, and investors shifted their view to the potential benefits of consolidating short lines into networks with direct connections to national outlets. These factors combined to undermine local prejudices against "outside" investors and opened the way for the growth of interstate rail lines (Taylor and Neu, pp. 1-7).

Northern New Jersey lay strategically in the path between New York City and the western markets, and as a result, it became one of the most hotly contested areas of railroad growth. New York's position at the intersection of the Hudson River, New York Harbor, and Long Island Sound already made it the preeminent harbor on the East Coast, but through

rail connections to Pennsylvania and the west would further its status. In 1861 the New York backed Erie Railroad became the first through trunk line to the Midwest and Great Lakes with financial control of lines to Buffalo and Chicago. The Erie's mainline began at Jersey City and cut across New Jersey's northeast corner over rights-of-way it acquired from locally controlled companies like the Paterson and Hudson River Railroad.

While the Erie led the way to the Midwest, the Central Railroad of New Jersey (CNJ), the Lehigh Valley Railroad (LVR), and the Delaware, Lackawanna, and Western Railroad (DL&W) contended over the Pennsylvania coal trade. In 1868 the Lackawanna, originating in the lucrative Pennsylvania coal fields, acquired the Morris and Essex Railroad to gain direct access to Newark and Hoboken, and thus New York City. By 1882 DL&W connections extended to Buffalo via Scranton and Binghamton to make it more than simply a coal hauling line. In 1875 the LVR, also originating in the coal fields and not to be outdone by the DL&W, built its own line from Phillipsburg to Perth Amboy, and over the next twenty years secured rights to several terminals on New York Harbor. The CNJ, outmaneuvered by its rivals and suddenly at a loss, fell into receivership in 1877, only to be purchased by the Philadelphia and Reading Railroad (Reading) to complete that line's connections from eastern Pennsylvania to Jersey City.

The expansion of the Reading Railroad brought a powerful new competitor on the New York-Philadelphia route. In 1871 the Camden and Amboy was leased by the Pennsylvania Railroad, ending the former's monopoly. The Pennsylvania Railroad had been desirous of the Camden and Amboy's terminals at South Amboy and Jersey City to complete its own through lines from New York to Chicago via Philadelphia. The Pennsylvania's and Reading's acquisitions placed Philadelphia capitalists in control of the New York-Philadelphia routes, much to the envy of New York City railroad backers.

The railroads' impact on the everyday patterns of life in New Jersey was all encompassing. Tracks extended into every important city, and small towns like Bridgeton in Cumberland County and Somerville in Somerset County grew and prospered because of the coming of the railroad. Other towns like Neshanic Station and Manville sprang up because of the railroad and the access to markets the line offered. More than any other factor, the rail lines stimulated the renowned industrial development of the state. The lines provided economical and efficient movement of raw materials and finished products, and the number of lines within the state offered ready access to the markets to the east and west as well as access to the major ports of New York and Philadelphia.

The railroads also allowed people to live further from their jobs in the city and to commute to work each day. Suburbanization was seen first in northeastern New Jersey where from 1869 to 1897 the number of daily railroad passengers making ferry connections from New Jersey to New York City increased from 48,000 per day to something over 175,000 (Condit, p. 129). The commuter traffic proved to be an extremely lucrative aspect of the operations of several rail companies, especially the CNJ and the Erie. Both built handsome suburban

stations along their routes in Bergen, Essex, and Union counties to cater to the residential commuter clientele.

During the late-19th and early-20th centuries, North Jersey lost much of its rural character as population increased and suburban communities took over farmland. Across the Delaware River opposite Philadelphia, the western portions of Burlington, Camden, and Gloucester counties also experienced suburbanization, but to a lesser scale and later than northern New Jersey. Philadelphia's suburban growth was most rapid to the north and west of the city, and it would remain to the 20th century and the automobile to complete New Jersey's suburban transformation.

More important to South Jersey was the fact that the railroads encouraged city dwellers to take vacations and weekend holidays. The shore became one of the most popular tourist destinations not only for Philadelphians and New Yorkers but for people as far away as Chicago. The Pennsylvania Railroad, the Reading Railroad, and the CNJ were the leaders in the development of the shore lines. Working in concert with land developers, religious retreat organizers, and tourist promoters the railroads opened up the entire length of the Jersey Shore from 1865 to 1900. In 1881 the Atlantic City Railroad, owned by the Reading line, alone carried over 330,000 passengers between Camden and Atlantic City. The New York and Long Branch Railroad (1873), a joint venture of the Pennsylvania and the CNJ, ran from South Amboy to Long Branch and was a significant factor in the development of Monmouth County. The extension of lines to the shore also helped develop interior portions of the Pine Barrens, especially allowing for agricultural development of such commercial fruit crops as peaches and cranberries, which could be grown in the sandy soil.

After 1890 emphasis shifted from the construction of new railroad lines to the upgrade and improvement of existing rights-of-way. The weight of rolling stock and the increased usage meant that most lines needed to be upgraded to meet current demand. Most railroads began campaigns to replace all of their older iron or wood bridges that had not been designed to carry the new, heavier loads, accounting for the scarcity today of 19th-century railroad bridges. The DL&W led the way in notable 20th-century railroad bridge engineering achievements with the Newark City grade crossing elimination (1902-1905), New Jersey's first large-scale effort to separate railroad from street traffic, and with the New Jersey Cutoff (1908-1911), a massive cut and fill project across the New Jersey highlands in Warren and Sussex counties. The cutoff includes two technologically distinguished open-spandrel reinforced concrete arch bridges and a host of other smaller reinforced-concrete structures (Casey & Douglas, pp. 140-141). The objective of the cutoff was to reduce the time and cost of moving coal from Pennsylvania to the New York market.

Despite the railroads' ongoing and often innovative efforts to keep up with traffic demand, it might be argued that success eventually overwhelmed New Jersey's rail system. The greatest problem was that New York Harbor had become a bottleneck of unforeseen proportions with enormous planning and construction difficulties. As one historian has noted, "perhaps the most remarkable characteristic of the Port of New York in the years

of rail ascendancy was not its size, but the fact that it worked" (Condit, p. 101). The width and depth of the harbor ruled out bridges to provide direct connections to Manhattan island. Traffic from the west transferred to ferries and lighters at the New Jersey shoreline and floated across the harbor to Manhattan proper. Because of the tremendous demand for access to the city, the railroad companies purchased almost every square inch of shorefront for their terminals and freight yards, installed automatic signals and switches, developed new technologies for the efficient loading and unloading of freight cars, but still met with numerous obstacles, not the least of which was direct passenger access to the city.

In 1908 the first subaqueous tunnels for passenger subways with connections to the major rail lines at Jersey City, Hoboken, and Newark were completed under New York Harbor. The tubes carry the present-day PATH rapid-transit trains. The Pennsylvania Railroad was the only railroad to undertake its own tunnels, which run under the Hudson River from Weehawken, New Jersey to Manhattan. The New York Extension was completed in 1910 for the opening of Pennsylvania Station.

The New York Harbor bottleneck caused tremendous traffic delays during World War I (1914-1919). The United States was the "Arsenal of Democracy," and New York, the primary shipping point for military supplies to the European theater of war. By late 1916 over 100,000 freight cars stood stalled in New Jersey railyards waiting to be unloaded onto ocean freighters, which themselves were becoming scarce because of the depredations of German U-boats. To make matters worse, the interlocking nature of the integrated rail systems meant that idle cars in New York equaled freight car shortages in other parts of the nation. In December 1917 the lines from Chicago east came to a complete standstill, prompting the federal government to takeover the administration and operation of the nation's railroads (Condit, pp. 114-115).

World War I marked a turning point in the history of American railroading. After 1919 government regulators increasingly demanded tighter controls of railroad rates, operating procedures and labor conditions, and railroad executives claimed regulations cut into profits. Meanwhile federal and state legislators and bureaucrats, disheartened by the railroad's poor performance during the war, turned their attention to the construction of better highways. The Holland Tunnel (1927), George Washington Bridge (1931), and Lincoln Tunnels (1937-1945) greatly improved vehicular networks between New Jersey and New York City and promoted interstate trucking. At the same time the agencies almost completely ignored the needs of the railroads. The railroads lost their market share rapidly even though postwar freight volumes surpassed prewar figures (Condit, p. 314).

The railroads' financial difficulties deepened in the Great Depression resulting in the merger of several formerly competitive lines, most notably the consolidation of the Pennsylvania Railroad's and Reading Railroad's lines in South Jersey in 1933 to become the Pennsylvania-Reading Seashore Line (PRSL). Even though freight volumes fell off during the economic downturn, the railroads remained the primary movers of through traffic

for the decades of the 1930s and 40s. During World War II they avoided the problems of the previous war and played a major role in the war effort. When economic prosperity returned after World War II, however, Americans took to the state highways in record numbers. The construction of the New Jersey Turnpike (1948-52) and the Garden State Parkway (1952-1955) demonstrated the state's continued commitment to meeting the demands of large volumes of vehicular traffic (Cranmer, pp. 62-66). At the federal level the Eisenhower administration's decision in 1953 to build an interstate highway system gave notice that even the railroad's superiority in long-distance bulk freight would not go unchallenged. In the 1960s the railroads entered a period of rapid decline eventually resulting in line abandonments and government take overs. Today, New Jersey Transit and Amtrak continue to operate passenger services, and Conrail freight services, on several of the historic lines, but at volumes greatly reduced from historic levels. Despite their recent decline, the railroads touched most every aspect of development in New Jersey between 1832 and World War I leaving a rich legacy that made the state what it is today.

HIGHWAYS AND BYWAYS

BEGINNINGS OF THE GOOD ROADS MOVEMENT 1880-1920

Until the very end of the 19th century, road and bridge building remained the jurisdiction of untrained elected local officials. By 1880, county freeholders spent most of their energy improving bridges while township or municipal officials built and maintained the roads. In some areas, the roads were maintained by statute labor performed in lieu of tax payments. Since most long-distance or heavy hauling at that time was done by rail, demand for good roads passable year round was not great.

It was the two-wheeled conveyance that sparked the Good Roads Movement. The high-wheeled bicycle, or "ordinary" bicycle, appeared about 1876, and the "safety" version with equal-sized wheels was introduced from England in 1887. A reliable pneumatic tire was available in 1889. Urban dwellers, especially, took up touring on bicycles, which became a national craze, and cyclists formed the League of American Wheelmen (LAW) in 1880. In response to encountering miserable roads, the LAW was instrumental in campaigning for programs to assist with improving roads in both developed and outlying areas. The organization met initially with little success because farmers feared that improvements for "idle-rich" urban cyclists would mean higher taxes with little return for them. The Wheelmen quickly recognized that success rested on enlightenment about the general benefits of improved roads, and they initiated an educational program which served as the basis for the Good Roads Movement for the next 25 years. The LAW claimed that good highways would raise property values, open new markets, provide access to manufactured goods, end rural poverty, increase political participation by farmers, and improve education. In other words, good roads would end rural isolation and get farmers out of the mud (Seely, p. 12).

In late 1892 the Wheelmen also formed the National League for Good Roads at a national conference. An outcome of that conference was the drafting of a federal bill creating a national highway commission. The bill failed, but concern about road improvement was such that in fiscal year 1894 an appropriation of \$10,000 was authorized to the Department of Agriculture for the investigation of road construction and management. The Office of Road Inquiry was established within the Department of Agriculture to gather and disseminate technical information about roads to locals. Later known as the Office of Public Roads (OPR), and the Bureau of Public Roads (BPR) after 1917, the agency became the very model of Progressivism with the apolitical expert as policy maker. The activities of the OPR, like object-lesson roads and scientific testing of road building materials, were directed toward achieving the most efficient application of scientific knowledge to solve technical and social problems. The federal agency established the model that would be imitated in state office after state office. The OPR and BPR are the direct predecessors of the Federal Highway Administration (FHWA).

The League of American Wheelmen worked for good roads on the state level as well as the national level. Cycling was extremely popular in New Jersey, especially at the Shore, and there were many LAW members in the state. Largely as a result of their influence, in 1891, New Jersey became the first in the union to establish a state aid road building program.

Their success was based in large part on the League's expanding its focus to prove that road use was not just local in nature and limited to cyclists. They demonstrated that wagon teams from any number of counties used other counties' township and municipality roads as through routes. It was thus argued that, in fairness, the county and the state should shoulder the burden of building them, not the localities. The 1891 law establishing the state aid program apportioned the cost of road construction among the adjacent property owners (1/10th of the cost), the state (1/3 of the cost), and the county (the balance). While the county could determine which roads would be improved, the state had the right to approve or disapprove specifications for state aid roads.

The 1891 New Jersey state-aid act represents a milestone in the history of highway administration in the United States because it clearly defined that road improvement was a shared responsibility between the state and local authorities. The first state aid road improvements consisting of 10.55 miles in Middlesex County were completed in 1892. In 1894 the legislature established the Commission of Public Roads, the predecessor agency to the New Jersey Department of Transportation, to administer the program. New Jersey became the second state, behind Massachusetts, to establish a state highway organization. The Commissioner of Public Roads was appointed for a three year term by the Governor (USDOT, p. 43). In 1895 Commissioner Henry I. Budd reported that 46.11 miles of state aid roads had been constructed, primarily in 1 1/2- to 5 1/2-mile long sections of gravel or macadam. Often built in the center of towns, the short sections of highway served as object lesson roads as well as civic improvements.

The object-lesson road was used successfully by the state as a means to disseminate information about road building to local contractors and elected officials and also as a "laboratory" in which to test new products and construction methods. Throughout the rest of the 1890s and into the 1900s, the New Jersey Commissioner of Public Roads and his small staff tested materials and methods, like oiling roads to keep dust down or the Telford versus the Macadam paving system, to ascertain their effectiveness under local conditions (Commission of Public Roads. Annual Report 1895-1910). In an era when technical expertise was increasing rapidly, disseminating information to local officials was an important activity of progressive-oriented agencies like the Commission of Public Roads. To that end the annual reports included the required summation of the year's activities as well as a host of articles and testimonials aimed at county engineers and elected officials charged with improving local roads.

The state aid was for new construction of roads only, and maintaining the state aid roads rested, often unsatisfactorily, with the county, township, or town to fund and execute. This was a source of constant frustration to the state agency because the counties often lacked the professional personnel to do the work properly or in a timely manner. As late as 1916, Commissioner Edwin A. Stevens was reporting to the governor that because all maintenance responsibility rested with local authorities, "the powers of the [state] road department to protect the state's investment [in state aid roads] are limited and ineffective..." Stevens stated that "the county was too small a unit to provide satisfactory service, and that the same was even more true of townships and municipalities" (CPR, 1916, p. 58).

Bridges were not initially included in the state aid activities. Like highways, there were no uniform statewide standards for bridges until well into the 20th century, and their improvement was strictly a county-controlled issue. Old bridges that were narrower than the improved roads were often bottlenecks as was their alignment. Bridges were primarily set at a right angle, or as close to it as possible, regardless of the actual alignment of the road. The result was sharp curves and abrupt grades that became a greater hazard as motor vehicles increased in currency (CPR, 1913, p. 113).

By 1899 the annual appropriation to the Commissioner was \$150,000, up from the initial expenditure of \$20,661 in 1892, and over 500 miles of roads had been improved. Macadam was the pavement of preference, and the annual reports were still a "how-to" and promotional publication. New Jersey was justly proud of the work of its position as a national leader in good roads, and it included an object-lesson pavement display as part of the state's exhibit at the 1903 Louisiana Purchase Exposition at St. Louis. At that time New Jersey was one of only seven states in the country with a highway department (USDOT, p. 65). In 1905 the legislature enacted an automotive license fee law with the revenue generated from registration to be used for maintenance on already improved roads.

The 1890s legislative acts did not resolve many of the existing problems that would continue to plague the effort to establish a network of good roads in the state in the early 20th century. There was no master plan or designation of arterial routes. Roads that were to be improved or built were strictly local decisions, a privilege that elected officials were not willing to surrender to the state. This arrangement meant that the roads that needed most to be improved might not be the ones done. There was also no guarantee that the improved roads would be interconnected, although by 1896 it was noted that "continuous highways were being built between cities" (CPR, 1896). State officials constantly railed against the continued use of narrow-wheeled conveyances which rutted and ruined improved and unimproved roads alike.

Like other states that were quick to establish a highway organization, New Jersey's enabling legislation and policies were set in the era of the horse and buggy, not the automobile. The 1891 act and its 1905 extension dealt primarily with farm-to-market roads and how to maintain them, not arterial roads capable of sustaining heavy truck traffic. By 1905 the increased weight and speed of the motor car and the truck was wreaking havoc with the already improved roads, and the existing bridges were frequently not of sufficient capacity. There were no state highway routes. By 1910 it was clear that reform was necessary in order to meet the needs of the present as well as the future. In his 1911 report to the Commissioner, Robert A. Meeker, State Supervisor of Roads, noted that because of "the change in the character of traffic over our roads due to the perfection of the motor vehicle, the necessity for a classification of our improved roads has arisen" (CPR, 1911, p.65). This involved questions of alignment, width, grade, and pavement. Meeker suggested that roads be classified on the French model of through, cross, and local routes with improvements predicated on the service level classification of the road.

New Jersey did not update its policies or increase funding for its road program until the election of Woodrow Wilson as governor in 1910. The state was controlled by corporation-favoring Republicans and strong party bosses from 1896 through 1910, but Democrat Wilson ushered in an era of reform that reflected the Progressives' objective of using apolitical specialists, or experts, and the scientific approach to solving social and technical problems. In theory, the learned replaced the political cronies as the setters of policy, with inefficiency and corruption replaced by honest, efficient administration.

Civil engineer Edwin A. Stevens, a Progressive Democrat from the famous Hoboken family, was Wilson's Commissioner of Public Roads. Under Stevens' leadership the department was transformed into the dominant influence in highway construction and maintenance that it is today. Stevens served from 1911 through the establishment of the State Highway Commission in 1916. He was appointed to the new commission for a 2-year term in 1916. He represented the new type of professionally trained civil servant that reflects the Progressives' philosophy of the expert as the policy maker. The transportation system was of vital commercial importance to the state, and road work needed, like any other business, to be addressed in a businesslike manner. Under Stevens' leadership, the staff of the department increased dramatically, as did its funding. Bridge construction was

included under state aid, uniform standards for construction and maintenance were implemented, and state highways were established, surveyed, and improved. As Stevens pointed out in his 1914 report, "the whole tendency of road legislation in this and other states is towards a more centralized control. Roads have become matters of general and no longer of merely local interest" (CPR, 1914, p.73).

As early as 1912 New Jersey state officials recognized that "increased vehicular traffic will restore the highway to the importance it occupied until about the middle of the last century" (CPR, 1912) when the railroad became king. With its geographic position between the two largest ports and population centers in the country and its industrial-based economy, New Jersey was a transportation bellwether state. The foresight the state exhibited in its highway improvement programs in the 1910s would serve it well in the post-World War I period of expansion, when the state's primary and secondary roads would become the most congested in the country.

The federal government also became a participant in road development in 1916 with passage of the Federal-Aid Road Act. "In the best Progressive fashion, the law provided a \$75 million federal carrot to encourage the slow but uneven movement by states toward centralized highway administration by experts, promising improved quality and greater efficiency" (Seely, p. 48). Passed at a time when a national discussion raged between one group intent on improving rural roads to facilitate mail delivery (RFD) and to get the farmers out of the mud, and another group promoting long-distance highways, the federal law favored the former and only addressed rural road improvements. Logan Page, director of the Office of Public Roads from 1905 through 1917, was like most people in 1916. He failed to anticipate a transportation system based on cars and trucks as the future of long-haul movement rather than railroads. His attitude affected how the federal funds that his agency would administer would be applied until after World War I.

CREATION OF NEW JERSEY STATE HIGHWAY DEPARTMENT

State Legislation creating the "modern" highway commission, the politically appointed body that directs the work of the state highway department, was passed in 1916. Its creation was linked to a federal mandate that each state have an OPR-approved state highway department in order to be able to receive federal funds. The OPR guidelines specified that each state highway department was supposed to prepare all plans and specifications and control all construction and maintenance on state highway routes. The 1916 legislation thus radically shifted control of road and bridge construction on through routes from the county and township to the state. Instead of its former role of distributing funds and approving plans, the department was now actually responsible for building and maintaining a state highway system. Road and bridge work was placed in the charge of "men who have made a study and a business of road work" (Public Road Comm. Annual Report, 1912, p. 106) to be handled in a fair and efficient manner to best serve the greater interests of the state.

The 1916 act legislated 15 routes to be designated as state highways, moving the state beyond the federal farm-to-market road orientation to one that acknowledged the need for a comprehensive statewide plan. The new state highways were to be made up of existing thoroughfares that would be taken over with compensation. The state was given the authority to improve and maintain the routes to its own standards. The program was funded by bond issues repaid by motor vehicle registration fees, license fees, fines and penalties. The department would do all the work on the state routes, from initial surveying through supervision of the construction and maintenance (NJ State Legislature, Chapter 285, Laws, Session of 1916).

In 1917, the Public Road Commission was succeeded by the State Highway Commission, of which two members had to be engineers, and a state highway department headed by George W. Goethals. The first order of business for the new department was to survey the legislated state routes to assess their condition and the cost of improving them. Bridges were also surveyed and rated, and those with a capacity of under ten tons were listed as substandard (Annual Report 1917).

World War I, which America entered in 1917, slowed both the expenditure of federal aid funds and the implementation of the reorganization of the state's road program, as men and material were in short supply until after the 1918 armistice. Virtually no work was done in 1918. Heavy truck traffic on its way to and from Port of New York facilities in Hudson and Essex counties, in particular, had wreaked havoc with the roads during the war, mandating that much of the work done on the state routes before 1918 would have to be redone.

COUNTY ENGINEERS

The responsibility for building and maintaining bridges was vested with the Board of Chosen Freeholders in 1714, and the practice continued in most counties until about the turn of the 20th century. Minute books reveal that the freeholders spent most of their time during the second half of the 19th century dealing with bridges. As new methods of bridge construction were developed and projects became more complex, freeholders sought professional advice. In 1872 a Somerset County bridge committee was authorized to "employ a practical Engineer to give the Best plan for the Construction of a good and Substantial Bridge" (Freeholders Minutes Book 4 1872:134). Civil engineers were retained on a project by project basis to assist freeholders and bridge committees with bridge type selection and designs for bridges, but final authority for acceptance of both design and fabricator remained with the lay freeholders.

The same demands that foisted the state into road improvement activities were felt more strongly on the county and local level, and around the turn of the century, counties were hiring professional civil engineers to work on both roads and bridges. Somerset County

hired its first county engineer in 1897; many other counties, like Warren and Monmouth, did not hire them until 1909.

The creation of the position of County Engineer by the legislature in 1909 (Chapter 220) and the introduction of state and then federally sponsored road and bridge programs removed the freeholders from the intimate position of control which they had enjoyed earlier in their history. In addition to the design and construction of bridges and roads, the county was responsible for maintenance and repairs as well. As county road systems kept improving, so did the staffing requirements. In 1930 Somerset County employed permanently, in addition to the county engineer, a bridge supervisor, a road supervisor, 5 foremen, and 35 laborers. Warren County had a county engineer, who also designed most of the bridges, and a supervisor of roads with a permanent crew under his direction. Even State Bridge Engineer Morris Goodkind served as a county bridge designer in Mercer County before moving on to his state position. Thus, the counties, townships, and towns, which continued to improve and build roads and erect bridges, followed the lead of the federal and state agencies by removing technical decisions from the elected local officials and placing the responsibility with professionally trained or skilled "experts" who increasingly answered to standards set by state and federal bureaucrats.

GOLDEN ERA OF HIGHWAY BUILDING 1921-1941

The post-war era ushered in the golden age of highway building. State highway departments headed by professionally trained engineers, like the New Jersey State Highway Department, took control of construction and maintenance and displaced the counties as the leading road and bridge builders on major through highways (Seely, p. 72). The strain the war effort put on the nation's road system, especially in New Jersey, did much to promote the need for intercity roads and roads and bridges capable of carrying great weight. The successful use of trucks to haul freight and material to ports proved that the future belonged to trucks, not trains. Now that state programs controlled road building, routes were determined by engineering and traffic considerations rather than the Progressive goals of fairness and getting the farmers out of the mud. As early as 1912, the New Jersey Public Road Commissioner had argued that "public roads constitute a transportation system of vital business importance to the state," but it was not until after the war experience of road failures and unprecedented congestion in Hudson, Camden, and Essex counties that the necessary resources were made available to adequately address the problems.

In 1919 a vast reserve of money was available to the highway department, including \$1,120,000 in federal aid. One hundred miles of state highway were "completely rebuilt," primarily with Portland cement concrete, and 210 miles of road were taken over by the state. Late in 1920 the State Highway Department was reorganized into divisions with bridges being placed within the construction division. The bridge division office had been

part of the Public Utilities Commission in Newark, but it was recommended that it be moved to the central office at Trenton as soon as possible.

Due in large measure to the favorable experience with trucks for long-distance hauling during World War I, the national highway system proponents were successful in 1921 in persuading Congress to concentrate the expenditure of federal funds on roads each state decided would be part of that interconnected nation-wide system. The complicated funding formula was known as the 7% system because each state could designate up to 7% of its total mileage as routes that would qualify for federal aid. It was not until 1933 that federal aid was again extended to non-federal aid system roads (FHWA, p. 108-109).

In the early 1920s the legislature authorized additional state highway mileage almost annually, so that from 1917 to 1926, state highway mileage increased from 655 miles to 1,459. However, money to take local roads into the state system and improve them was historically slow in coming. In 1926 only 875 miles of the 1,459 miles authorized had actually been taken over by the state, and not all of that had been improved.

Based on its location between the two largest cities on the east coast, the New Jersey State Highway Department faced more complex traffic problems than most other states. In addition to the 90-mile long corridor that links New York and Philadelphia and the densely developed urban areas adjacent to those cities, the state's 120-mile Atlantic Ocean coastline was still immensely popular as a draw of both in-state and out-of-state visitors, many of whom reached the area by automobile. The volume of traffic produced by the resident and the traveler was augmented by that incident to traffic related to the industries and agriculture of the state (Sloan, p. 1-2). The intersection of Routes 1 and 4 at Rahway (Middlesex County) saw a 251% increase in traffic between 1921 and 1926 (Sloan, p.5). And, in 1927, a tunnel under the Hudson River and a bridge across the Delaware River would bring more vehicles into the most congested portions of the state at an even faster rate. Traffic increased faster than facilities for handling it could be provided.

Addressing the congested conditions within the state brought the New Jersey State Highway Department to the fore as a national leader in highway and bridge engineering. Under the guidance of William G. Sloan (1876-1960), State Engineer 1923-1929 and 1933-1937, the department developed innovative solutions to complex traffic problems. Recognizing the potential impact that the 1927 tunnel under the Hudson River and the 1926 bridge across the Delaware River at Camden would have on already congested areas, Sloan appointed and chaired commissions to study the problem spots in Hudson County, Camden, Keyport-Perth Amboy, and Newark in order to come up with the best solution to the problems particular to each site. The studies resulted in solutions that ranged from the 1926-1932 Route 1 Extension and Pulaski Skyway, an engineering masterpiece that ranks as America's first super highway, to an interconnected series of traffic circles and collector perimeter roads to feed major bridges and tunnels. In response to the volume of traffic in the congested sectors of the state, separating highway grade

crossings at intersections was a constant goal for the department. In 1928 it produced the first four-leaf clover intersection in the country at Woodbridge (Middlesex County). Highway ramps and overpasses from the late 1920s and 1930s throughout the state attest to the continued constant striving of the State Highway Department to design roadways in an efficient and aesthetically pleasing manner.

William G. Sloan, a Cornell-trained engineer with a strong background in transportation-facility engineering, also oversaw the writing of the 1926 20-year plan for the department. By identifying need and outlining several classifications of routes and specific rights-of-way, most of which were eventually developed, Sloan and the department established the tenor of the department through the Second World War. Unlike his predecessors, Sloan saw the automobile and truck, rather than mass transit and rail, as the transportation system of the future, and the statewide plan was drafted accordingly.

Based on Sloan's plan, the State Legislature expanded the state highway system, in 1927 to 50 primary and secondary routes totaling about 1,820 miles. At that time, only about 800 state highway miles had permanent or semi-permanent paving. Through the rest of the 1920s and the entire 1930s, state highway development necessitated more than just the reconstruction of existing roads. The volume of traffic in the state mandated that the department develop ways to provide economical operation, freedom from congestion, and safety. The department acknowledged in 1930 that "some of the solutions of cross traffic have necessarily been intricate," and at times confusing. Solutions to the existing and anticipated needs included wider and straighter roadways, by-passing centers of population, viaduct construction, railroad grade separations, highway grade separations, and proper directional and cautionary signage. Considerable work of this character, including viaducts, grade separations, and traffic circles, was the hallmark of the department until the outbreak of World War II. In 1930, the construction division reported that its projects underway included 307 miles of roadway with various pavings, 115 stream bridges, 19 railroad grade separation bridges, and 27 highway grade separation bridges. The projects were funded by both state and federal aid monies and included local aid.

In spite of the Great Depression, the road and bridge building boom of the 1920s continued through the 1930s thanks to federal involvement. While the state and municipal ability to match federal funds decreased, primarily because personal and property tax revenues dropped markedly during the Depression, the federal government filled the gap with work-relief funds. Eligibility for federal aid was extended from predominantly state highways to county, township, and borough projects. Highways became the largest public works program undertaken by the federal government. Rather than "make-work" projects, the federal work relief money went into existing programs administered by the states through the BPR to produce needed physical improvements. It is estimated that between 35% and 45% of all workers on federal relief during the 1930s were involved with building roads (Seely, p. 91). In 1932 the state built 114 miles of state highways and had about 103 bridge projects underway, and the "high level" Route 25 connecting link over the Passaic and Hackensack rivers known as the Pulaski Skyway opened in November.

The biggest disruption to the state program occurred in 1933 when a combination of events left the department unable to function for several months. In addition to two unfilled vacancies on the four-person State Highway Commission, the State Highway Engineer resigned, and state revenues to pay sinking bond obligations and fund new construction fell dramatically. The Roosevelt administration established new programmatic procedures that required federal-aid projects be concentrated in areas of the state with high unemployment. Most of the projects on the state's 1933-1934 work plan did not conform to the federal requirements, so a great deal of time was lost negotiating an acceptable state work plan with the federal work relief agencies. Because of a reduction in funds and thus projects, and the reapportionment of federal aid to include county and municipal projects, the State Highway Department reorganized. In 1935 the four-person commission was replaced by a single governor-appointed State Highway Commissioner, the administrative and executive head of the State Highway Department. The existing five divisions of the construction section were reduced to two district engineers and the bridge division was cut from 85 employees to 59. All in all, State Highway Engineer William S. Sloan, who returned to head the troubled department in 1933, stated in his annual report to the governor that the work of the construction division had been delayed about a year because of all the problems (SHD 1933).

Throughout the 1930s the department worked on separating local and through roads by dualizing highways like NJ 46 and separate highway grade crossings in the congested areas of the state. It also worked with the Port of New York Authority to plan, design, and build the approximately 2.5-mile long connector to and from the express highways to the west and the 1937 Lincoln Tunnel. Designated NJ 3, the highway, with its unusual three-level interchanges, was developed as both a limited-access through route and a local road. Located in a congested, developed urban area, the road reflects the high level of understanding of traffic flow in congested areas the department possessed as well as its ability to design innovative and successful solutions to difficult engineering problems. Additionally, Route 3 represents the concern with aesthetics that also distinguished the department throughout from the mid-1920s on.

After 1929 the department had more control over railroad grade crossing eliminations. Previously the almost exclusive purview of the Public Utilities Commission, which regulated the railroads within the state, grade crossing eliminations were fractious with agreement among the concerned parties difficult to achieve. Legislation passed in 1929 gave the State Highway Department the authority to design and build overpasses, which were made mandatory on the newly developed state highways the department was developing. Between 1917 and 1942, 46 grade crossings were eliminated, 67 new crossings were not at grade, and 20 inadequate structures were reconstructed. Additionally 28 grade crossings were eliminated on non-state routes using federal aid funds (SHD 1942).

America's entry into World War II after the attack on Pearl Harbor in December of 1941 stopped the great era of highway development in the state and nation. As during World

War I, men and material were redirected into the war effort. The department's staff was greatly reduced, with personnel serving in both the armed services and in civilian capacities with the Army or Navy. Construction materials such as steel and concrete were controlled by the War Production Board. What little activity there was in the state between 1942 and 1947 was primarily related to improving access to military bases, like the Picatinny Arsenal in Morris County and the Navy Dry Dock at Bayonne, and defense industries. Maintenance of existing roads was increasingly important during the war, but the construction division, with few actual projects to complete, spent a portion of its time planning for post-war improvements to the state's roads and bridges.

NEW JERSEY STATE HIGHWAY DEPARTMENT BRIDGE DIVISION

Bridge work was first made a part of the state road program in 1912 when the State Road Department funded bridge construction through its local aid activities. The number of bridges built with local aid increased by about 25 every year, and in 1915 the department was authorized to hire civil service bridge inspectors.

When the State Highway Department was established in 1916, State Highway Engineer George Goethals thought that it was an unnecessary expense to organize a separate division under the State Highway Commission. The bridge work was assigned to the Public Utilities Commission Division of Bridges in Newark. The Public Utilities Commission was responsible for all railroad-related bridges, and Goethals reasoned that, by expansion, the Division of Bridges could take care of this area of the state's work and that "such an arrangement would eliminate any liability of friction" (SHC, 1918, p. 3-4). Thus the office of "Inspector of Bridges" was initially eliminated from the state's highway department organization. When the State Highway Department was reorganized in 1920, it was recommended that the bridge division, actually part of the construction division, be moved from the Public Utilities Commission in Newark to the department's central office at Trenton. That consolidation did not occur until December, 1923, when the 41 employees of the bridge division relocated to the downtown Trenton office of the State Highway Department.

When the bridge division was created in 1913, there were no standards as to width and type, and old narrow and substandard bridges often proved a bottleneck on improved roads. The bridge section promoted a uniform width of 30' and a capacity of at least 15 tons. In 1914 it was studying reinforced concrete arch and slab bridges to determine the most economical designs, and it was funding those concrete and steel stringer bridges, not metal truss spans. With the passing of the 1916 act that created the 15 state routes, the bridge division began surveying the extant bridges to determine which were adequate. Those that did not have a 10-ton rating were listed as substandard.

With the exception of movable spans, which were handled by consulting engineer firms with proprietary designs, the bridge division was responsible for the design and

construction of all bridges and structures with a clear span of at least five feet on the state routes as well as approving the plans and specifications for local aid bridge projects. Its output during the "golden age" of highway construction, as the period between 1921 and 1936 is known (Seely, p. 67) was tremendous. In 1925, nearly half the of the total amount of state and federal funds expended that year was for bridges. There were 89 bridge projects underway, and in 1927, 54 new contracts for bridges were let. In 1930 the division's 67-person staff was responsible for about 140 projects, but in 1933, cutbacks and funding problems reduced the staff, and the current projects to 60. In addition to the bridges on the state system, the division was responsible for many more technically sound spans built by the 21 counties with local aid.

Morris Goodkind (1888-1968) was a Columbia University trained engineer who joined the division in 1922 as a general inspector and served as State Bridge Engineer from 1925 until 1955. He was a strong proponent of the use of concrete in bridge construction, and it is this preference that characterizes the work of the bridge section during Goodkind's tenure (Lichtenstein Interview). Goodkind recognized the long-term value of encasing rolled stringer in concrete to protect them, and the encased stringer became the most common bridge type used by the division and many of the counties prior to 1946. Goodkind also demanded that state-designed bridges exceed American Association of State Highway Officials (AASHO) standards for thickness of concrete deck and allowed deflection. His insistence on high design standards resulted in spans that have stood the test of use and time.

In addition to its technical proficiency, the Goodkind era is distinguished by its emphasis on bridge aesthetics. He appreciated the plastic (moldable) qualities of the material as reflected in the designs the department was producing. An architectural section headed by Arthur Lichtenberg, a Pratt Institute-trained designer, was established about 1927. The Goodkind-Lichtenberg collaboration resulted in New Jersey being considered a national leader in the area of bridge aesthetics. Foremost among their designs are the open-spandrel reinforced concrete arch bridges built at major crossings between 1929 and 1950. The spans define the highest level of refinement in reinforced concrete arch technology, and the earliest of them, the US 1 over the Raritan River at New Brunswick (1203150), earned Goodkind the Phebe Hobson Fowler Architectural Award in 1930. Bridges of similar design grace state highway crossings at Paterson (1606158, 1607163, 1607168) and Hackensack (0205150).

Attention to appearance was afforded to all types of state-designed bridges, with detailing such as well-proportioned concrete balustrades, faience tile characters identifying route and date set in the end posts, tile mosaics and borders, and incised decoration on abutments common. Starting in the late 1920s when the state was developing divided highways with separation of grade intersections, Lichtenberg preferred to utilize one design or one decorative motif for the entire route.

Because of the emphasis on aesthetics, many of the bridges built on state highways prior to World War II are distinguished for their high quality, architectonic design. Good representative examples of the department's work are the late 1930s Moderne-style overpass bridges on US 46 in the northern part of the state and the classically inspired accents on the NJ 9 overpasses in Middlesex County. Most such detailing, especially the Moderne detailing of the pilasters and the tile borders, proved to be too costly after World War II, and stone facing became the division's favored motif in the post-war era (Fox Interview).

SUMMARY

Between 1922 and 1942, the State of New Jersey spent nearly a half billion dollars on the construction of a state highway system (Albion p. 313). It was an extraordinary achievement. Many of the highways met the engineering profession's most exacting standards, and New Jersey could boast of one of the highest proportions of highway mileage to land area in the nation. Even more impressive was the tremendous volumes of through traffic whisked along the state's vital transportation arteries.

Hand in hand with the development of a modern highway system went other social, economic, and cultural changes. Most notably, unprecedented numbers of New Jersey residents took to the roads in cheap, mass-produced automobiles. In 1915 motor vehicle registrations in New Jersey totaled a mere 81,000 motor vehicles. In 1940 the number had soared to over 1.1 million motor vehicles (Albion, p. 314). The rapid increase in automobile usage set the stage for massive shifts in where the state's citizens chose to work, live, and recreate. Automobiles in concert with state highways encouraged suburbanization of areas that had been too far distant from urban areas and commuter rail lines to be easily accessible. As early as 1937 city planners characterized the whole east coast from New York City to Philadelphia as a continuous band of metropolitan settlement (Flink 1988, p. 151).

Trends only partially visible in the pre-WWII era, accelerated during the postwar boom. In Middlesex County, for instance, population more than doubled from over 264,000 in 1950 to over 560,000 in 1965 as commuters and businesses relocated outward from troubled urban areas (Cunningham, p. 140). After the war, automobile prices continued to fall making a motor vehicle well within the economic reach of not only middle-class families but working class families as well (Flink 1988, p. 158). The Jersey Shore, which after a rapid period of growth in the 1920s had experienced difficult times during the Great Depression, in the post-WWII period saw a return of prosperity as automobile-driving vacationers returned in even greater numbers. The state highway system encouraged the expansion of state parks and recreation areas, and promoted the growth of a host of roadside services, such as campgrounds, motels, gas stations, and fast food restaurants, all designed to service the traveler on the move.

Between 1920 and 1940 buses captured a large share of the passenger traffic formerly carried by the railroads. The state highways followed fairly closely the same transportation patterns developed by the railroads, canals, and turnpikes, which naturally connected the points most passengers wanted to go. In the late-1920s and 1930s the completion of major highway bridges and tunnels connecting northern New Jersey and New York City lured commuters away from the rails and onto buses that were generally less expensive, picked up passengers nearer their homes, had fewer transfers, and delivered passengers closer to their final destinations. In 1939 state figures indicated that railroads carried 454 million passengers in comparison to buses' 252 million, the latter a startling high number considering most bus lines had been in operation less than 15 years (Albion, p. 314).

Long and short-distance trucking also benefited from improved public highways. In 1940 over 137,000 trucks were registered in New Jersey. Railroads had difficulty matching the rates and services offered by the trucking industry. The maintenance of railroad rights-of-way, locomotives, rolling stock, and real estate was costly, and railroads paid higher taxes than trucks. Furthermore, unless a private siding was available, railroads could not guarantee the picking up of freight at its point of origin or delivering it to its final destination. Some railroads recognized the challenge and went to lengths to integrate trucking companies into their operations, yet still had difficulty lowering expenses to meet the competition. After 1950 the railroads entered a period of extended financial crisis that eventually ended in bankruptcies, abandonments, and government take overs (Albion, pp. 314-315).

In the 1920s the automobile became the backbone of what one historian has called the "car culture," a consumer-goods-oriented society that has persisted to the present day. Over the next several decades the automobile and an improved system of highways revolutionized the lifestyle of the average American family. The automobile freed families from the confines of home, and permitted shopping at self-service supermarkets and shopping centers. It even changed the manner young adults courted and dated; by the 1960s one survey found that over 40 per cent of marriages had been proposed in a car. The garage and driveway became larger and more prominent features of suburban homes. The style and design of one's automobile reflected status and personality, a deliberate marketing strategy of Detroit manufacturers. Throughout all of these transformations in American culture, New Jersey because of its quickly developing suburban character and its excellent system of state highways was among the first states in the nation to feel the impacts of the car culture (Flink 1975, p. 140; Flink 1988, pp. 158-168).

Of course, all of the economic, social, and cultural changes that accompanied the automobile and the state highway system were not without their supporters and critics. While the automobile accompanied increases in the average standard-of-living and offered greater personal mobility, it also held costs to the environment and was a contributing factor to the decline of inner cities in the post-WWII period. During the "golden age of highway building" few planners foresaw the tradeoffs that were made, and perhaps even today, because the influence of the automobile and highway continues so strong, it may

be impossible to tell how history will someday judge the patterns of transportation development in the second-half of the 20th century.

Clearly, no matter what the verdict, throughout the expansion of New Jersey's highway system, bridges provided a vital link. The majority of pre-1945 bridges in the state date from 1919 to 1936 and are thus visible markers on the cultural landscape of the fundamental changes that accompanied the automobile in New Jersey. Dramatic as the impact of the automobile has been on the development of the state, its impact would have been different were it not for the transportation networks (colonial road, early turnpikes, canals, railroads) that came before the car. This is the multifaceted heritage, from the late-1700s stone arch spans on the Great Road to the nation's first clover-leaf interchange, that is so richly embodied in New Jersey's historic bridges.

IV. HISTORY OF BRIDGE BUILDING TECHNOLOGY IN NEW JERSEY FROM THE EARLIEST DAYS UNTIL WORLD WAR II

Just as New Jersey's transportation networks evolved in response to technological advances, the bridges that support canals, railroads, and highways also reflect the advancement of engineering and technology. As one of the most heavily travelled states in the union, the demand to meet the ever-increasing volume of traffic mandated that New Jersey be in the forefront in the development and use of innovative bridge technology and highway engineering. From the application of wood trusses to span major water features in the early 1800s to early utilization of reinforced concrete to build bridges, viaducts, and median barriers, New Jersey has been a leader in the development and application of innovative technologies. From 18th-century great roads with impressive stone arch bridges to America's first superhighway, the evolution of bridge engineering and the impact of technology on social and economic history is well chronicled by the assemblage of historic bridges that survive within the state.

MASONRY ARCH BRIDGES

STONE ARCHES

The earliest extant bridge type in New Jersey is the stone arch. The arch is curved construction with the convex side upward consisting of shaped blocks called the arch ring that compress together under vertical loads. To work, the outward thrust at the base of the arch must be countered by abutments. Regardless of size, the principle behind the arch remains the same; the vertical forces have to be balanced by equal reactions at the abutments.

This was the technology that settlers brought to this country, and it was the technology used when a substantial structure was desired. Over 60 stone arch bridges dating from 1792 through the early 1900s survive in New Jersey. The earliest extant stone arch bridge in the state is barely visible and is not in use, but the buried and bypassed single-arch span over Green Brook near its confluence with the Raritan River in Bound Brook (Somerset County) is believed to date to 1743. It chronicles how early stone arch spans were being constructed in the state.

Toward the end of the 18th century stone arch spans were frequently built at major crossings in cities or on heavily trafficked highways, such as the part of the Philadelphia-New York great road from New Brunswick and Trenton (NJ 27). While not technologically innovative, the remaining stone arch bridges in New Jersey are significant as survivors of first generation-type bridge technology in this country. Examples are located from the Trenton area north; there are no stone arch bridges in the southern half of the state.

Two of the earliest stone arch bridges still in use rank among the longest examples of their type. Built as part of post-Revolutionary improvements to the New York to Philadelphia great road, the 1792 3-span arch over Stony Brook (1129155) at Princeton and the 4-span example over the Millstone River at Kingston (1105151) are constructed of rubble-coursed fieldstone or random-coursed ashlar. Both have corresponding stone spandrel walls and parapets. The ring stones are dressed and gauged. Such detailing is typical of the period, and was dominant into the second quarter of the 19th century.

Coursed ashlar masonry (cut rectangular block) arch bridges date to the 1820s and 1830s. Laid up with crisp, thin mortar joints and dressed blocks with either a smooth or tooled face, the more architectonic stone arches employ similar technology as the rubble-coursed arches, but they reflect finer craftsmanship. Among the earliest documented examples of ashlar stone arch structures are the 1823 New Jersey Turnpike Company span that carries Easton Avenue in New Brunswick over One Mile Run (123B171), a 22'-long span with dressed ring stones defining the arch, and the 1832 aqueducts that carry the Delaware & Raritan Canal over water features in Somerset and Middlesex counties (18G0403).

The use of dressed stone for the arch ring itself, the ring stones, or voussoirs, and the spandrel walls and parapets continued through the 19th century. It was particularly favored for bridges in urban settings to mark their stature. Towns like Rockaway in Morris County, Trenton in Mercer County, and Rahway in Union County all used stone arch bridges to ford the rivers and brooks prior to 1880.

In the mid-1880s, the general acceptance of metal truss bridge technology for highways marked the waning of stone arch spans in New Jersey. Among the last of the great stone arch bridges in the state is the handsome, rusticated 1903 multi-span Pennsylvania Railroad bridge over the Delaware River at Trenton. The railroad's chief engineer, William H. Brown, opposed the use of concrete, except for bridge footings.

After the turn of the 20th century, however, stone was used more often as a non-structural veneer on other types of bridges, like concrete rigid frames or encased steel stringers. A representative example is the 1942 Mercer County Engineer-designed Quaker Road over Stony Brook rigid frame bridge with a rubble-coursed stone veneer. It was used in the state on bridges built after the second world war, especially on the free portions of the Garden State Parkway and on the Palisades Parkway.

BRICK ARCHES

The brick arch utilizes similar engineering principles and method of construction as the stone arch, but the main material of the arch is several layers of mortared brick. Built primarily during the last quarter of the 19th century, brick arches are constructed with falsework and earth fill. They are finished with stone spandrel walls and parapets like those

used for stone arch spans. Only the 1853 White Street over the North Branch Rancocas Creek bridge in the Mount Holly Historic District (03D4108) (Burlington County) was built before about 1875, and it is the only one of the 14 brick arch spans not located in the northern part of the state. The greatest number of brick arch spans are located in Essex and Union counties.

The reason behind the frequency of the bridge type during the 1870s and 1880s is based in part on improvements in both bricks and artificial (Portland) cement mortars, availability of those materials, and ease of erection when compared to stone arches. Additionally, metal truss bridges had not yet completely come to the fore as an alternative technology for highway applications, making brick arches one of the few alternative technologies to stone arches.

The extant brick arch bridges in New Jersey vary from one to three spans. The largest example is the 52' clear span, single arch US 202 over the Whippany River in Morristown (1416152) built in 1891 adjacent to the Speedwell iron foundry. More typical is the handsome NJ 276 over Robinson's Branch Rahway River in Rahway (2006151) (Union County). It is a 3-span bridge composed of 20' to 30' arches with handsome ashlar spandrel walls and parapets.

The most architectonic example of the brick arch bridge type is the nationally significant 22'-span designed by the Olmsted Brothers landscape architecture firm in 1898 as part of the development of National Register-listed Branch Brook Park in Newark (0700077) (Essex County). Richly detailed with stone and concrete accents, the span is finished with a brick-faced spandrel wall. It is as fine a design as the Olmsted firm's other notable bridges in Central Park in New York City.

TRUSS BRIDGES

WOOD TRUSS BRIDGES

The modern era of bridge technology in this country was ushered in about 1800 when the truss was applied to building longer-span bridges. Until that time, bridge technology was limited to stone arches or wood beam structures. While the truss (a triangular shape in which the diagonal members transfer vertical forces in a horizontal direction) was known since at least the 16th century, what was innovative at the beginning of the 19th century was that the basic truss pattern was multiplied many times over to span much greater distances than those possible with timber-beam or king- or queen-post bridges of the 18th century (Clouette, p. 18).

The 1872 Howe pony truss bridge known as Green Sergeant's Bridge at Sergeantsville in Hunterdon County (1000110) is the sole surviving wood truss span in the state, but freeholders' minute books and historical photograph collections are filled with written and

pictorial evidence that wood truss bridges were ubiquitous during the middle quarters of the 19th century. As significant as its contribution to the history of bridge technology in New Jersey, the bridge type was not without inherent weaknesses that eventually made it defunct as stiffer, stronger bridge types requiring much less maintenance were developed. Wood truss bridges were particularly vulnerable to washout from floods or freshets. They were also susceptible to fire, from both locomotives and carelessness, insect damage, and moisture-related deterioration. But the most significant factor in the disappearance of the wood truss bridge from New Jersey's highways and byways in the late-19th century was the development and acceptance of metal truss bridges, which started in the state in the late 1850s.

Wood works well in compression, but it cannot accommodate tensile forces efficiently. This limitation was resolved by William Howe (1803-1852) who, in 1840, patented a truss bridge design that used wrought iron rods for the tension members (posts) and wood for the bulkier compression members and top and bottom chords. His design with the iron tension rods, which is represented by the Sergeantsville bridge, heralded the beginning of the switch from wood to metal truss bridge technology.

METAL TRUSS BRIDGES

The most dramatic and far reaching advance in truss bridge design was the introduction of metal into truss bridges. In the 1840s American bridge designers and builders began to experiment with substituting wrought and cast iron for wood for both compression and tension members. Wrought iron possesses good tensile qualities, and William Howe, Thomas Pratt, Squire Whipple, and others all patented historically and technologically important truss designs utilizing these qualities. Their truss designs ushered in an era of unprecedented advancement in metal bridge technology that was both a product of and a response to industrial advancement in this country.

New Jersey became a microcosm of the national development and application of metal truss bridge technology in large part because it had to keep pace with the demands of its industrial development. The movement of coal from the anthracite coal fields in eastern Pennsylvania to the New York market put a strain on the state's transportation networks. Just as railroads made the 19th century the age of iron, they also made metal truss bridge technology a necessity (Condit, p. 103). By the 1880s, metal truss bridges, introduced less than 40 years before, had become an integral part of America's transportation networks.

The era of metal truss bridges also ushered in new scientific methods for analyzing and predicting the structural action of bridges. Squire Whipple's A Work on Bridge Building (1847) and Herman Haupt's General Theory of Bridge Construction (1851) were among the first treatises to apply mechanical and mathematical principles to truss design and construction. Although Whipple and Haupt attempted to place bridge building on sound theoretical grounds, most antebellum bridge builders continued to work within the craft

tradition of empirically derived knowledge. After the Civil War, advances in engineering education accompanied new standards of materials, workmanship, and construction. A generation of college-educated civil engineers applied scientific theory and experimentation to bridge construction and energetically sought out the cooperation of manufacturers and builders. They established the modern approach to bridge building that included stress analysis, plans, specifications, testing, and inspection (Condit, pp. 115, 139-140; Plowden, pp. 62-63).

INFLUENCE OF THE RAILROADS

It was the growth of railroads in the 1840s and 1850s that more than any other factor prompted advances in metal bridge development. Much of that growth was on the east coast in general and New Jersey in particular, owing to the state's location on the direct route between Eastern Pennsylvania and New York. As the size and weight of locomotives and rolling stock increased through the 19th century, the need for stiffer, stronger bridges forced railroad bridge engineers like Albert Fink, Wendell Bollman, and New Jersey's own Francis C. Lowthorp into a period of dramatic technological experimentation and advancement that resulted in a variety of truss designs in cast and wrought iron.

Examples of first-generation metal truss railroad bridges that illustrate this period of experimentation and transition are rare because subsequent technological advances rendered them obsolete. Between 1890 and 1910, most were replaced by stronger spans. An important survivor from this era is the 1879 Mill Lane Pratt thru truss near Neshanic Station in Somerset County (1852160). In 1890, when no longer strong enough to support the increased weight of rolling stock on the Central Railroad of New Jersey's Hibernia Railroad line, the bridge, built with patented Phoenix-section compression members and compression fittings, was moved to its present location and converted to highway use. Its history illustrates both the evolution of metal truss bridge design during the third quarter of the 19th century and how metal truss technology moved from railroad to highway applications.

Other important early metal railroad truss bridges that survive in a highway application include the 1890 riveted wrought iron Howe pony truss over the Lehigh Valley line in Hunterdon County (1050160) and several open-web girders dating to ca. 1890 in Hudson and Warren counties (090011, 0950163, 2160152). All are significant remnants from the early days of the development of the metal truss bridge type.

TRANSFER OF RAILROAD BRIDGE TECHNOLOGY TO HIGHWAY APPLICATIONS

The history of the Phoenix section illustrates how technology and refinements developed by and for railroad applications were transferred to highway spans, a practice that began in New Jersey in the late 1850s. Patented in 1862 by Samuel Reeves, president of the

Phoenix Iron Company, the Phoenix column is a built-up wrought iron circular section that is stronger and more economical than its cast iron equivalent. Developed at a time when empirical formulae for columns were in their infancy, the section proved to be a stable compressive building block that did as much as any detail to advance the promulgation of metal truss bridges for railroad use because it was economical and not prone to failure. The Phoenix Iron Company was so successful selling bridges with its proprietary section to the railroads in the 1860s and 1870s that it virtually ignored pursuing the highway bridge market. But when the Phoenix-section bridge could no longer provide the strength and stiffness that the railroads were increasingly demanding in the early 1880s, the technology was successfully redirected by the company to the highway bridge market with its lighter load requirements.

As a result of the change in application of the Phoenix section, seven of the eight bridges in New Jersey built with Phoenix sections were built as highway spans, and six of them were erected after 1884. The earliest New Jersey highway application of Phoenix sections is the remarkably complete and historically important 1878 Raven Rock Road Pratt thru truss span in Hunterdon County (10XX300). Fabricated by the nearby Lambertville Iron Works, the well-preserved bridge features idiosyncratic cast iron connections that were made by the iron works. All other New Jersey bridges with Phoenix sections have Phoenix Iron Company-made connecting pieces and feet (bearings). They include the 1885 Hamden Road pony truss bridge in Hunterdon County (10XXF65) and the similar 1892 Elm Street span in Bergen County (020044B).

Another significant group of truss bridges that chronicle the evolution of metal truss bridges for highway applications are the three Pratt pony truss spans designed by noted railroad bridge engineer Francis Lowthorp (1810-1890) of Trenton. He designed bridges for the Lehigh Valley, New York Central, and Belvidere and Delaware railroads. The cast- and wrought-iron highway bridges located in Hunterdon County (10XX0N1, 10XXL95, 10XXG63) date to 1868-1870 and reflect Lowthorp's preference for the use of cast iron for compression members. He declared in a paper delivered to the American Society of Civil Engineers, "there is much more to be feared from defects in wrought iron used for tensile than for cast iron used for compressive purposes " (Lowthorp, p. 228). Lowthorp's distrust of wrought iron, based on experiments he conducted to test each element before acceptance, were prompted by the inability to control impurities in the metal and the shortage of skilled foundrymen. This problem was overcome by his collaboration with Lambertville foundryman William Cowin, who fabricated the three extant Lowthorp trusses in Clinton, Glen Gardner and Lebanon Township. The bridges are nationally significant examples of the gradual movement from wood to metal and the evolution of thinking about metal trusses, which initially was limited by a lack of understanding of the material itself.

The application of metal truss bridges to highway use was generally not as early, quick, or crucial as with the railroads, but county freeholders and private bridge companies were receptive to following the lead of the railroads. When the first metal truss highway bridge in the state was built is not known, but it is documented that Hunterdon County opted to

build in iron rather than wood in as early as 1858 (Hunterdon County Freeholders Minutes, op. cit.). It appears that the freeholders of Somerset County initially considered metal truss bridges in 1869. In May, 1869, a committee appointed to rebuild two bridges over the Millstone River was to determine the difference in cost between iron and wood spans (Freeholders Minute Book 4:40). The committee found the price for an iron bridge "acceptable," but it decided to send a committee "to examine different iron Bridges in the state and neighboring states if necessary" (Freeholders Minutes 4:44). The outcome of their investigation at that time was to build a wooden bridge, but a few years later, in 1872, the first iron bridge built by the Somerset County freeholders was erected (Freeholders Minutes 4:136), and in 1873 another was constructed over Peters Brook at the east end of Somerville (Freeholders Minutes 4:185). While the truss type and fabricator were not specified in the minutes, what is significant is that by the early 1870s, metal truss spans were replacing wooden bridges in the Somerset County (the earliest metal truss bridges in Somerset County, including the 1875 Queens Bridge at Bound Brook that was built with Phoenix columns, have all been removed). The oldest surviving metal truss bridge in Somerset County is the 1886 double intersection Pratt thru truss known locally as the Nevius Street bridge in Raritan (18E0801).

The last quarter of the 19th century was the halcyon era of the metal truss bridge in America. During this period bridge designs tended toward greater uniformity and standardization because of advances in understanding of engineering principles enhanced by experience, better metallurgy, and refinements in the fabricating process. Introduction in this country of the Bessemer process of making steel in 1868 made the material that works well in both tension and compression an increasingly reasonably priced option for bridge components. In the majority of truss bridges built after 1895 steel replaced brittle cast iron, and, because of its higher strengths, it also replaced wrought iron.

The Pratt truss designs emerged as the most popular of the myriad of truss configurations because of its simplicity of design and economy of fabrication and erection, especially the use of eye bars to facilitate field connections. In addition to providing the long-sought after "stiff truss," the standardized members, made by building up standard shapes like rolled plate, angle, and or channels, eliminated the need for expensive custom cast iron components.

From the perspectives of quantity and variety of truss designs, New Jersey possesses an exceptionally rich and well preserved assemblage of 19th century metal truss highway bridges. Over 50 thru, or high, truss bridges and 142 pony, or low, truss spans were identified during the 1991-1993 New Jersey Historic Bridge survey. Of that total, 100 or about 50% are Pratt designs, or a variation of the Pratt truss, like the double-intersection Pratt (Whipple) truss where the diagonals and counters span two panels rather than one, or the Parker (a Pratt truss with a polygonal top chord). Exceptionally fine early examples of the Pratt thru truss bridges are scattered throughout the northern part of the state with Hunterdon and Somerset counties having the greatest numbers. There are no surviving

19th-century truss bridges in the southern half of the state. Pony truss bridges are more numerous, and they follow the same distribution pattern as the thru truss spans.

The 1880 Stanton Road over the Raritan River span in Hunterdon County (10XX179) with its original haunch-shaped trussed floor beams built-up of angle section and richly detailed floral builders plaque, ranks as one of the best early examples of its type. It was designed and fabricated by the King Iron Bridge and Manufacturing Company of Cleveland, Ohio. Two other significant King Iron Bridge and Manufacturing Company spans dating from the mid-1880s are located in Mercer County on Mine Road over Stony Brook (1100072) and Bear Tavern Road over Jacobs Creek (1100060). Another distinguished early high truss is the 2-span, approximately 300'-long 1886 Nevius Street over the Raritan River in Somerset County (18E0801). The truss design is a double-intersection Pratt, or Whipple.

Another interesting truss design represented in the state is the lenticular truss with parabolic curved chords that meet at a singular end point and suspended flooring system. The 1896 Elm Street over the South Branch Raritan River in the Neshanic Station Historic District in Somerset County (18C0601) is the only thru truss example of the truss type in New Jersey. It is represented in its pony form by the 1888 Bear Swamp Road over the Ramapo River in Bergen County (020033A). Both bridges were fabricated by the Berlin Iron Bridge Company of Berlin, Connecticut, the firm that built the proprietary design patented in 1878 by William O. Douglas.

PONY TRUSS BRIDGES

Pony truss bridges, those with shallower truss depths for shorter spans and thus no upper bracing between the top chords, were very common by the end of the 19th century. The standardization of truss members and the proliferation of bridge fabricating companies in both New Jersey and throughout the northeastern portion of the United States, especially Ohio, made these bridges readily available. The bridge type was wholeheartedly embraced by county officials in the mid 1880s as an economical and low maintenance alternative to masonry arch and timber spans, and they were built in great numbers. As with thru truss spans, the Pratt proved to be the design of preference, and over 70 Pratt pony truss spans in twelve different counties survive with Hunterdon and Somerset counties having the most.

Several of the more noteworthy examples of the pony truss type in New Jersey have distinctive details that reflect the experimentation inherent in some early bridges. The ca. 1882 Groveville-Allentown Road pony truss in Mercer County (1100028) features the Wrought Iron Bridge Company's patented T-section used for the verticals. The wrought "beaded T"-section is touted in their 1885 "illustrated pamphlet" as providing "perfect lateral bracing." Other examples of uncommon construction details utilized by the Wrought Iron Bridge Company are a pair of late-1890s pony truss bridges in Hunterdon County with cast bearings and end post/top chord connecting pieces. The details are also illustrated in the

1885 catalog, and they reflect, at times, the retarditaire nature of the highway bridge business.

Most 19th-century bridges, from light Pratt pony trusses to heavier Parker through truss railroad spans, were assembled in the field (at the site) with pinned connections. The reasons for the use of the pins (circular bars with threaded ends which were passed through the individual components) were several including the ease of erection and the use of forged wrought-iron eyebar diagonals and bottom chords in Pratt-design trusses until nearly the end of the century.

In the mid- to late-1890s better knowledge of the strength of materials and metallurgy combined with the improvement of field pneumatic riveting led to the transition from pinned to riveted connections. The adoption of riveted field connections resulted in a rapid shift from the Pratt to almost exclusive use of the Warren truss design by the 1910s. Patented in 1848 by British engineers James Warren and Willoughby Monzani, the straightforward truss is particularly well suited for rigid connections. It is distinguished by its simplicity of design, ease of construction with equal-sized members, and ability of some of the diagonals to reverse stresses. Capacity could be increased by adding a second set of diagonals (double intersection Warren), and it can be stiffened by the addition of verticals.

Warren pony trusses are among the best represented of all the metal truss bridge types and designs in the state. Over 77 Warren truss bridges comprising 40% of all the metal truss spans in the state were surveyed. Fifteen of the population are thru trusses and 62 are pony trusses with 58 of them dating from the 20th century.

There are no extant pin-connected Warren truss bridges in New Jersey. Among the earliest applications of the riveted Warren truss is the 1888 Province Line Road thru truss span on the boundary between Somerset and Mercer counties (18C0104). The well-preserved span was fabricated by New Jersey Steel & Iron Company of Trenton, and it is significant because of its riveted field connections. Not as early but a nevertheless noteworthy is the 1896 2-span double-intersection Warren thru truss span built by Mercer County to carry East Ward Avenue over Peddie Lake in Hightstown (1100034). The bridge was also fabricated by the New Jersey Steel and Iron Company of Trenton, successor to the Peter Cooper's Trenton Iron Works.

Because of the popularity of the Warren truss, very few Pratt or Pratt variation design pony truss bridges with either pinned or riveted field connections were built in the 20th century. One notable exception is the 1909 Parker pony truss span at Burnt Hill Road over Beden's Brook in Somerset County (18D0207). In addition to being the only example of its design in the state, the well-preserved span is notable because it has bolted, rather than pinned or riveted, field connections.

The construction of metal truss bridges peaked during the first two decades of the 20th century. Their decline in popularity, just like their rise to prominence, was based on

technological advances of other bridge types, particularly steel stringers, steel girders, and reinforced concrete spans. Those new technologies proved to be more economical and required less maintenance than metal truss spans. They quickly gained favor during the first two decades of the 20th century when the state was developing and improving both its farm-to-market and rural delivery road systems as well as early state highways systems.

A few welded pony truss bridges were built in the state during the mid 1930s. Developed in Europe in the 1880s, electric arc welding is thought to have first been done in this country by Baldwin Locomotive (Ridley, Pennsylvania) in 1902. It became a common repair technique for bridges during the 1930s, but its application to new construction was limited until after World War II, when welded bridges became the rule rather than the exception. The 1934 CR 543 over Rancocas Creek Warren pony truss swing span at Riverside in Burlington County (0300003) and the 1934 Pratt pony truss that carries Roxiticus Road over North Branch Raritan River in Morris County (1400639) are well preserved examples of the emerging technology.

CANTILEVER TRUSS BRIDGES

A significant 20th-century innovation in truss design in New Jersey occurred in the design and construction of cantilever spans, epitomized by the Pulaski Skyway (0901150), built 1930-1932 as part of the approach road to the Holland Tunnel in Hudson County. The route is considered America's first superhighway, while the skyway itself ranks as one of the great early-20th century engineering achievements. Planned and designed by the New Jersey Highway Department, the soaring viaduct is a milestone in the advancement of metal truss bridge technology. The development and refinement of the cantilever span type as represented by the Pulaski Skyway reflects the late-19th and early 20th centuries as both understanding of materials and empirical formulae.

Rather than each span resting or bearing independently on its piers or abutments, the cantilever truss is continuous over its supports, where it is deeper to resist bending stresses (moments). The cantilever truss thus provides for longer clear spans between supports. While the cantilever truss bridge was known in the late-19th century (1895-1896 Northampton Street Bridge over the Delaware River between Phillipsburg, NJ and Easton, PA owned by the Delaware River Joint Toll Bridge Commission), it was not until after World War I that the long-span thru and deck cantilever truss bridges came into their own. The Skyway, designed by the state highway department under the direction of Sivgald Johannessen, design engineer, the structure brought the bridge form to new technological and aesthetic heights. In addition to the Pulaski Skyway and its approach spans, cantilever trusses were used by the state highway department and Port of New York Authority for major crossings like the 1928 Goethals Bridge between Union County and Staten Island, New York (3800072). The bridge type is still in use today, usually for spans of over 300 feet. (Condit 1961:88-94, 207-212).

DECK TRUSS BRIDGES

Although not nearly as common in New Jersey as the thru and pony types of truss bridges, the deck truss, where the roadway is supported on top of the truss, is represented within the state's population of metal truss spans. Two 19th-century deck truss highway spans were identified (the 1890 rivet-connected Pratt truss over the Passaic River at Little Falls and the 1895 Washington Street over the Jersey City Reservoir at Boonton in Morris County). Starting in the 1910s, the riveted deck truss was often used in conjunction with deck girders on viaducts, like the 14th Street viaduct between Hoboken and Jersey City (0900016) and the late-1920s historically and technologically innovative approach known historically as the Route 1 Extension to the Holland Tunnel. Deck trusses are used when clear spans exceed 80'-100'. They are used in the cantilever form as part of the 1931-1932 Pulaski Skyway (0901150).

The reason that the bridge type is not more common in New Jersey is that it is best suited for locations where vertical under clearance is great, like over ravines and gorges. The topography of New Jersey is such that situations where a deck truss would be appropriate are not frequent.

CONCRETE BRIDGES

Concrete, composed of sand, gravel, or other aggregate held together by a hardened paste of natural cement and water, has been known since Roman times, but it was the 1813 perfection of Portland cement, an artificial hydraulic cement, that concrete came to the fore as a modern building material. Portland cement, noted for its strength and abrasion resistance, was developed in England. Initially it was very expensive, and as result of the cost, its use in this country was limited. In 1871, David O. Saylor was granted a United States patent for the manufacture of artificial cement, and this breakthrough gave great impetus to the experimentation and usage of the material in a variety of building applications. The earliest use of the material, which has good compressive strength but little tensile strength, was for building footings and walls (Condit, pp. 224-227).

Perhaps the earliest application of concrete to "bridge" construction in New Jersey is the use of plain concrete for Erie Railroad's important 1856-1861 route of tunnels and open cuts through Bergen Hill or the Palisades in Jersey City (Hudson County). The tunnels dug through the fissured-rock ridge were lined with concrete. The tunnels are now abandoned, but the west portal of one of them is adjacent to JFK Boulevard over the Erie's 1907-1910 Bergen Archways route (0951170), and the original concrete lining is clearly visible.

Reinforcing plain concrete with internal metal (either rods or mesh) was developed in Europe in the mid-19th century and then experimented with in this country by farsighted engineers like Ernest L. Ransome and Edwin Thacher. While most American engineers

were familiar with a combination of concrete and reinforcing by about 1870, it took another 30 years of experimentation and theoretical and empirical investigations before engineers and builders had a mature understanding of the capabilities and versatility of the material (Condit, p. 232). During this period of experimentation, types of reinforcing systems and designs of reinforcing bars were developed. Engineers were even uncertain what to call the new hybrid. Names included ferro-concrete, concrete-steel, and armed-concrete before reinforced concrete became the standardized terminology about 1905.

The earliest reinforced concrete bridges built in this country were arches dating to around 1890. It was also used for bridge substructures. The technology did not begin to seriously challenge metal truss bridges in New Jersey until the very end of the 19th century with the earliest in-state example being the 1896 concrete-steel arch span that carries Mount Avenue over Grand Avenue in Atlantic Highlands (130MT50). Other surviving early examples of reinforced concrete bridges illustrate reinforcing systems that document the process of design refinements and expanded applications of the material through the 20th century.

EARLY REINFORCED CONCRETE BRIDGE TECHNOLOGY

One of the earliest reinforcing systems applied to arch bridges was developed in 1861 by a Parisian gardener named Jean Monier, who intended it for making pots and tubs. Monier used wire mesh nets embedded in the concrete near the intrados of an arch ring for reinforcing. His single-net design proved insufficient for handling the tensile stress introduced by live loads, so a second net near the surface of the extrados was added to provide the tensile capacity needed at the outer limits of the arch ring. Over time this system proved less than satisfactory as the mesh was difficult to work with, and the transverse wires of the mesh take no stress making them an expensive but useless detail. Despite these and other weaknesses, the detail was successfully employed in early concrete arch bridges in Europe and this country.

The Monier system was used in New Jersey through at least 1905. Several bridges in Hudson and Bergen counties with Monier's or wire mesh reinforcing were documented by either plans or field inspections. The designer of the Bergen County examples is not identified on the plans for the 1902 East Ramapo Avenue over Mosonicus Brook and the 1903 Colonial Road over Tributary of Pond Brook spans, but the two layers of mesh reinforcing for the approximately 40'-long arches are. The bridges were finished with plain concrete spandrel walls and corresponding parapets with concrete caps, the most common detailing for reinforced concrete arch spans in the state. Stylistic comparison with other similar spans suggests that the Monier system was used with some frequency in areas where concrete spans were built prior to about 1907.

Although it is not documented as being a Monier arch, the 1905 Ogden Avenue over Holland Avenue bridge in Weehawken (Hudson County) characterizes the transition from

traditional masonry technology to reinforced concrete. The Ogden Avenue span is a concrete arch, and although plans do not confirm that it has internal metal reinforcing, its nearly flat segmental profile of the short arch suggests that it probably does. In contrast to the new structural material, handsome and well crafted ashlar masonry that recalls earlier stone arch technology is used for the spandrel walls and ring stones.

Of greater influence in promulgating reinforced concrete arch technology is the Melan design. Invented in 1892 by Austrian engineer Josef Melan and patented in this country in 1893, the design utilizes steel beams (I-beams for shorter spans and latticed angle girders for longer ones) embedded in concrete. Really more a steel arch with concrete encasing than a true reinforced concrete structure, the Melan system was able to support greater capacity for longer span lengths than the Monier system.

New Jersey features two important early examples of this design. The skewed 1896 Grand Avenue bridge in Atlantic Highlands apparently designed by William Muser (who later joined Edwin Thacher and formed the Concrete-Steel Engineering Company of New York City) and the 3-span 1897 West Broadway over the Passaic River at Paterson (1600017) designed by Edwin Thacher (1840-1920), then a principal of Keepers and Thacher in Detroit, rank among the most significant national examples of Melan's design. Both are early, large, and well-preserved. Other notable examples of Melan arch bridges include the 132'-long 1905 Park Avenue over Branch Brook Park Road span in Newark (0700101), the longest of its design in the country when it was completed, and Keepers & Thacher's 1899 Wyckoff Avenue over Ho-Ho-Kus Brook bridge in Wyckoff Township (020033E). Two other steel arch spans in Bergen County, both believed to have been built in 1904, are attributed to Thacher, but no plans survive to prove the attribution (020051A, 020028D).

By 1906, the reinforcing system had been eclipsed by designs based on Ernest Ransome's late 1880s scheme of using reinforcing bars distributed only in the tension zones (Ransome received a patent for the commonly used square twisted reinforcing rod in 1884) (Loov, p.68). After 1905, reinforced concrete arch technology became commonplace in New Jersey. Over 20 examples from before 1907 have been identified. They are primarily spans of less than 60' finished with concrete spandrel walls and parapets. Reinforced concrete arches proved to be an economical, more rigid, and relatively low maintenance alternative to metal truss spans.

Part of the reason for the rapid acceptance and application of the technology is that the material was also being used for a variety of structure types, like buildings, railroad ties, piers and bulkheads, and even ships, and the knowledge transfer benefited all. Additionally, individual promoters and companies such as Daniel Luten and the Corrugated Bar Company that published "how-to" brochures on reinforced concrete bridges using their designs, calculations, or reinforcing bars. In the era before the consulting engineer and a professionally trained county engineer and staff, such promotional literature did much to spread information about the advantages of reinforced concrete bridges.

The 1908-1911 New Jersey Cutoff built by the Delaware Lackawanna & Western Railroad ranks as one of the great, early uses of reinforced concrete for an entire improvement campaign. The nearly 29-mile long route required 73 structures, all of reinforced concrete, and over 14 million cubic yards of earth and gravel fill to create a relatively flat crossing of the hills and valleys of northwestern New Jersey (Warren, Sussex, Morris counties). Sixteen cutoff bridges are included in the 1991-1993 NJDOT bridge survey, including the earliest open-spandrel arch bridges in the state; the well-proportioned, 9-span Delaware River Viaduct (2114159) and the 7-span Paulins Kill Viaduct. Under the direction of Chief Engineer George Ray, the DL&W Railroad was a forerunner in the use of open-spandrel structures for long-span bridges. Ray's protégée A. Burton Cohen would be influential in concrete bridge design in the state in the 1920s, and he in turn would influence state bridge engineer Morris Goodkind.

The reinforced concrete arch, especially the gracefully attenuated deck arch design, where the roadway is located at or near the crown of the arch, continued to be popular in New Jersey through the 1920s. Owing to the moldable qualities of concrete and the desire to make civic improvements aesthetically pleasing in accordance with the tenets of the City Beautiful movement, arch bridges were particularly favored for applications in urban and park settings, especially in the northern half of the state. The park commissions in Hudson and Essex counties built richly detailed concrete arch spans in the 1910s and 1920s, as did the county engineers of Somerset, Middlesex, and Union counties as part of joint-county improvements in the 1920s.

The attention afforded the aesthetics of many reinforced concrete deck arch spans in New Jersey is epitomized by the 1931 2-span bridge that carries Main Street over Green Brook in Middlesex Borough on the Somerset-Middlesex counties border. The span exemplified the good proportions that are a hallmark of their custom design. It is finished in the Neo-Classical or Beaux Arts taste, as were so many of the period. Detailing often included paneled spandrels with a textured finish within the panel and balustrades composed of either squared or vase-shaped balusters. The Main Street example retains its original concrete light standards and classically-inspired luminaires that were once common on prominent 1910s and 1920s bridges. Such classical detailing remained in vogue through the 1930s.

OPEN SPANDREL ARCH BRIDGES

The development of reinforced concrete technology came to a graceful yet powerful culmination about 1910 in the open-spandrel arch bridge, which efficiently combines the compressive ability of concrete with the tensile capacity of steel reinforcing. The type can have a continuous arch ring across the width of the bridge or individual ribs, which results in further economy of material. Both designs are finished with spandrel columns to support the deck. In New Jersey the first examples of the bridge type were completed in 1911 by the DL&W Railroad as part of their New Jersey Cutoff route. The earliest highway

application of the technology was the 1926 JFK Boulevard bridge over rail lines at Journal Square in Jersey City (0900008). It was designed by A. Burton Cohen (1882-1956), who from 1910 until 1920 worked almost exclusively with concrete for the DL&W Railroad. Cohen went into private practice in 1920, and in 1927 was awarded a medal from the American Concrete Institute for his achievement in solving bridge problems "with economy as well as architectural merit" (The New York Times, 2/12/1956).

Morris Goodkind (1888-1968), who served State Bridge Engineer for the State Highway Department from 1925 until 1955, used the open spandrel arch with great technological and aesthetic distinction at major river crossings within the state starting in 1929 with the College Bridge (Route 1) over the Raritan River at New Brunswick (1203150). The 1902'-long bridge with six ribbed open-spandrel spans represents the level of refinement in reinforced concrete arch technology in the state. It has been renamed the Morris Goodkind Bridge to acknowledge and honor Mr. Goodkind's contribution to bridge engineering in New Jersey. It was followed by five more bridges of the same type, including the two handsome examples that carry US 46 over the Passaic River in Passaic County (1607168, 1606158). All are located in the northeastern portion of the state, and they reflect the State Highway Department's integration of aesthetics with technical achievement in resolving the state's ever-increasing usage demands.

It was economic considerations rather than technological advances that resulted in the passing of the reinforced concrete arch bridge. Their erection is labor-intensive, and it requires expensive, custom falsework.

SLAB, TEE BEAM, GIRDER, AND RIGID FRAME BRIDGES

Late 1890s advancement in the understanding of reinforcing placement to accommodate tension and shear forces resulted in reinforced concrete being used more frequently for slab, tee beams, and girder bridges early at the turn of the 20th century. The appropriateness of one bridge type over another was predicated on several factors, such as length of span, roadway profile, and economical use of steel. While all four reinforced concrete bridge types are represented in the state, they do not appear with the frequency found in some other states. This may be due, in part, to the fact that the economic availability of both structural steel and fabricating shops made steel spans more economical here than in other areas.

The simply supported slab was used primarily for clear spans of up to 20' prior to World War I. Through the 1920s and 1930s, the State Highway Department and county engineers used the bridge type for spans up to about 35', and the bridge type is present in nearly every county in the state.

The tee beam, where the longitudinal beam and deck section are integrally connected, is a more efficient use of material than the slab design. Tee beam design proportions the

deck thickness and longitudinal beam size and spacing to achieve a lighter, stronger, and more economical section. With the exception of Salem County, where the county used the bridge type extensively in the years between the world wars, tee beams were not that popular in New Jersey. Forty-nine placed between 1913 and 1942 were identified. Ranking among the most significant are a group of four surviving precast tee beam bridges built between 1913 and 1916 by the Delaware Lackawanna and Western Railroad in Warren County (2154162, 2154163, 2154165, 2154169). The spans are an important record of the railroad's experimentation with reinforced concrete structures. The balustrades are also precast, and all bridge components were fabricated with lifting hooks to facilitate easy installation.

Uncommon as the reinforced concrete girder bridge is within the state, the one notable example, those used as part of the helix-like viaduct (3800031) built in 1937 as part of the Lincoln Tunnel approach road, ranks among the largest and most complex in the country (Condit, p. 210). Again, the infrequent use concrete girders in New Jersey is attributable to the availability of steel spans.

The rigid frame bridge, where the top member and the verticals are integral, remains one of the most efficient uses of both steel and concrete, but it requires expensive and restrictive form work to erect. The bridge type is capable of spanning greater lengths than a slab bridge. The telltale detail that usually distinguishes a rigid frame span from a slab is the arch soffit of the rigid frame that provide strength at the knees. The bridge type was developed in Europe during the last part of the 19th century, but it was not utilized in this country until the 1920s on the Westchester County (New York) parkways. Its pre-World War II use in New Jersey is limited, but it was a widely used type in New Jersey after the war.

The earliest rigid frame bridge in the state was built in Camden County in 1930 (044D025), but the most impressive examples are the nine overpasses built in 1938 to carry local Weehawken (Hudson County) streets over the open-cut approach road to the Lincoln Tunnel. Designed by the State Highway Department and the Port Authority of New York, the bridges are part of a technologically innovative route that brings traffic through a congested area with difficult topography. Both their bridge type and finish detailing reflect the then-current philosophy about urban roadway design.

METAL GIRDER BRIDGES

Contemporary with the development of metal truss bridges was the origin of the girder span, which takes advantage of the tensile strength of wrought iron. Built-up girders, composed of rivet-connected plate for the web and angles for the flanges to make a I-beam section of sufficient depth to span greater distances than possible with the available rolled beams, were used by the railroads as early as 1847, and they proved to be the only serious competitor to the metal truss for railroad use in the 19th century. Noted bridge

engineer and author J.A.L. Waddell states that while "plate girders are as unscientific structures as a bridge specialist ever has to design, they are without doubt the most satisfactory type of construction possible for short spans [up to 100']" (Waddell, p. 408).

By the 20th century, the built-up girder bridge was steel rather than wrought iron. It proved to be the most efficient and economical railroad bridge type for shorter crossings as evidenced by the hundreds of pre-1940 examples in the state. Another reason for the popularity of the bridge type is its ease of installation. Since the girders were almost completely assembled in fabricating shops, conveniently located on rail lines, the bridges could easily be loaded onto flatbed cars. Once at the erection site, cranes quickly hoisted them into position, often on earlier abutments, with minimal traffic interruption. The ability to transport girders was often the factor limiting their length.

The most common girder bridge type in New Jersey is the thru girder where the floor beams are placed in line with the bottom flange of a pair of girders with the roadway passing between the paired girders. The depth of the girders is determined by its span length. In railroad applications, both rail over road and road over rail, the 3-span arrangement is common with two short, and thus shallow, girders supported on the abutments and built-up curb columns flanking the longer and deeper main span. The single span thru girder is also very common, especially in urban areas where aesthetics (curb columns were not considered a civic amenity) and/or vertical clearance were considerations.

If the built-up thru girder bridges were used on non-railroad related highways in any significant numbers prior to World War I, they have not survived. Representative of the early county-built examples of the bridge type include the 233'-long, 3-span, 1898 Passaic Avenue bridge over the Passaic River in Garfield (0200015) and the 1905 Union Avenue bridge over Green Brook in Scotch Plains (2016059). The Union Avenue span is 46'-long, and has concrete jack arches between the stringers to assist with distribution of live loads. Jack arches (shallow, small arches placed between the I-sections and bearing on the bottom flanges of the beams), first in brick and after about 1905 in concrete, are not an uncommon detail on pre-1915 girder and stringer bridges in New Jersey. The pipe railing affixed to the top flange of the Union Avenue girders preserves a once-common detail.

The State Highway Department used the bridge type with some frequency on its early state routes with the 1921 CR 662 over Black's Brook on the old highway from Bordentown to Camden (03E2528) being a representative example. Like the earlier ones, the plain, straightforward superstructure is unadorned, but concrete end posts have been added to protect the girders from impact damage. Another common 20th-century detail is concrete encasement, either of the flooring system (partially encased) or of the entire superstructure for the purpose of protecting the steel. The thru girder is not more common on highways for one reason because it loses its economy of material as it gets wider and the floor beams increase in dimension.

The deck girder bridge, with the floor beams placed near the top flanges of the girders and the roadway located at the top of the girders, was used when vertical clearance and grade considerations permitted. The technological development and application of the deck girder bridge in New Jersey is similar to that of the thru girder span; it was developed and used extensively by the railroads in the 19th century. Among the most interesting of early deck girders in New Jersey are three wrought-iron lattice web girders located in Hudson (0950163, 0900011) and Warren (2160152) counties. Not documented as to date of construction, they are believed to date to about 1890. Each has an open, lattice web with T-section diagonals rather than a solid plate web. A hybrid design that in many ways is akin to a truss as a girder, lattice web girders were short lived, and they appear to represent experiments in balancing weight with efficient use of material. All three were built for the Central Railroad of New Jersey. No built-up (solid web) deck girder highway bridges from the 19th century were identified, but several early girder and multi-girder (more than two girders) spans from the early 1900s were.

Prior to the development of the rolled deep web I beam and its application for mid-sized spans slightly later in the century, the built-up girder span served as a longitudinal metal beam for stringer bridges. Gerard Avenue over Green Brook in South Plainfield (18M0903) is typical of the early examples. The 49'-long bridge is composed of two sizes of built-up girders with the deeper being the fascia girders.

Simply supported built-up deck girders are frequently used as approach spans for long spans or viaducts where vertical clearance is not a limitation. Both the simply supported and the continuous form of the deck girder are well represented at the monumental 29-span 1939 Edison Bridge that carries US 9 over the Raritan River in Middlesex County (1209155). It was designed by the State Highway Department Bridge Division, and the 3-span continuous built-up girders at the river crossing are 21' deep.

STRINGER BRIDGES

The stringer, or longitudinal beam, bridge represents the oldest bridge technology, dating to time immemorial when felled trees were laid across streams. Whether the material is wood or metal, the principle behind the stringer bridge is the same; it relies on the bending strength of the material to resist the loads.

Timber stringers bridges were built from the earliest days of settlement and are still being constructed. They are not common in the northern half of the state, but they are very common in the less developed southern half of the state. Also, timber stringers have historically also been used in conjunction with bridge types, especially truss bridges, as part of the flooring system.

The wrought iron and later steel I-beam bridge, or stringer, came into common use in New Jersey in the years just before the first world war. By the end of the 1920s, it had

surpassed all other bridge types for spans up to about 35 feet in length, and it went on to become by far the most common bridge type in the state prior to 1946. Of the approximately 2200 pre-1946 bridges recorded in the state, over 910, or approximately 42% are steel or wrought iron stringer spans.

Although structural wrought iron I beams had been rolled in this country since the early 1850s (wrought iron I beams are thought to have first been rolled by Peter Cooper at his Trenton Iron Works in the Chambersburg section of Trenton), and steel since the early 1870s, several technological and financial hurdles prevented their widespread use for short-span bridges (20'-35') until immediately before World War I. By the end of the 19th century civil engineers were well aware of the potential application for metal beams in bridge construction, but they were generally employed for components, particularly the flooring, of truss bridges. J.A.L. Waddell commented in his 1884 The Designing of Ordinary Iron Highway Bridges that in most cases built-up members were far stronger and stiffer than wrought iron I beams, and he limited his recommended use of rolled beams for stringer spans of less than 20'.

The introduction of steel I beams for stringer bridges appears to have been related to improvements of the open-hearth steel making process that resulted in larger quantities at lower prices. The Pencoyd Iron Works (established in Philadelphia in 1852) advertised their steel I beams in Engineering News beginning in April, 1896, noting their progress in the production of beams of greater depth and strength (April 23, 1896, p. 279). Despite the claims of the trade, the inability to roll steel beams of sufficient length and depth at a competitive price remained a technological limitation into the early 20th century.

A major technological breakthrough that affected bridge building in New Jersey occurred in 1908 when the Bethlehem Steel Company began producing wide-flange steel beams on the Grey Mill (used in Germany since 1902). The mill rolled beams at greater speed with greater depths and at an approximately 10% savings in material with no reduction in strength (Misa, pp. 247-272). Although the company first met difficulties producing and marketing the new 26-, 28-, and 30-inch deep beams, by the early 1910s, it had overcome the problems. In his 1916 edition of Bridge Engineering, J.A.L. Waddell now touted the superiority of steel stringers, calling them "a great boon to bridge designers and builders" because of their simplicity, compactness and lower price (Waddell, 1916, p. 47, 411). The 30-inch beam was suitable for spans up to 35', according to Waddell.

The earliest metal stringer bridges in New Jersey date to the 1880s and their use is, in part, related to the expanding desire for masonry bridge decks which are supported on, initially, brick and, later, concrete jack arches set between the stringers. Wrought iron or steel stringer bridges without jack arches may well have been built in the state prior to 1900, but only one was identified. Located in Smithville, the nationally significant industrial village developed during the middle of the 19th century by Hezekiah Smith to manufacture his woodworking machinery, the 3-span, 56'-long stringer bridge on Foundry Road over North

Branch Rancocas Creek (03D4130) has unique castings to connect the components, and it appears to reflect the technological ingenuity of Smith and his associates.

Over 50 wrought iron and steel stringer bridges with brick jack arches built between 1882 and ca. 1905 were identified, with Essex and Union counties possessing the most. Because the early stringer bridges were often originally about 18' wide, many of the surviving examples have been widened to one or both sides, but a few examples, like the 1899 River Road over Van Horn Brook span in Kingston (Somerset County) (18E0104) retain their integrity of original design, including the tie rods anchored through the fascia stringers to counteract the outward thrust of the approximately 6- to 8-inch rise of the arches. After about 1905, concrete instead of brick was used for the jack arches. Examples throughout the state illustrate that both plain and corrugated form liners were used. Jack arches dating from after the first world war are rare as by then technology moved to the reinforced concrete deck.

Steel stringer bridges without jack arches dating from the first decade of the 20th century are not uncommon, and, with the exception of some of the southern counties, they are distributed throughout the state. Their use on the county level was promoted by state Public Roads Commission and the federal Office of Public Roads through "how-to" pamphlets. The stringers were used plain, completely encased in concrete as a composite member of the slab deck, like the 1909 span carrying the D & R Canal Feeder over Parkside Avenue in Trenton (3001160), or with the beams themselves covered with a several-inch deep concrete encasement, like the well-preserved 1904 Diamond Bridge Road bridge in Goffle Park in Passaic County (1600104). Encasement of steel stringers in concrete to protect them from corrosion was a known technique since the late 1890s, and it is a common detail in New Jersey. Morris Goodkind, state bridge engineer from 1925 until 1955, favored its use, and encased steel stringer bridges were built and survive in great numbers on the state's highways because of the measure of protection the concrete added.

Steel stringer bridges, like reinforced concrete spans, were historically finished with reinforced concrete balustrades or parapets that were successfully designed to be both safe and attractive. Aesthetics was always an important consideration to state bridge designers, and that emphasis on appearance is well reflected in the large population of handsome, well-proportioned bridge railings and corresponding abutment and pier detailing from the 1920s, 1930s, and 1940s throughout the state.

MOVABLE SPAN BRIDGES

The movable-span bridge remained in its primitive stage until about 1895, but with advances in both mechanical, electrical and civil engineering during the last quarter of the 19th century, the bridge type progressed rapidly, especially during the 1890-1910 period. The same need for accommodating greater capacity and span lengths that spawned the

railroad's great era of experimentation with metal truss bridges had a similar affect on movable bridge technology. It was not until the end of the 19th century, however, that movable bridge technology entered the modern era which was dominated initially by the swing-span bridge and after 1896, the bascule (French word meaning balance) bridge. With its long coastline and many navigable rivers, New Jersey, by necessity, possesses a rich and distinguished heritage of movable bridges with the surviving structures chronicling the very evolution of the bridge type. Over 65 movable bridges built between 1896 and 1942 survive, with concentrations in the great industrial cities in the northeast portion of the state and along the Atlantic Ocean in the region known as the Jersey Shore. Although no early timber movable spans survive, period literature illustrates a variety of wood horizontally folding, pivoting, retracting, jackknifing, and lifting spans that were built in New Jersey, especially by the railroads. Historical documentation also shows most of the current movable bridges service crossings that have been in use since the 18th or first half of the 19th century. In many instances, the present movable span bridge is the second, third, or even fourth, successive movable bridge at a crossing.

Prior to the development of the bascule bridge in the 1890s, the swing span was the most popular movable bridge technology in New Jersey, and by the late-19th century, the bridge type was ubiquitous. Historic plans and photographs preserved in state and county agencies and historical societies throughout New Jersey show that most 20th-century bascule bridges were built to replace truss swing spans. Surviving swing span bridges in New Jersey date from 1896 until 1934 with 3 dating to the 19th century and 19 to the 20th century. Remarkably, over half of them are still operable.

SWING SPAN BRIDGES

As the name implies, the swing span bridge rotates on a central pivot to a position parallel with the channel to permit passage of marine traffic. It was the earliest bridge type to accommodate movable spans of substantial length and weight. Most instate examples are center bearing (dead load supported on center bearing when bridge is open), but the four long, wide swing span bridges built over the Passaic River at Newark between 1897 and 1913 are rim-bearing (supported on a circular drum and rotated on rollers on a circular track). All swing spans are operated by rack and pinion drive and open reduction gear sets. Most were originally powered either by steam or electric motors after about 1890. Some small swing span bridges, like the 1905 New Bridge Road over Alloway Creek bridge in Salem County, were manually operated. The movable spans themselves were traditional truss or girder bridges with the specific type and design matched to the length and capacity needed at the crossing.

The earliest extant swing span bridge in New Jersey is the 1896 center-bearing Union Avenue over the Passaic River span in Rutherford (Bergen County). It is a pin-connected Pratt thru truss with parallel chords, and it is still operable. Another historically significant pin-connected thru truss is the 1898 State Street bridge in Camden. It is still in service.

The operable 1904-05 Park Avenue over the Passaic River swing span bridge at Nutley (Essex County), known locally as the Avondale bridge, is a riveted Warren thru truss that reflect the state of movable bridge design knowledge at that time which could only account for simply supported spans for live load considerations. The top chord is composed of both pinned and riveted sections. The presence of the pin-connected eye bars prevented the transfer of live-load stresses when the bridge is in the closed position carrying live loads. A good example of a Warren thru truss swing span with a totally riveted top chord is the 1905 New Bridge Road over Alloway Creek bridge in Quinton (Salem County). The manually operated bridge is one of the most complete examples of its design in the state. Its significance is enhanced by the fact that it was designed and fabricated by a New Jersey bridge builder, the New Jersey Bridge Company of Manasquan.

Pony truss and thru girder swing span bridges use the same operating technology as the larger thru truss examples, but they were used for shorter crossings. Several good examples survive in the southern half of the state. The 1911 riveted Warren pony truss swing span over the Rancocas Creek at Swedesboro (Gloucester County) is a typical early 20th-century example of the type, complete with the original tenders house. The thru girder type, which is later than the thru and pony trusses, is represented by the 1925 bobtail swing span at Quinton (Salem County) that carries NJ 49 over Alloway Creek and the 1933 Beaver Dan Road span over Beaver Dam Creek in Ocean County, one of the last extant swing span bridges built in New Jersey. The bobtail arrangement was used when the pier was set close to one shore in order not to restrict the channel.

BASCULE BRIDGES

As popular as the swing span was, the design was not without its drawbacks. The open span and pier are located mid channel thus restricting the channel. The space needed for operation of the bridge as well as holding marine traffic limits dock frontage in the vicinity of the bridge. Also, swing spans operate slowly which inconveniences traffic in congested area.

The beginning of the modern era of the bascule bridge in this country is traditionally held to be the successful completion in 1893 of the Van Buren Street bridge in Chicago, a rolling lift developed and patented by William Scherzer (1858-1893) (Hool & Kinne, p. 1). J.A.L. Waddell, however, dates it 1891 and the completion of the Michigan Avenue span at Buffalo, a double-leaf rolling counterweight trunnion bridge (Waddell, p. 700). The Van Buren Street bridge was a significant milestone in bascule technology as it was the first movable design that quickly rotated a span of significant length and weight up and out of the shipping channel. In a rolling lift bridge, the center of rotation continually changes and the center of gravity of the rotating part moves in a horizontal line, thereby shifting the point of application of the load on the pier. The movable leaf rolls back on segmental girders attached at the heel end of the movable leaf that are matched to a track affixed to the top

of each pier. The earliest and most common Scherzer design is that with an overhead counterweight, but it also was built with a fixed underneath counterweight.

The Scherzer design, with its commanding overhead counterweight and frequently long movable leaf, was favored by the railroads into the second decade of this century despite its frequent operational and substructure problems. So synonymous is the Scherzer design with railroads that no highway bridge of that design was identified in New Jersey; they are all on railroads.

The only rolling lift bridge in the state is the Rall design that carries Stone Harbor Boulevard over Great Channel in Stone Harbor (0500006). The double-leaf bridge built in 1930 is one of the few example of the infrequent bridge design in the country. Theodore Rall patented his design in 1901 (reissued in 1906), and by the time the Stone Harbor span was constructed, the patent was owned by the Strobel Steel Construction Company of Chicago who continued to actively promote the design. The basis of the Rall patent and its principle characteristic is that the trunnion is installed in a large steel roller. Rather than on a segmental girder, the span pivots on a trunnion that rolls on a horizontal track girder while a swing arm pulls the movable span up. The bridge is operated by a rack and pinion drive placed above the trunnion and track girder. The center of rotation is far enough above the trunnion pier that no counterweight pit is required (Waddell (1925), p. 703).

Unlike the rolling lift designs that are not well represented in the state's highway bridge population, New Jersey's early trunnion bridges chronicle the technological evolution of the design. The ca. 1898 cable-lift rolling counterweight Brielle Road over Glimmer Glass bridge in Monmouth County ranks as one of the most significant movable spans in the state because it is the same technology J.A.L. Waddell credits as being "the first important bascule bridge built in the United States" (Waddell, op. cit.) The cable-lift rolling counterweight design was developed in Europe in the 1700s (see B.F de Belidor's La Science des Ingenieurs originally published in 1729, later edition in 1813). An 1896 Scientific American article described the Erie Railroad's recently completed example of the rolling counterweight design on its main line over Berry's Creek near Rutherford, New Jersey (non-extant). The article states that "although the principle upon which the bridge is constructed is not entirely new, the Berry Creek bridge is the first application of this system of counter weighting the structure of this magnitude." The principle is to use a curved track and rolling counterweights where the work expended in raising the leaf is equal to the energy released by the falling counterweight. The toe end of the movable span is linked by cables to cylindrical rolling counterweights. The cables pass over tower columns with a curved tracks. Moving the counterweights along the curved track raises or lowers the bridge.

It is known that in addition to erecting the rolling counterweight span at Berry Creek in 1896, the Erie Railroad used the design to carry its Greenwood Lake branch over the Morris Canal, and that the Central Railroad of New Jersey built a similar bridge over the Morris Canal guard lock at Dover (Morris County). The canal bridges are recorded in the

abundant photo documentation of the canal. While the date of construction of the Glimmer Glass bridge, or even if it is at its original location, is not known, the bridge stands as an important example of first generation bascule technology.

The "modern" trunnion bridge was first built in Chicago in 1902. It was developed by the City of Chicago engineering department as a response to some of the functional deficiencies of the Scherzer design. On a trunnion bascule, the center of rotation remains fixed and is placed near or at the center of gravity of the rotating part. Trunnions support the entire weight of the bridge when it is in operation or in the open position, and the counterweight, which serves to balance the long end with the shorter heel end, is attached at the heel end, either overhead or underneath.

Although the Chicago trunnion design was not protected by proprietary patents, there are no early extant examples in New Jersey. It was another Chicago bridge engineer, Joseph B. Strauss (1870-1938), whose designs captured the bulk of the movable span market prior to 1925. Strauss reasoned that if, unlike the traditional trunnion bridge, which operates like a seesaw and moves in a vertical plane on a horizontal steel pivot, the entire weight of the counterweight could be concentrated at the end (tail) of the moveable leaf, it would then be possible to use a lighter counterweight. Such an arrangement also meant a shorter tail end to the leaf, thus saving on materials that the "counterweight could be made in such shape that no pit is required to receive it when the leaf is in the upright position" (Waddell, p. 704). His patented counterweight linkage, or arms, ensures that the counterweight will always move in a series of parallel positions and thus maintain the position of the weight at the tail end of the leaf.

Strauss applied for a patent on his pivoting counterweight linkage in 1905, the same year the first bridge of this type was built in Cleveland. He also founded the Strauss Bascule and Concrete Bridge Company in 1905 to market his movable bridge designs that went on to become the most popular in America prior to the depression.

The 14 surviving Strauss-design movable bridges in New Jersey built between 1906 and 1928 represent the three designs for which the company is known. Two are heel trunnions, and there are six each of the articulated overhead and articulated underneath counterweight designs. The overhead counterweight design was particularly well suited to locations with low vertical clearance over mean high water. The most important of the population is the 1906 Federal Street over the Cooper River in downtown Camden (043B008). Built just one year after the first Strauss design in Cleveland, the fairly complete bridge is nationally noteworthy for its age and its rich architectonic detailing in the City Beautiful tradition. The counterweight and tower are concealed behind a Beaux Arts facade that transforms the utilitarian structure into a civic monument. The sheathing was designed by the Strauss Bascule Bridge Company as an original element of the bridge, and although it has been altered somewhat, the architectural treatment contributes greatly to the overall significance of the structure. The 1908 S. First Street bridge at Elizabeth (2004002) has

a metal lattice grill around the overhead counterweight, and while less ornate than the Federal Street cladding, it too reflects the emphasis placed on aesthetics in bridge design.

Strauss developed an underneath articulated counterweight design in the mid-1910s. The earliest surviving example in New Jersey is the 1922 NJ 147 over Grassy Sound (Cape May County) double-leaf span (0517151). The most technologically noteworthy of the Strauss underneath counterweight bridges in the state is the 1924 US 9 over the Bass River in Burlington County (0302150). The single leaf span is chain driven rather than by a rack and pinion. Due to its location in a low tidal area, the gasoline Hercules engine is set well above the reduction gears and water to protect it. The drive chain connects to a sprocket at the end of the main drive shaft.

Another important example of the design is the 1929 double-leaf Dorset Avenue over Inside Thorofare in Ventnor (01V0001). It is finished in the prevailing architectural style of the day to be a civic amenity as well as a functional structure. Handsome Moderne-style machinery and operators houses are placed at each quadrant of the movable spans, and the concrete and metal railings are correspondingly detailed.

Like the Scherzer rolling lift bascule, Strauss's heel trunnion design was more frequently used as a railroad bridge than a highway span because it was capable of long and rigid single-leaf spans. Only two highway Strauss heel trunnions were identified in New Jersey; the 1914 NJ 7 (Bellville Avenue) over the Passaic River at Belleville (0208150) and the 1920 South Front Street over the Elizabeth River in Elizabeth (2004001). Unlike the articulated counterweight bridges, in the heel trunnion design the counterweight trunnion is a fixed pivotal point located at the top of a stationary tower. The counterweight is carried by one end of a trussed frame. The other end of this trussed frame is connected by a pivot to a link which in turn attaches to the inclined end post of the thru truss superstructure by a pin. This arrangement provides a parallelogram of linkages with the side formed by the triangular counterweight tower with the initially mentioned fixed pivotal point. Near the center of the tower is an "operating strut" with a rack that is pulled by the operating pinion causing the parallelogram to close up thereby opening the leaf.

Strauss's articulated counterweight designs were eclipsed in popularity in New Jersey by the trunnion bridge with a fixed counterweight designed by Ash Howard Needles & Tammen, the noted consulting engineering firm from Kansas City, Missouri that is credited with developing and popularizing the vertical lift bridge. The firm opened a New York City office in 1922 for the specific goal of capturing the lucrative eastern market. In September, 1926, several of the firm's partners applied for a patent on a trunnion movable span. Utilizing traditional trunnion technology, the Ash Howard Needles and Tammen design provided a well braced trunnion column (or tower) that also provided improved support for the free end of the fixed span that extends over the counterweight. The design was so popular in New Jersey that survey statistics show that nearly 90% of the surviving trunnion bridges built between 1927, when the oldest Ash Howard Needles & Tammen movable span was erected, and World War II, are theirs.

The approximately 20 extant examples are both single leaf and double leaf arrangements, and they were selected by all agencies that were building bridges in the state; the state highway department, counties, and private bridge commissions. The design was operated by rack and pinion drive mechanisms with power transmitted from electric DC-current motors through reduction gear sets. Open sets of gears were used until the late 1930s when sealed reducers were introduced. An early example of a sealed unit is the well-preserved 1939 Oceanic Bridge that carries Bingham Avenue-Locust Point Road (CR8A) over the Navesink River in Monmouth County. The 2700-foot long bridge with a double-leaf main span of 98 feet is handsomely detailed in the Moderne style with all gates, railings, and structures reflecting the robust, streamlined detailing for which the style is noted. Other noteworthy late-1930s examples of the bridge type are the four single-leaf examples built by the Cape May County Bridge Commission built along the Ocean Highway in that county. They have open gear sets, and like the Navesink River bridge and many others in the state, survive in a nearly complete state of preservation. Earlier but equally complete examples of the design are located along the south east coastal area of the state (Monmouth, Ocean, Atlantic, Cape May counties).

VERTICAL LIFT BRIDGES

The vertical lift bridge, where the span is hoisted vertically by means of cables that pass over sheaves placed atop towers and connect to counterweights that move up and down as the span is raised or lowered, was developed by J.A.L. Waddell and first built in Chicago in 1892. The technology was used extensively by the railroads after 1908, when Waddell's consulting engineering firm (Ash Howard Needles & Tammen now known as Howard Needles Tammen & Bergendoff) refined the vertical lift bridge type into a "rational and well-integrated design." The firm went on to become the national leader in the design of vertical lift bridges for both highway and railroad applications. The earliest highway example identified in New Jersey is the privately built 1929 Burlington-Bristol bridge at Burlington. It was designed by AHN&T, and at the time it was completed, it had the longest movable span of any vertical lift bridge in the country. Another example from the same period, also designed by AHN&T who had a virtual lock on vertical lift bridges in the country prior to World War II, is the 1930 NJ 7 over the Hackensack River (Wittpenn bridge) in Jersey City (0905150). It is a large multi-span thru truss structure that shares its substructure with two similar railroad bridges.

The vertical lift bridge was popular for its simple design and economy of construction and operation. It was particularly suitable for long spans with low lifts, like the NJ 7 location, with its 35 feet vertical clearance. The bridge type was used for three bridges on state highway department road improvement campaigns in the southwestern part of the state between 1935 and 1940. The three bridges, all designed by AHT&T, vary in span length from 167 feet to 285 feet, and they represent the last vertical lift bridge built on New Jersey

roadways prior to World War II. Interestingly, all the highway vertical lift bridges in the state replaced swing span bridges.

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SUMMARY QUALIFICATIONS OF PRINCIPAL PREPARERS

Mary Elizabeth McCahon, Architectural/Technology Historian, A.G. Lichtenstein & Associates, Inc. Ms. McCahon, the project manager, has over 18 years experience in the analysis and documentation of historic structures, with special expertise on bridge structures and historic contexts. She has served as the project manager and principal researcher on bridge surveys and individual structure reports and recordation. She is very experienced with Sections 106 and national Register eligibility recommendations and preparation of nominations. She has been the project manager or project historian for the Statewide Historic Bridge Survey for the New Jersey Department of Transportation, the Somerset County Metal Truss Bridge Survey in New Jersey and the survey of railroad bridges in the greater Boston area for the Massachusetts Bay Transportation Authority - all projects which required field survey, research, documentation and evaluation of National Register eligibility and preparation of survey reports.

James Patrick Harshbarger, Senior Historian, A.G. Lichtenstein & Associates, Inc. Mr. Harshbarger has over nine years of experience on researching and evaluating a wide variety of industrial resources against National Register criteria and historic contexts with particular emphasis on transportation resources. He has successfully served as project historian on Historic American Engineering Record recordation projects. He researched and documented hundreds of bridges as part of the Statewide Historic Bridge Survey for the New Jersey Department of Transportation, and he researched and prepared National Register Multiple Property nominations for metal truss bridges as part of the firm's Somerset County Metal Truss Bridge Survey in New Jersey. Mr. Harshbarger was also the project historian for the Massachusetts Highway Department and the Historic American Engineering Record for the historic documentation of significant highway bridges in Massachusetts.

Joseph J. Pullaro, P.E., Principal, A.G. Lichtenstein & Associates, Inc. Mr. Pullaro has over 29 years of bridge engineering experience and he has served as the principal-in-charge or project manager for the majority of the firm's work involving historic structures or structures located within historic districts. He is experienced with Sections 106 and cultural resource survey and national Register eligibility recommendations. Mr. Pullaro was the principal-in-charge of the statewide Historic Bridge Survey for the New Jersey Department of Transportation and the Somerset County Metal Truss Bridge Survey in New Jersey, as well as many of our innovative and award-winning historic bridge preservation and restoration projects. Mr. Pullaro has written technical papers and made presentations at over 20 conferences in both the United States and Europe on the evaluation and restoration of historic bridges and their settings.

Ronald Giamario, P.E., Associate, A.G. Lichtenstein & Associates, Inc. Mr. Giamario has 13 years of experience in the design and management of a variety of bridge projects

for the firm. He has special knowledge of historic bridges, from alternate analysis in accordance with Section 106 to their rehabilitation. He was the project manager or project engineer for many of the firm's major historic truss bridge projects in the Northeast, including the New Jersey Historic Bridge Survey of over 2,300 pre-1946 bridges; the alternatives study, preliminary plan development and final design of the two span Nevius Street Truss Bridge Widening in New Jersey; the rehabilitation design of this historic Church Street Railroad Bridge in Cumberland, Rhode Island, a 107 ft. thru truss; and an alternates analysis for a historic 40 ft. pony truss bridge in Southampton Township, New Jersey.

Abba G. Lichtenstein, P.E., Dr. Eng (hc), founder of and consultant to A. G. Lichtenstein & Associates, Inc. Dr. Lichtenstein served as the principal investigator on the project. He reviewed all conclusions and recommendations, and he edited the context narratives and provided technical descriptions. Dr. Lichtenstein is a nationally known bridge engineer who specializes in historic bridges and inspections. He has written and lectured extensively on the subjects. 1991 he was elected to the grade of Honorary Member of the American Society of Civil Engineers and was recipient of its History and Heritage Award for his "pioneering work on inspection and rehabilitation of existing bridges and his contributions to the preservation of historic bridges." In addition to his experience with older bridges, Dr. Lichtenstein served as principal investigator on upgrading of the AASHTO "Manual for Maintenance Inspection of Bridges." and for preparation of a new manual for rating bridges through nondestructive load testing.

ATLANTIC COUNTY TRANSPORTATION HISTORY OVERVIEW

The historic bridge survey evaluated 76 pre-1946 bridges in Atlantic County. A small number of the bridges are noteworthy for either their excellent state of preservation, their location within a historic district, or as technologically significant examples of increasingly rare bridge types. Bridges with historic merit included several movable bridges such as the Port Republic-Smithville Warren pony truss swing span (01PROO7, Port Republic City, 1904), the Dorset Avenue double-leaf bascule (01V0001, Ventnor City, 1929), the Green Bank overhead-counterweight Strauss bascule (01M0001, Mullica Township, 1926), and the Margate-Northfield single leaf Strauss bascule (4700001, Margate City, 1929). Other exceptional bridges include two of southern New Jersey's few remaining extant metal truss highway bridges, the Eighth Street riveted Warren pony truss bridge over Hospitality Creek (01BV007, Folsom Borough, c.1910) and the Weymouth Road riveted Warren pony truss over the Great Egg Harbor River (01HML22, Hamilton Township, 1920), and a well-preserved railroad overpass, the Frankfurt Avenue thru girder bridge (0162153, Egg Harbor Township, 1905). The Mays Landing Historic District (1837-1935) includes two state highway bridges, US 40/NJ 50 over the Great Egg Harbor River (0107151, Hamilton Township, 1928), and US 40/NJ 50 over the Pleasantville Section of the Pennsylvania Railroad (0107152, Hamilton Township, 1929). As a group the bridges reflect Atlantic County's transportation growth from relative isolation in New Jersey' colonial period to incorporation within a modern integrated highway system in the early 20th century.

Until the mid-19th century Atlantic County's transportation history was dominated by water transportation. In the late 17th and 18th centuries the earliest colonists built towns on the county's two principal navigable rivers, the Great Egg Harbor River and the Mullica or Little Egg Harbor River. Sandy soils prevented much commercial agriculture, and the settlers relied upon fishing, lumbering, shipbuilding, and trading for their livelihood. Schooners regularly plied between Mays Landing, Somers Point, and Wranglesboro (later renamed Port Republic) and the major colonial ports of Philadelphia and New York. Population grew slowly, probably numbering less than 4,000 at the time of the American Revolution. The area of Atlantic County remained part of Gloucester County until 1837 when local residents petitioned the legislature for incorporation (Heston 1924; Cunningham 1978: 243-245; McMahon 1964).

In the 17th and 18th centuries local residents worked to maintain a road parallel to the shore from Somers Point to Nacote Creek, along portions of the present-day route of Shore Road. The road was established in 1716 and a local history mentions "Jeremiah Adams Bridge" across Absecon Creek as one of the county's earliest bridges. Nonetheless, the Somers Point-Nacote Creek road was the exception rather than the rule; roads across the Pine Barrens to west New Jersey were at best slow, unreliable, rugged, rutted, sandy or muddy to travelers. Major rivers such as the Great Egg Harbor River at Somers Point were manned by ferry services, but most smaller streams had to be forded.

Where bridges existed they were usually simple wood structures, difficult to maintain and frequently washed out by floods (Boucher 1963: 22-23; Heston 1924).

The first decades of the 19th century saw an increasing interest in the building of improved roads. In 1777 a map by William Faden showed only one road entering Atlantic County from outside its borders; the road from Burlington followed the course of the Mullica River to Leeds Point (Port Republic), and portions of it are still in use today as several various county routes. By 1837 a map by Thomas Gordon showed four additional roads including routes from Camden to Weymouth, Mays Landing, and Tuckahoe (present CR 559/NJ 50), from Woodstown to Mays Landing (US 40), Tuckerton to Absecon and on to Cape May (US 9), and Blue Anchor to Absecon (US 30). The roads were at least a partial response to the development of iron works in remote Pine Barrens villages such as Weymouth and Batsto. Road improvements included the construction of numerous short span wood bridges. Norman F. Brydon's history of New Jersey's covered bridges lists no record of the construction of covered bridges in Atlantic County (Boucher 1963: 22-25; Brydon 1970).

In 1854 the Camden and Atlantic Railroad Company began the first regularly scheduled train service between Camden and the shore. Entrepreneurs and land developers recognized the possible profits to be made from a coastal resort within easy reach of the Philadelphia-Camden area. By 1870 the railroad was carrying over 417,000 passengers annually and paying a handsome dividend. Atlantic City was a growing beach resort of grand hotels, summer homes, and amusements. In 1875 passenger traffic had grown to such a point that a second railroad line from Camden to Atlantic City was chartered. The Philadelphia & Atlantic City Railway paralleled the Camden and Atlantic Railroad for most of its route. By 1900 branch lines to Longport and Somers Point had promoted the development of new resort towns including Ventnor, Margate, Long Port, Somers Point, Linwood, Northfield, and Ocean City in Cape May County (Cook and Coxey 1980: 5-17).

Besides promoting tourism, the railroads gave an economic boost to small isolated villages in the Pine Barrens. Prior to the railroads a small but increasing trade in charcoal, marl, and vegetables had been delivered to Camden and Philadelphia by wagon over the poorly maintained roads. The railroads increased the trade and towns such as Hammonton and Egg Harbor City grew rapidly. Manufacturers built several glass and paper mills, and farmers began experimenting with grape, cranberry, and blueberry horticulture. From the 1860s to the 1890s the railroads constructed several branch lines connecting most of the county's towns with the main lines. At the same time, the Camden and Atlantic Railroad and the Philadelphia and Atlantic Railway were respectively consolidated under the control of the Pennsylvania Railroad and the Philadelphia and Reading Railroad. The branch lines included the Winslow branch of the Camden and Atlantic Railroad, the Pleasantville and Ocean City section of the West Jersey Railroad, the Mays Landing and Egg Harbor Railroad, and the Cape May Branch of the Atlantic City Railroad (Cook and Coxey 1980: 32-56; Wilson 1954: 847-855).

During the last half of the 19th century, the county's citizens began making organized efforts at highway improvement with some good results. In the 1850s a number of turnpikes were chartered in southern New Jersey. Some, like the Camden & Atlantic Turnpike Company, were never built because of railroad competition. Others, like the White Horse Pike (US 30), were moderately successful and eventually formed the basis for 20th-century highways. In 1852 Atlantic City's developers mapped the city streets naming the longitudinal avenues for the seas, and the cross-avenues for the states. In 1853 the New Jersey Legislature chartered the Pleasantville and Atlantic Turnpike Company to construct and operate the first road and bridge across the salt meadows between the mainland and Atlantic City, connecting at Florida Avenue. Due to difficulties in building and obtaining sufficient capital the turnpike was not opened to travel until 1870. The drawbridge across Beach Thorofare was one of the first significant highway bridges in the county. The turnpike remained open until the late 1930s when the bridge was demolished (Butler 1952: 59-67; Kaplan 1991; Wilson 1954: 765-777).

In the 1880s and 1890s the county government became increasingly involved in efforts to improve roads and bridges. Partly this was in response to the growing interest in bicycling, which offered a cheap, fun and fast means of traveling across the level terrain of the shore counties. Enthusiasm for the new mode of travel reached such levels that by the 1880s local newspapers were calling for regulations governing the speed and conduct of bicyclists. Cycling was not limited to short rides along the beach; numerous local residents commuted across the salt meadows from the mainland to their jobs in Atlantic City. By the 1890s it was not uncommon for three or four thousand people to cycle on weekends from Philadelphia to Atlantic City. The record time from Camden to the shore was two hours and forty-seven minutes. Cyclists placed much attention on road conditions, published guide books to good roads, and formed groups to lobby federal, state and local governments for road improvements. In 1896 the Bicycle Road Improvement Association successfully had the White Horse Pike from Absecon to Hammonton upgraded from a sand to a graveled surface at public expense. Other county improved roads included the Mays Landing-Egg Harbor City Road and the Longport "Speedway" (Ventnor Avenue) from Atlantic City to Longport. By 1900 Atlantic County had 30 miles of gravel road and 3 miles of stone road with 19 miles under construction (Nelson 1900: 398; Wilson 1954: 789-800).

In the latter part of the 19th century a few metal truss highway bridges were constructed in the county. Three short-span metal bowstring pony truss bridges have been identified from photographs. One was located across the Great Egg Harbor River on Mill Street in Mays Landing. Two others spanned Absecon Creek in Absecon. Most bridges, however, remained simple wood stringers. No 19th-century highway bridges are known to survive in the county (Abrhamson 1987: 20-21, 61, 84-85).

In the first decades of the 20th century the pace of road and bridge improvement quickened in Atlantic County. Probably the most important single factor was the arrival of the automobile and increasing public pressure to provide better and safer roads. In 1899 the first automobile was seen in Atlantic City, and by 1905 automobile races on the beach

became a regular summertime attraction. In 1908 Atlantic City began sponsoring an annual Sociability Run from Philadelphia to Atlantic City. Local newspapers mentioned automobile accidents and complaints of poor roads with increasing regularity, and like the bicycle enthusiasts before them, the motorists organized to lobby governments for road improvements. The state government began providing Atlantic and other county governments with increased revenues for road construction, and in 1905, for example, the county received \$11,308 from state auto license revenues. In 1909 Atlantic County's Board of Chosen Freeholders appointed the first county engineer to oversee road and bridge projects. While the majority of vacationers still traveled to the beach by train, the steadily growing numbers of automobile tourists were a precursor to the momentous shift in transportation technology (Wilson 1954: 820-847).

The greatest efforts at road improvement occurred during and after the First World War. In 1912 the New Jersey General Assembly proposed a state highway system, but it was not until 1916 that large amounts of state aid was given to the counties. In 1917 the White Horse Pike (current US 30) was designated a state route. When the paving was completed in 1922, a celebration banquet dinner for 3,000 people was held at the Camden Armory. Other state-aid highways in Atlantic County included the Harding Highway, in honor of President Harding, and the Black Horse Pike. The Harding Highway (current US 40) also opened to traffic in 1922 and served travelers from the Delaware River ferry at Pennsville to Atlantic City. The Black Horse Pike (current US 322) was planned in 1925 but not completed until 1932. By 1940 Atlantic County residents registered over 23,000 automobiles, and over 274 miles of improved highways crisscrossed the county (Butler 1952: 63-66; Wilson 1954: 830-847).

In the post-WWI period the state, county, and township governments shared overlapping responsibility for the construction and cost of roads and highways. The New Jersey State Highway Department oversaw the construction and maintenance of state highways, but sometimes the county built the road before the State was ready to build it, under a law providing for the reimbursement of the County by the State. Most road and bridge construction occurred at the county level under the supervision of the County Engineer with the State Department of Highways setting standards, lending technical assistance, and paying a portion of the costs. In 1929, for example, State aid amounted to nearly 29 per cent of total expenditure for county road construction and maintenance. Broadly speaking, the County Engineer oversaw the construction and maintenance of bridges and the construction of roads, but in practice the separation of work and responsibility was never clear-cut. The Board of Chosen Freeholders through its Roads Committee initiated and approved contracts and often controlled certain work directly. Moreover, the townships also built roads and bridges with state and county aid, but usually used their own contractors and engineers. After construction the county frequently took over township road maintenance and bridge repair (Atlantic County Survey Commission 1930: 58-71).

The greatest part of the responsibility for Atlantic County's bridges fell to the County Engineer. From 1913 to 1947 the County Engineer's position was held by Alexander H.

Nelson. He was a college-educated civil engineer and a graduate of Princeton University and the Massachusetts Institute of Technology. Prior to becoming the County Engineer, Nelson specialized in bridge construction. In 1897 he joined the Pittsburgh Bridge Company and, within two years, became its vice president. Shortly thereafter, the company was taken over by the American Bridge Company, and Nelson engaged himself as a private consulting engineer. In 1906 Nelson moved to Atlantic City seeking out the ocean resort as a therapy for temporary ill health. In 1913 he accepted the County Engineer's position and began focusing his attention on the development of the county's system of roads and bridges (National Biographic News Service 1925: 22, 156).

Nelson was perhaps one of the best qualified and highly educated county engineers in southern New Jersey. From 1913 to 1924 he oversaw more than 5 million dollars worth of construction of roads and bridges and established the modern system of county road administration. By 1929 the county engineer's office had expanded to include an assistant county engineer, a transitman, a rodman, a bridge engineer, 10 bridge tenders, a foreman of bridge maintenance, a 5 man bridge maintenance crew, a secretary, a stenographer, and a chauffeur. Nelson either designed or approved the design of well over one hundred bridges built by the county over 30 years (Atlantic County Survey Commission 1930: 68-69).

The majority of pre-1946 bridges in Atlantic County date from the better roads campaigns of the 1920s and 1930s. The historic bridge survey identified 27 state highway bridges and 43 county highway bridges. The majority of state highway bridges are representative examples of common New Jersey State Highway Department bridge types found throughout the state. Twelve are concrete slab bridges, 7 encased steel stringer bridges, 4 through girder bridges, 2 movable single-leaf bascule bridges, 1 timber stringer bridge, 1 multi-deck girder bridge, and 1 T-beam bridge. Eighteen of the 27 bridges date from 1921 to 1931, the most active period of state highway construction. The remain 9 of 27 bridges dated from 1934 to 1946.

Most of the 43 county highway bridges are also representative examples of common bridge types. Twenty-two are steel stringer bridges, 8 timber stringer bridges, 4 movable span bridges, 4 through girder bridges, 3 metal truss bridges, and 1 concrete slab bridge. The county bridges date from 1904 to 1941 with 41 of 43 bridges dating from post-1914.

Several of the most historically and technologically significant of the state and county highway bridges are movable spans. One of the results of increased reliance on automobiles was that local residents, land developers, and tourists placed a growing emphasis on the construction of better roads and bridges between the shore and the mainland. From 1902 to 1930 four major roads and bridges were built across the salt meadows and navigable back-bay waterways. In 1902 the Board of Chosen Freeholders authorized the construction of the first toll-free highway from Pleasantville to Atlantic City connecting with Albany Avenue (US 40/322). The road was completed in 1905 and crossed Beach Thorofare with a metal truss swing span bridge. In 1916 the boulevard from

Longport to Somers Point opened to travel (present NJ 152). In 1919 Absecon Boulevard, an extension of the White Horse Pike (US 30), was completed with a gravel highway and 10 bridges including a steel draw over Beach Thorofare. And, in 1929 the Margate-Northfield Boulevard, a private toll causeway (4700001-4, Margate City and Egg Harbor Township), was built with four bridges including a Strauss bascule (Butler 1952: 59-66).

The 1929 Margate-Northfield movable Strauss single-leaf bascule bridge (4700001, Margate City) is the only remaining original bridge between the mainland and Absecon Island. In 1928 the Albany Avenue metal truss swing span was replaced with a bascule bridge, which in 1990 was replaced with a modern bascule bridge (0109155, US 40/322, Atlantic City). In 1946 the Absecon Boulevard draw was replaced with a bascule bridge (0103152, US 30, Atlantic City), which has since been significantly rehabilitated. And, in 1988 the Longport-Somers Point bridges (0122155, NJ 152, Egg Harbor Township) were replaced with modern high-rise bridges.

Although most of the bridges to the shore points have been replaced with modern bridges, Atlantic County retains several older examples of movable bridge technology across other navigable rivers and streams. While maritime commerce declined in the 20th century, recreational boating became an increasingly important pastime for the county's summertime residents. The oldest of the county's surviving movable spans is the Smithville-Port Republic Road steel pony truss center-bearing swing span over Nacote Creek (01PR007, Port Republic City). The hand-operated bridge was constructed in 1904 by the New Jersey Bridge Company of Manasquan, New Jersey (for more information on the company see long form). The bridge is within the boundaries of the Port Republic Historic District, and is the only known example of a surviving highway bridge swing span in Atlantic County.

Another historically significant example of movable span technology is the Egg Harbor-Green Bank Road Strauss single-leaf bascule bridge over the Mullica River (01M0001, Mullica Township). The operable bridge was constructed in 1926 and is one of New Jersey's few surviving examples of the prestigious Strauss Bascule Bridge Company's patented overhead counterweight design. The Dorset Avenue bridge over Inside Thorofare (01V0001, Ventnor City, 1929) is the county's only example of a double-leaf bascule bridge. The movable span is also a Strauss Bascule Bridge Company design and is distinguished by its decorative operators' houses, railings, and light standards. The bridge is within a community of large well-preserved homes built in the first decades of the 20th century for wealthy summer residents.

In addition to the historically significant movable spans, Atlantic County has three riveted Warren pony truss bridges dating from 1910 to 1920. No metal truss highway bridges, exclusive of movable spans, are known to survive in neighboring Cumberland, Salem, Ocean, and Gloucester Counties. In Cape May County only one metal truss bridge survives, the Marshallville Road over Mill Creek Bridge (1500019, Upper Township, 1901). Metal truss bridges were never as numerous in southern New Jersey as in the northern

part of the state, yet they played a significant role in the improvement of local highways in the late-19th and early-20th century. The best preserved and documented of the Atlantic County Warren pony trusses is the 4-panel truss bridge on Weymouth Road over the Great Egg Harbor River (01HML22, Hamilton Township, 1920). The Weymouth Road bridge is built upon standardized plans prepared by county engineer Alexander H. Nelson and was constructed by Henry S. Kraus. Another Warren pony truss is the Eighth Street over Hospitality Brook bridge (01BV007, Folsom Borough) that was constructed in c.1910 and moved to its present location in 1937. The third metal truss bridge, the Somers Point-Mays Landing Road over English Creek Warren pony truss (01EH021, Egg Harbor Township, 1914), has been significantly altered.

In addition to the state and county-built bridges, the historic bridge survey evaluated several overpasses originally built by the railroads. By the early 20th-century speeding passenger trains from Camden to Atlantic City often exceeded 100 mph. In response to the public's concern for highway safety, the railroads began building numerous overpasses even in the relatively unpopulated areas of the Pine Barrens. Nine of the bridges evaluated by the survey are railroad overpasses originally constructed and maintained by the railroads. Seven of the 9 are plate girder bridges, and 2 are steel stringer bridges. The bridges date from 1905 to 1940 and most are standard railroad overpass designs.

One of the overpasses is historically and technologically noteworthy. The Frankfurt Avenue over the Atlantic City Line bridge (0162153, Egg Harbor Township, 1905) is one of the oldest and best preserved continuous through girder bridges in New Jersey. It is technologically representative of a once common bridge type constructed by the Pennsylvania Railroad. In 1904 over 1 million passengers traveled the Pennsylvania Railroad's Atlantic City Line, and the Frankfurt Avenue bridge is representative of one of the most profitable period's of the railroad's history.

Construction of new roads and bridges inaugurated widespread changes and transformations in the everyday life of Atlantic County residents. By 1950 most people traveled to and from the county by automobile rather than by train. Farmers had made the transition from small to large scale commercial farming, sending their specialized fruits and vegetables to Philadelphia by truck. The roads, however, did not bring back the millions of visitors brought to the resort hotels and boardwalks by the train. Following a brief resurgence in the late 1940s and early 1950s tourism continued its Depression era decline, as travelers took advantage of highways and airplanes to visit other distant destinations such as Florida and California. The construction of modern 4-lane, limited access highways such as the Garden State Parkway and the Atlantic City Expressway did little to reverse the trend of Atlantic City's urban decay, but did lead to increasing suburban sprawl in neighboring seashore towns. The highways also were partially responsible for land developers' dreams of new planned residential communities in the Pine Barrens. A look at a county map shows many neat street layouts west of the Garden State Parkway, but closer inspection usually shows only vacant lots and scrub pines. It has only been in recent

years with concerted efforts to attract tourists through casinos and other seashore attractions that the county's tourism industry has revived (Cunningham 1978: 249-253).

In summary, the inventory of surviving historic bridges in Atlantic County reflects the important economic and political commitment made to automobile transportation in the first decades of the 20th century. The large number of movable spans are indicative of the county's maritime heritage and the importance of recreational boating to the county's tourism industry. The state highways run straight as an arrow across the Pine Barrens, and have numerous standardized short-span bridges designed to carry vacationers from Eastern cities to the Atlantic City resort hotels and seashore communities. The county highways also have numerous common short-span bridge types, including a few riveted Warren pony trusses. In isolated areas of the Pine Barrens are found simple wood and steel stringer bridges. Several large railroad overpass bridges span once heavily traveled passenger lines, a testimony to the county's railroad heritage.

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BERGEN COUNTY TRANSPORTATION HISTORY OVERVIEW

The history of Bergen County's bridges is associated closely with changes in its transportation and settlement patterns from the colonial period to the present day. County transportation history has been dominated by the proximity of New York City and efforts to improve the movement of goods and people to and from the city, yet a related story has also been local efforts to improve access to nearby towns, farms, and homes. All of the 156 Bergen County bridges evaluated by the New Jersey Historic Bridge Survey fit within the historic context of the county's transportation development, but several stand out as particularly significant for their historical or technological qualities. One group of extant highway bridges date from between 1885 and 1910 and include distinguished examples of timber truss, metal truss, concrete steel arch, reinforced-concrete arch, and movable span bridges. Another group of nearly 70 bridges date from 1927 to 1936 and a remarkable period of State Highway expansion surrounding the construction of the George Washington Bridge. The county's bridge history reflects the area's growth from a rural colonial settlement to a major metropolitan suburb.

Bergen County is located at the northeast corner of New Jersey bordered by the Hudson River to the east, New York State to the north, and the Passaic River to the west. Until 1840 the borders extended southeast to New York and Newark Bays and included areas that are now part of Essex and Hudson Counties. The county was inhabited by the Leni Lenape Indians and settled by the Dutch beginning in the late 1610s. Since the earliest days inhabitants had close ties with Manhattan, the location of the Dutch Fort Amsterdam. The Dutch land grants in Bergen County lay along the Hackensack, Passaic, and Saddle Rivers, which provided natural transportation corridors between the harbor and inland areas, but permanent communities were not established until after 1664, primarily due to hostilities between the Native Americans and the Dutch. In 1664 the English captured the New Netherlands colony and in 1666 signed a peace treaty with the local tribes opening Bergen County to colonization. Farmers prospered on the fertile land along the banks of the Hackensack River and soon carried on a growing trade with Manhattan. By 1750 lumber, grain, hemp, pork, beef, butter, flax seed, and other farm produce flowed down the Hackensack River making it one of the most important commercial streams in New Jersey, and Hackensack one of the most important commercial towns (Bergen County Panorama, pp. 120-122; Cunningham, pp. 85-86).

Bergen County's natural endowment of navigable rivers satisfied most of the inhabitants' transportation needs in the colonial period, but roads were locally important for the movement of goods and people to the streams. The history of road development followed the typical pattern of improvement of existing Indian trails into wagon roads leading from river settlements to inland areas. The earliest and most significant roads connected Bergen County with several ferries across the Hudson River to New York City. The first ferry mentioned in county histories is the Communipaw Ferry at present-day Jersey City, Hudson County. The road from Hackensack to Communipaw (portions of present Bergen

Turnpike) was described in 1679 as a "fine broad wagon-road." In the 18th century ferries at Weehawken, Hoboken, Paulus Hook, and other points within the present boundaries of Hudson County, were established often with the financial backing of New York merchants interested in improving connections with their city wharves. In the eastern part of Bergen County roads tended to run in a north to south direction converging at the ferries on the narrow strip of land between the Hackensack and Hudson Rivers. Roads included the Slaughterdam Road bordering the Passaic River (River Drive), the Kinderkamack Road, and Boiling Springs Road (Union Avenue). In western Bergen County important roads followed the course of the Saddle River (Paramus and Saddle River Roads) and the Ramapo River (Ramapo Valley Road, US 202), opening that area to increased settlement in the mid-18th century (*Westervelt*, pp. 159-162; Lane, p. 44; *Bergen County Panorama*, pp. 121-126).

Construction, management and repair of the county's roads and bridges was left to local officials under the general provisions of the colonial legislature. In 1761 the Minutes of the Bergen County Board of Justices and Freeholders first made mention of raising funds exclusively for bridge support. From 1761 to 1795 over 20 different bridges were mentioned by name, one of the most prominent being the draw bridge across the Hackensack River at Hackensack near the location of the present Court Street Bridge (1908, 020004A, Hackensack City). Most early bridges were timber stringers on braced timber bents with hand rails. Draw bridges, which numbered over a half-dozen by 1795, were manually operated by rope or chain hoisting mechanisms and sometimes had weights "fixed at the end bearers to facilitate the hoisting." The preferred building material was white oak or pitched pine (*Minutes of the Justices and Freeholders*, pp. 77, 230-231, 245).

By the end of the colonial period Bergen County had a rudimentary network of roads criss-crossing its countryside, but road improvements did not begin in earnest until the beginning of the "Turnpike Era." Bergen County's privately owned and operated toll turnpikes were typical of those chartered by New Jersey and other states in the first three decades of the 19th century. The turnpikes were seen as a means of improving internal transportation and attracting trade to major towns whose merchants were willing to pay for the expensive road improvements, such as McAdam and Telford foundations, in order to bolster the local economy. In northern New Jersey turnpikes established trading patterns from New York Harbor to western New Jersey, eastern Pennsylvania and Upstate New York stimulating markets in wool, beef, iron, and coal. The turnpikes were the first important cross-state east-to-west routes in the area and made a significant contribution to the development of New Jersey's highway system.

Hackensack, already the commercial center of Bergen County, became its highway hub as well with three of the county's five major turnpikes having their termini at the city. In 1802 the Bergen Turnpike Company was granted the first turnpike charter in the county and in 1804 opened its route from Hackensack to the Hoboken Ferry taking over part of the former route of the old Hackensack-Communipaw Road. Portions of the Bergen

Turnpike are still in use today as county roads in the vicinity of Hackensack, Ridgefield and Ridgefield Park. In 1815 an extension of the Paterson-Hamburg Turnpike (Market and Essex Streets) reached Hackensack and with connections to the Bergen Turnpike became the county's first east-to-west route with linkages to the Hudson and Delaware Rivers. Freighting of bulk goods by long-distance teamsters was particularly heavy along the Hamburg-Paterson-Hackensack- Hoboken route. Lastly, in 1828 the Hackensack and Fort Lee Turnpike (Fort Lee Road) opened improving the route directly east from Hackensack to the Palisades and the Hudson River.

Bergen County had two other turnpikes of note. In 1806 the Franklin Turnpike, connecting New York State with Ho-Ho-Kus, started operations with a high volume of trade. The Franklin Turnpike is still in use today as a county road that parallels the route of NJ 17. In 1849 the Paterson and New York Plank Road was constructed from Paterson to Hoboken, a distance of 15 miles. The Paterson and New York was built during a short-lived revival of turnpike construction, and was the longest plank road in northern New Jersey. The circumstances surrounding its construction were unusual in that a group of Paterson businessmen who felt slighted over the leasing of the Paterson and Hudson River Railroad to the Erie Railroad decided to build the plank road in competition. The turnpike company eventually failed but the right-of-way is still in use and known as the Paterson Plank Road (Lane, pp. 143-165; Bergen County Panorama, pp. 129-131; Westervelt, pp. 162-163).

Turnpikes required large capitalization and upkeep, and after 1830 they faced increasing competition from canals and railroads. Often, such as in the case of Bergen County's Hackensack and Fort Lee Turnpike, traffic volume was small with the result that after paying for initial road improvements the turnpike was sold at sheriff's sale and eventually reverted to public ownership. In 1834 the Morris Canal bypassed Bergen County on the southerly bank of the Passaic River contributing to the growth of Paterson, Passaic, and Newark as industrial centers, and to the decline of Bergen's turnpikes to the north. After 1865 sentiment turned against toll roads in favor of free roads, and in 1878 the County Freeholders were empowered to purchase the remaining turnpikes for public use. In 1899 the Bergen Turnpike, the first and last of the county's toll roads, was converted to a trolley line by the Jersey City, Hoboken and Paterson Street Railway Company. In 1915 the county purchased the right-of-way from the trolley company as a county road (Hudson Street and Bergen Turnpike) running from Main Street Hackensack through Little Ferry, Ridgefield Park, Ridgefield, and Fairview (Bergen County Panorama, pp. 141-143).

Interest in turnpikes declined in the mid-19th century in large part due to the success of railroads. In the fifty years from 1830 to 1880 no less than seven different railroad companies established lines in Bergen County making it one of the most densely developed in the state. The county's first railroad was the Paterson and Hudson River Railroad, chartered in 1831, and built across the Hackensack Meadows in 1834 to make connections with the New Jersey Railroad which ran south from Jersey City to New Brunswick. In 1847 the line was extended north to the New York State line through the

Ramapo region under the name of the Paterson-Ramapo Railroad with connections to the New York and Erie Railroad at Piermont, New York.

Bergen County's proximity to New York City had a significant impact on the pattern of railroad development. Because of the geographic importance of the county in a direct route from New York Harbor to the west, the New York and Erie Railroad in 1852 leased the Paterson and Hudson River and the Paterson-Ramapo Railroads completing its route from New York to Buffalo. The New York and Erie Railroad was the nation's first long-distance trunk line, and in combination with the Erie Canal gave New York City a distinct advantage over other eastern cities in respect to the volume of freight shipped to and from western points.

The steady increase in freight and passenger traffic on the Erie line emboldened other railroads to establish lines in Bergen County as farmers and townsmen demanded short line connections with the main line. In 1854 the Northern Railroad of New Jersey began construction of a line from Bergen Junction to Sparkill, New York following a route on the west slope of the Palisades. In 1869 the Hackensack and New York Railroad was completed from Jersey City to Hillsdale stretching across the county's middle from south to north. In 1872 the New Jersey Midlands Railroad opened its tracks from Hackensack to Paterson, and in 1881 merged with three other railroads in New Jersey, New York, and Pennsylvania creating the New York, Susquehanna, and Western Railroad, an important through route across the mountainous northern part of the state (Condit, vol. 1, pp. 53-64, 70-75).

The railroads were a major factor in the expansion of truck farming in northeastern New Jersey. Agriculture was Bergen's largest 19th-century enterprise supplying New York City and New Jersey's industrial cities to the south with fresh fruit and vegetables. The furthest reaching impact of the railroads, however, was the establishment of suburban residential and resort communities. The railroads provided easy access to the cities and attracted new middle class residents anxious to escape the increasingly crowded and industrialized urban centers. In 1854 Carlstadt was Bergen's first official real estate development of 270 plots. By 1890 Bergen County railroads were carrying well over 7 million passengers per year, the majority male commuters to daytime jobs New York City. Suburban towns on the Northern New Jersey Railroad included Ridgefield, Palisades Park, Leonia, Englewood, and Tenafly; on the New Jersey and New York line Carlstadt, Hasbrouck Heights, River Edge, Oradell, Emerson, Westwood, and Hillsdale; on the Erie Main Line Garfield, Fairlawn, Glen Rock, Ridgewood, and Ho-Ho-Kus; and on the New York, Susquehanna, and Western Maywood and Rochelle Park. Famous 19th-century resort hotels attracted weekend vacationers to Fort Lee, Edgewater, and Park Ridge and offered amusements to suit all ages and tastes (Condit, vol. 1, pp. 351, 354; Cunningham, pp. 89-90).

Bergen County's railroads spurred economic and population growth with the secondary result that townspeople increasingly demanded improved roads and bridges, especially those providing access to important railroad stations. Beginning in the 1830s stone arch

bridges found favor over the older style timber bridges, although no county bridges of either vintage are known to survive. Brydon's 1964 survey found no records of covered bridges ever existing in Bergen County. Generally, the new suburban communities had stone or gravel paved streets and stone arch bridges, while more rural areas dispensed with expensive road improvements.

Sectional disagreements over financing of road and bridge construction was often a central feature of local politics. In 1889 the Freeholders assumed full control of the public roads and bridges from the townships. The motivation was not so much for greater efficiency but an effort of local interests to gain control of county funds for highway improvements in their own communities. The initial outcome was bitter political warfare between the eastern suburbs and the western rural areas, however, by the mid-1890s animosities had cooled down and the county entered into a cooperative period heralded by a local paper as "Bergen's new era of good roads." Still, in 1908 Bergen had less than 40 miles of Macadam road (Walker, "Bergen County History," n.p.; Bergen County Panorama, pp. 130, 139, 143; Brydon, p. 6; Cunningham, pp. 90-91).

Several bridges dating from 1885 to 1910 survive in Bergen County as illustrations of the type of work undertaken during those years. Two bridges demonstrate directly how railroad construction stimulated highway and bridge improvements. The Warren Avenue bridge (c.1890, 020028A, Ho-Ho-Kus Borough), a single-span pin-connected Pratt thru truss, was originally a rail-carrying facility on the Erie Railroad near Narrowsburg, New York. In 1908 the Erie opened a new suburban rail station at Underwood, Bergen County, in response to commuter demands. As part of the station's construction the former railroad bridge was moved and rebuilt as a highway span on the station's new access road. Another bridge, Ivy Avenue over Conrail (c.1885, 0250164, Haworth Borough), was built as part of an agreement between the New Jersey and Albany Railroad and local landowners who donated right-of-way in return for an overpass connecting farmland on either side of the tracks. The railroad built a three-span timber and metal pony truss, a common 19th-century bridge type but the only example of its kind known to survive in the state. The middle span has been replaced with a modern structure but the two end spans survive in much their original configuration.

In the last third of the 19th century bridge companies were active in Bergen County selling their prefabricated metal truss designs for use on local highways. Only a small handful of the wide variety of truss types that once existed survive. The Bear Swamp Road bridge (1888, 020033A, Mahwah Township) is a well-preserved example of a lenticular pony truss built by the Berlin Iron Bridge Company of East Berlin, Connecticut. The company had a national reputation for its distinctive "pumpkin seed" shaped bridges popular from the mid-1880s to about 1900. The Elm Street Bridge in Somerset County (1896, 18C0601, Branchburg Township) is the only other example of this truss type extant in the state. The Glen Gray Road bridge (1904, 020033G, Oakland Borough) and Underwood Station's Warren Avenue bridge (c.1890, 020028A, Ho-Ho-Kus Borough) are the county's only two examples of pin-connected Pratt thru trusses. The truss type was developed in the 1850s

by Thomas Pratt and eventually became a standard railroad and highway bridge design contributing to the widespread acceptance of structural rolled iron and steel.

Two Pratt pony trusses with Phoenix Column sections, Doty Road bridge (1891, 020042A, Oakland Borough) and Elm Street bridge (1892, 020044B, Oradell Borough), are examples of another technologically and historically significant truss type represented in the county. The Phoenix Column, composed of semi-circular wrought iron segments riveted together at their flanges, was a patented design of Samuel Reeves of the Phoenix Iron Works of Phoenixville, Pennsylvania. In the 1870s the column widely supplanted cast iron as a building material for compressive members in metal truss bridges. The 1891 Doty Road bridge was erected by noted New York City builders Dean and Westbrook and the 1892 Elm Street bridge by J. W. Swagg, a subcontractor to Dean and Westbrook. Both bridges have structural alterations but the trusses retain integrity of design. Only two other Phoenix Column pony truss are known to survive in the state (Hamden Road, 1886, 10XXF65, Franklin Township, Hunterdon County; and Walns Mill Road, 1886, 1300U47, Upper Freehold Township, Monmouth County).

Bergen County is home to over 14 arch bridges constructed between 1897 and 1911. As a group, the bridges are the most unusual and noteworthy of any county in the state. Many have elaborate decorative detailing such as brick spandrel walls, balustrades, stone voussoirs, and metal railings. Several represent state-of-the-art styles of arch construction such as Melan or Monier. Developing suburbs often chose to build the arches as part of efforts to lend a sense of style, grace, and permanency to the surrounding community while making use of the most modern construction techniques.

The history of reinforced-concrete arch bridge construction is important to the historic context of Bergen's arch bridges. The technology developed in Europe in the mid-19th century but was not introduced in this country until the late 1880s. The United States' earliest reinforced-concrete arch bridges were ornamental in style and often located in city parks such as the Alvord Lake Bridge (1889) in San Francisco's Golden Gate Park. Today concrete is one of the most important structural materials, but in the late-19th century bridge engineers viewed it with suspicion and poorly understood its scientific properties. Experimentation led to several styles of reinforcing and a wide variety of patented systems of which the most prominent were the Melan, Monier, and Ransome. The Melan system, developed by Austrian Joseph Melan, used parallel I-beams embedded in concrete along the same general lines of the intrados. The Melan arch was functionally best described as a metal arch with concrete covering, and was often referred to as a "concrete steel bridge." The Monier system, named for Frenchman R. Jean Monier, employed wire mesh reinforcing near the extrados. The Ransome system, designed by Ernest L. Ransome of San Francisco, was concrete reinforced with twisted bars, and although initially less popular than the Melan and Monier systems became standard practice by 1910 because of its practical and economic advantages (Plowden, p. 297-298).

In Bergen County the Survey identified three Melan arches dating from 1899 to 1904. The earliest of these, Wyckoff Avenue over Ho-Ho-Kus Brook (020033E, 1899, Wyckoff Township), employs a patented variation of the Melan system developed by American engineer Edwin Thacher. Thacher was the most important builder of Melan arches in the United States, and his work included a bridge over the Kansas River at Topeka that was in 1897 the longest span concrete steel arch in the world. According to county records, Thacher kept an office in Paterson but only one other Melan arch attributable to him is known to exist in New Jersey (1897, West Broadway Avenue over Passaic River, 1600017, Paterson City). The remaining two Melan arches in Bergen County are the Maple Avenue (1904, 020028D, Ho-Ho-Kus Borough) and East Ridgewood Avenue (c.1904, 020051A, Ridgewood Borough) bridges. The Maple Avenue bridge has had extensive alterations but the East Ridgewood Avenue bridge retains much of its original appearance including railings, buff brick spandrel walls, and sandstone voussoirs.

The county's three surviving Monier arch bridges were built from 1902 to 1903 and include the Colonial Road (1902, 020020A, Franklin Lakes Borough), Pulis Avenue (1903, 020020B, Franklin Lakes Borough) and East Ramapo Avenue (1902, 020033D, Manwah Township) bridges. In all cases spalling reveals wire mesh reinforcing and scored voussoirs are common treatment. Unfortunately, each of the bridges has extensive alterations including widening that obscures the original design. The Colonial Road bridge has been found National Register eligible by the SHPO as a representative example of the Monier technology.

Although concrete was increasingly popular, more traditional materials such as brick continued to be used for bridges in Bergen County until about 1910. The only surviving brick arch bridge identified in the county is the well-preserved Hardenburgh Road bridge (1909, 020009A, Demarest Borough) located in a town park. More common from 1890 to 1910 were stringer bridges with brick jack arches that span between the stringers to carry the deck and transfer live load onto the stringers. At least seven examples of the stringer and brick jack arch bridge type were identified in the county. The most complete and well-preserved example is the Upper Cross Roads bridge (c.1900, 020058C, Saddle River Borough). In the 1900s brick jack arch construction was gradually replaced with concrete jack arch which quickly gave way to concrete slab decks for reasons of strength and economics.

An unusual example of the combination of steel ribbed arch and brick jack arch construction is the Lake Street bridge (1897, 020035A, Midland Park Borough). The single span steel arch bridge has closely spaced rolled steel beams spanned by brick jack arches, and is the only known example of its type in the state. It was constructed by F. R. Long and Company, a prominent Hackensack contractor, that built numerous bridges of various types in Bergen County from 1896 to 1911. Frank R. Long, the company's president, began his bridge building career with Dean and Westbrook of New York City before establishing his own successful business (The Evening Record, 30 Aug. 1911, p.1). Other F. R. Long & Company Bridges of note are the Passaic Avenue thru girder bridge

(1898, 0200015, Garfield City), the Madison Avenue over the Hackensack River multi-girder bridge (1902, 020038C, New Milford Borough) and the Court Street over the Hackensack River swing span bridge (1908, 020004A, Hackensack City).

A special category of Bergen County bridges are movable spans. In northeastern New Jersey movable highway and railroad bridges of all types - swing span, bascule, and vertical lift - are a unique feature of the landscape and a testimony to the important engineering problem of linking communities while still serving the needs of water transport. Bergen County, because it is located on the upper navigable portions of the Hackensack and Passaic Rivers, does not have as many examples of the impressive long-span movable bridges seen further downstream in Essex and Hudson Counties, but it is noteworthy for the survival of several technologically significant examples of shorter-span late-19th and early-20th century movable bridges that have not been replaced due to obsolescence or structural inadequacies.

Among the most important of Bergen's surviving movable bridges are at least four swing spans dating from 1888 to 1908. Swing spans were the most common late-19th century movable bridge type and a common solution to providing low-level crossings to navigable streams until the early-20th century. The New Bridge Road bridge is an 1888 pony truss rim-bearing swing span located at the New Bridge Landing County Park in River Edge Borough. The bridge has been closed to traffic since the 1950s when it was bypassed by a fixed-span upstream. It is one of the earliest and most significant of its type remaining in the state but was not rated in the Survey because of its removal from highway service. The Union Avenue bridge (1896, 0200011, Rutherford Borough) is the oldest of Bergen County's center-bearing thru truss swing spans, and the only one of its type surviving over the Passaic River. Dean and Westbrook of New York built the historically significant bridge and it is an excellent example of an uncommon swing span type that when in the closed position acts as a non-continuous structure with the two halves independent of each other in respect to live loading.

The Court Street bridge (1908, 020004A, Hackensack City), a well-preserved thru truss, center-bearing swing span, is the only remaining operable highway draw across the upper navigable portions of the Hackensack River. In the early-19th century the river had over a half-dozen swing span crossings and was one of the most important navigable streams in New Jersey. In the late-19th century as the industrial cities of Jersey City, Newark, and Passaic grew in importance traffic on the river declined. Other than the New Bridge Road and Court Street swing spans, the only other remaining swing span bridge over the Hackensack River is the Salem Street bridge (1900, 020004B, Hackensack City). It was originally constructed by the Bergen County Traction Company to carry its trolley lines from Fort Lee to Hackensack, and in the 1940s the county converted the bridge to highway use. It is the least complete of the remaining swing spans.

In the 20th century many swing spans were replaced with either bascule bridges where water transport still demanded clearance or with fixed spans where navigation had declined

to the point that movable bridges were no longer needed. Of the later generation bascules two are of particular note. First, the NJ 7 over Passaic River bridge (1914, 0208150, North Arlington Borough) is a patented Strauss Heel Trunnion Bascule built by the Strauss Bascule Bridge Company of Chicago. The company was founded by noted engineer Joseph Strauss who did more than any other engineer to popularize the bascule bridge type. Strauss's patented designs included the underneath, overhead, and heel trunnion counterweight types. The heel trunnion design with its impressive overhead counterweight and supporting superstructure is not an uncommon single-leaf bascule type but is more frequently found on railroads which require its heavier load capacities. Second, the US 46 over Hackensack River bridge (1934, 0221155, Ridgefield Park Borough) is a well-preserved double-leaf bascule span designed by the engineering firm of Waddell and Hardesty of New York City. J. A. L. Waddell and Shortridge Hardesty were among the most noted American bridge engineers and made significant contributions to the advancement of movable span technology, especially in the area of vertical lift bridges. In 1934 the firm joined with the New Jersey Highway Department to prepare plans for the US 46 bridge, which with its distinctive operators' towers is one of the most distinguished of its type in the state.

While Bergen's movable spans are an interesting chapter in its bridge history, water transportation was not an important force in the transformation of the county's transportation system in the 20th century. Bergen County had already developed a suburban residential character due to the impact of the railroads in the 19th century, but after 1910 the tendency for city dwellers to seek out new housing further from urban centers accelerated due to the freedom offered by the automobile and an integrated system of state and county highways. Bergen's changing population gave it an increasingly progressive spirit and local municipalities and county government took up the cause of improved roads earlier than many other parts of New Jersey. By 1920 Bergen County already had over 179 miles of improved road paid for by middle-class resident taxpayers and by aggressive use of state-aid funds (Bergen County Panorama, p. 143).

In Bergen County the appointment of officials to oversee bridge and road construction followed a pattern seen in other New Jersey counties. Before 1907 the Freeholders supervised all bridge projects through their standing committees. When professional advice was necessary they hired consulting engineers on a project by project basis. In 1907 work had expanded to the point that the Freeholders appointed a salaried County Engineer to take responsibility for the design of roads, bridges, storm sewers and drains; to prepare specifications, bids, and plans for county projects; and to submit detailed and itemized completion reports at the finish of each project. The appointment was two years before state law required counties to hire a county engineer (New Jersey Historical Records Survey, p. 167).

The creation of the County Engineer's office marked the beginning of ongoing efforts to improve and upgrade Bergen's bridges. The Survey identified at least 39 surviving county bridges built in the period from 1910 to 1946. Of the 39 bridges, nine were constructed in

the 1910s, 12 in the 1920s, and 18 from 1930 to 1945. The large number in the post-1930 period was related to the availability of works project funding from the federal and state governments during the Depression. The majority of the 39 bridges were common bridge types and included 24 steel stringer spans, five reinforced-concrete arch spans, five reinforced-concrete slab spans, three thru girder spans, one deck girder span, and one encased pony truss span. Of the county-built bridges, the encased Warren pony truss span (1919, 020031E, Lodi Borough) carrying Borig Place over the Saddle River is the most noteworthy. The bridge is the only known example of an encased truss in the state, and appears to be a one-time experiment by the County Engineer. Concrete encasing increased dead load while providing little additional strength, and no explanations for the choice of bridge design were located in the County Engineer's records.

In the 1910s and 1920s federal and state money provided increasing support for major through highway routes in Bergen County. In 1920 State Highway Routes included Route 10 from Paterson to Fort Lee (portions of US 46 and NJ 5) and Route 17 from Hackensack to the New York State Line (NJ 17). The State Highway System in the county, however, became congested as population and automobile usage rose rapidly. While the roads were adequate for local and recreational travel, most commuters crossing the Hudson River to New York City in 1920 completed the trip by railroads and ferries. Several factors combined in the early 1920s to make it desirable to span the Hudson River for automobile traffic, not the least were the demands of commuters. During World War I the capacity of New Jersey's New York Harbor rail terminals had been strained to the limit by the inability to quickly move freight from rail cars to waiting ships and ferries. The rail transport system as it existed was the result of numerous private railroad companies building what each thought best with little overall concern for centralized planning. Immediately after the war the railroads did not move quickly to initiate capital improvements giving government officials further reason to embrace highway bridges and tunnels spanning the Hudson River. The New York and New Jersey State Legislatures created several intergovernmental bodies to oversee highway and harbor planning, the most important of which was the Port of New York Authority. A comprehensive plan of highway improvements was developed resulting in the construction of the Holland Tunnel (1920-1927), the George Washington Bridge (1927-1931) and the Lincoln Tunnel (1934-1945).

The George Washington Bridge, which had its New Jersey terminus at Fort Lee, had the greatest impact on highway development in Bergen County, although the Lincoln and Holland Tunnels, which had their termini in Hudson County, also provided important routes for commuters traveling to Midtown or Downtown Manhattan. The George Washington Bridge, the world's longest span suspension bridge, was in itself one of the most important engineering achievements in United States history, but it also posed significant challenges in terms of designing limited access, grade eliminated, multi-lane approach highways that served both the needs of through traffic traveling north and south along the East Coast or east and west from New York City, and of local and commuter traffic traveling within Bergen County or crossing the Hudson River. The New Jersey State Highway Department coordinated closely with the Port of New York Authority and local Bergen County officials

to achieve workable solutions to the complex weave of State Highways feeding on and off the bridge. From 1927 to 1933 the State Highway Department spent over 40 million dollars within a ten mile radius of the bridge. Highways included NJ 1 (present US 9W) to the north and also to the south (US 1-9), NJ 17 to the northwest, and NJ 4 and NJ 6 (US 46) to the west (Evans, pp. 378-380; Engineering News-Record, pp. 657-664).

The impact of the George Washington Bridge on Bergen County's transportation development can be seen in that out of 71 pre-1946 State Highway bridges surveyed 65 were built from 1928 to 1936 and were associated with highway improvements either related directly to the George Washington Bridge approaches or to major highways feeding into the bridge. For the most part the highway bridges were common bridge types and included 36 stringer spans, 13 thru girder spans, eight multi-girder spans, three deck girder spans, two slab spans, two double-leaf bascule spans, and one open spandrel arch. Many of the bridges have similar architectonic features such as horizontal abutment scoring, balustrades, obelisk lantern posts, and pilastered piers that give design cohesion to individual stretches of highway. The architectonic motifs do not differ markedly from those seen on other State Highway bridges throughout the state and do not in themselves constitute historic corridors. Good examples of the design approach are the overpasses on US 1-9 and US 46 (1930-1931, 0202150-0202156, Palisades Park Borough & Fort Lee Borough) and the overpasses on US 46 (1936, 0220150-58, Elmwood Park Borough, Garfield City & Lodi Borough).

Bergen County's State Highways were built on a large scale but generally employed non-innovative solutions to achieving grade-separated crossings and uninterrupted traffic flow. The major routes were either carried by built-up or depressed roadways with standard steel stringer or girder overpass and underpass bridge types. An exception was the three-tier bridge intersection (1930, 0202160 & 0206187, Fort Lee Borough) of NJ 4 and NJ 1 & 6 (US 1-9 & US 46) near the top of the Bergen Ridge west of the George Washington Bridge approach. The innovative three-tier structure was necessary to maintain grade separated crossings and a maximum six per cent grade at a critical highway juncture. Another noteworthy bridge was the encased steel stringer span with steel bent piers (1930, 3800016, Fort Lee Borough) carrying the George Washington Bridge approach (I-95) over Hudson Terrace. The structure located 600' west of the suspension span and east of the upper level toll plaza was the only approach bridge on the New Jersey side designed and built by the Port of New York Authority.

By the end of the Second World War, an integrated system of State Highways was in place in Bergen County. The highway system was an important factor promoting a post-war suburban boom that soon surpassed pre-1946 highway capacities. Growth prompted another round of highway construction paralleling already existing routes and including portions of the New Jersey Turnpike, the Garden State Parkway, the Palisades Parkway, I-80, I-95 and NJ 208. Shopping centers and malls, high-rise office buildings, and corporate office parks followed the highways to be closer to their suburban workforce, eventually radically changing the county's landscape and character.

In summary, Bergen County, located proximate to the nation's largest metropolis, evolved through its history from a predominately rural and agricultural community to a suburban residential and commercial community. Bergen's colonial and early-19th century bridges were replaced to meet the expanding traffic needs of later periods and therefore surviving bridges represent national trends in bridge construction from the 1880s through the present day. Several spans in the county are unusual designs, especially noteworthy are a small but significant number of early metal and reinforced-concrete arch spans that distinguish the county as an innovator in an important modern construction technique. The county also has its share of technologically distinguished examples of once common but increasingly rare extant metal truss and movable span bridge types. The majority of pre-1946 bridges date from the late 1920s and early 1930s and mark the great period of State Highway expansion surrounding the construction of the George Washington Bridge.

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BURLINGTON COUNTY TRANSPORTATION HISTORY OVERVIEW

Burlington County, largest county in New Jersey, stretches from the Delaware River to the Atlantic Ocean. On the Delaware River side it is situated between Camden and Trenton. The area was initially settled by the Dutch, but English Quakers arrived beginning about 1677. The history of the county through the 1700s is dominated by Quaker farmers and merchants. In addition to the navigable Delaware River, which forms the county's western boundary and had a dramatic influence on its economic development, the numerous navigable rivers and streams in the county provided not only transportation links into the interior portions of the county. The streams also provided power for proto-industrial development, especially grist and saw mills like the one preserved at Kirby's Mill in Medford Township. Shipbuilding, tanning, and brick making were also significant early Burlington County industries. Despite the industrial activities that continued into the 19th and 20th centuries, Burlington remains a sparsely populated, decidedly rural, agriculturally oriented county that projects and preserves its 19th century prosperity derived, in large part, from its successful farms.

The oldest bridges in the county are the only two spans documented as having been erected in the 19th century. Both are representative of the prevailing technology of their day, and both are located in historically significant communities. The oldest is the ca. 1831 stone arch (0350162) that carries the main street of Bordentown City over the first rail line in the state of New Jersey. The right-of-way was developed by the Camden & Amboy Railroad, a branch of the United Companies that operated the Delaware and Raritan Canal as well as the rail line. Bordentown flourished through the middle years of the century as the terminus of both the canal and the railroad. The Camden & Amboy developed car shops in Bordentown, but when the company was taken over by the Pennsylvania Railroad in 1873, the works was moved to other locations, marking the end of Bordentown's prominence in the transportation history of the state. The stone barrel arch, however, is well preserved, and it ranks as the most tangible local artifact from the heady days of railroading in Burlington County. It is also believed to be one of the oldest grade crossing elimination bridges in the state.

Another early arch is the 1853 brick arch that carries White Street over the North Branch Rancocas Creek in Mount Holly (03D4108), a well-preserved 18th- and 19th-century industrial and trading center located at the head of navigation on Rancocas Creek that retains its historic character. The bridge, the only documented example of a brick arch in the southern half of the state, enjoys integrity of original setting.

Navigable rivers and streams formed the most important transportation network in the 18th and first half of the nineteenth centuries, and they carried much of the county's agricultural bounty to market in Philadelphia and the greater New York area. While no 19th-century moveable span bridges crossing the historically important waterways survive, an impressive collection of pre-World War II examples remain with the 1903 Warren pony

truss center-bearing swing span over the Rancocas Creek at Centerton (03C4004) (Mount Laurel Township) being the oldest. The Centerton bridge marks the site of a movable span first erected in the mid-1830s, and the present bridge is one of the most complete early examples of a manually operated swing span in the state. Its historical significance is enhanced by the fact that it was fabricated by a state bridge manufacturer, the New Jersey Bridge Company of Manasquan.

Another early 1900s Warren pony truss swing span was built over the same stream at Riverside (0300003), but that span was replaced in 1934 with a Warren pony truss bridge of welded construction. The Riverside bridge is technologically significant as an early and nationally known example of an all welded bridge.

On the east side of the county, the tidal Mullica River, the boundary between Burlington and Atlantic counties, and the Wading River were crossed by Strauss overhead bascule bridges. Characterized by an articulated counterweight that moves parallel to itself when the bridge is in operation, the bridge type was so successful that it became the most common pre-World War II movable bridge type in the country. The Wading River bridge (03H8001) and Lower Bank bridge (03G8045), both in Washington Township, have been replaced, but the 1925 Strauss bascule at Green Bank (Atlantic County) survives. Another important example of a Strauss bascule bridge is the 1924 NJ 9 bridge over the Bass River in Bass River Township (0302150). Built with the articulated counterweight underneath rather than above the movable through girder span, the bridge is significant for its operating equipment that includes the original gasoline-powered engine and chain-driven gearing. It is the only documented bridge in the state with such an arrangement.

Two other movable span bridge that serve the county rank as important engineering achievements of their day. Both the 1929 Tacony-Palmyra Bridge in Palmyra Borough (3000001), an early example of a tied steel arch with the movable spans consisting of a double-leaf Scherzer spans, and the 1931 Ash-Howard-Needles & Tammen-designed vertical lift bridge (3000002) linking Burlington, New Jersey with Bristol, Pennsylvania were significant Delaware River crossings when they were completed. Both bridges survive unaltered, and both have played a significant role in the subsequent development of their surrounding areas. The bridges rank as the last of the privately financed major Delaware River crossings, a practice that dates back as far as the early 1800s.

As in other counties in the southern part of the state, the earliest roads were Indian trails. The English designated improved roads in the last quarter of the 17th century. The county was part of the overland route from Philadelphia to the ports of Amboy and Elizabeth that provided water access to New York. The first turnpike road in the county was completed in 1808 linking Burlington City, the most populous settlement in the county, with Bordentown to the north and then Amboy on the east coast. Railroads, linking the county with larger urban markets, were developed beginning in the mid-1830s when the Camden & Amboy developed its line between Bordentown and Camden. Although many small local lines crisscrossed the county by the 1870s, their impact on the county byways is not

significant as most of the railroads remained small, lightly traveled lines that rarely constructed grade crossing elimination bridges. With the exception of Bordentown, where three local streets are carried over the old Camden & Amboy main line, most rail-related overpasses are located on mid-20th century state highways.

Because much of Burlington County is sparsely developed, which limits the need for bridges with great live-load capacity, historically the most common bridge type was the timber stringer span --- an economical, easily erected bridge type. Representative of the one of the earliest type of bridges known, the simple but efficient bridge type continues in use today. Most county examples of timber stringer spans are of mid- to late-20th century construction, and they represent the inkind replacement of a bridge type used since the earliest days. Good representative examples of timber stringer bridge technology, usually with braced timber pile bents, can be found on the approach spans to the NJ 9 bridge over the Bass River and in the state parks and forests in the Piney Woods section of the county.

There are not many examples of metal pony truss bridges. Only three survive, but each is a historically or technologically distinguished example of what was, prior to 1930 a popular alternative to timber stringer bridges on both county and state routes. The 1904 Cedar Lane pony truss in Springfield Township (03D3760) is an interesting transition span that combines design elements from both riveted and earlier pin-connected bridges. The unusual floor beam hangers that straddle the lower panel point gusset plates have not been identified on any other bridge in the state. The Hilliards Bridge Road (03E4400) (Southampton Township) pin-connected pony truss bridge erected in 1907 is a late but well- preserved example of the work of the prolific Wrought Iron Bridge Company of Canton, Ohio, one of the most successful bridge fabricators of the late 19th- and early-20th centuries. The Hanover Street bridge (03E4550) in Pemberton was built in 1922 and is a good example of the later Warren pony truss spans designed to accommodate secondary stresses. Widened in 1950, it is the most altered of the three pony truss spans.

Another historically important bridge type that is represented in the county is the reinforced concrete span, especially the reinforced concrete arch. Introduced in this country from Europe in the 1890s, the bridge type quickly came into its own in the years the turn-of-the-century because of its durability and low maintenance. One of the most successful promoters of reinforced concrete arch and slab bridges was Daniel Luten (1869-1946) who held several patents on reinforcing systems and who marketed those proprietary designs nationally through a series of authorized agents. The Ferro-Concrete Company of Philadelphia and later Harrisburg was established prior to 1906. The company represented Luten and was building his reinforced concrete arch bridges in New Jersey by 1906. Burlington County retained Ferro-Concrete Company, which was also building bridges in other New Jersey counties, to erect several of its proprietary concrete arch spans between 1906 and 1911. Unfortunately, all the Ferro-Concrete erected arch bridges have been significantly altered, but their history represents an important chapter in the chronology of bridge building in Burlington County. During the late-19th and early-20th centuries, national and state bridge companies that erected both metal truss and concrete spans were

represented by local agents who competed with local contractors for county contracts to erect bridges specified by the Burlington Board of Chosen Freeholders. It was often the bridge companies that were designing the spans for a crossing rather than their responding to a specific county specification. This practice continued into the early years of this century, at which time the county appointed its own engineer.

Among the most significant early concrete spans in the county is a 7-span continuous slab bridge (03E4440) built in 1914 over North Branch of Rancocas Creek on Smithville Road (Easthampton Township) near the 19th-century industrial village of Smithville, now a county park. The well-preserved bridge is an early documented use of reinforced concrete driven piles. It was designed by James Logan, the Burlington County Engineer.

As previously mentioned, stringer bridges are among the most common bridge type in Burlington County. Stimulated by advances in both metallurgy and the ability to roll economically larger I-sections, the steel stringer bridge came into its own as a commonly used type in the 1910s. After World War I it would eclipse the metal truss bridge as the preferred span on the ambitious road improvement programs undertaken by both the county and the newly established State Highway Department that was developing New Jersey's initial 15 state routes. The most significant of the stringer bridges in the county is the ca. 1885 span (03D4130) built by and possibly designed by industrialist Hezekiah Smith (died, 1887) at his village of Smithville. Smith manufactured woodworking machinery at his Smithville works, and the bridge, with its unique X-beam piling caps and cast railing brackets on the fascia stringers, is not only the earliest stringer span in the area, but it is also the most technologically distinctive. It has statewide significance.

As part of its development of state routes, which were expanded from the initial 15 in 1926, the New Jersey State Highway Department built many stringer bridges. The Bridge Division of the Department was under the direction of noted bridge engineer Morris Goodkind (1888-1968), and he favored protective encasement in concrete of the steel stringers. Most of the state roads cross the numerous streams in the county on encased stringer spans, although some are slab spans. All are enclosed by well-proportioned concrete balustrades. All of the fixed-span state-built bridges in the county are standard designs and are not individually technologically or historically noteworthy. They are representative of the work the State Highway Department was undertaking throughout New Jersey.

In conclusion, the surviving pre-1947 bridges in Burlington County reflect both local and national trends in bridge construction. The surviving spans illustrate the long and well-established tradition of timber stringers and the use of swing spans at crossings that required a movable span. Documentation suggests that since timber stringers were so common, metal truss bridges were not as common in Burlington County as they were in counties to the north; only three remain, and they are rivet-connected Warren pony trusses. Railroad crossings remained largely at grade in the predominantly rural county until the 1920s when the development and then expansion of the state highway system mandated that the two transportation networks not intersect one another at grade. Because

the county did not develop as a major late-19th and 20th-century industrial center, much of its 18th and 19th-century character is preserved, offering integrity of setting to its most historic bridges, like the masonry arches in Bordentown and Mount Holly, both large National Register of Historic Places-listed historic districts, and Hilliards Bridge that survives in its unspoiled bucolic surroundings. The early example of a stringer bridge at Smithville is also preserved in its historically significant setting.

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CAMDEN COUNTY TRANSPORTATION HISTORY OVERVIEW

Camden County was created as a political entity in 1844. By that time its character of the densely populated, industrial area flanked by decidedly agricultural regions was firmly established. The history of the county goes back to the late 17th century. The Dutch had early contact in the area, but it was the Irish Quakers who took up farming the area on the eastern bank of the Delaware River opposite Philadelphia. Camden County remained predominantly agricultural through the 18th century, serving as a source of foodstuffs and commodities for the bustling and growing port city of Philadelphia.

It was not until after the Revolution that Pennsylvania really discovered its New Jersey neighbor. In addition to more and more trade with America's second largest port, the east bank became popular with Quakers because of its accommodating liquor laws and as the site of seasonal dwellings and recreational pursuits like horse racing. Bog iron from the Pine Barrens was also shipped to Philadelphia from Camden County.

Because of its reliance on navigable waterways as transportation corridors, especially the Delaware River, ferries were very important. The early roads lead from the Great Road connecting Burlington with Salem to ferry crossings, like Cooper's Point and Gloucester Point. Cooper's Point, later to become the city of Camden, was particularly important. During the early 19th century, the dominance of waterborne transportation retarded the development of turnpikes within the county. Steamboat service between Camden and Philadelphia was introduced by 1810. As the linkage between Camden County and Philadelphia became easier, the prosperity of the region increased and the population grew.

The most significant antebellum boon to the region in general and Camden in particular was the coming of the Camden and Amboy Railroad from Bordentown in 1834. This put Camden, originally known as Cooper's Ferry, at the confluence of several transportation systems (rail, navigable waterways, and highways) and thus its burgeoning importance as a regional center. The first of the "big four" companies that would dominate Camden's 20th century economy, the Esterbrook steel pen company, built its factory there in 1858. The Camden and Atlantic Railroad, linking Camden and a then-undeveloped Atlantic City, was completed in 1854. It intended to cash in on the seasonal traffic escaping Philadelphia for the relief offered by the Jersey Shore. In addition to increasing Camden's stature as a ferry port, the Camden & Atlantic railroad stimulated growth in the interior by providing economical transportation of commodities like lumber and glass and ceramic factories. The West Jersey Railroad was chartered in 1853 and ran between Camden and Cape May by way of Millville, Woodbury, and Glassboro, and a local line was built between Mt. Ephraim and Gloucester. All these lines passed into Camden at grade and terminated at ferry houses on the waterfront.

The 1860s and 1870s was a period of unparalleled growth in Camden. Shipbuilding, iron works, woolen mills, chemical plants, and carriage factories grew and prospered. Joseph Campbell built a modest canning plant in 1869. Manufactories had increased from 80 in 1860 to 125 in 1870, and by 1880 two out of three persons in Camden County lived in Camden City. The era of industrialization of the waterfront continued into the 20th century with Campbell developing condensed soups in 1897, the Victor talking machine and record company being established in 1897, and New York Shipbuilding starting its Camden facility in 1899.

The electric street railway played a significant role in the development of the county. The increased in size and prominence of Camden stimulated a like increase in the demand for housing. The suburbanization of the area, made possible by the advent of the electric street car, dominated the last quarter of the 19th century and the first decade of the 20th century with the small residential communities developing along the railroad lines leading to Camden proper. As farms were subdivided into residential subdivisions by real estate developers, the street railways linked them with Camden proper and the industries. The suburban settlements offered a variety of housing, from the large gracious homes of Merchantville, which was incorporated in 1874, to the working class community of Audubon, established in 1905 along the main line of the Reading Railroad. Clementon was incorporated in 1903 and Haddon Heights broke from Haddonfield in 1904 while Collingswood dates back to 1882. The development pattern of small "street car suburbs" linked to the large industrial center is a classic late-19th century and early-20th century development pattern that has its base in public transportation.

Another significant factor in shaping the county's infrastructure was the growth of tourism on the Jersey coast and the appeal of the area to the Philadelphia market. The 1870s and 1880s were the great era of railroad development in southern New Jersey, with the mighty Reading and Pennsylvania lines acquiring existing smaller railroad companies servicing that market and then improving those lines. The first of the Jersey Shore railroad lines, the Camden and Atlantic Railroad, was turning a nice profit, and by 1874, was hauling over 500,000 passengers annually. It was taken over by the Pennsylvania Railroad. Recognizing the profit potential, a second rail line between Camden and the shore, the Philadelphia and Atlantic City Railroad, was completed in 1877. It was taken over by the Reading system in 1883 and upgraded to standard gauge. A host of smaller lines were built off these two main lines to service the smaller coastal communities and interior stops. With no railroad bridge across the Delaware River until 1896, all the east-west rail traffic terminated in Camden City and its ferry terminals. The Camden waterfront was crisscrossed with train tracks leading to large train yards like Bulson Street and the snub-nosed rail/ferry terminals on the river. Other rail lines serviced the industry that lines the river's edge.

The Pennsylvania Railroad completed the first crossing of the river south of Trenton in 1896 with the Delair railroad bridge. The bridge provided direct connections from Philadelphia to the Jersey Shore and eliminated the need for crossing the river by ferry. A

spur line was built from the bridge to the Pennsylvania's main line at Haddonfield, and three of the grade-crossing elimination bridges erected as part of the 1896 development of the line remain in Cherry Hill and Pennsauken (0466152, 0466153, 0466160). Historically the spans are associated with the important Delaware River Bridge and Railroad Company building campaign, and technologically the bridges represent some of the earliest railroad-built spans in the county.

The shallow built-up thru girder supported on ashlar abutments and steel bent also survives in the interior of the county. The Reading Railroad's 1904 Old Whitehorse Pike over the Philadelphia and Atlantic City line in Waterford is the most significant (0462157). The only metal truss bridge in the county is also railroad related. The Warren pony truss bridge (0460150) was built in Winslow by the Pennsylvania and Reading systems as part of the joint-line improvements of shore routes. The span was fabricated by the American Bridge Company.

The impact of railroads on the development of Camden County and its transportation networks is reflected in the number of railroad related bridges that remain. Approximately one-third of the 90 pre-1945 bridges in the county are railroad related. The most common type is the thru girder, and it was used in the county from at least 1896 through 1941.

At the turn of the 20th century, many of the 19th-century toll roads still existed as such in Camden County. They were not in good condition, and the county assumed control of about 10 of them between 1903 and 1910. Like other counties in the state, the county freeholders were responsible for bridges and some roads while the various municipalities took care of local roads. It was at this time that old roads, especially in congested areas were improved by being oiled and paved with macadam.

The two oldest highway bridges remaining in the county are two of its most historical and technologically significant because they are movable spans.

The 1898 center-bearing swing-span bridge at State Street over the Cooper River at Camden (042A001) is the only example of its type in the county, and it represents first-generation movable bridge technology in the state. The 1906 Federal Street Bridge over the same feature in Camden (043B008) is the most significant and complete example of a Strauss overhead articulated counterweight bascule bridge in the entire state. Erected just two years after Chicago bridge engineer J. B. Strauss developed the design, the span has a rare Beaux Arts-style sheathing. The handsome span reflects the tenets of the City Beautiful movement. The bridge is the only known example of a Beaux Arts Strauss bridge in the Northeast.

The county-built fixed bridges represent the 20th-century application of reinforced concrete technology. The earliest extant bridges are a group of six reinforced concrete deck arch spans built between 1915 and 1919. The spans are not technologically innovative, as reinforced concrete arch bridges were common by 1905, but they do illustrate the fact that the John J. Albertson, county engineer, favored the bridge type for short spans prior to

1920. The 1916 span (0404150) that takes US 30 (Whitehorse Pike) over Newton Creek between Collingswood and Oaklyn is a well detailed and well preserved example of the type.

During the era between the two world wars, the county built encased rolled steel I-beam stringer, reinforced concrete slab, and rigid frame bridges. Again, these spans represent common period bridge technology. The encased stringer was also used almost exclusively on the state routes that were developed within the county.

The event that had the greatest mid-century impact on the county was the 1926 completion of the suspension bridge between Camden and Philadelphia. Originally called the Camden Bridge, the name of the Ralph Modjeski-designed span was changed to the Ben Franklin Bridge in 1957, and it carried both vehicular and rapid transit traffic. The bridge was initially planned in 1917, but its progress was interrupted by the first world war. The span eliminated the barrier of the river for commuters, and the continuing suburbanization of the area surged.

The state highway department under the leadership of William G. Sloan, State Highway Engineer, studied the problem of devising a means for handling the volume of traffic that would be developed within the county by the new bridge. Existing legislation called for the extension and improvement of state routes 2, 3, and 6 to the proposed toll plaza in the oldest part of Camden. Sloan's advisory board recommended that a belt, or crescent, road intersecting the three state highways and other major roads be constructed and that the crescent road would connect to an entrance road leading to the toll plaza. To maximize traffic flow, the roads were to have no grade crossings with railroads, be of concrete, and have traffic circles to expedite directional changes. The connector road, named Crescent Boulevard, intersected the entrance road at Airport Circle. Several bridges were built as part of the development of what the state highway department called the Camden Extension, but they were the same standard type and design being erected throughout the state, and they were not technologically innovative. The road network developed as the Camden Extension remains in place, but, and, with the exception of some of the traffic circles that appear to be among the earliest in the state, it too is not technologically innovative. The state-improved roads made it easier to live further from the center of Camden and Philadelphia. Increased traffic demands have resulted in many of the roadways being widened.

The street railways and most of the railroad traffic in Camden County have disappeared, and most of the once-bustling industries, including the shipbuilding, pen making, records and talking machines, and condensed soup producing for which Camden was known, have ceased operations, but the infrastructure that supported their development and growth remains in place.

The surviving bridges and rail and highway networks that converges on Camden illustrate that railroads and waterways played an important part in the development of the county.

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CAPE MAY COUNTY TRANSPORTATION HISTORY OVERVIEW

The New Jersey Historic Bridge Survey evaluated 34 bridges in Cape May County. All of the county's surviving highway bridges date to the twentieth century, and the majority to the post-1920 era of highway improvements. The county's bridge inventory is exceptional for the high proportion of movable bascule bridges spanning the numerous navigable waterways of the peninsula. Eleven bascule bridges date from 1922 to 1940 and include several well-preserved and technologically distinguished examples of the important trunnion bascule design (3100001, 3100003, 3100005, 3100006, 0510152, 0511153, 0500028, AND 0517151) and one rare example of the Rall-type bascule (0500006, Stone Harbor Boulevard over Great Channel, Stone Harbor Borough). Another noteworthy bridge is the 1901 Marshallville Road over Mill Creek span (0500019, Upper Township), the oldest surviving highway truss bridge in southern New Jersey and the oldest surviving highway bridge in Cape May County.

Cape May County's high proportion of movable bridges speaks to the county's long historical association with maritime transportation. Until after the American Revolution, the sparsely settled region with vast marshlands and numerous tidal inlets had few overland transportation improvements. Although favorably situated at the southern tip of Delaware Bay, the county lacked large protected harbors; and difficult tides, shifting sand bars, barrier islands and extensive wetlands made colonization difficult. In the mid-17th century the early inhabitants pursued whale for a living and relied upon small sailing vessels for transportation, but whaling was a seasonal activity and soon gave way to plantations and farming at scattered sites on the ridges of arable land on the county's east and west margins. In 1692 the provincial government created Cape May County, but by 1750 population numbered barely 1000 and was spread out in three general areas that formed the boundaries of present-day Lower, Middle, and Upper Townships (Dorwart, pp. 1-45).

A tangle of swamps, forests, and tidal inlets to the northwest of Cape May helped to isolate the county from the rest of New Jersey. In 1697 the provincial government ordered a road cut from Cape May to Burlington, but it took the county's inhabitants nearly ten years to complete the route, which followed portions of present day Kings Highway (CR 608) and Long Bridge Road, named after a bridge over Cedar Swamp Creek. The portion of the route that ran through swamps in what is now the Belleplain State Forest proved so difficult to maintain that it was eventually abandoned in favor of a road from Mount Pleasant to Tuckahoe (Tuckahoe-Mount Pleasant Road). Of greater importance to the county's inhabitants was the building of a road to connect the county's upper and lower portions. The route, which was known as the old Cape Road, ran north to south near the path of present-day US 9. It was well established by 1706 and connected with a ferry at Beesleys Point on the Great Egg Harbor. In 1744 county officials chose Romney Marsh (later renamed Cape May Court House) near the old Cape Road's midpoint as the seat of county government and later built several roads across the peninsula's midsection to connect the court house with newer communities on the bay shore. These roads included Goshen

Road, Dyers (Dias Creek) Road (CR 612) and South Dennis-Court House Road (CR 657) (Dorwart, pp. 34-35).

With the exception of the Cape Road (US 9), the most important of Cape May County's highway routes were not well established until after the American Revolution. During the war, several Cape May merchant-landowner families made profits in privateering and shipbuilding businesses and strengthened connections with Philadelphia merchants. From 1780 to 1810 they built saw and gristmills, stores, and houses on large land tracts and contributed to the growth of towns such as Dennisville, Steelmantown, West Creek, Petersburg, and Tuckahoe. Concentrating their political and economic power they inaugurated one of the most active periods of new road and bridge construction in Cape May County government's history and made Dennisville the county's northwestern highway hub. Roads built or rebuilt included the East Mill Creek Road and portions of NJ 47 north and south of Dennisville including timber bridges over the north and south branches of Dennis Creek (one of them near the present site of 0508151, NJ 47 over Branch of Dennis Creek, 1928, Dennis Township); the Dennisville-Petersburg Road (CR 610); the Dennisville-Woodbine Road (CR 611); the South Dennis-South Seaville and Corson's Tavern Roads (CR 628); and the Tuckahoe-Seaville Road following portions of present-day NJ 50 including a timber bridge over Cedar Swamp Creek (Dorwart, pp. 61-64; History of Upper Township, pp. 48-49).

Although Cape May County's roads crossed no major rivers, the many low-lying areas and even minor tidal creeks, also known as guts, posed significant obstacles to the development of serviceable roads. Corduroy roads made from series of logs placed adjacent to each other perpendicular to the direction of the road were a common means of "bridging" low-lying marshes, and some places such as Long Bridge in the Cedar Swamp (Long Bridge Road) were probably actually corduroy roads rather than traditional timber stringer spans. The tidal action of Dennis Creek annually washed away the road and bridge from Dennisville to South Dennis, and in 1803 business leaders began construction of the Dennis Creek Crossway, an earthen fill, to connect the two. The Crossway on the route of present-day NJ 47 assured that the main through road from Cumberland County to Cold Spring and Cape Island at the county's southern tip would pass over Dennis Creek rather than taking the more northerly route through Mount Pleasant to the Cape Road (US 9). After 1803, the permanent maintenance of the Crossway contributed to growth of the bay side towns of Goshen, Dyer's Creek, Green Creek, and Fishing Creek (Dorwart, p. 71-73).

Early in Cape May County's history the interests of overland versus maritime transportation needed balancing even though few roads spanned navigable waterways. Among the first Cape May bridges on record to span a navigable stream was the bridge over Cedar Swamp Creek on the Tuckahoe Road at Fasts Landing. The bridge's history demonstrated that the location, construction and maintenance of movable spans was to be an ongoing, and at times controversial, issue in the county's transportation development. In 1762 the bridge had been originally built as toll bridge with a draw, but several years later rebuilt as

a fixed span. A locally prominent shipbuilder, who established a shipyard above the bridge after the construction of the fixed span, caused an uproar when he repeatedly tore away the bridge in order to get his vessels into the creek. Eventually a solution was reached between the county and the shipbuilder to build a bridge with a "removable middle section."

In 1845 after the decline of the shipbuilding business, the bridge was rebuilt as a fixed span. (History of Upper Township, p. 48). Today the bridge is a post-1946 structure and was thus not evaluated by the Bridge Survey.

The spread of road and bridge building in the county from 1780 to 1810 contributed in a small way to the growth of Cape May ocean resorts. As early as 1766 a newspaper advertisement mentioned that small numbers of visitors were taking to Cape May's waters for bathing and their health (Dorwart, p. 63), while receiving room and board at local farmhouses. In 1783 Cape Island, the current site of Cape May City, was connected by a road from Cold Spring (Seashore Road, CR 626), prompting the establishment of several inns. Within a few years stage coaches regularly traveled the route from Camden to Cape May by way of Woodbury, Glassboro, Malago Mill (Malaga), Lehman's Mill, Port Elizabeth, and Dennisville, for a distance of about 82 miles (NJ 47). The one-way trip took two days and coaches left Camden once per week on Thursdays and returned on Tuesdays (Alexander 1956, p. 16).

Most early 19th-century visitors to Cape Island, however, preferred not to make the arduous journey overland, and the resort did not begin to grow rapidly until after 1816 when regular steamboat service began between Cape Island and Philadelphia. The trip by steamboat was a day long journey, and in 1827 one traveler described the food and company on the steamboat as "more pleasurable" than the two-day trip by stagecoach. The same traveler, however, also wrote that "the roads were very even and good, and we felt some interest in riding through long groves of pine and oak woods, sometimes 10 to 15 miles in unbroken continuation. It was a novelty to a citizen" (Alexander 1956, p. 34).

By the 1820s Cape Island with its growing number of hotels and guest houses was well on its way to becoming one of the most exclusive upper-class seashore resorts on the East Coast, entertaining numerous dignitaries including US presidents. Visitors arrived at the steamship landing on the bay side of the point, near present-day Sunset Beach, and traveled about 2 miles overland to Cape Island on the Atlantic Ocean side of the point.

In 1833 a new stone bridge (nonextant) was built where the road (now Perry Street) crossed Cape Island Creek. Stone bridges were relatively rare in Cape May County, and the willingness of the County Freeholders to pay for the costly structure spoke of the growing influence of the Cape Island resort owners. Still, in 1844 Cape May had only about 3000 visitors per year, a very small number by modern standards (WJRR, p. 2).

From 1820 to 1860 Cape May County's private businessmen continued the tradition started after the American Revolution of working to improve the county's roads and bridges. From their position of community leadership, they used a combination of private and public funds

to direct extensive creek-banking, road and bridge building projects on West, Cedar Swamp, Green, Fishing, and Cape Island Creeks. They formed private associations known as meadow companies to build dikes and sluices to reclaim swampland and tidal marshes, while at the same time using county government taxes and in-kind labor toward the construction and improvement of roads and bridges that extended into the reclaimed land (Dorwart, p. 85).

Of the bridges built during this period, one of the most significant was the 1830-31 drawbridge over the Tuckahoe River at Tuckahoe on one of the two main routes northwest out of Cape May County. The bridge, which was built in cooperation with Gloucester County freeholders (Atlantic County was still part of Gloucester County), was a "pivot" or swing span patterned off of similar bridges in use on the Delaware and Chesapeake Canal (Dorwart, p. 85). The bridge stood at or near the site of the NJ 50 over Tuckahoe River bascule bridge still in use today (0510152, 1926, Upper Township). Another significant bridge was the ca. 1850 South Dennis-Dennisville covered bridge over Dennis Creek, the only documented covered bridge in Cape May County history (Brydon, p. 106). The span's truss type is unknown, and it was torn down in 1907. It stood near the Dennisville shipyards where NJ 47 crosses Dennis Creek (0508150, 1928, Dennis Township).

While Cape May County's leaders did much to improve local roads, they showed little inclination to develop major turnpikes as was the case in other parts of New Jersey, especially the northern counties. Even in the mid-1850s, when a brief revival of turnpike building occurred in neighboring Gloucester, Salem, and Cumberland counties to better connect towns such as Bridgeton, Glassboro, and Salem with Camden and Philadelphia, Cape May remained far enough removed from New Jersey's urban center to be better served by maritime commerce. Cape May County did have two short-distance turnpikes, the most significant of which was the Cape Island Turnpike (Sunset Boulevard, CR 606). It was organized in 1846 to improve the road from the steamboat landings on Delaware Bay to the hotels on Cape Island. The turnpike was noted for its beautiful seashell road surface and remained a toll road until the early-20th century (Book of Cape May, p. 60). Cape May County's other turnpike, the Cape May Turnpike, chartered in 1854 and constructed from 1856 to 1858, was a gravel-surface improved road running from Cape May to Cape May Court House on the route of the old Cape Road (US 9). The turnpike was strongly opposed by several local land owners who did not wish to pay tolls or sell their land to the turnpike company which eventually ended in financial failure (Dorwart, pp. 96-97).

In 1863 the construction of the Cape May and Millville Railroad marked a milestone in the transportation history of Cape May County. The railroad was the first major improvement on the overland route from Cape May to Camden and Philadelphia since the construction of the old Cape Road in the early colonial period. It inaugurated a half-century of growth that included the expansion of the Cape May City resort and the settlement of new resort communities such as Wildwood, Stone Harbor, Avalon, Sea Isle City, and Ocean City on Cape May County's barrier islands. As in other parts of South Jersey, the railroad

contributed to the growth of small-scale commercial agriculture and industrial interests, which in Cape May County generally took a back seat to tourism.

Rail line development came a decade late to Cape May County in comparison to other parts of southern New Jersey not only because the county was at the southern tip of the state but also because the chartering of a line was caught up in a political contest between competing groups of businessmen. As early as 1852 engineers surveyed a railroad route over Cape May's ideally level terrain, but it was not until 1860 that a syndicate of Cape May businessmen combined with owners of the Millville and Glassboro Railroad to construct the line. Early attempts at building the railroad had been blocked by the powerful Camden and Amboy Railway interests who had established New Jersey's first operating railroad line in 1832, the proprietors of the Cape May Turnpike who feared the competition, or more importantly by the owners of the Camden and Atlantic Railroad who in 1854 had opened a line between Camden and Absecon Island (Atlantic City; Atlantic County). The Camden and Atlantic Railroad was covetous of a route into Cape May but lacked the capital for its construction until it merged with the Philadelphia and Reading in 1893.

From 1863 to 1893 the Cape May and Millville Railroad operated the only rail line into Cape May County. In 1868 it came under the control of the West Jersey Railroad, which itself was taken over by the Pennsylvania Railroad in 1879. The railroad's right-of-way, now abandoned, ran roughly down the center of the county southeast from Belle Plain through Woodbine, Mount Pleasant, and Sea Isle Junction, where it turned southwest in a straight line through Swain Station, Cape May Court House, Wildwood Junction, Cold Spring, and ended in Cape May City. Several of the towns, such as Belle Plain, Woodbine, Mount Pleasant, and South Seaville owed their most significant period of growth to the railroad's influence. By 1876 the West Jersey Railroad offered four trains daily plus five on weekends from Camden to Cape May as well as special excursion trains for tourist groups at affordable prices. It attracted tens of thousands of vacationers to Cape May through specially published guide books advertising the Cape's hotels, beaches, amenities, and weather (WJRR, frontpiece).

In 1893 the Camden and Atlantic Railroad finally built the only other major rail line into Cape May. It branched from the main line in Atlantic County and then passed through Tuckahoe, Mount Pleasant, Dennisville, and Goshen then paralleled the Cape May and Millville Railroad's tracks to Cape May City.

The railroads' most significant contribution to transportation patterns within Cape May County was the opening of the barrier islands to resort development. For over 200 years Cape May's four major barrier islands along its eastern shore had remained relatively unsettled with pristine white sand beaches. In the 1880s ambitious real estate developers took advantage of the relatively cheap land and the idea that the islands were now only a short train ride away from Camden and Philadelphia to build new resort communities with hotels, beach houses, and summer cottages. In 1879 Ocean City, the northernmost island, was developed as a Methodist camp meeting, and the following year connected by ferry

to Somers Point in Atlantic County and a branch of the Camden and Atlantic Railroad known as the Pleasantville and Ocean City Railroad (Beitel and Enck, p. 120). The next in line to develop in the early 1880s were Sea Isle City and Anglesea (North Wildwood), followed by Avalon and Stone Harbor in the late 1880s and early 1890s.

An obstacle to the islands' development was providing transportation links across the tidal meadows and streams to the mainland. In 1882 the owners of Sea Isle City struck a deal with the West Jersey Railroad to develop a right-of-way from Sea Isle Junction on the main land to the island, but the poorly built track and bridges on mud foundations constantly washed away. Railroad executives were generally reluctant to lay out funds for expensive capital improvements of the branch lines due to the technically challenging nature of securing causeways and bridges in the tidal meadows and inlets. The bridge over Townsend's Inlet washed out four times from 1888 to 1891 before the Phoenix Iron Bridge Company erected a swing-span bridge (non-extant) that could withstand the tides. In most cases, the private developers footed the largest portion of the bill, sometimes as in the case of Anglesea creating their own railroad companies only later to sell out at a loss to the West Jersey or Atlantic City railroads. By 1892 the West Jersey Railroad's Sea Isle City branch line had connections north to Ocean City and south to Avalon and Stone Harbor, and further south a separate branch line connected to Anglesea, Wildwood, and Holly Beach. From 1896-98 the Atlantic City Railroad improved its Cape May County connections with the construction or acquisition of branch lines from Tuckahoe to Ocean City and Sea Isle City. Today, all of Cape May County's railroad lines to the barrier islands have been abandoned (Wentzel, pp. 2-3; Dorwart, pp. 124, 141-150).

The railroads brought thousands of vacationers to Cape May County, and by the 1890s the new summer residents and the developers who built the resorts were increasingly turning to local and county governments to provide amenities and internal improvements such as boardwalks, water, sewer, public safety, and better roads and bridges. Similar to shore counties such as Atlantic and Monmouth, in Cape May the origins of the good roads campaign began in the 1890s with the bicycle and accelerated in the early 1900s with the introduction of the automobile. In the 1890s tourists enthusiastically adopted the bicycle as their favorite means of traveling and recreating up and down the beaches and around the countryside. Eventually the bicyclists formed groups that successfully lobbied for better maintained roads, and were even instrumental in helping several Cape May County municipalities to adopt model bicycle traffic safety regulations (Wilson, p. 792). The automobile, which appeared in Cape May County around the turn-of-the-century, at first was a luxury item for the wealthy who often rented the automobiles for "sojourns on the coast," but by 1915 it was an increasingly common and utilitarian vehicle bringing thousands of vacationers to the shore. The motor cars sped across the county's outdated wagon paths and over the narrow bridges and causeways causing concern for safety and life (Cape May Board of Trade, n.p.).

In Cape May County, as in other New Jersey counties, road and bridge politics had often been at the forefront of county governance, and the Freeholders responded to the

introduction of the automobile by building over 100 miles of gravel-surfaced county roads from 1900 to 1915. Around 1910 the Cape May Board of Trade published a promotional brochure that proudly proclaimed, "One Hundred Miles Of Good Road: No section of the country has progressed more rapidly than Cape May county and automobilists, therefore, find Cape May city the most delightful place of sojourn on the coast (n.p.)." Cape May's claims to large-scale public works projects in advance of other New Jersey counties may not have been exaggerated, when in 1907 the state commissioner of public roads, E. C. Hutchinson, wrote to the Cape May County's Board of Chosen Freeholders to object to expense overruns in state-aid roads and to oppose the purchase of gravel for new roads in anticipation of future aid. Newspaper articles suggested graft and corruption accompanied county road and bridge contracts to local builders, and in 1903 county engineer, N. C. Price, was dismissed after complaining of poor quality materials and work at inflated prices. Apparently, bribery and bid rigging remained part of county road and bridge politics until 1921 when several freeholders and the county engineer pleaded guilty to charges of conspiracy to defraud the county. The scandal resulted in the reorganization of county government with a smaller Board of Freeholders and appointment of professional civil servants (Dorwart, p. 178, 199-201).

From 1900 to 1920 major highway bridge projects included new construction or improvement of several of the causeways linking the barrier islands with the mainland. The causeways usually paralleled the preexisting railroad lines and consisted of multi-span timber stringer on timber pile bridges with metal truss swing spans over navigable waterways. Some of the causeways, such as the 1912 Ocean City-Somers Point Road (NJ 52), were originally built as private toll bridges under state charters, while others such as the 1901 Rio Grande-Holly Beach Road (Wildwood Boulevard, NJ 47), the 1907 Tuckahoe-Ocean City Road (Roosevelt Boulevard, CR 623) and the 1907 Dennisville-Sea Isle City Road (Sea Isle Boulevard, CR 625) were county projects that were frequently controversial because of local road and bridge politics.

Present-day causeways more or less follow the rights-of-way established in the first part of the century, but no first-generation causeway bridges survive. Some causeways still have timber stringer on timber pile bent bridges (e.g. 0517152, NJ 147 over Beach Creek, 1919, North Wildwood City; 0500017, Stone Harbor Boulevard over Scotch Bonnet, 1930, Middle Township) but these bridges are replacements of earlier bridges and themselves have been rebuilt in-kind several times.

In the first two decades of the 20th century, bridge improvements also included the construction of numerous short- to medium-span structures to replace outdated or worn-out bridges. The county government built mostly common, well-tried, and technologically uninnovative bridge types such as timber stringer, steel stringer, and metal truss bridges. The 1901 Marshallville Road bridge (0500019, Upper Township) is noteworthy as the county's only surviving example of metal truss bridge technology, and the oldest metal truss highway bridge in southern New Jersey. The single-span, rivet-connected, Warren pony truss is of standard construction and outstanding for its state of preservation and

location within the Marshallville Historic District, a 19th and early-20th century community on the Tuckahoe River.

Increased state aid for highways encouraged Cape May County's tourism boosters to organize and promote the development of better roads. By 1905 groups such as the Board of Trade and the Progressive League were agitating in support of improved highways and bridges. In 1910 Cape May County's resort developers were part of an effort that resulted in the designation of an Ocean Highway stretching the length of the Jersey Shore from Atlantic Highlands in Monmouth County to Cape May City along already existing roads as near to the ocean as possible. The State Commissioner of Public Roads authorized funds for minor road improvements but the route, which ran on local streets and lacked major bridges between Cape May County's barrier islands, was more a tourist promotion than a modernized highway. Still, the idea of an Ocean Highway was an important development and would eventually bear fruit in the late-1930s.

In 1916 the state government legislated the creation of a state highway system and created the New Jersey State Highway Department to take over, upgrade, and maintain major through roads. The 1916 act shifted control of road and bridge construction away from the counties and to the state. In Cape May County new state highway routes included Route No. 14, the old Cape Road from Tuckahoe to Cape May City (present NJ 50 & US 9 south of Seaville); and Route No. 15 from West Creek to Rio Grande (present NJ 47). World War I slowed the expenditure of state and federal funds for the implementation of New Jersey's highway program, and until the mid-1920s the State Highway Department delayed its plans to take over and improve Cape May County's roads. In 1926 Route No. 14, an all concrete-surfaced highway was completed from Cape May City through Tuckahoe and on to Egg Harbor City in Atlantic County where it connected with the White Horse Pike (US 30). That same year the Camden Bridge over the Delaware River (now the Ben Franklin Bridge) opened to automobile traffic accelerating the flow of visitors from Philadelphia to Cape May and contributing to a boom in the Cape May County real estate market. Part of the Route No. 14 improvements included the single-leaf Strauss-underneath bascule bridge over the Tuckahoe River between Cape May and Atlantic Counties (0510152, 1926, NJ 50 over the Tuckahoe River, Upper Township).

For the State Highway Department streamlining the authorization of funds and addressing congested highway conditions in the state's urban areas were challenging problems that to impatient Cape May County residents often appeared to take precedence over their concerns for good roads and bridges in southern New Jersey. In 1920 the Cape May County Freeholders took matters into their own hands and paid for concrete surfacing to portions of the old Cape Road in spite of plans for the State Highway Department to take over the road. Constant agitation for a bridge over the Great Egg Harbor Bay between Beesleys Point and Somers Point, Atlantic County eventually resulted in a state charter for a private bridge company to construct and operate a toll bridge (3900001, Upper Township). Cape May County tourism boosters considered the bridge, completed in 1928, vital to their efforts to attract vacationers from as far north as New York City (Cunningham,

p. 156). Today, the 120-span bridge with an 80' double leaf bascule main span carries US 9 over the harbor and continues under the private ownership of the Beesleys Point Bridge Company.

From 1927 to 1933 the State Highway Department made up for its slow start in Cape May and other parts of southern New Jersey with an accelerated period of road and bridge construction boosted in the early 1930s economic depression by increased New Deal federal aid. In 1927 the number of State Highway Routes expanded to include Route No. 4 from Beesleys Point to Cape May City (present US 9), Route No. 47 from Millville, Cumberland County to Tuckahoe (present NJ 49), Route No. 49 from West Creek to Ocean View (present NJ 47 north of South Dennisville and NJ 83), Route No. S-49 from South Dennisville to Rio Grande (present NJ 47 south of South Dennisville), and Route No. 50 from Tuckahoe to Seaville (present NJ 50). Highways were graded, realigned, resurfaced, provided with guard railings, and posted with signs. Bridge projects replaced old county-built bridges on the routes with spans that met New Jersey State Highway Department design specifications. As in other parts of New Jersey a common bridge type was the encased steel stringer span with concrete balustrades (e.g. 0509150, 1930, NJ 49 over Mill Creek, Upper Township) and the concrete slab span with concrete balustrades (e.g. 0508151, 1928, NJ 47 over Branch of Dennis Creek, Dennis Township). The highways and bridges provided several alternative routes for travelers to Cape May County from points to the north and west.

The State Highway projects also included several grade eliminations of dangerous railroad crossings. Cape May County's flat topography had encouraged the railroads to build long stretches of straight track where passenger locomotives often attempted to set speed records on the Camden to Cape May run. Furthermore, the Pennsylvania Railroad and the Philadelphia and Reading Railroad offered competing service to Cape May and they rivaled each other for the fastest timetables. Increasing amounts of automobile traffic combined with express trains to create an unsafe situation ripe for collisions on several of the busy state highways. The construction of highway overpasses in Cape May County was part of a statewide effort to separate rail from highway, and the Cape May County overpasses were typical of 1920s and 1930s designs. In 1925 the Philadelphia and Reading Railroad built a five-span encased steel stringer bridge (0510151, Upper Township) to carry Route 14 (NJ 50) over its Ocean City branch line, and in 1929 the Pennsylvania Railroad built a three-span reinforced-concrete deck girder (0512151, Dennis Township) to carry Route 47 (present NJ 83) over its Sea Isle City branch.

The Depression created severe financial difficulties for the railroads and in 1933 the Pennsylvania Railroad and Philadelphia and Reading Railroad merged their South Jersey operations into the Pennsylvania and Reading Seashore Lines (PRSL). Eventually the PRSL chose to eliminate redundant lines and abandoned the old West Jersey Railroad (Pennsylvania Railroad) right-of-way. After 1929 the State Highway Department expanded its efforts to fund, design, and build grade eliminations, picking up the slack left by the railroad companies. In 1930 the State Highway Department oversaw the construction of

a five-span encased steel stringer bridge (0509151, Upper Township) to carry NJ 47 (present NJ 49) over the Pennsylvania Railroad near Tuckahoe. The last major grade elimination was in 1940-41 when a three-span encased steel stringer bridge (0512150, Dennis Township) over the PRSL was built as part of the South Dennis bypass (now NJ 83), a New Deal works project providing local employment (Dorwart, p. 222).

In the post-1920 era of highway building among Cape May County's most challenging bridge projects were improving the causeways and bridges spanning between the main land and barrier islands in response to increased automobile traffic volumes, especially during the summer tourist season. From 1908 to 1915 the state had funded the construction of an 111-mile long Inland Waterway from Cape May to Bay Head, Monmouth County. The Inland Waterway offered a protected route for small craft and barges and in Cape May County was dredged to a depth of at least six foot in the tidal channels west of the barrier islands. After WWI it led to an increase in maritime traffic and necessitated more numerous and frequent movable bridge openings where boats required vertical clearance and roads spanned the Inland Waterway and other navigable channels and inlets. Consequently, Cape May County has one of the highest concentrations of movable bascule bridges in New Jersey (Wilson, p. 954).

The rarest of Cape May County's bascules is the 1930 Stone Harbor Boulevard over Great Channel bridge (0500006, Stone Harbor Borough). It is New Jersey's only example of a Rall-type bascule. The Strobel Steel Bridge Company of Chicago, which controlled the Rall patents, designed the bridge which spans part of the Inland Waterway on the causeway connecting Stone Harbor with the mainland. The horizontally retreating and vertically lifting motion of the bascule is obtained through the means of pinions engaging pivoted racks, trunnions nested in rollers, and pinned swing struts. The bascule was rehabilitated in 1984, but it retains design integrity.

The county has two technologically significant examples of Strauss trunnion bascules with underneath counterweights. The 1922 NJ 147 over Grassy Sound bridge (0517151, Middle Township) is a double-leaf bascule spanning the Inland Waterway on the North Wildwood causeway. The bridge was built as a county bridge and transferred to the state in 1970 as part of the NJ 147 take over. The 1926 NJ 50 over the Tuckahoe River bridge (0510152, Upper Township) is a single-leaf Strauss bascule in a remarkably complete state of preservation. The two bridges are representative of Strauss's patented articulated counterweight design that was a milestone in the development of movable spans.

There are at least eight other examples of Strauss articulated underneath counterweight bascules in New Jersey, and the two Cape May County bascules rank among the least altered in terms of state of preservation. Of minor note, the Lafayette Street (NJ 109) over Cape Island Creek bridge (0500007, Cape May City) was originally built in 1927 as a Strauss bascule but in 1974 closed in the fixed position and the operating machinery and houses removed.

Seven of Cape May County's bascule bridges built from 1928 to 1940 are simple trunnion bascules (3100001, 3100003, 0500028, 3100005, 3100006, 0511150, 0511153). The bascule bridges are all distinguished as the designs of consulting engineers Harrington, Howard and Ash (1922-1928) and the reorganized successor firm of Ash, Howard, Needles, and Tammen (1928-1940). The engineering firm, originally established in Kansas City, Missouri, was one of the nation's leading designers of movable bridges and in the late 1920s and 1930s became the most prominent of New Jersey's bascule bridge engineers working closely with the State Highway Department, county engineers, and private bridge commissions. The Ash, Howard, Needles, and Tammen (AHNT) bridges represented 1920s refinements to the bascule design and included a patent (US Patent No. 1,633,565) for an improved span support to resist the various stresses in the bridge when in operation and at rest. The official history of AHNT credits the South Jersey movable bridge projects as critical to the firm's survival through the Great Depression (Brown, p. 30).

All of the AHNT-designed bascule bridges were part of efforts to improve access to Cape May County's barrier islands. The 1927-1928 Ocean Highway over Great Egg Harbor double-leaf bascule bridge (3100001, Ocean City) was the earliest AHNT bascule in the county, and was built by the Ocean City Coastal Highway Bridge Company and its subsidiary Ocean City Longport Automobile Bridge Company to connect Ocean City with Longport in Atlantic County. The bridge reduced the time of an automobile trip from Atlantic City to Ocean City to about 15 minutes and represented the first step in the long-wished for Ocean Highway connecting all of Cape May's barrier islands north to south (Wilson, p. 840). In 1932-33 two AHNT bascule bridges were used to improve the Ocean City-Somers Point causeway (NJ 52), which had been originally built as a private toll bridge in 1912 and purchased in 1922 by the state as a free public bridge (Wilson, p. 839). The 1932-33 causeway, four traffic lanes wide, consists of a 50' single leaf bascule with deck girder and T-beam approach spans over Ship Channel (0511153, Ocean City), a 70' single leaf bascule with deck girder and T-beam approach spans over Beach Thorofare (0511150, Ocean City), and two multi-span T-beam bridges over Rainbow Thorofare (0511151, Ocean City) and Elbow Thorofare (0511152, Ocean City). The bascule bridges were rehabilitated in 1988.

In 1934 the county government created the Cape May County Bridge Commission as a means to apply for Federal Emergency Administration Funds to build bridges on the Ocean Highway and to bring to completion the promotional tourist route from Atlantic City to Cape May. The Ocean Highway bridges, five movable spans and two fixed spans, were the largest New Deal public works project in Cape May County, employing from 350 to 500 local men. The private commission offered the county a means of constructing self-liquidating toll bridges without cost to the county, and the Ocean Highway was viewed as balancing the decline of train service to the seasonally-oriented tourist area. AHNT, who designed all of the Ocean Highway bridges, played a significant role in the whole planning and construction process, preparing the Federal Administration of Public Works application and steering it through the bureaucratic approval processes.

Ocean Highway bridge construction began in 1939 and four of the movable bridges were completed in 1940 (3100003, Ocean Highway over Townsends Inlet, Avalon Borough; 0500028, Ocean Highway over Great Channel, Stone Harbor Borough; 3100005, Ocean Highway over Grassy Sound, Middle Township; and 3100006, Ocean Highway over Middle Thorofare, Lower Township). A fifth bridge over Corsons Inlet (3100002, Upper Township) was not completed until 1947-48. The bridges were all similarly designed with single-leaf, haunched deck girder, trunnion bascule main spans, deck girder and T-beam approach spans, Moderne style operators' houses, safety sidewalks with metal railings, look-out benches, and toll booths at the center of the bridge adjacent to the movable leaf. The bridges retain original enclosed primary reducer and open gear sets, and most retain original operators' controls and equipment. In 1946 the Cape May County Bridge Commission purchased the 1928 Ocean City-Longport Bridge (3100001, Ocean City), refinancing the debt of the Ocean City Coastal Highway Bridge Company which went bankrupt in 1934. The acquisition of the Ocean City-Longport Bridge brought all of the bridges on the Ocean Highway under the commission's control. The Ocean Highway bridges were the last major pre-WWII development in the history of Cape May County's roads and bridges.

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CUMBERLAND COUNTY TRANSPORTATION HISTORY OVERVIEW

The New Jersey Historic Bridge Survey evaluated 30 pre-1946 bridges in Cumberland County. All of the evaluated bridges date from the 20th-century, and the majority from 1930 to 1946. Most are representative examples of common bridge types that hold in a statewide context hold no special historical or technological significance. An exception is the West Park Drive over the Cohansey River bridge/dam (1938, Bridge No. 0600018, Bridgeton City), an unusual example of an inverted-siphon spillway that also functions as a roadway.

Although no pre-1900 bridges survive in Cumberland County, bridges have played a significant role in the development of the county's transportation systems. Cumberland County in southern New Jersey has been described by historian John T. Cunningham as "tidewater country." The low-lying 30-mile southern coast borders Delaware Bay, and is noted for broad tidal marshes. The county's two major tributaries, the Cohansey Creek and the Maurice River, are wide-mouthed, meandering rivers, navigable for many miles inland. The county's first European settlements were founded along the banks of the rivers, and the county's earliest European colonists relied upon water transportation, in large part because the rivers and marshes presented significant obstacles to overland transportation.

In the 18th century Cumberland grew slowly, and agriculture dominated local life. Greenwich, the first town in the county, was located on Cohansey Creek and carried on a brisk trade with Philadelphia and other colonial ports. Wheat was the primary export. The most significant road in the county was the Greenwich-Salem Road (c.1700), but most so-called highways remained little better than paths even though the colonial government provided for the setting aside of land for roads. In 1748, when the Legislature created Cumberland County out of the eastern half of Salem County, only three thousand people lived in the new county, and most of them along Cohansey Creek (Cunningham:173-175; Cushing:515-518).

The first bridge of importance in Cumberland County spanned Cohansey Creek, but was located in a sparsely settled area on its upper reaches. In 1716 the few people who lived near Hancock's sawmill built a bridge at a spot where the creek was fordable at low tide. The settlement was known as Cohansey Bridge, or simply "The Bridge," and then later as Bridge Town, eventually shortened to Bridgeton. The bridge was a simple wood structure, probably timber beams and posts. It was located at the present site of the Commerce Street bridge, a post-1946 structure (Cunningham:174; Cushing:586-587).

The settlement of the banks of the Maurice River proceeded more slowly than the Cohansey. Millville at the head of navigation of the Maurice River also was founded around a saw mill and a bridge, but not until the mid-18th century. In 1754 a log crib bridge was constructed as a part of a road leading from the Maurice River to Bridge Town. It was

constructed shortly downstream from the mill near the present site of the Main Street bridge, a post-1946 structure (Cushing:635-36).

In the 19th century Bridgeton and Millville emerged as the largest towns in Cumberland County. They were commercial centers for the surrounding agricultural areas, and the location of a growing number of industries, especially of glass makers attracted by the local availability of sand. Water-borne traffic remained the primary means of trade and communication, with regular steam ferry service to Philadelphia established in both towns in the 1840s. New Jersey's early 19th-century internal improvements movement of turnpikes, canals, and railroads largely bypassed Cumberland County, and local roads and bridges remained little improved over the colonial period.

It was not until the 1860s that the Millville and Glassboro Railroad and the West Jersey Railroad constructed unbroken lines from Millville and Bridgeton, respectively, to Camden. Prior to the railroads, stages had travelled the Bridgeton to Camden route over often poorly maintained roads, but the railroads firmly set the pattern of overland transportation from Cumberland to the Philadelphia-Camden region, as well as established through routes from Philadelphia to Cape May County shore resorts. These routes would later be followed by state highways (Cunningham:177; Cushing:587-588, 637).

Many of the most historically significant 19th-century bridges in Cumberland County were movable spans, reflecting the county's orientation toward water transportation and the difficult presented in crossing the Cohansey Creek and the Maurice River. In 1823 the county constructed a movable span at Millville, and in 1824 a bascule draw bridge in Bridgeton. These bridges were subsequently replaced with wrought-iron pivot or swing span bridges in the 1870s. The furthest downstream crossing of Cohansey Creek has always been at Bridgeton, but in 1867 a private company received authorization to construct a swing span across the Maurice River at Mauricetown. Rebuilt in 1874 by Dean and Westbrook of New York City, the bridge was a multi-span thru truss with wrought iron Phoenix Columns. In the 1880s a local account reported that the bridge's location "remained unsatisfactory to watermen" who worried about damage to their vessels. The bridge has since been replaced with a post-1946 fixed-span high rise bridge, but the west portal and a single panel of the old bridge survive in a park in Mauricetown (Cushing:587-588, 636-637, 647; Mints:144-145).

Cumberland County's 19th-century bridges appear to have been typical of other southern New Jersey counties with a predominance of timber beam and pile bridges, and in the late-19th century with an increasingly reliance upon prefabricated metal truss bridges for longer span crossings. The New Jersey Historic Bridge Survey identified no extant stone arch, covered, or metal truss highway bridges in Cumberland County. A stone arch bridge is known to have existed at South Avenue in Bridgeton (c.1800); covered bridges at Port Elizabeth (1840) and Dividing Creek (1841); and an iron truss at Sharp Street, Millville (1871), and Cedar Creek (n.d., demolished c.1940) (Cushing:587, 635-636; Mints:37, 87).

Significant changes did not occur in Cumberland County's bridge inventory until after the First World War. Throughout New Jersey, in the period between 1919 and 1941, a concerted effort was made to improve roads and bridges at the local, state, and federal levels through revenue sharing, the creation of interlocking highway systems, and investigations of better road and bridge building technologies. Proponents of the highway improvement campaigns saw the roads and bridges at first as an important link in the development of farm to market roads, and then later as part of statewide and even national highway systems. As mass-produced automobiles became available to a wider range of Americans, they hoped that better roads would end the cultural and social isolation of rural dwellers, and would provide a recreational outlet for automobile-owning city dwellers. The roads brought perishable goods, such as milk and vegetables, to the cities, and were one factor leading to the expansion of specialized agriculture in rural Cumberland County (Seely:1-15).

In 1912 the first State Highway System was legislated, although routes in Cumberland County were not taken over until 1920. The original routes included Route No. 6 from Camden to Bridgeton along portions of current routes NJ 49 and NJ 77, and Route No. 15 from Bridgeton to Cape May Court House along portions of current route NJ 47. Other state highways soon followed and included Route 20 (now NJ 47 north of Millville) in 1924-27, and Route 46 (now NJ 77), in 1927. In Cumberland county, bridge construction was not a large part of the state highway program. Only five state highway bridges in Cumberland County date to before 1946 and include a bascule bridge (NJ 49 over Cohansey Creek, 0604152, Bridgeton City); a bobtail thru girder swing span (NJ 47 over Manantico Creek, 0601152, Maurice River Twp.); a four-span thru girder (NJ 47 over Manumuskin Creek, 0601151, Maurice River Twp.); a thru girder railroad overpass (New Jersey Central Railroad over NJ 77, 0607150, Bridgeton City); and a concrete slab (NJ 49 over Manantico Creek, 0606150, Millville City). The two movable bridges (0604152 and 0601152) are no longer operable and better-preserved examples of both exist within the state. The other bridges are technologically and historically undistinguished examples of common standard-design bridge types (NJDOT 1972: 10-11; NJDOT, 1988).

In Cumberland County, as with other of the more isolated counties in New Jersey, the pace of county bridge improvements did not quicken until the 1930s when large-scale New Deal public works funds became available. The Historic Bridge Survey identified 25 highway bridges under county purview that date to before 1946. Of those 25 bridges only three date to before 1930. The three pre-1930 bridges are a highly-altered steel stringer (0600004, Chestnut Road over Chestnut Run, c.1900, Stow Creek Twp.) and two reinforced-concrete arches in Bridgeton City Park (0600020, West Park Drive over Irelands Mill Run, 1923, Bridgeton City; and, 0600023, Mayor Aitken Drive over Sunset Lake Raceway, 1923, Bridgeton City).

Of the 22 county bridges dating from 1930 to 1946, seven are steel stringer bridges, six timber stringer bridges, three concrete slab bridges, three concrete culverts, two reinforced-concrete T-beam bridges, and one a rigid-frame bridge. The timber and steel

stringers, the most common bridge types in the county, typically show a high degree of alteration and replacement.

Several of the county highway bridges are noteworthy for their location in Bridgeton City Park, and their design reflects a concern for setting. The park was formerly owned by the Cumberland Iron and Nail Works, and in 1903 the city purchased the property and converted it to a public park, preserving the factory's water power reservoir and canal (Logue, 12). The county engineer and park commissioners probably chose the two previously mentioned 1923 concrete arches (0600020 and 0600023) and the one arched rigid frame bridge (0600016, Washington Street over Cohansey River, 1941, Bridgeton City) for their aesthetic appeal. Nationally, concrete arch bridges had some of their earliest applications in late-19th century city parks, however, the bridges in Bridgeton City Park, although appropriate to the setting, are not the earliest or most technologically significant examples of reinforced-concrete arches in New Jersey.

Another bridge in the park, West Park Drive over Cohansey Creek (0600018, Bridgeton City), is an unusual example of a combination bridge and dam with inverted-siphon spillway. The structural association of bridges and spillway/dams is common in the South Jersey bridge complex (e.g. see Salem County), but a bridge with the inverted-siphon spillway feature is exceptional. The inverted-siphon spillway is a system for drawing water off the bottom of the lake through a series of siphon-shaped inlets and discharging the water downstream through culverts. In the case of the West Park Drive bridge the application of the inverted-siphon spillway probably performed two functions: first, to serve as the superstructure for the roadway over the dam; and second, to control the water level of a small lake which is both a feature in the park and a source of fresh water. The bridge/dam is located at the site of an earlier dam associated with the water power system of the Cumberland Iron and Nail Company.

In summary, the history of highway bridge building in Cumberland County dates to an early period, but no pre-1900 highway bridges are known to survive. Until the early-20th century Cumberland County was a relatively-isolated, sparsely-populated county with a strong history of maritime-related transportation. In the 1920s and 1930s, the county embarked on highway improvement campaigns prompted by state and federal aid. Most of the older wood and iron bridges were replaced with more modern types of standardized steel beam and reinforced-concrete design. At the same time, the mass-produced automobile and the improved system of state and county highways largely displaced older modes of transportation including maritime and railroads.

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ESSEX HISTORY TRANSPORTATION HISTORY OVERVIEW

Essex County, at the heart of urban northeastern New Jersey, possesses a variety of bridge types and styles that reflect its history as one of New Jersey's most important transportation and manufacturing centers. The county, which shares its borders with Bergen, Hudson, Passaic, Morris and Union Counties, grew to prominence in part because of its strategic location due west of New York City on the most direct overland routes to points of transfer on the Hudson River. Over the course of more than 300 years of development, highway, railroad, and marine transportation systems created dense, overlapping, and interconnected traffic patterns for the movement of people and goods into, out of, and through the county's urban environment. The history of these transportation systems provides a significant historical context for the understanding of Essex County's bridges.

Essex County's early modes of transportation differed little from other parts of colonial New Jersey that relied primarily upon waterborne commerce for long distance travel and wagon roads for short distance trips inland. In the late 17th century European colonists of Dutch and English origins settled most of Essex County, which was established by the East Jersey legislature in 1682 and included portions of Union County until 1857. Colonists arrived by boat, and early in the county's history Newark emerged as a small but important town by virtue of its location on a level bluff bordering the Passaic River. The meandering river, which flowed north along the western border of the county and into Bergen and Passaic Counties before heading back south along the eastern border of Essex County and emptying into the Newark Bay, was the county's first significant transportation corridor navigable to a few miles above Newark (Cunningham 1953, pp.75-76).

As in most other counties in the state, the earliest roads in Essex County were constructed on the trails established by New Jersey's original inhabitants, the Lenni-Lenape. In 1705 Essex County Freeholders surveyed several highways to outlying areas. The roads contributed to the agricultural development of the environs around Newark with settlements starting in the Oranges, Bloomfield, Irvington, Montclair, the Caldwells, Verona, Livingston and towns in Morris County. The main highways branching from Newark included Broad Street south to Elizabeth, "Crane's Road" which is today's Market Street; "First Road" which is Main Street in Orange; and "Third Road," which is now South Orange Avenue. Farmers brought grain, cattle, sheep, and other staple goods to markets at Newark for shipment to New York City and other ports. Roads and bridges were of simple timber construction and difficult to maintain with the constant passage of wagons, carts, and packhorses (Shaw, pp. 184-185; Folsom, pp. 157-158).

Prior to 1765 the principal roads between New York City and Philadelphia bypassed Newark in favor of ferries at Elizabeth or Perth Amboy. The area that comprises modern-day Essex County had no significant through routes and was overshadowed by Elizabeth to the south and Hackensack to the north. In 1765 Newark residents made the first of many

successful efforts to make their town a significant connecting point on the route to New York City. They petitioned the New Jersey Legislature to pass an act authorizing an approximately eight-mile long road across the marshes and rivers between Newark and Paulus Hook (later Jersey City, Hudson County) to a point directly opposite Manhattan. The road, probably of timber corduroy construction over the marshes, came into Newark along what is now Ferry Street. The new road, despite three ferry crossings at the Hudson, Hackensack, and Passaic Rivers, offered, especially in poor weather, a significant improvement over the relatively longer and more unpredictable ferry crossings of New York Harbor from Elizabeth and Perth Amboy. The addition of regular stage service soon brought Newark and Essex County a considerable portion of the New York to Philadelphia traffic (Lane, pp. 51-52).

In the half century following the American Revolution, Essex County by virtue of its access to eastern markets developed quickly with the establishment of industries including leather, hat, and shoe factories. Newark area merchants were among the leaders of New Jersey's internal improvements movement offering their financial backing to private bridges, turnpikes, and canal companies. In 1795 two toll bridges with draw spans over the navigable Passaic and Hackensack Rivers replaced earlier ferry service to Paulus Hook. The timber bridge over the Passaic River measured 492 in length and was a predecessor span to the present Bridge Street bridge (0700H03, Newark City). Tolls from the two bridges regularly brought an annual ten per cent profit to the proprietors, and proved the viability of publicly-chartered but privately-owned and operated bridges and toll roads. They also encouraged the first instances of businessmen commuting to New York. The bridges over the Passaic and Hackensack Rivers ranked among the most significant of New Jersey's early engineering achievements (Lane, pp. 122-125).

Newark's merchants, more than those of any other New Jersey town, took advantage of the wave of enthusiasm for turnpikes in the first two decades of the 19th century to make their community the center of a regional road system. Turnpike companies usually took over already existing routes but improved them with gravel or stone surfaces, straighter alignments, and rebuilt bridges of timber or masonry. The turnpike roads radiating from Newark were designed to service heavy wagon traffic and funnel through Newark northern New Jersey's rich agricultural and natural resources. The turnpike companies oversaw the first major improvements to Essex County's roads since the early colonial period and the right-of-ways formed the basis of several of Essex County's present state and county routes. Among the most significant of the turnpikes were the 1806 Newark and Pompton Turnpike (CR 506 Spur, NJ 23), the 1806 Springfield and Newark Turnpike (Springfield Avenue, NJ 124), the 1806 Newark and Mount Pleasant Turnpike (Mount Pleasant Avenue, NJ 10), the 1809 Parsippany and Rockaway Turnpike (CR 506), and the 1811 Newark and Morris Turnpike (Orange Avenue, CR 510). Many turnpikes achieved profits in the short run but eventually high upkeep, competition from canals and railroads, and public sentiment for free roads caused Essex County's turnpikes to convert into public highways as early as the 1820s continuing through the 1870s (Lane, pp. 148-150, 160-161; Gordon, pp. 17-18).

In 1832 Essex County's industrial and urban development was further enhanced by the completion of the Morris Canal between Phillipsburg, Warren County (then Sussex) and Newark. The canal brought to Newark large quantities of iron ore and pig iron from northwestern New Jersey and anthracite coal from eastern Pennsylvania leading directly to the expansion of manufacturing enterprises within the city and the conversion to coal-fired home heating. The canal also contributed to the growth of Newark as an important transfer point between canal boats and packet boats at the Newark Canal docks. In 1836-37 the canal was extended from Newark to Jersey City facilitating access to the New York market. In Essex County the Morris Canal traveled in a northerly direction passing from Newark through Bloomfield and into Passaic County. Canal construction within the county's corporate boundaries included two inclined planes, two locks, and several short-span stone arch aqueducts, none of which are extant (Gordon, pp. 23-26; Kalata, p. 199; Lane, pp. 221-250).

In the late 19th century the markets served by the canal were eventually taken over by the railroads and in 1924 the Morris Canal was abandoned and shortly thereafter largely dismantled. Still, the former canal remains to this day a significant feature in the Essex County landscape. In the early 1930s portions of the waterway within the Newark City limits were deepened to permit the construction of a subway covered over by Raymond Boulevard south of Lock Street to Penn Station. Another portion of the canal's route, also used by the subway, forms the western border of Newark's Branch Brook Park. North of Bloomfield Township the Garden State Parkway follows the canal's path (Kalata, pp. 609-637; Cunningham 1988, pp. 270-271).

Beginning in the 1830s railroad companies attempted to build upon trade patterns already established by turnpikes and canals by offering parallel rail services. In Essex County the earliest efforts in railroading were made to improve passenger connections between Newark and New York City with through connections to Philadelphia. In 1834 Essex County's first railroad, the New Jersey Railroad and Transportation Company, began offering its services from Jersey City across the meadows to Newark with plans to extend the route south via the old Essex and Middlesex Turnpike. In 1839 the line was completed to New Brunswick where connections could be made with the Camden and Amboy Railroad, marking the first direct rail communication (except for ferry passage over the Hudson and Delaware Rivers) between New York City and Philadelphia. In addition to the New Jersey Railroad, a significant antebellum railroad in Essex County was the Morris and Essex Railroad, chartered in 1835. The Morris and Essex Railroad connected Morristown, Morris County with Newark by way of the Oranges, and in the 1850s and 1860s was extended eastward to Hoboken, Hudson County, and westward to Phillipsburg, Warren County on the Delaware River. The Morris and Essex grew to become a major anthracite coal hauler and competitor to the Morris Canal (Shaw, pp. 193-196; Lane, pp. 309-317; 381-383).

The early railroads met many financial and technological difficulties, but by the mid-19th century they had jumped to the forefront of New Jersey's transportation system by virtue of their expanding ability to move greater capacities of people and goods at greater speeds than canal boat or wagon. New Jersey's railroad system as it developed suffered from track gauges of different widths, lack of connections between adjoining lines, and complex transfers between land and water transportation, especially at points on New York Harbor. The inadequacies were brought to the forefront during the Civil War when they hampered the through movement of men and supplies, and after the war major railroad companies attempted to organize trunk lines that guaranteed uninterrupted long distance through travel. Essex County played a major role in the integration of New Jersey's railroad system because of its key position on Newark Bay west of New York City harbor terminals. In 1868 the Delaware, Lackawanna, and Western Railroad with connections reaching into eastern Pennsylvania coal mines and westward to Buffalo leased the Morris and Essex Railroad, and in 1871 the Pennsylvania Railroad with connections to Philadelphia and west to Pittsburgh leased the New Jersey Railroad as part of its agreement with the Camden and Amboy (Lane, pp. 318-319, 383).

The integrated rail systems contributed in the late 19th century to the acceleration of Essex County's industrialization. Factories concentrated bordering the Passaic River and Newark Bay where land and water intersected. Here industrialists had access to both the raw materials and inland markets afforded by railroads and to those afforded by ships sailing to and from distant ports. Besides, water was also often necessary to industrial processes. While the Passaic River and Newark Bay were natural resources, they also represented a natural barrier separating Newark City from the New York Harbor terminals at Bayonne, Jersey City, and Hoboken. The industrial and commercial growth of these cities was part of the general growth of the New York City area and led to increased travel and necessitated new bridges across the river and bay.

The interconnections between water and land transportation and their relationship to northeastern New Jersey's industrial growth were nowhere better illustrated than by the history of the numerous movable span bridges crossing Essex County's Passaic River. The movable bridges were an engineering solution to spanning the waterways while affording navigational clearance to harbor shipping. A toll highway draw bridge had spanned the Passaic River as early as the 1790s, and the New Jersey Railroad built their first crossing in the 1830s. The toll bridge proprietors and the New Jersey Railroad considered their bridges so critical to the control of transportation routes between Newark and New York that in the 1850s they fought court battles to deny others the right to build bridges over the Passaic River. A federal court ruled against their petitions, and in 1855 the Newark Plank Road and Ferry Company as part of its turnpike road between Newark and the Hudson River built a draw bridge in lower Newark, a predecessor span to the present US 1 & 9 Truck vertical lift bridge (0705151, Newark City) (US Circuit Court, pp. 3-5). In the following half century more than a dozen additional railroad and highway crossings were constructed or rebuilt providing Essex County with one of the heaviest concentrations of movable span bridges in New Jersey.

Essex County's earliest surviving movable highway spans are four rim-bearing swing-span bridges carrying city streets over the Passaic River. The swing spans date from 1897 to 1913 and with one exception were replacement spans of bridges built earlier in the 19th century. All of the bridges remain operational and are technologically significant as examples illustrating late-19th and early-20th century refinements to long-span through-truss swing-span bridge construction at the very height of the technology's development. Swing spans were the dominant movable bridge technology of the 19th century, and after the first decade of the 20th century bascule and vertical lift bridge types increased in popularity because they offered several advantages including clearer channels of navigation and ease of operation.

The 1897-98 Jackson Street Bridge (0700H02, Newark City) is the oldest of Essex County's four swing span bridges. It demonstrates a curved multiple-intersection Warren truss design that was repeated in two later swing span bridges, the 1908 Clay Street Bridge (0700H01, Newark City) and the 1912-1913 Bridge Street Bridge (0700H03, Newark City), also designed jointly by the Essex and Hudson County Engineers. The curved truss profile was an aesthetic concern and was probably repeated to provide a sense of unity to the subsequent bridges' appearance. The 1904-05 Park Avenue Bridge, sometimes called the Avondale Bridge (0700B01, Nutley Township), differs from the other three Essex County swing spans in its truss design. The through truss is a double-intersection Warren with riveted connections except for pin-connected eye bars in the top chord between the center tower and the first panel point of the swing-span arms. The pin-connections are for the tension-only, double cantilever configuration the span assumes during operation, and the design reflects the state of early-20th century engineering knowledge that could only account for live loads in simply supported spans. All four Essex County swing spans are of rim-bearing construction, where the trusses rest on cylindrical drum girders rotating on a series of multiple wheels, a late-19th century innovation designed primarily as a better means of distributing and balancing a relatively long-span bridge's weight in the open position. The bridges each continue to operate in original fashion although numerous alterations, repairs, and replacements have been made to equipment and machinery.

The swing span bridges are historically fitting symbols of Essex County's transportation heritage, and reflect the growth of the eastern part of the county into a densely developed urban center. Concurrent with Essex County's industrialization was the transformation of Newark from a traditional "walking city", where all points were within walking distance, to a modern city with an urban core surrounded by outlying suburbs to the north and west. The railroads encouraged commuting to Newark, as well as New York City, and they built handsome railroad stations designed to attract upper- and middle-class businessmen to planned residential communities. The first commuter rail line was the Morris and Essex Railroad (est. 1835) with stations at Newark, East Orange, Orange, South Orange, Maplewood, Millburn and Short Hills. Prior to the Civil War much of western Essex County remained rural in character, but after 1850 suburbanization accelerated rapidly. In addition to real estate developments the railroads gave renewed life to Millburn's paper and

Orange's hat industry while also promoting several resorts in the vicinity of South Mountain. Other railroads with commuter services included the Newark and Bloomfield Railroad (est. 1852) with stations at Newark, Bloomfield, Glen Ridge, and Montclair; the Paterson, Newark and New York Railroad (est. 1868) with stations at 4th Ave. Newark, Woodside, Belleville, and Nutley; and the New York and Greenwood Lake Railway (est. 1874 as the Montclair Railroad) entering Essex County in North Newark with stations at Forest Hill, Belwood Park, Bloomfield, Glen Ridge, and Montclair. The commuter railroads were supplemented by several horse-car railroads, and later motorized trolley lines, that often serviced areas not reached by the major commuter lines. By 1900 large portions of western Essex County had given over to residential development (Shaw, pp. 192-205; Condit, pp. 1:53-69).

Expansion included the laying-out and construction of numerous streets and bridges throughout Essex County. The amount of planning varied with municipalities and ranged from the surveying of a semi-regular street grid pattern in Newark City to meandering, romantically-landscaped drives in Llewellyn Park. Road construction meant primarily the filling-in of streets between already well-established through roads that had been in use since the 18th century, and little thought was given to future congestion. The unprecedentedly rapid population growth, both from natural increase and immigration, and the well-known 19th-century urban problems of disease, poverty, pollution, and crowding would eventually lead after the 1890s to greater attention to urban planning and infrastructure, especially within Newark City, but prior to that time county leaders pointed with both pride and astonishment at the pace of change.

In the mid-19th century with increasing wealth many Essex County communities abandoned earlier simple timber and masonry bridges and turned to bridge styles more befitting their urban sophistication. The oldest extant bridges evaluated by the Survey date to the late-1860s and are neatly-dressed coursed ashlar stone arch bridges that offer a contrast to the roughly-coursed field stone arch bridges of similar age found in many of the more rural parts of the state. Features associated with some of Essex County's stone arch bridges are decorative iron railings, granite capped parapets, and vermiculated finishes. Of the seven stone arch bridges dating from circa 1867 to 1876, among the most historically distinguished are the 1867 Bridge Street over Second River bridge (0700068, Belleville Twp.), the 1868-69 Washington Avenue over Second River bridge (0700036, Belleville Twp.), and the 1869 Millburn Avenue over the West Branch of the Rahway River bridge (0700027, Millburn Twp.). The two former bridges are within the boundaries of the National Register listed Branch Brook Park, and although predating the park's development from 1895 through the early-1930s were retained by the Essex County Park Commission as appropriate to the park landscaping.

In the last quarter of the 19th century bridge styles in Essex County changed with increased numbers of brick arch or metal stringer with brick jack arch bridges making up a majority of bridges built to carry city streets over minor watercourses. Availability of brick and iron from nearby factories may have played some role in local decisions about choice

of materials because several other northeastern New Jersey counties such as Bergen, Union, and Hudson demonstrated similar trends. The period however was also characterized by city betterment activities that included the reorganization of public works departments and such projects as paved streets, bridges, parks, water systems, sewers, gas light, and public health improvements. America's urban areas were among the first places to demonstrate the progressive spirit of civic improvements that characterized turn-of-the-century society and this placed Essex County, and Newark in particular, at the forefront of developments.

As early as 1882 Essex County hired James Owens as the county's civil engineer. Many New Jersey counties did not hire county engineers until the 1910s, and Owens ranked as one of the first in the state, if not the nation. Essex County's approach to bridge building differed from other counties because the county engineer took responsibility for the design and contracting of bridges at a time when most New Jersey counties still relied upon civilian Freeholders to make all of the decisions related to bridge construction. In the late-19th century in what were the more rural parts of New Jersey most bridges were either prefabricated metal trusses, sold to the counties by bridge-building companies, or traditional timber stringer and stone arch bridges built by local craftsmen. In Essex County, where the county engineer designed many bridges, the trend in bridge design foreshadowed early-20th century developments where engineers promoted standardized bridge types for reasons of economy and efficiency.

Essex County Historic Bridge Survey findings bear out the influence of the county engineer on the uniformity of local bridge design. The Survey identified eleven county bridges dating from 1880 to 1900 and carrying local roads over small streams. Of the eleven, six were attributable to county engineer Owens and these were all metal stringer with brick jack arch spans. Four additional bridges, also stringers or girders with brick jack arches, appeared to be Owens' designs but were undocumented. One other undocumented bridge was a brick arch span. Stringers with brick jack arches were a common late-19th century construction technique for supporting bridge decks and were seen throughout northern New Jersey. In no other county, however, was there such a concentration of similar bridges that also originally featured ashlar abutments, metal picket railings, and metal tie rods between the jack arches. Although most of the surviving bridges have been widened or otherwise modified to meet modern traffic demands, a handful remain in a relatively unaltered condition. The best of the remaining stringer with jack arch bridges include the 1898 Harrison Street over Third River bridge (0700063, Nutley Township) and the Hillside Avenue over Toney's Brook bridge (0700088, Glen Ridge Borough). The latter bridge retains its historic setting within the boundaries of the National Register listed Glen Ridge Historic District, an exceptionally well-preserved late-19th and early-20th century suburban residential community.

Essex County's quickening urbanization prompted in the 1890s plans to provide residents with parks and recreational space as part of progressive civic improvements. In 1895 Essex County formed the nation's first county park commission with the goal to develop

two major parks, two reservations, and four smaller parks. Of the original parks, Branch Brook Park in Newark and Belleville, was the most important and extensively landscaped, primarily under the direction of the nationally-recognized Olmsted Brothers landscape architecture firm. The park, which is a National Register-listed historic district, is significant because of its precedent setting landscaping design, and in terms of the county's bridge history for its outstanding examples of stone, brick and reinforced-concrete arch bridges dating from 1867 to 1930. The arch bridge form was considered the most aesthetically pleasing and appropriate design for city parks and was often accompanied by elaborate architectonic details omitted in bridges built for other settings. The seven bridges (0700008, 0700035, 0700036, 0700068, 0700076, 0700077, 0700101) within the park boundaries offer a technological case study in the development of changing materials use in arch bridge construction. The bridge's contribute to the historic character of the park, and several are also recognized in terms of their own technological and historical merits.

The earliest bridges designed specifically for the park were comparatively ornate with special expensive architectural stone constructions and plantations. The bridges fit within the formal setting of Branch Brook Park's southern division. One of these spans measures less than 20' in length and was thus not evaluated by the Survey, but the other is a brick-lined elliptical arch bridge spanning 28' (0700077, Newark City). The bridge ranks as one of the most architectonic in the region with buff brick spandrel walls and wingwalls, ashlar voussoirs and pilasters, and concrete parapets and pylons clearly demonstrating the aesthetic concerns of the park designers.

Public parks were the first places to make extensive use of reinforced-concrete arch bridge designs, which originated in Europe in the last half of the 19th century. European engineers developed many types of reinforcement systems, but in this country the Melan system, named after Viennese engineer Jose Melan and consisting of a series of parallel iron or steel I-beams curved to the profile of the soffit, was one of the most influential from the 1890s to the early 1900s. Branch Brook Park is home to a dramatic and graceful example of the Melan type, the 132'-span Park Avenue Bridge (0700101, Newark City), constructed in 1905. The bridge passes over the lake and a footpath between the southern and middle divisions of the park and has engaged octagonal columns at the corners. The Concrete-Steel Engineering Company, headed by Edwin Thacher who was one of the most influential promulgators of reinforced-concrete bridge designs in the United States, engineered the bridge while the equally-recognized architectural firm of Babb, Cook, and Willard provided the architectural detailing. The Park Avenue Bridge is one of fewer than one half dozen Melan arches remaining in New Jersey, and is generally ranked among the most outstanding examples of its type in the United States.

In Branch Brook Park the 1904 Bloomfield Avenue bridge (0700008, Newark City) spanning the park road between the middle and northern divisions is an early example of the type of reinforced-concrete arch designs that eventually superseded the Melan arches and came to dominate reinforced-concrete construction. In contrast to the Park Avenue Bridge, the Bloomfield Avenue bridge employs a reinforcing system of steel bars rather

than curved I-beams. It also has few embellishing details that keep with the character of the less formal northern division park landscaping. The simplicity fit with modern 20th-century aesthetics that spoke to functionality and clean lines of design rather than high styling.

In the mid-1920s the land along the Second River between Newark and Belleville occupied by Hendricks Copper Mills was acquired by the Essex County Park Commission in order to extend Branch Brook Park. The extension bordering Second River brought within the park boundaries two 1860s stone arch bridges (0700036, 0700068, Belleville Twp.), and a 1918 reinforced concrete arch bridge (0700035, Belleville Twp.). The bridges although not designed for the park were probably considered appropriate for the setting because of their arch form and were therefore not demolished or replaced. Plans for the park extension included the realignment of Mill Street and the construction of a new bridge to carry the road over Second River and through an extensive planting of cherry trees. In 1930 noted bridge engineer A. Burton Cohen designed the Mill Street bridge (0700076, Newark City), a 66'-span elliptical reinforced-concrete arch with concrete parapets topped by decorative capstones, pilasters, and bush-hammered finish. The last of the bridges built for the park, the Mill Street bridge was one of the most prominent features of the park extension (Branch Brook Park NR Nomination, pp. 8:1-10).

A progressive civic improvement that influenced the history of Essex County bridges on a wider scale than city parks was the elimination of at-grade railroad crossings. In 1900 Newark City officials passed an ordinance requiring the Pennsylvania, the Central Railroad of New Jersey, and the D.L. & W. to begin work to minimize the growing conflicts between rail and street traffic that were increasingly leading not only to traffic jams but serious accidents. In Newark, because it was New Jersey's largest industrial city with dense local street patterns and numerous main tracks and spurs, the problems were particularly acute, and it was not until 1913 that the New Jersey Legislature adopted similar grade crossing elimination measures for the entire state. Among Newark's largest projects were the Central Railroad of New Jersey and Pennsylvania Railroads' main line completed in 1904, and the D.L. & W.'s main track from Newark to Harrison in 1905.

Newark's concern for grade separated traffic spread to other parts of the county and the D.L. & W., for instance, from 1910 to 1913 eliminated crossings on its line from Bloomfield to Montclair, and from 1914 to 1923 from South Orange to East Orange, the latter of which included viaducts of an innovative reinforced-concrete slab system of construction (New Jersey Transit, pp. 60-61). The City Plan Commission of Newark was so impressed with the South Orange viaduct that in their 1915 report they recommended outlawing plate girder overpasses as a measure to encourage the "suppression of ugliness," while permitting the construction of reinforced-concrete bridges as a measure "creating of beauty." The proposed law was apparently never carried into affect, but it did demonstrate a bias toward the types of bridge designs that would become most popular in the post World War I period (City Plan Commission, pp. 104-110). The Survey evaluated only two pre-1917 railroad overpasses in Essex County (0700108, Verona Twp.; 0719152, Cedar

Grove Twp.) Both bridges were thru girders on the abandoned Morristown Branch of the Erie Railroad, and were unassociated with the county's historically and technologically distinguished grade separation projects.

The railroads in the years preceding the First World War remained Essex County's most significant movers of people and freight, and the grade separation projects were but one part of efforts to upgrade the rail lines and connecting transportation systems. Of first importance was the improvement of facilities joining New Jersey with New York City. Railroads such as the Central New Jersey, the Lehigh Valley, the D.L. & W. and the Erie expanded ferry and ship terminals, built multi-track lines and freight yards, electrified train service, replaced bridges over the Passaic and Hackensack Rivers, and added new signaling and traffic control devices. The Pennsylvania Railroad took measures one step further and in 1910 brought to completion a project to construct a tunnel under the Hudson River and began offering direct passenger service from Newark to New York City's Pennsylvania Station. In 1908 the Hudson and Manhattan Railroad opened "the Tubes," passenger railway tunnels between Hoboken and New York City, and in 1911 extended the line westward to Newark, giving the city a second direct connection to its eastern neighbor. Another layer was added to the county's transportation networks when from 1911 to 1915 Newark officials sponsored the construction of the Port Newark Terminal in the oozy meadowlands bordering Newark Bay southeast of the city complete with ship channels, docks, and rail connections (Cunningham 1988, 245-248; Condit, 1:127-175; 2:101-110).

Suburban growth continued apace shortened commuting times and convenient train service, and the Essex County engineer's office undertook the construction of new streets and bridges in the county's expanding western residential areas. The Survey evaluated eight county bridges constructed from 1908 to 1916 (0700045, 0700046, 0700053, 0701065, 0700071, 0700087, 0700105, 0701565), all of which were located in suburban communities such as Maplewood, Millburn, Verona, Fairfield, Livingston, and West Caldwell. New bridge styles were similar to those found throughout New Jersey and reflected more extensive use of concrete for bridge decks and parapets, encasement of stringers and beams, and substructure. In the mid-1910s W. A. Stickel replaced James Owens as county engineer, and under the former's guidance the use of encased steel stringer spans with concrete parapets became more pronounced.

In 1915 Essex County boasted of a modern transportation system built on the backbones of several large and successful integrated trunk lines. The railroads transferred people and goods with a network of paved streets and roads, up-to-date bridges, street railways, and a brand new port facility. Essex County's transportation facilities joined it with a vast New York metropolis that itself was at the center of a national rail transportation system, a monumental engineering achievement, yet it had grown without the benefit of centralized planning. A fundamental unsolved problem was the large amounts of time spent by immobilized railroad cars in yards, terminals, and industrial spurs, and year-by-year increases in freight tonnage were overwhelming the ability of the transportation network to bear the load. The extraordinary strain placed on the railroads by the doubling of exports

during the First World War brought the Port of New York, and consequently the nation's railroads to the point of near collapse. After the war, public policy makers' confidence in the railroads was shaken, and although the railroads resumed a significant place in the region's transportation system, emphasis shifted to the alternative of improving major through highways for use by automobile traffic with a significant impact on the future of Essex County's bridges (Condit, 2:111-121).

The political groundwork for a state highway system began in the late 1890s but did not gain momentum until the 1910s with the automobile's increasing popularity. State-aid for county roads consisted initially of funds for paving and construction of existing roads, but that changed in 1916 when the State Legislature created the New Jersey State Highway Department to build and maintain a system of 15 routes. In Essex County routes included Route 1 through Newark on the main New York to Philadelphia road by way of the old Newark Plank Road (present Ferry Street, Market Street, Broad Street, and Frelinghuysen Boulevard in Newark City), and Route 5 from Newark to Irvington and on to Morristown (present NJ 124, Springfield Avenue). The First World War delayed funding for major improvements and even when funding did arrive it did little to ease the mounting traffic congestion in the immediate postwar period. The densely-built urban environment in Essex County and other counties bordering New York City posed extraordinary engineering problems for the planners of New Jersey's modern highway system and simply improving already existing city streets did little to solve the problem, which by the mid-1920s had reached such an extent that over 35,000 vehicles per day were passing Broad and Market Street in downtown Newark (Cunningham 1988, p.265).

Addressing traffic conditions in northeastern New Jersey was one of the priorities of the State Highway Department but it was not until the mid-1920s that the Department had the mandate, appropriations, and organizational capabilities to further expand and upgrade the highway system. The centerpiece of the state's plans for Essex County was the Pulaski Skyway over the Passaic River (completed in 1932) connecting to the Route 1 Extension (Hudson County) and from there linking to the Holland Tunnel (1927) under the Hudson River. Highways such as Routes 1 & 4 (US 1 & 9), Route 29 (US 22), Route 25 (US 1 & 9 Truck), and Route 21 (McCarter Highway) fed through traffic onto the superhighway while also offering limited access to local points. Traffic into and out of downtown Newark from surrounding suburbs was carried by Route 10 from Morris County, Route 21 from Belleville, Route 23 from Passaic County to Verona, and a renumbered Route 24 (NJ 124) from Springfield, while Route 6 (US 46) cut across the far northwestern corner of the county and offered connections to Bergen and the George Washington Bridge (1931) over the Hudson River.

The interconnected highway system was characterized by innovative bridge and viaduct construction that achieved highway and railroad grade separations in the dense urban environment and set the standards for future superhighways. Projects began in the late-1920s and continued throughout the 1930s with both state and federal aid monies. The Survey evaluated at least eight state highway related or railroad grade separation bridges

(0700079, 0705151, 0713151, 0714150, 0718150, 0722157, 0749160, 0755160) in Essex County dating from 1927 to 1939 associated with this golden age of highway building. The Survey did not include the more than ten US 1 & 9 viaducts and bridges, but did include some related entry and exit ramps such as the 1931 Haynes Avenue viaduct over the former Pennsylvania Railroad yards (0749160, Newark City). The encased girder and floorbeam with concrete parapets viaduct is similar to the type of construction used for other viaducts and bridges carrying related roads and highways.

Occasionally cross traffic required intricate bridge engineering such as at the three-tier crossing of Weequahic Park Road, the Lehigh Valley Railroad's six-track main line, and the four-lane wide Route 29 (now US 22) in the southern section of Newark City. In this case, consulting engineer A. Burton Cohen worked in cooperation with the Essex County Park Commission, the railroad, and the State Highway Department to design a graceful 222'-span open spandrel ribbed arch carrying the park road over the railroad (0700079, Newark City), and a 138'-span, 248'-wide, skewed reinforced-concrete slab bridge (0718150, Newark City) to carry the railroad underneath the park road and over a depressed section of the highway. Cohen, a former bridge engineer with the D.L. & W Railroad, was noted for his often innovative and monumental reinforced-concrete bridge designs. The three-tier crossing ranks as a historically significant example of his work, and as a technologically innovative example of bridge engineering.

State Highway construction also included one of the last pre-World War II movable span bridges over the Passaic River, the old Route 25 (now US 1 & 9 Truck) viaduct and vertical lift bridge (0705151, Newark City). Old Route 25, also known as the Lincoln Highway and itself on the old route of the Newark Plank Road, was bypassed in 1932 to the north by the Pulaski Skyway yet remained an important route for vehicles prohibited from the Skyway and for local traffic between Newark, Kearny and Jersey City. In 1939 the state replaced an outdated draw span with the present 2005'-long viaduct with a 332' main vertical lift span. Ash-Howard-Needles & Tammen (AHNT), consulting engineers, designed the movable span, which is one of the longest of its type in the region. AHNT specialized in movable span bridges and several of its principal members began their careers with noted bridge engineer J.A.L. Waddell who is largely given credit in the 1890s and 1900s for developing the modern vertical lift technology. The bridge, which retains much of its original machinery, was built under the guidance of State Highway Department bridge engineer Morris Goodkind, who in 1941 received an award recognizing the bridge as that year's most beautiful movable span.

State highway bridges were the largest and most notable of Essex County bridges built from the mid-1920s to the 1940s, yet bridge construction within the county boundaries included a large number of standard-designed short and medium span structures to carry local roads and streets over the many streams, especially in the suburbs and western portions of the county. The Survey evaluated at least 23 county-owned bridges dating from 1920 to 1946. Most of the bridges were built under the tenure of county engineer W. A. Stickel who oversaw county efforts to replace worn out bridges and to upgrade bridge

construction for modern standards as suburban residents increasingly took to their automobiles. Funding for the bridges was a combination of local sources supplemented by state and federal aid that carried construction through the Depression years of the 1930s. The most popular type of county bridge was the encased steel stringer with concrete balustrades (e.g. 0700054, Ridgewood Road, Millburn Twp.) but other bridge types included in the 1920s thru and deck girder spans (e.g. 070M060, Two Bridges Road, Fairfield Twp.), and in the late 1930s and early 1940s reinforced-concrete slab spans (e.g. 0701665, Nye Avenue, Irvington Twp.) and reinforced concrete T-beam spans (e.g. 0700028, Northfield Ave., West Orange Twp.). None of these bridges ranked as individually distinguished and were part of a statewide trend in bridge building where all counties were updating their bridge inventories with more modern bridges of reinforced-concrete and steel between the world wars.

The Second World War provided a watershed in the county's bridge and transportation history. By 1941 a system of through highways was in place connected to an extensive network of paved streets and local roads that fed traffic onto the main arteries. The impressive number of bridges constructed from 1920 to 1941 served to carry automobile traffic over, under, and through the urban industrial environment that was the product of more than three centuries of growth. Newark emerged prior to the Second World War as a center of the trucking industry that used the highways to carry freight and goods to factories and markets. Suburban residents adapted themselves to the automobile and it, along with the highways that could barely keep up with the rising traffic demands, became the favored mode of travel. After World War II emphasis in highway and bridge design again shifted to the construction of an interconnected system of interstate highways. The interstates accelerated the trends in transportation already presented in the prewar period and eventually eclipsed the railroads as the primary movers of long-distance freight, they also introduced new styles of bridge design. The postwar period, however, owed much of its transportation legacy to Essex County's late-1920s and 1930s pioneering superhighways, which themselves owed much of their historical and technological heritage to prior modes of transportation such as railroads, canals, and turnpikes. Essex County's highway bridges, as a significant part of this transportation heritage, reflect not only the impact transportation has had on the growth and development of the county, but also include a more than average number of distinguished contributions to bridge engineering history.

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GLOUCESTER COUNTY TRANSPORTATION HISTORY OVERVIEW

The history of Gloucester County bridges is best understood through the development of the county's transportation patterns. Most early transport in Gloucester County was oriented toward the Delaware River and its tributaries such as Oldmans Creek, Raccoon Creek, Mantua Creek, Woodbury Creek, and Big Timber Creek. The first 17th- and 18th-century European colonists -- Swedish, Dutch, and English -- were for the most part small farmers who chose to live in a scattered settlement pattern radiating from the streams. In the colonial era, Gloucester County's packets and river boats carried on a vigorous trade with nearby Philadelphia, making that city the center of the region's economy. The farmers brought their exportable produce, primarily wheat in the colonial period, via road to towns like Bridgeport, Swedesboro, Mantua, Woodbury, and Westville, that had been founded on the banks of the navigable creeks. Old county and township records show that the repair and maintenance of roads and bridges leading to and from the towns to the farms was one of the most consistent concerns of local governance. These roads eventually formed the basis of many present-day secondary road rights-of-way.

While river transportation dominated most long distance travel to and from Gloucester County, through roads connecting the county's major towns with other points within New Jersey were founded shortly after the arrival of colonists. The first roads of importance in the county were the King's Highway (1681) passing through Gloucester County from Salem to Burlington, and the Gloucester-Egg Harbor Road (1696) connecting the county with small settlements near the shore. This pattern of through travel from Gloucester north to Camden and Burlington, and eastward through Gloucester County to the shore continues until the present day. The county court of sessions regularly appointed citizens to the repair and upkeep of the roads and bridges, often noting the generally poor conditions and impassability of the highways. Local people constructed and laid out most minor roads and bridges as a response to settlement and trade patterns, often following already well-established paths.

The bridges, where streams could not be forded, were simple timber pile and beam structures. The Great Timber Creek Bridge on the King's Highway, which once stood near the current NJ 47 over Big Timber Creek crossing (0815152, Westville Borough), was one of the largest and most important of the county's bridges. In 1715, instructions for the rebuilding of the bridge stated "to make it in Breadth, from outside to outside, Eleven foot, the Sleepers & Campsells to be made of Good white oake, Got in proppre Seate, and to Jutt over as is necessary to Rayle ye bridge in of Each Syde [sic]" (Cushing:113). Few striking changes in the methods of bridge construction occurred in the early history of the county. No 18th-century bridges are known to survive in Gloucester County (Cunningham:195-198; Heston:393-436; Cushing:112-114).

In the first half of the 19th century turnpikes, canals, and railroads had a wide-ranging impact on the way New Jersey's citizens traveled. While the "transportation revolution," as it has been called by historians, promoted economic growth and opened new markets, it also proceeded unevenly and not all parts of New Jersey benefited in the same ways at the same time. In southern New Jersey, where small populations were already well-served by maritime transport, turnpikes had little long-lasting impact, and canals were unnecessary. The dominance of river-born traffic was not broken in most cases until after the Civil War when railroads finally built lines to most of the region's major towns and cities.

Gloucester County because of its proximity to Philadelphia-Camden was one of the first southern New Jersey county's to benefit from railroads. In 1838 the Camden and Woodbury Railroad, later the West Jersey and Atlantic City Railroad, went into operation soon offering five trains daily to Camden with ferry service to Philadelphia. In the 1860s Woodbury grew into a significant railroad junction with branch lines extending in three directions to Glassboro and Bridgeton, to Swedesboro, and to Salem. In the 1870s the major railroads passing through Gloucester County were consolidated under the control of the Pennsylvania Railroad. In 1933 the merged with the Reading Railroad's southern New Jersey lines to become the Pennsylvania-Reading Seashore Lines.

The railroads were a significant factor in the growth and economic development of 19th century Gloucester County. Agriculture continued to dominate local life well into the 19th century, but fresh vegetables and fruits surpassed grains as the county's most important commercial crops. Philadelphia remained the primary market, but the railroads opened up more distant cities such as New York to perishable agricultural products. Towns such as Sewell, Gibbstown, Iona, Newfield, Repaupo, and Clayton grew as a result of locally-important railroad depots for the shipment of fruits and vegetables.

The railroads also led to industrial and suburban development. The most prominent early industry, other than the scattered water-powered saw and grist mills, was glass making in Glassboro, which received a needed boost by the arrival of the railroad. In the 1880s, a local directory listed at least 6 glass factories in operation. The chemical industry gained a foothold in the county in 1880 with the establishment of Du Pont's dynamite factory in Gibbstown. Other installations such as petroleum refineries at Paulsboro and Westville followed in later decades. By the century's last decades Westville, Woodbury, Woodbury Heights, and Wenonah were growing middle-class neighborhoods, as urban white-collar workers moved their homes from Camden and Philadelphia. Still population increased relatively slowly, reaching approximately 23,000 by 1820 and 31,000 by 1900, and it remained for the automobile to quicken Camden and Atlantic counties' suburban development (Cunningham:200-203; Heston 455-457; Cushing:176).

In light of railroad development, little economic incentive existed for the systematic improvement of major through highways and bridges in 19th-century New Jersey. In Gloucester County, as in other parts of the state, county governments took responsibility for maintaining local roads and bridges, primarily as a means of linking outlying farms and

villages with larger towns and railroad depots. County Freeholders provided for bridge maintenance and replacement on a bridge by bridge basis based upon local needs and availability of funds, which were often minimal. In the last quarter of the 19th-century, Gloucester County began to avail itself of prefabricated iron truss bridges, built quickly and inexpensively by a score of regional bridge building companies. The iron trusses, based upon a technology pioneered by the railroads, became the preferred means of bridging most major streams. For other than the shortest-span bridges, iron trusses were often as economical as older timber stringer or timber truss bridge styles. County records indicate that in the late-19th century Gloucester had numerous metal truss bridges, but that none from that period have survived into the present day because of demolition and replacement.

The New Jersey Historic Bridge Survey identified only one surviving 19th-century highway bridge in Gloucester County. The Broad Street Bridge (NJ 45 over Woodbury Creek, 0810150, Woodbury City) is a single-span multi deck girder bridge constructed in 1892 by the Edgemoor Bridge Works of Edgemoor, Delaware. The bridge is an early example of steel girder construction, and is associated with the proposed Woodbury Historic District. The Broad Street Bridge, located on a principal thoroughfare in the prosperous county seat of Woodbury, is not typical of the more numerous short-span wood stringer, wood truss and metal truss bridges that at one time existed in the county's rural sections.

In the 20th century a new era of road and bridge building was ushered in by the automobile and by progressive attitudes. In Gloucester County, and throughout New Jersey, bridges designed by professional county engineers rapidly replaced older bridges (often timber stringers) in the highway improvement campaigns of the century's first decades. The automobile quickened the pace and individualized the pattern of travel. Proponents of state-aided roads believed that better roads would end the cultural and social isolation of rural dwellers, and would provide a recreational outlet for automobile owning city dwellers. Federal, state, and local governments hired increasing numbers of engineers to design and supervise the construction of roads and bridges, standardizing designs and experimenting with new materials, especially concrete (Seely:1-15).

The pattern in Gloucester County was typical of that seen in other parts of New Jersey. In 1909 the Gloucester County Board of Freeholders hired the county's first engineer, William C. Cattell. Cattell (1869-1948) was the son of a local farmer and received no formal engineering training except at the hands of a professor at a local private academy. At the age of 21, he entered into the business of surveying and civil engineering, and, like many of his contemporaries, learned his trade by practical experience. Despite his lack of formal education, Cattell was intimately involved with the professionalization of engineering; he became a member of the American Society of Civil Engineers, and was the first president of the New Jersey Society of Professional Engineers (Biographical History:477-478; Woodbury Daily Times, 1948; Gloucester County Board of Freeholders, 1909).

The influence of Cattell on the development of Gloucester County's bridges cannot be underestimated. From 1909 to 1942 Cattell had a lengthy tenure as county engineer. He followed the best engineering practice of his time, drawing up general specifications for the systematic improvement of Gloucester County's roads and bridges. By the 1920s Cattell had settled upon a concrete-arch design for the hillier western sections of the county, and a concrete-slab design for the flatter topography of the eastern part of the county. The survey identified 19 concrete arch bridges and 23 concrete slab bridges designed by William C. Cattell. The bridges are remarkable for their standardization including paneled concrete parapets and builders' plaques, but generally speaking are not technologically innovative nor early state-wide examples of their types.

Local contractors competed for the county bridge contracts through a bidding process overseen by Cattell. Most of the short-span county bridges were constructed by less than a half-dozen contractors. A representative of the concrete arch bridge type, US 322 over Raccoon Creek (0825152, Harrison Twp.), has been listed as contributing to the Mullica Hill Historic District. An early and well-preserved representative example of Cattell's concrete slab bridge design is the 1922 Coles Mill Road over Scotland Run bridge (0809L02, Franklin Twp.).

Gloucester County in comparison to other New Jersey counties has few stringer bridges, largely due to the prevalence of Cattell's concrete slab and arch bridges. The survey identified 13 county-owned stringer bridges, and of these seven were unexceptional wood stringer bridges constructed in the 1940s. Other county-owned bridges, not including railroad overpasses, were four T-beam bridges, three pipe culverts, two steel girders, and one movable swing span.

The swing span, Locke Avenue over Raccoon Creek (0805D04, Swedesboro Borough) has a rivet-connected Warren truss steel superstructure, and is the only example of a metal truss bridge in Gloucester County. The moveable bridge spans what was at one time a navigable portion of Raccoon Creek, and was constructed in 1911 by the Owego Bridge Company of New York. The center-bearing swing span pivots on a center pier and is a late, but typical example of a bridge type that was the dominant movable span technology in the late 19th century. At least seven other non-extant metal truss swing spans are known to have existed in Gloucester County. The Lock Avenue bridge is a reminder that as late as the early 20th-century Gloucester County still had some active riverboats.

Bridges not only carried highways over navigable streams but also spanned previously developed transportation systems such as railroads. Due to the relatively flat topography and rural character of Gloucester County, most railroad crossings, except in the few more densely populated towns, remained at grade until the first half of the 20th century when increased automobile traffic raised concerns for safety. The county has five pre-1946 railroad overpasses in the historic bridge survey. The 1914 Hunter Street over Conrail bridge (0802I14, Woodbury City) is the oldest and a representative example of thru girder construction. It is located in the proposed Woodbury Historic District. The other railroad

overpasses are all historically and technologically undistinguished examples of 1930s and 1940s grade elimination projects associated with state highways..

The most far-reaching change in the transportation history of Gloucester County has been the development of state highways. The county's efforts to improve roads and bridges under its purview corresponded with an increased concern for highways at the state level. The state government began financial and engineering aid to counties with road construction in the 1890s; in fact, the first mile of state-aided stone road in New Jersey was constructed in Swedesboro in 1893. Nonetheless, state-aid remained small-scale until the 1912 when the state legislature mandated the creation of a state highway system. It was not until after World War I that a newly created State Highways Department began taking over the new routes and funnelling large sums of money into road and bridge improvements and construction. The new highways largely followed transportation patterns pioneered by colonial roads and later by railroads, connecting Gloucester County with the Camden-Philadelphia area, and providing through routes to the Jersey Shore (Cunningham:202; NJDOT 1972:10).

One of the original 15 State Highway Routes, Route No. 6 (taken over in 1920), passed through Gloucester County, along portions of current route NJ 45. Other state highway routes soon followed and included NJ 18 South (current US 40) in 1924; NJ 20 (portions of current route NJ 47) in 1924-1925; NJ 17 South and NJ 44 (portions of current US 130) in 1926-1927; NJ 45 and NJ 47 in 1927; NJ 42 in 1927-1932; and NJ 51 (current US 322) in 1947-55. Although the highways tended to follow already well-established roads, improvements in grading, road surfacing, bridge construction, and maintenance and repair greatly enhanced the speed and ease of traveling by automobile. Trucking became the most desirable means of moving fruits and vegetables to the city, and city dwellers sought out some of the more distant portions of the county for lake-side summer homes and campgrounds (NJDOT: 1972:10-11; NJDOT 1988).

Bridges were an important component of the state-sponsored highway improvements. The New Jersey Historic Bridge Survey evaluated 15 pre-1946 state-built highway bridges in Gloucester County. Of these 5 were encased steel stringer bridges, 3 plate-girder bridges, 3 concrete-slab bridges, 2 culverts, and 2 vertical lift movable bridges. Except for the vertical lift bridges, the bridges are prototypical examples of New Jersey State Highway Department bridge designs built throughout the state from 1920 to 1945.

The vertical lift bridges (NJ 44 over Mantua Creek, 0806151, Paulsboro Borough; and US 130 over Raccoon Creek, 0818151, Logan Twp.) are two of three vertical lift bridges (the other is 1710152, US 130 over Oldmans Creek, Oldmans Twp., Salem Co.) built as part of old route NJ 44. They are a special structural type combining both civil and mechanical engineering technologies in order to provide navigational clearance for passing boats, and were built as parts of New Deal era public works projects in the period between 1935 and 1940. Unlike standard fixed-span bridges engineered in-house by the New Jersey State Highway Department's Bridge Division, the vertical lift bridges were designed by the firm

of Ash-Howard-Needles and Tammen, consulting engineers nationally-known for their movable bridges. The three vertical lift bridges are technologically significant examples of a relatively rare bridge type, and were the last major pre-1946 bridge project undertaken in Gloucester County. Today, the bridges primarily open to pleasure craft in the summer months.

The expansion of the State Highway System had a profound impact on the development of Gloucester County. Better highways promoted suburbanization, commuters found easier access to Camden, and with the completion of the Benjamin Franklin Bridge (1926, Camden County) and the Walt Whitman Bridge (1957, Camden County), travel to Philadelphia by automobile became easier as well. In recent decades, the construction of NJ 55, I-295, and the Commodore Barry Bridge have only hastened the movement of businesses and residents into Gloucester County, increasingly changing the county's character from rural to suburban (Cunningham:202-203; NJDOT, 1988).

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HUDSON COUNTY TRANSPORTATION HISTORY OVERVIEW

INTRODUCTION

Hudson County contains proportionally more historically and technologically significant bridges than any other county in the state due in large measure to its strategic location on the west bank of the Hudson River opposite Manhattan. Of the 91 highway-related bridges included in the survey, approximately 45% have historical or technological distinction, either individually or as part of important transportation routes through the county. On the road leading west from New York City, its early roads and turnpikes figured prominently in 18th and early-19th century travel between New York and Philadelphia, and its borders would be crossed by no less than seven major railroad companies by the middle of the 19th century. The 20th century witnessed the impact of the motor vehicle. While it afforded freedom and convenience of movement, cars and particularly trucks struck the death knell for the railroads and made Hudson County one of the most congested places in the country. The solution was the development of the super highway -- the limited access divided highway that offers economy in transportation and direct through connections. With the construction of major Hudson River crossings (1928 Holland Tunnel, 1937 Lincoln Tunnel, 1931 George Washington Bridge) historically and technologically significant access roads to speed through traffic were built in the county. The trilogy of transportation networks, old roads, railroads, and modern highways, endow Hudson County with a rich and varied transportation history that in many ways is a microcosm of New Jersey itself.

New Jersey has always been a corridor state, and nowhere is this more apparent than in Hudson County. The geography of the place, located directly opposite Manhattan on the west bank of the Hudson River and Upper New York Bay, made the county a natural corridor. All the more significant is the fact that to access the New York City waterfront, the formidable Bergen Hill (or Palisades) trap rock ridge had to be traversed. Although Hudson County was not established as a political entity until 1840 (when it separated from Bergen County), it is an area that has historically played a pivotal role in the urbanization and industrialization of the region. Fortunately, the record of the overlay of transportation networks that have dominated the history of the county is well preserved and clearly illustrates its development from colonial days to the present.

Geographically Hudson County consists of two peninsulas. Most of the county lies on a 14-mile long peninsula between the Hudson River and Upper New York Bay on the east and the Hackensack River and Newark Bay on the west. The Kill van Kull connects the two bays on the south. The second peninsula lies west of the Hackensack River, extending still further west to the Passaic River. This portion of the county was mostly marshlands.

The most prominent natural feature in Hudson County is a ridge of trap rock (consisting of igneous diabase) running like a spine the length of the east peninsula. It is known both as Bergen Hill (portion south of King's Bluff in Weehawken) and the Palisades north of King's

Bluff, where it rises 200' and more as a steep cliff out of the Hudson River. At King's Bluff the ridge steps back westward, leaving room for Hoboken and lower Jersey City along the riverbank. To the south the ridge sinks lower and lower until at the Jersey City - Bayonne boundary it reaches sea level. South of this point it rises a little again, with the geological formation continuing as the bedrock under Bayonne, Kill van Kull, and a portion of Staten Island. The top of the ridge forms a level area around 2,000 feet wide. It slopes westward down to the vast Hackensack meadowlands (Jersey Meadows) that occupy much of the area between the Bergen Hill and the First and Second Mountain ridges several miles to the west (west of Newark).

Initially controlled by the Dutch, the county remained decidedly Dutch even after being granted to the English in 1664. The first ferry to Manhattan was established at Communipaw (Jersey City) in 1661. Initially it was an area of scattered farming settlements, but about 1750, the area's isolation began to change. Through roads were constructed, especially "corduroy roads," made by using logs laid transversely with a little earth thrown on top of them. The roads connected with the Hudson River ferries, like the Communipaw ferry and the Hoboken ferry established in 1774, and they became the favored routes between New York and Philadelphia. Developed both privately and by the colonial government to facilitate through traffic of goods and people, these early routes form the nucleus of the present roadway system in the county.

One of the earliest colonial roads in the county was a king's highway from the settlement of Bergentown (part of present-day Jersey City) to Bergen Point at the south tip of Bayonne (now part of Hudson Boulevard). When this road was initially developed is not known, but it was under the jurisdiction and responsibility of the colonial government, not the county. In 1764 the king's highway south of Bergen was relocated closer to the sandy shore of Newark Bay, and in 1766, the colonial government authorized improvements to the road. In 1764 the road became part of the stage route between New York and Philadelphia, and it quickly became the favored route because it offered a shorter water crossing than going to ports on Raritan Bay (Lane, p. 128).

The early county road that proved most important was the one that crossed the Jersey Meadows to Newark. It led from the lower end of Newark's "Great Neck" across the Passaic and Hackensack rivers, with causeways over the marshy meadows between and east of the rivers. It went up the west side or back of Bergen Hill, connecting with the King's Highway. The original layout of the road was provided for by an act of the colonial legislature in 1765 in response to pleas from Morris and Essex counties for access to the Paulus Hook ferry (Jersey City) and Manhattan.

An early "corduroy road" built as a causeway across the Meadows to the Hackensack River is the present Belleville Turnpike. It was probably built ca. 1750 by Colonel John Schuyler to carry copper from his mines near Belleville (in what is now North Arlington in Essex County) east to the Hackensack River for transshipment. Travelers using the road wished to continue east from the Hackensack to Paulus Hook, so Douw's Ferry across the

Hackensack River was established, and the road extended to Paulus Hook (the present Newark Avenue). The Belleville Turnpike (NJ 7) still traverses the meadows, and the location of Douw's ferry, which also serviced the Newark Turnpike, is the present NJ 7 Witpenn vertical lift bridge (0909150).

Travelers favored these routes, and soon a demand arose for bridges instead of the ferry for fording the rivers. In response to this demand the colonial legislature in 1790 provided for an improved road and bridges from the Newark courthouse to Paulus Hook. Five commissioners were appointed and authorized to raise money by a lottery. Detailed surveys were made of five alternate routes, and the one selected was via Douw's Ferry over the Hackensack, and across the Passaic River at a point opposite downtown Newark. This road was the predecessor of the present Newark-Jersey City Turnpike (CR 508). The bridges, completed in 1795, were the first to span the lower reaches of the rivers.

The important colonial and early republic era roads were augmented and improved by privately financed turnpikes that were established in the county as early as 1805. In 1801, following the lead of Pennsylvania and the New England states, New Jersey chartered its first turnpike company, and between 1801 and 1840, some forty-seven turnpikes were established in the state. The privately financed roads were a great boon to the internal improvement efforts in the state, and Hudson County in particular, owing to its situation opposite New York City and its easy access by ferry. The turnpikes provided the through connections for destinations to the west and south, especially Trenton and on to Philadelphia. The most successful of all the early 19th century turnpikes was the Newark Plank Road, which yielded the greatest return to its investors of any in the state (Winfield, 1874, 360). It incorporated part of the historic road that linked the 1764 Paulus Hook ferry with Newark. Its right-of-way is largely the present US 1-9 Truck west of the crest of Bergen Hill.

At the height of the turnpike era there were several other toll roads through Hudson County. Colonel Stevens built toll roads to provide traffic for the ferry he established just south of his estate in Hoboken. His Hoboken Turnpike to Five Corners was built 1794. This road was somewhat realigned to its present position east of Central Avenue in 1848 (Winfield, 1874, 363). Others were the 1804 Bergen Turnpike to Hackensack and another turnpike from Hoboken to Five Corners in upper Jersey City (Eaton, p. 78). The Bergen Turnpike used in part a road laid out in 1718 from "Crom-kill to Whehocken" (Winfield, p. 358).

Although the area was a well-established route for the stages to Newark and beyond, and efforts had been made by the Jersey Associates to develop the Paulus Hook area, little development took place in the county until after 1834 when New York state relinquished its claim of jurisdiction over the Hudson River up to the high water mark on the Jersey shore. That year also marks completion of the first railroad, which linked Newark and the ferry at Paulus Hook. In 1840 Hudson was established as a county. With these events,

development began in earnest, stimulated in large part by new transportation technologies -- canals and railroads.

Road building for the rest of the 19th century and first two decades of the 20th century took second place to newer transportation technologies and was primarily limited to local streets laid down between existing through routes. The old colonial roads and turnpike routes continued to serve as the major Hudson County thoroughfares, with the addition of a grid pattern of streets, in a pattern similar to that of most cities in North America. Some new routes were created; for example Hoboken's 14th Street was extended west by a major viaduct (0900016) in 1910. The 31-span viaduct scales Bergen Hill, and it greatly improved access to the portion of the county on Bergen Hill and beyond. Half way up the hill the viaduct joins with one road that led north and one that lead south the rest of the way up in sidehill fashion.

The future of Hudson County belonged to other technologies. It was the canal and then the railroad, however, that endowed Hudson County with its highly developed urban/industrial character.

CANAL ERA

Built between 1824 and 1831 from Phillipsburg to Newark, the Morris Canal was extended 11 miles to the Jersey City waterfront by 1836. Jersey City proved to be a more suitable terminal than Newark for the canal boats. The canal crossed the Bergen Hill at its lowest point in Bayonne and then traversed up the peninsula to its terminal in Jersey City. The greatest impact of the canal was in demonstrating that Hudson County was an important conduit to the New York City market. It also was a major factor in launching the industrial era in the state of New Jersey, especially iron manufacturing in northern New Jersey. But it soon had to compete with railroads, and after the Civil War, its importance declined rapidly. The Lehigh Valley Railroad leased the canal in 1871, but by the turn of the 20th century, its traffic was almost gone. For legal reasons, the canal was difficult to abandon, and it had to be kept clear until about 1924 when abandonment was approved. Most of the right of way was subsequently been filled.

Other than the turning basin in the north portion of Liberty State Park at Jersey City, few traces of the Morris Canal in Hudson County remain. Two bridges built during its last days still stand: a ca. 1918 railroad bridge (0905151) built over Lincoln Highway (NJ I&9T) and canal in Kearny and a simple steel stringer footbridge over the canal built 1917 to provide access from a trolley stop on the Lincoln Highway to the World War I federal shipbuilding plant in Kearny.

IMPACT OF RAILROADS

Most dramatic of all influences on the development of the county was the railroad and the objective of access to the port of New York. Since Hudson County included miles of

shoreline on one of the finest natural harbors in the world, it might have become a major port city on its own, if it were not for its situation opposite Manhattan. Some steamship lines did build piers on the New Jersey side of the Hudson River/Upper New York Bay waterfront. The Cunard Line established the first regular steamship service from Europe to New York Harbor in 1856, and it chose to locate its terminal in Jersey City on the Paulus Hook waterfront. This seemed eminently sensible, since the pier was next to the terminal of the New Jersey Railroad & Transportation Co., so that passengers and freight to and from the west could be transferred between ship and rail without having to cross the Hudson River. But by the 1870s, Cunard had moved to piers on Manhattan, where most other steamship lines docked (the German Lines' Hoboken facility was an exception). Most of Hudson County's waterfront found a more prosaic function, though one equally vital to the port.

The geography of New York harbor is complex, and the pattern of local transportation that developed was somewhat different than at other ports. Railroad companies found it impossible to span the waterways of the port, or to lay track through the congested city. Instead of direct access to Manhattan proper, each railroad company approaching the city from the west developed its own terminal somewhere on the west side waterfront. There they transferred passengers and freight to ferries or barges for transshipment into New York. These water craft could deliver their cargoes to any point on the vast archipelago, making of the harbor's waters a much more flexible medium than rails on land could be. For the seven major railroads reaching the port of New York from the west (Erie, Lehigh Valley, Central Railroad of New Jersey, Pennsylvania, New York Susquehanna & Western, and Delaware Lackawanna & Western railroads), Hudson County was the natural place to locate a terminal. Hence, instead of marine berths, the waterfront of Hudson County developed with a host of vast rail yards and their associated piers. Servicing those terminals and yards was an array of trackage that were some of the busiest in the country. With the decline of railroads since the end of the second world war, many of the freight yards and passenger facilities have been abandoned and dismantled, but the number of rail lines with their underpass and overpass bridges that remain bespeak of the influence and dominance of railroads. Of the 91 bridges included in the NJDOT historic bridge survey, 45 of them, or nearly 50% are railroad related. They date from ca. 1890 through the eve of the second world war, and they include all types of railroad bridges, from tunnels and wrought iron lattice web girders and through trusses to built-up thru girders, the most common 20th century bridge type used by the railroads.

The railroads crossing Hudson County on their way to the waterfront met the same obstacles as the roads -- the ridge of Bergen Hill and the swamps on either side of it. How to traverse or skirt the ridge would dominate engineering decisions for the next hundred years, frequently producing innovative and technologically distinguished solutions. Solutions include tunnels, deep cuts with bridges for local streets, as the Erie did, or crossing the ridge where it was very low and then coming up the peninsula on the east side of the ridge, like the Central Railroad of New Jersey's (CNJ) main line across Newark Bay at Elizabeth.

One of the innovative routes, the 1907-1910 Bergen Archways, is potentially significant as a historic district. This is an open cut with interspersed tunnels and bridges built 1907-1910 by the Erie Railroad as a route for its successful passenger operations. Originally the company had bored a 4,000'-long double-track tunnel straight through the ridge in 1856-1861, but by 1897 the traffic had increased to a point that traffic in the smokey tunnel was very congested. It took over ten years to complete four-track improvement campaign that relied on a deep cut with four concrete-lined tunnels (550' under Oakland, Hoboken, and Central avenues and intervening properties 0951167; 200' under Summit Ave. 0951168; 260' under the intersection of St. Pauls and Bean streets 0951169; 200' under Hudson (JFK) Blvd. 0951170) and two reinforced concrete arch bridges (Palisades Ave. 0951165 and Baldwin Ave. 0951166). The cut was 40 to 75 ft. deep and 4400 ft. long. The bridges were originally to be steel truss bridges (the usual bridge material used by railroads) but just before construction began, the Erie RR decided to use reinforced concrete arches instead. These bridges were, like the combined tunnel-cut itself, innovative solutions to the problem of inserting a densely trafficked rail corridor into a built-up urban area without impeding traffic flow on any of the streets. Although the Bergen Archways has not seen passenger service since about 1960, nor any railroad traffic at all since the mid-1980s, it still retains its integrity, with its original tunnels and bridges mostly intact, as is the original 1859-1861 tunnel.

Another deep open cut was developed by the Newark & New York Railroad. The mile-long double-track line was built in 1869 to provide the shortest, fastest route between Newark and the CNJ ferry terminal at Communipaw (Jersey City). The route was built by and operated by the CNJ, and it has two of the oldest and technologically most significant overpass bridges in the county. Both Ocean Avenue (0950163) and Bergen Avenue (0900011) are rare wrought iron lattice web deck girder bridges that date to ca. 1890. They were "reconditioned" by the CNJ in 1913. The wrought iron girders are rare surviving examples of a 19th-century bridge type that reflects the experimentation that characterizes the early days of metal bridge technology.

In the 1920s, 38 daily local passenger trains traversed the Newark & New York's route, which serviced four passenger stations on its mile-long roadway through Jersey City. Passenger service ended in 1948, and the line was single-tracked and used for freight only (Trains, p. 52). When Conrail took over the CNJ's property in 1967, the line became known as the West Side Avenue Branch. It was abandoned by Conrail in the mid-1980s.

Other rail lines were built at grade. The two crossings of the Bergen Hill ridge at low points were originally largely at grade (CNJ, Pennsylvania Railroad), as were all the lines in the lower Jersey City area near the Hudson River waterfront and on the west side of Bergen Hill. Parallel to Bergen Hill on both its east and west sides there were also important rail lines. Their grade crossings with local streets were dangerous and caused much congestion in the county. During the first two decades of the 20th century, most of the grade crossings in the lower Jersey City area (east of Bergen Hill) were elevated eliminated

with thru girder overpasses like the 1918 example at Chestnut Avenue (0954164). West of the ridge, Tonnele Avenue, the main north-south road, was elevated above the railroads in the late 1920s, thus eliminating grade crossings with the New York Susquehanna & Western and Erie Lackawanna lines. Some other remaining grade crossings in the county, like Willow Avenue in Hoboken (090002), were eliminated as public works projects during the 1930s.

Another technologically significant rail route in the county was developed between 1904 and 1910 by the Pennsylvania Railroad to provide direct passenger service with its new terminal in New York City. The New York Extension, as the route is known, is still in service as Amtrak's line to Pennsylvania Station, and with a cost of about \$116 million, it was the most costly undertaking by an American industry up to that time. It crosses the Jersey Meadows in Hudson County on a high fill interspersed with grade crossing elimination overpasses, like the deck girder that carries the line over NJ 7 (0910152). But what is noteworthy about the route was construction of a 4-track tunnel through Bergen Hill and under the Hudson River connecting to the tunnel under Manhattan proper. The subaqueous tunnel was the second under the Hudson River to be completed, but the first, the famous 1908 Manhattan and Hudson Railway's "Tubes" from Manhattan Transfer and Hoboken to 34th Street in New York, was serviced only electrified street-railway like cars, not standard-gauge rail cars. The M&H extended its passenger service to Newark and Harrison, and the line operated from Manhattan Transfer until 1938, and its tunnels are used today by PATH.

BOULEVARDS, PARK ROADS AND BRIDGES

In 1892 the Hudson County Park Commission was created to plan a park and boulevard system like those provided in other cities such as Boston and Newark. The first feature the commission addressed was a county-long boulevard that would connect the future parks. The drive was called Hudson Boulevard (renamed John F. Kennedy Boulevard in the 1960s), and it became the principal north-south route in the county. It was constructed 1892-1897, under Chief Engineer Edlow W. Harrison, using existing roads in some places. In the southern part of the county it was built on New Bergen Point Road, and was thus an incarnation of the old King's Highway. From Bergen Point in Bayonne it wound north 14 miles almost to the Bergen County line, where it turned east in a loop through North Hudson Park and went south again as (Hudson) Boulevard East along the top edge of the Bergen Hill cliff to end at King's Bluff in Weehawken. The Boulevard East section was finished a few years later than the rest of the route. In 1908 the State of New Jersey reconstructed the road to "improve and beautify it." Although Hudson Boulevard became an important route in the county, and did connect the new parks, it has never been (for most of its route) the sort of continuous linear park feature that the term "boulevard" implies (Hudson County Park Commission, 1908).

The old Hudson Boulevard bridge over the Pennsylvania Railroad and Hudson & Manhattan Railway cut was replaced in 1926 by a new reinforced concrete open spandrel

arch bridge (0900008). At the same time the street was widened here to a broad plaza, known as Journal Square, making this area the important business district for Jersey City and an urban landmark (Writer's Project, 1939, p. 272). The bridge was designed by noted engineer A. Burton Cohen (1887-1956), former chief engineer of the DL&W Railroad, and it is the earliest highway bridge of its type in the state. Cohen, with his almost exclusive use of reinforced concrete, was a great influence on state bridge engineer Morris Goodkind.

Between 1900 and 1916, the park commission also planned and built five large parks in the county. Prior to 1900 Hudson County had only a few urban squares, and open land was fast disappearing as the county urbanized and developed industrially. The commission acted quickly to secure the remaining parcels they evaluated as suitable for parks, and they hired landscape architect Charles Lowrie who worked in the tradition of the 19th century English landscaping of parks. Development precluded establishing a "linear park" system like Boston's or the one in the Bronx, but four of the five parks could be connected to each other by the boulevard.

The parks were all landscaped in the picturesque Olmsted fashion, "generally with a pastoral landscape using elements that pre-existed the park where possible" (Hudson County Park Commission, 1910, p. 22). Lowrie's description of his design for West Hudson Park, for example, emphasizes its woodland scenery, viewpoints, and the opportunity to create a picturesque lake out of several ponds already on the site.

Several bridges built to carry park roads over footpaths or city streets were treated as elements of the overall park design, and they were well detailed and proportioned. Using the moldable properties of concrete, four reinforced concrete arch bridges were built prior to World War I (0900020 West Hudson Park Drive over Davis Ave.; 0900022 Bayonne Park Road over park footpath; 0900023 Bayonne Park Road over park footpath; 0900024 Bayonne Park Road over park footpath). They reflect the attention and detailing that is indicative of park architecture of the era. All have been evaluated as historic.

TROLLEY ERA

In the second half of the 19th century, street railways were laid along the major north south routes, and also along almost all the roads that led from the top of Bergen Hill down to the ferries, including the old turnpikes. Some of these lines used private rights-of-way (not associated with a public street) to ascend the hill. These streetcar lines were the major local transporters of people, especially after 1895-1900 when they were electrified (Eaton, p. 103). A number of bridges and two spectacular viaducts were built for the exclusive use of the electric railways, and although often seen in old photographs, very few traces of them remain. The street railway lines were all abandoned by the late 1930s, put out of business by the motor vehicle. The one bridge that reflects the street railway era is the 1910 2-span reinforced concrete arch Palisade Avenue bridge over the Erie Railroad's historic Bergen Archway and the parallel trolley track (0951165). Both rights-of-way have been abandoned.

MODERN HIGHWAY ERA

With the creation of the New Jersey State Highway Department in 1917 came the designation of the first state highways. Of the 15 original state routes, curiously, none of them were to link the Hudson County ferries with the rest of the state -- a role conceded to the railroads (highways connected with Elizabeth and Newark instead). The original routes reflected the orientation of the first state highways to intrastate travel, not interstate.

World War I changed all that, and the modern highway era, especially the superhighway, came swiftly to Hudson County after the war. In 1922, for example, the number of vehicles crossing the old Hackensack River Bridge in Hudson County was 12,600 per day, or 4,600,000 per year while the number crossing the Hudson River into Hudson County on ferries was 3,850,000 (Sloan and Johannesson, 1934). One of the reasons that crossings and thus congestion increased so dramatically is the shift in hauling from trains to trucks. World War I clearly demonstrated the advantage of the versatility of trucks for long-distance hauling as the port of New York struggled to move the materiel needed for the war effort. Port congestion was reduced significantly when trucks rather than trains were used. And while it was not apparent to all immediately, it was clearly trucks to which the future of hauling belonged, and they would pass through Hudson County with New York-bound goods.

The poor capacity of roads in Hudson County was spotlighted by the proposed opening of the first vehicular Hudson River crossing, the 1926 Holland Tunnel between Jersey City and lower Manhattan. It was acknowledged that not attending to the congestion already existing on Hudson County roads would make the new tunnel virtually worthless, as the vehicles would have no place to go. The solution was to expand several of the existing arterial and connecting state highways in the county and to build the Route 1 Extension, a 13-mile long limited access road from Bayway Circle in Elizabeth (Union County) to the entrance to the tunnel. The extension would become what is commonly regarded as America's first superhighway.

With no precedent to follow, the State Highway Department, under the lead of William G. Sloan, State Highway Engineer, planned, developed, and built the innovative roadway that embodies the full trunk highway concept, which requires limited access, no grade crossings, separate roadways for each direction of travel, and provision for commercial vehicles (trucks and buses), for more than pleasure driving. The first segment was completed in 1928, but the section over the Hackensack and Passaic rivers (Pulaski Skyway) was not finished until November, 1932. The new route was lauded in the press for lowering the travel time from Manhattan to Newark airport from 2 hours to 20 minutes

Planned using railroad economics, the Route 1 Extension is an innovative combination of engineering solutions to the difficult problems of locating a wide highway in an area that was densely developed and crisscrossed with active and important rail lines and yards.

Using traditional bridge types, the encased stringer, the thru and deck truss, and the girder, the state's design engineers developed a roadway that passes under or over local Jersey City streets and rail lines. The road is a subway with one open side through Bergen Hill, and predominantly viaducts to either side. Most spectacular of the engineering solutions is the Pulaski Skyway itself, planned and built between 1929 and 1932. The 3.5 mile-long viaduct is the culmination of the continuous thru truss with a suspended section design. The entire route of the Route 1 Extension from the west end of the Pulaski Skyway to the entrance of the tunnel, and all the bridges associated with that section, have been evaluated as significant based on the transportation and engineering significance of the route and the integrity it enjoys after over 50 years of service.

With its access ramps and acceleration lanes entering in the center of the structure, the Pulaski Skyway proved dangerous for both car and truck usage. As the result of several horrific accidents, trucks were banned from the Skyway in 1938 when the alternate truck route (US 1&9T) was created (Public Roads: A Journal of Highway Research, 19, July 1938, p. 86). The truck route made use of the earlier Lincoln Highway route.

The pattern of superhighway established by the Route 1 Extension was repeated for the approach road for the 1937 Lincoln Tunnel at Weehawken. Building on the solutions that preceded it, the 2.8 mile long Route 3 approach was also constructed in an area that was fully developed. Route 3 was designed to serve as both a local thoroughfare as well as a limited access trunk road. This was accomplished by innovative bridge and highway designs that segregated local from through traffic through an efficient use of multi-level ramps and overpasses. It was decided to traverse Bergen Hill with an open cut rather than a tunnel, which was expensive to construct and would require complicated venting equipment. Local streets are carried over the open cut on reinforced concrete rigid frame bridges, and the route is unified architecturally by Moderne-style stone veneering on the bridges, retaining walls, parapets, and related details. Just as the Skyway has its engineering marvel, Route 3 transitions from the crest of Bergen hill to the tunnel via a helix-shaped span that allows the approximately 150' descent to the tunnel portal in a limited amount of space. In total, 21 bridges are associated with the Lincoln Tunnel approach.

The historic character of Hudson County as the conduit to New York continues. In the early 1950s the New Jersey Turnpike was built from Newark north through the Jersey Meadows (east of the Hackensack River) to improve access to the US 46 approach to the George Washington Bridge (Ft. Lee, Bergen County). In Secaucus it made an important connection to the approach to the Lincoln Tunnel (Route 3 is now NJ 495). In response to the inadequate capacity of the Route 1 Extension and 1&9 Truck approaches to the Holland Tunnel, in the late 1950s the New Jersey Turnpike Authority built the Hudson County Extension to provide a direct route from the turnpike to the tunnel. The extension was built west from Newark across Newark Bay and then across the Bergen Hill ridge at the Bayonne-Jersey City line, the same place earlier crossed by the Morris Canal and a pair of railroad lines. Then it turned north and snaked among the many railroad rights-of-way

along the shore of the bay until it reached lower Jersey City, where by means of spectacular ramps and viaducts it joined the Holland Tunnel approaches.

By 1960 the system of freight and passenger handling used by the railroads had become obsolete. Few ocean-going ships serviced Manhattan or Brooklyn. Passengers more frequently traveled by air, and freight was loaded in containers at a port built by the Port Authority in Newark and Elizabeth. Most of the freight containers arrived at the ports by truck. The automobile took over the formerly lucrative commuter passenger market. In the space of a decade the railroads abandoned all but a few vestiges of their terminals in Hudson County, and many of the railroad-built bridges of Hudson County now span abandoned rights-of-way, or in some cases, a single track that sees a train once a day where formerly there were busy multiple tracks.

Few counties in the entire country can boast as proud a transportation heritage as Hudson. Despite the loss of the trains and the watercraft, the corridor character of the county is readily apparent, due in large part to the survival and integrity of the significant transportation networks from both the 19th and 20th century that remain in place and in service. The ever-present New York City skyline serves as a vivid reminder that Hudson County was and is the gateway to Manhattan.

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HUNTERDON COUNTY TRANSPORTATION HISTORY OVERVIEW

Hunterdon County, located in the Piedmont and Highlands of the western part of the state, is characterized by rolling hills and charming 19th-century hamlets that preserve the agrarian and proto-industrial past of the county. Created in 1713 as a large county that extended from Assunpink Creek (in present Mercer County) north to the New York border, Hunterdon County included what is now Mercer, Morris, Sussex, and Warren counties. The Delaware River forms the western boundary. It achieved its current boundaries in 1838 when Mercer separated from Hunterdon County. Warren, Sussex, and Morris counties were separated in 1738. The county was settled before the Revolution by English, Irish, Scotch, German, Dutch, and French settlers who established an ethnically mixed but basically agricultural-based society. Germans established Germantown (now Oldwick) in Tewksbury prior to 1750, and John Ringo established a settlement that bears his name in East Amwell about 1720. Irish established settlements in Flemington and into the High Bridge area where locally produced iron was worked in armaments for the Revolution. Flemington became the county seat in 1785.

The earliest roads in the county were Indian trails that had been created by generations of Lenni Lenape, who selected routes for the most gentle grade, the firmest ground, and the easiest fordings over the many streams and rivers in the county. Colonists followed these trails, widening them as they went. A branch of the Minisink Trail followed the Raritan, providing entry to the western lands including Hunterdon. A trail named "Old York Road" by the colonists crossed the Delaware at Lambertville and traveled to Newark, passing through Mount Airy and Reaville. A north-south trail passed through Cherryville, Pittstown, and Hampton to the falls of the Delaware at Trenton (Mercer County). The trail intersected Old York Road at the town of Ringoes (East Amwell). At Reaville, the Amwell Road to New Brunswick branched from the Old York Road. Hopewell Road from Lambertville also led to New Brunswick (Snell 1881:106; Lane 1939:33; Stevens 1989:69).

The New Jersey Turnpike, an ambitious cross-state route chartered in 1806, went from New Brunswick to Easton, passing through Whitehouse, Potterstown, and Clinton. The corporation failed when farmers, especially those of Hunterdon County, forcibly resisted paying tolls, creating "shunpikes" to by-pass the tollhouse.

Other turnpike roads traveled through Hunterdon. The New Germantown and Spruce Run Turnpike Company began at North Branch and passed through Oldwick on its way to the Washington Turnpike in Morris County. The Spruce Run Company began in Clinton and traveled north through the Spruce Run Valley but was never finished. The Hopewell Road was privatized and became the Georgetown and Franklin Turnpike. Although none of these ventures was successful, the routes form the basis for present-day roads (Schmidt 1945:163; Stevens 1989: 70).

Water transportation was an option for Hunterdon farmers, and rafts, flatboats, and dug-out canoes plied the Delaware River carrying produce and lumber. Durham boats, created to carry iron, were also used for carrying corn, wheat, barreled pork, and limestone to market. Coal arks were used to carry coal from Pennsylvania's coal fields to markets. However, rapids and rocks are common in the river north of Trenton, and it was not easily navigated. Well's Falls, south of Lambertville, a drop of twelve feet in less than a mile, was especially treacherous.

Canals paralleling the river were proposed as a solution to the risky navigation. Hunterdon residents vigorously lobbied for the creation of a canal to bypass the treacherous Delaware River. The Delaware and Raritan Canal, completed in 1834, traversed the state from Bordentown to New Brunswick. Of more interest to Hunterdon residents, a twenty-two mile long navigable feeder canal drew water from the Delaware River above Stockton and traveled south to join the main D & R Canal at Trenton. On the Pennsylvania side of the Delaware River, construction of the Delaware Division Canal in 1834 also provided transportation on the west bank for Hunterdon farmers.

The feeder canal did much to stimulate development in the southwestern portion of the county because it offered access to markets like Philadelphia, New York, and Trenton. Lambertville, located on the feeder canal and at a transfer point for the Delaware Division Canal, especially benefited by becoming an important shipping center. The town experienced a boom beginning in the 1840s. Roads leading to Lambertville carried the farmer's carts and wagons loaded with produce bound for canal shipping.

Concurrent with the canals was the arrival of the railroad, which more than any other factor shaped the development and character of the county. Although bypassed in the 1830s by New Jersey's first railroad, the Camden & Amboy, Hunterdon entered the railroad age during the late-1840s with the development of the right-of-way of the Somerville and Easton Railroad Company's connection to Whitehouse (Readington). In May of 1852, the line reached Clinton, and in July, its route to Easton, Pennsylvania was opened. The Somerville and Easton Railroad joined with the Elizabethtown and Somerville Railroad in 1849 to form the Central Railroad of New Jersey (CNJ). The CNJ had stations at Annandale, Asbury, Valley, Hampton, High Bridge, Lebanon, Glen Gardner, Whitehouse, and Bloomsbury.

The effects of the railroad on northern Hunterdon were significant. Farmers benefited in securing transportation for resources and crops. Increases in commerce, population, and communication with the wider world resulted. The CNJ became even more important when a junction was made with the Delaware, Lackawanna and Western Railroad (DL&W) at Hampton Junction (Lebanon Township) in 1856. Both railroads built shops there. The DL&W pushed through to Scranton and the heart of the coal fields. (Snell 1881:111; Schmidt 1945: 184-186).

Shorter railroads were constructed as connecting links with through rails. The South Branch or Short Line was built in 1863 to connect Somerville to Flemington. The Flemington Railroad was chartered in 1854 to connect Lambertville to Flemington. A flourishing freight business developed hauling coal, lime, lumber, and merchandise. The Belvidere and Delaware, known as the Bel-Del, was authorized in 1848 and passed through Lambertville, Frenchtown and Milford, paralleling the Delaware and the D & R Canal Feeder. The Bel-Del was a subsidiary of the Camden & Amboy, and the company built shops in Lambertville and manufactured cars and locomotives there until 1871. The Easton and Amboy was begun in 1872 and joined those two towns, traversing northern Hunterdon and Somerset counties. To secure the most direct route, the railroad constructed a tunnel through Musconetcong Mountain at West Portal. Renamed the Lehigh Valley Railroad, it traveled to Jim Thorpe, Pennsylvania, and the anthracite fields. Stations on the Lehigh Valley included Flemington Junction, Landsdown, Pattenburg, and Bloomsbury. Spurs serviced Clinton and Pittstown, a major shipping point for Hunterdon's peach crop. The Rockaway Valley Railroad was a late arrival, completing its route in 1900 to join the New Jersey Central at Whitehouse with the DL&W at Morristown. The railroad was handicapped by the failure of the peach crops. It ceased to exist during World War I. (Snell 1881:110-116; Schmidt 1945:187).

The railroads and canals had a significant impact on the construction of roads and bridges. Stagecoach routes were designed to take passengers to rail connections. As railroads pushed the tracks further west, the stagecoach route altered and shortened. Wagons loaded with produce used turnpikes and plank roads to connect with railheads and canal towns. Bridges capable of carrying heavy loads were necessary. As early as 1757, road construction and maintenance was managed by townships through overseers of the highway. The construction of bridges was administered by the county through the County Board of Chosen Freeholders. The first bridge was constructed in present Hunterdon in 1785 at Readings Ford across the South Branch of the Raritan. "T. Reading" was appropriated 215 L for the project. By 1795, the Freeholders were levying taxes to construct bridges over inland creeks. In 1830, a third of the county budget, \$6446.52, was spent on building and repairing bridges. By 1860, the expenditure was over \$25,000 (Snell 1881:189, Schmidt 1945:168, Stevens 1989:74).

The earliest extant bridges in Hunterdon County are stone arches. Thirteen 19th-century stone arch bridges remain, and they date as early as 1840 (No Number, Woodville Road over Peters Brook in the village of Linvale). Most are short, single-span bridges that are representative of a commonly used bridge type when permanence of a crossing was desired. The three stone arch spans over Swan Creek in Lambertville (100056, 100Y040, 100Y041) date from the mid-1870s, and they chronicle the historical significance of Lambertville as a major transportation and mercantile center. All three are contributing resources to the National Register-listed Lambertville Historic District.

The other early bridge type, the wooden truss covered bridge, is not as well represented. Primary sources and photo documentation indicate that covered bridges were very

common over both the numerous streams and rivers within Hunterdon as well as for the privately built multi-span bridges over the Delaware River at Milford, Frenchtown, Stockton, and Lambertville. Most of the metal thru or "high" truss bridges in Hunterdon County or on its borders today replaced covered bridges. However, only one covered wood truss bridge remains, and it is the only one in the state. Dated 1872, the Green Sergeant's Covered Bridge 1000110), as the Howe truss bridge is known, has been modified by the addition of steel stringers to carry live loads. In spite of the alteration, the span is technologically and historically important, and it is individually listed in the National Register of Historic Places.

The glory of Hunterdon County is its assemblage of metal truss bridges which ranks as not only the most impressive in the state but one of the finest in the country. Thanks in large measure to a fortuitous combination of an economic decline which the county experienced from the 1860s well into the 1930s and the mid-20th century discovery and preservation of the quaint charms of the county by "city folk," more metal truss bridges survive in Hunterdon County than any other county in the state. The peak of population of 40,758 in 1865 was not matched again until well into the 1940s. The result of the decline was an absence of development and modernization pressure that proved a boon to bridge preservation. Consequently, Hunterdon County presents an almost encyclopedic array of metal truss bridges that chronicle the development and standardization of the bridge type.

Another factor in Hunterdon's plethora of older bridges was the slower pace of highway development in the county. Public pressure for good roads increased initially with the bicycle, and then the automobile. The Flemington Bicycle Club, incorporated in 1893, declared better roads to be a matter of "National Pride!" (Sorby, 1971:np). Many Hunterdon landowners, however, resisted the idea as too costly. The state enacted legislation in 1876 which enabled counties to take over and macadamize roads, but as the cost was to be primarily borne by landowners, no roads in Hunterdon were macadamized at that time. State legislation in 1890 reduced the landowner's contribution, but the residents still rejected the idea. Flemington finally macadamized its main street in 1901. In 1917, the state legislature designated 15 routes which were to be acquired or constructed as an integrated State Highway System. Of those original routes, only Route 9 from Elizabeth to Phillipsburg crossed Hunterdon, passing through Whitehouse, Clinton, West Portal, and Bloomsbury (portions of current US 22) (NJDOT 1972:10-11).

Thirty-two of the total 63 metal truss bridges in the county are documented or date stylistically to pre-1901, an era dominated by pinned field connection spans. The other 31 were built in 1901 and after. The county first built a metal truss span in 1858. Among the most important of the early "low" or pony truss metal bridges are the three surviving examples of the collaboration between noted bridge designer Francis C. Lowthorp (1810-1890) of Trenton and foundryman William Cowin of Lambertville. The three bridges were built between 1868 and 1870, and they reflect as well as any bridges in the state the experimentation in the era of transition from wood to metal truss bridges. Concepts in both design and the properties of the ferrous material were being worked out. The compression

members are composed of cast iron, while the tension members are wrought iron which has better tensile strength than cast iron. The 2-span bridge that carries Main Street over the South Branch of the Raritan River in Clinton (10XXON1) and the single-span School Street over Spruce Run bridge at nearby Glen Gardner (10XXG63) were both erected in 1870, and they reflect Lowthorp's conviction that cast iron was an acceptable compressive material as well as Cowin's ability as a foundryman to work the material into structurally sound members that continue in service today. The massive square end posts from which the trusses are hung is a wood bridge characteristic, but the use of well-detailed castings for the compression verticals and top chords marks a departure from the heretofore traditional wood truss designs. To compensate for imprecise members, the Glen Gardner and Clinton bridges have William Johnson's 1870 patented eccentric adjusters which could be used to "tune" the bridge after field erection. The more common method was with turnbuckles on the counters. Both Lowthorp and Cowin bridges and their 1868 span on Shoddy Mill Road over the Musconetcong River (included in the Warren County inventory) have national significance.

William Cowin's firm was established in 1849 as Laver & Cowin, and he was producing metal bridges as early as 1859 (Engineering News-Record, 11/11/1920). By 1859, the name had been changed to the Lambertville Iron Works, and it was making railroad car wheels, axles, safety boilers and steam engines in addition to truss bridge members (Snell 1881:283). William Cowin died in 1874, but the Lambertville Iron Works continued and erected a wrought iron Phoenix Column through truss bridge at Raven Rock (10XX300) in 1878.

Another type of pioneering metal truss bridges are those with the patented Phoenix-section. Circular in section with stiffening flanges, the wrought-iron Phoenix section, manufactured by the Phoenix Iron Company of Phoenixville, Pennsylvania, proved to be a sound compression member because it was able to resist stress (also called strain) equally well in every dimension. The Phoenix section, a built-up column composed of 4, 6, or 8 rolled wrought-iron flanged sections riveted together along the flanges, was patented in 1862 by Samuel J. Reeves of Phoenixville, Pennsylvania, and in the 1870s it, along with its corresponding cast bearing blocks, or feet, and connection "pieces" was "a great factor in causing the substitution of wrought iron for cast iron in compression members of pin-connected bridges," according to J.A.L. Waddell (Waddell, p. 24). There are less than 10 bridges built with the technologically significant Phoenix columns in the state, and three of the earliest and most complete are in Hunterdon County.

In addition to the 1878 Raven Rock bridge built by the Lambertville Iron Works, which is as significant as any Phoenix-column bridge in the country, two other were both constructed in 1885 by Dean & Westbrook, the New York City-based bridge fabricator that was the sole agent for Phoenix-section highway bridges in New Jersey, New York, and New England. The Hamden Road bridge over the South Branch of the Raritan River (10XXF65) is the only multi-span Phoenix pony truss identified in the state. The other Dean & Westbrook Phoenix-column span is a single-span high truss that carries Lower

Lansdowne Road over the Capoolong Creek (10XXF82). All three are significant in the state and national context.

Other technologically distinguished pin-connected metal truss highway bridges in the county include an undocumented Fink- or Bollman-like pony truss on Hollow Brook Road over the Lamington River (100T022) that dates stylistically to ca. 1880 (since the span is only two panels long, it is not known which configuration it would have taken were it longer). Although only two-panels long, the span has the floor beam supported by a pair of diagonals that span from end to end of the truss lines and is thus the most basic expression of a Bollman truss. The short bridge is technologically significant in that it is the only documented example of the Fink or Bollman truss principle in the state, and it too reflects the experimentation inherent in early metal truss bridge designs. Another rare example of an uncommon pony truss type is the ca. 1890 queen post pin-connected span at Mill Street in Milford (100M112).

In addition to the rare examples of uncommon truss types, Hunterdon County possesses a remarkable number of well-preserved examples of what would become the most popular metal truss bridge type in the 19th century, the Pratt pin-connected span. The truss, with vertical compression members and diagonal tension members, was patented by the brothers Pratt in 1844, and it went on to enjoy great popularity because of its strength and straightforward design (Jackson, p. 24). All of the 11 remaining thru or "high" truss bridges in the county are Pratts with the earliest not using Phoenix sections being the 1880 Cleveland Bridge and Manufacturing Co. span on Stanton Road over the South Branch Raritan River. In addition to being a good and early local example of a Pratt thru truss, it is noteworthy for its built-up fish-belly floor beams. Because of the relative rarity of pre-1905 thru truss bridges in New Jersey, which has about fifty examples, and the complete state of preservation of the structure and the setting that most of the thru truss bridges in Hunterdon County enjoy, all but one were evaluated as significant.

Pratt full-hip and half-hip pony trusses are also well represented in the county with several, like the ca. 1895 Hamp Road over Alexauken Creek span having rare design details like cast bearings and connectors. Others, like the 1896 Bell Avenue over Spruce Run (10XXG62), are rare and well preserved examples of a small but historically significant fabricators such as the Groton Bridge & Manufacturing Co. of Groton, New York. Other important 19th century fabricators represented in the county include the Wrought Iron Bridge Company of Canton, Ohio and a local fabricator, J. W. Scott of Flemington.

The final major 19th-century truss design that was developed was the Warren truss, with diagonal members that carry both tensile and compressive forces. It was used in the 1890s, but it came into its own in the first decade of the 20th century, and its popularity coincided with advances in connecting truss members. During the 1890s portable pneumatic riveting systems were developed making the more rigid riveted field connection possible. Warren pony truss spans were built in Hunterdon County through the second world war. The earliest examples to survive are technologically significant wrought iron

trusses built by the railroads. The 1890 riveted Warren pony truss bridge over the Lehigh Valley Railroad (now Conrail) on Higginsville Road (1050167) reflects the railroads' adoption of technological advances in metal truss bridge designs. The Higginsville Road bridge is the only 19th century Warren truss bridge in the county. An 1891 wrought iron Howe truss bridge was moved to its present location on Milford Road over the Lehigh Valley Railroad (1050160) in 1933. It ranks as one of the most significant railroad bridges in the region based on its age, condition, truss type, and T-section members, a rare detail.

Railroads were building grade crossing elimination bridges in the county as early as 1870. The Hunterdon Republic noted on March 10, 1870, "A bridge has just been completed by [the New Jersey Central] over their track below Whitehouse, so that vehicles on the public road in crossing are entirely out of danger." That bridge no longer exists, but two other Warren pony truss bridges constructed by the railroads in the early 20th century, and the 1890 Warren truss bridge at Higginsville, remain. (Snell 1881:111).

Because there are 24 Warren pony truss spans in the county and the truss type is also well represented throughout the state, selection of significant examples was based in large measure to the state of preservation and the setting of the span. Historical significance was greater if the fabricator was known and if it was a local or regional builder. Significant examples include Upper Kingston Road over Capoolong Creek (10XXF48) and County Route 609 over Back Brook (100E239).

Many of the truss bridges are located in rural settings with little traffic, a fact which has contributed to their preservation. Hunterdon County has also frequently chosen to strengthen existing metal bridges rather than construct new structures. On a few occasions, metal truss bridges were moved, presumably to areas with lighter traffic demands.

World War I stimulated highway development. The need to ship war materiel to the east coast overburdened the existing system. After the war, freighting by truck was common. Trucks required better roads and stronger bridges. Automobiles, too, were placing new demands on the system. The rallying cry to "get the farmer out of the mud" was heard. Despite the acknowledged need, Hunterdon lagged behind more urban counties in the state in constructing and re-surfacing roads. Between 1910 and 1915, the impoverished county borrowed \$315,000 to resurface its roads (Cunningham, p. 37), and by 1922, there were 60 miles of county macadam roads. State aid to townships beginning in 1916 helped complete routes. Hunterdon, lacking in any large cities, found the expense of road construction to be burdensome. In 1924, Hunterdon State Senator David Agans secured passage of an act allowing the state with federal aid to take over the main north-south route in Hunterdon (portions of current NJ 31), as well as roads from Ringoes to Lambertville and from Flemington to White House. In 1925, the road from Flemington to Ringoes became the first concrete highway in the county (Schmidt 1945:167-168). In 1930, 150 miles of roadway in Hunterdon County was macadamized, and by 1944, the figure was boosted to 200 miles. In 1938 the county built its first and only surviving rigid frame bridge

(100028); other bridges were improved or replaced with the steel stringer, with and without encasement, being the most commonly used post-World War I bridge type in the county. The most distinguished county-built example of an encased stringer bridge is County Route 523 over Mine Brook (1000016) built in 1934 with funds from federal Depression-era work relief programs. Located on what was the main road into Flemington, the county seat, the bridge was enhanced with rubble-coursed fieldstone parapets and spandrel walls. It is also fitted with planters and ornamental lighting and reflects the "city beautiful" philosophy which encouraged making utilitarian structures, like bridges, attractive civic amenities. While not technologically innovative, the span reflects civic attitudes and pride.

Interestingly, enthusiasm for the newer construction material of reinforced concrete did not overwhelm the metal truss bridge. Over ten pony truss bridges built in the decades of the 1920s and 1930s were evaluated, and Hunterdon County appears to have continued to build pony truss bridges in the 1940s.

Identified contractors for the county-designed bridges were primarily local firms, including William Schaaf of Baptistown, F.R. Lee of Whitehouse, Snook & Sons, Snook Brothers, Stout & Crate, Thompson & Drumm, Sutton & Ernest, C.A.Sharp & Son, and Delta Construction.

Over 25 bridges designed by the New Jersey State Highway Department Bridge Division were built in the county in the years between the world wars, and all were standard types and designs with concrete-encased steel stringers and concrete deck arches predominating. They are indistinguishable from state-designed and funded bridges in other sections of New Jersey.

In summary, Hunterdon County has an embarrassment of riches in the bridges surveyed. Stone arches, a wooden covered bridge, cast and wrought iron truss bridges, thru truss bridges, and pony truss bridges continue to carry traffic. Hunterdon is unique in the state for the number of surviving metal truss bridges. These bridges record the history of metal truss technology from the experimental use of cast and wrought iron, hybrid designs, and Phoenix sections through standardized designs. The survival of these bridges is due to the sustained agrarian culture of Hunterdon, delayed population growth, the high level of interest in preservation, and concern for the environment found among its residents.

Hunterdon County now has over 1,100 miles of roadway. Six state and federal highways traverse the county. A rapid growth in population coupled with the increasing urbanization of the countryside since 1960 has brought dramatic changes. The construction of corporate and research facilities for large companies have drawn white collar workers to the county. Housing in Hunterdon County was comparatively inexpensive through the 1970s and thus encouraged the development of bedroom communities. Construction of Interstate 78 provided easy access from the New York metropolitan areas, furthering Hunterdon's appeal. Population figures reflect the change in the character of the county; in 1960, the

census recorded a population of 54,107 for the county, while in 1989 the population was estimated to be 114,592 (Stevens 1989:86).

This dramatic increase in population places the winding county roads and one-lane metal truss bridges at risk. Offsetting the impact of increased population, however, is the value which Hunterdon residents place on the rural charm of the countryside. Careful planning has left Hunterdon, among the highest-income counties in the state, with over seventy per cent open space. Agriculture remains a major industry producing soybeans, sheep and lambs, and grain corn (Wood 1981:10-11). Tranquil country roads are still plentiful.

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MERCER COUNTY BRIDGE HISTORY NARRATIVE

Mercer County was established in 1838 from portions of Hunterdon, Somerset, Burlington, and Middlesex counties. Trenton, also the county seat, was fixed as the state capital in 1790. Historical development within the county, however, goes back to the earliest days of exploration and settlement of the region. The Dutch explored the Delaware River in the early 1600s, and by mid-century, English settlers, both Quakers and Episcopalians, had established settlements in the area. Nottingham (Hamilton) was the earliest, established "from Crosswicks up as far as present settlement" in 1688, followed by Maidenhead (Lawrence) in 1697 and Hopewell in 1700. In 1714, successful Philadelphia merchant and statesman William Trent purchased the Mahlon Stacy tract at the falls of the Delaware River because he recognized the potential of its location on the great road between what were developing as the major cities in the region, New York and Philadelphia. Trent built a home and moved to the small settlement, which would later bear his name, in 1721. His assessment of the site was correct as Trenton went on to become one of the leading manufacturing centers in the country based on its location and the confluence of transportation networks.

Mercer County ranks with Hudson County as being the political entity whose development and history were most directly shaped by transportation. Because of its location at the falls of the Delaware River, Trenton from the earliest days was a natural site for a river crossing. Just as New Jersey is the link between the two great colonial centers of New York and Philadelphia, Mercer County was important as the western instate terminus of the great road between them. The Kings Highway passed into the county at Kingston, then on to Princeton, location of the College of New Jersey, or Princeton, since 1756, Lawrenceville, and into Trenton where the river was crossed by ferry. So significant was Trenton in the development of early transportation networks that the first bridge across the Delaware River was built there in 1806. Trenton would remain the southernmost crossing of the river until the completion of the Delran railroad bridge by the Pennsylvania Railroad in 1896. A vehicle or pedestrian bridge south of Trenton was not opened until the completion of the Ben Franklin Bridge between Camden and Philadelphia in 1926.

But more significant to the overall development of the county than the bridges at Trenton was the overlay of internal improvements that dominated the first half of the 19th century. First came the turnpikes, the privately financed toll roads that appeared in the early 1800s. Since it was the state capital and was the site of the first bridge over the river, Trenton was the terminus for quite a few turnpikes, like the 1804 Trenton-New Brunswick Straight Turnpike (present US 1) and the 1808 Trenton & Bordentown Turnpike. The historic pattern of highways converging on Trenton like spokes connected to a hub is clearly maintained today as the old, historic routes have been incorporated into the modern road network. Several of the state highways, like NJ 29 and NJ 33, were historic trails converted to vehicular use and taken over as part of the state system after 1917.

While the new roads and the advent of stage service improved overland travel, movement of materials and goods was primarily still restricted to navigable waterways. Such limitations were eliminated with the completion in 1825 and the successful operation of the Erie Canal, which linked New York City with the rich farmland of the midwest. Much of the impetus to build canals in New Jersey was a response to the desire to move anthracite coal out of northeastern Pennsylvania to the New York and Philadelphia markets.

Because of its location on the impassable falls on the Delaware River, Trenton became an important port on the Delaware and Raritan Canal that was built between 1832 and 1838. The main canal linked New Brunswick at the mouth of the Raritan River and Bordentown, some 12 miles south of Trenton on the Delaware River. A feeder canal was built parallel to the Delaware River from Raven Rock in Hunterdon County, through Lambertville and Somerset (Ewing) into Trenton proper and joined to the main canal near the Perry Street train yard in downtown Trenton. Simultaneous with the chartering and building of the canal was the advent of the railroad. Instead of favoring the interest of one group over the other, the state legislature chartered both the railroad and the canal as a joint company, and while their routes from Bordentown across the state somewhat paralleled one another, it was the railroad that would have the greatest impact on the development of both Mercer County and the state. But, early on, it was the canal that stimulated antebellum development in Mercer County. Settlements such as Port Mercer, Port Windsor, and even Princeton grew and prospered from canal-stimulated trade.

Trenton was particularly well positioned to capitalize on both transportation networks. Although the initial line of the Camden & Amboy Railroad did not come into Trenton proper until after 1840, the city would become an important stop and market on major interstate routes. The Camden & Amboy Railroad built the Belvidere & Delaware Railroad between Trenton and Warren County in 1856, and the Philadelphia & Reading line constructed a spur from its main New York to Philadelphia line in 1876. The railroads sought out the Trenton market because of its location and the confluence of a myriad of transportation networks (natural waterways, highways, canals, and railroads) made it a logical location for industry.

In marked contrast to the rest of the county, which remained decidedly agricultural well into the middle of the 20th century, Trenton developed into a manufacturing center of national prominence. It was noted for its iron, steel, pottery, wire rope, rubber, and sanitary and electrical porcelain. One important reason those industries located in Trenton was because of transportation and thus accessibility to raw materials and markets. The pottery industry found the underlying clay in the central portion of the state to its advantage, and the coal to fire kilns was brought in via the canal and railroads. Peter Cooper, who established the Trenton Iron Works (later New Jersey Steel & Iron Company) in the Chambersburg section in 1847, did so because of the good transportation for his raw materials (iron from Warren County and coal from eastern Pennsylvania) and his finished products, which included the first rolled 7" I beams in the country and the first American Sieman-Martin open-hearth

process steel. Cooper encouraged John A. Roebling to locate his wire rope facility in Trenton for the same reasons.

Throughout the rest of the 19th century and into the early decades of the 20th century, the railroads expanded and improved their Trenton operations to better serve the industrial and passenger needs of the area. The Pennsylvania Railroad built the present multi-span stone arch bridge across the Delaware River and improved its right-of-way through Trenton in 1903. Its main line electrified in Mercer County in 1933.

This historical development is clearly reflected through the old bridges that remain in the county. The earliest extant spans represent the Colonial era when the great road or Kings Highway was the principal overland route. The multi-span stone arch bridge that carries the historic Kings Highway over Stony Brook between Princeton and Lawrenceville (1129155) was built in 1792, and although after the colonial era, it is part of an early and important regional thoroughfare. Interestingly, the old right-of-way itself is so significant that the road, which dates to the earliest days of settlement in the county, was designated as the Lincoln Highway and then made part of the state highway system.

The stone arch is the earliest bridge technology represented in the county although it is not the earliest used. Those were timber bridges, but, owing to their material and construction techniques, they were susceptible to deterioration and washout. As areas grew in size and prominence, timber bridges were frequently replaced with stone arch spans that offered permanence and less maintenance. Colonial and early republic records are laced with accounts of citizens pushing for stone arch bridges to replace timber spans lost in freshnets or through deterioration. One example of such action is Trenton's Broad Street crossing of Assunpink Creek at what was the boundary between Hunterdon and Burlington counties (1100002). The rude timber bridge that separated Trenton from Nottingham was repeatedly being lost in spring freshnets. A stone arch bridge was initially built there in 1774 as a "permanent" solution to the problem. However well-intentioned the early stone arch bridge was, it too was lost in a freshnet in 1822 as was its in kind replacement in 1843. The present stone arch bridge was put up in 1843, and it ranks as the oldest bridge in Trenton proper.

Turnpikes, privately financed toll roads built by companies chartered by the state legislature, played an important role in the expansion and improvement of county roadways beginning in 1801. Although seldom profitable, the turnpikes, like the Princeton & Kingston Branch Turnpike Company that ran along Princeton Avenue up to Princeton and joined the old road in Kingston, were frequently developed with permanent stone-arch bridges. Spans like the multi-span stone arch bridge that carries Princeton Pike over Stony Brook in Princeton Township (1100005) illustrate both the proliferation and impact of early-19th century toll roads on the present county infrastructure.

The canal era is also represented through stone arch technology. Two impressive stone-arch viaducts that were built as original (1832-1834) elements of the canal feeder remain in Ewing and Hopewell townships (1110152, 1110158). They carry the canal and towpath

over creeks. Both viaducts have been widened to accommodate later transportation networks (the Belvidere-Delaware Railroad on the river side and River Road or NJ 29 on the upstream side), but the original stone arch construction is visible from the underside.

Mercer County has an impressive assemblage of stone arch bridges built to meet the engineering needs of three types of transportation; non-toll highways, turnpikes, and canals. Another stone arch span, the S. Clinton Avenue bridge (1100052) was altered to accommodate the railroad. A total of 11 survive, and of that total, nine were built between 1792 and 1873. Two others appear to be from the 19th century, but their original date of construction is not documented (1105150, 1115150). Four of the 11 stone arch bridges were built in Trenton between 1843 and 1873 (1100053, 1100002, 1100051, 1100052), and three of them, Montgomery Street, S. Clinton Avenue, and East State Street, were designed by Trenton's leading architect of the day, Henry E. Finch.

Truss bridges played a significant role in the improvement and/or expansion of transportation networks in the county. The earliest truss bridges were the wood and wood and iron arch-truss spans built across the Delaware River between 1804 and 1860. They replaced ferries. Although none survive, these early bridges, like Theodore Burr's 5-span tied arch built between 1804-1806, are important in appreciating the existing road pattern in the county as the Delaware River crossings are the major reason transportation networks converge on Trenton. Burr's 1804-1806 bridge was later converted to rail use, and it continued in service until 1865.

Metal truss bridge technology came into its own in the 1860s and 1870s. Advances in engineering and metallurgy as well as a proliferation of bridge fabricating companies made the new technology readily available to the county freeholders during the last third of the 19th century. The excellent bridge records maintained by the Mercer County Engineer illustrate that the county was erecting metal truss bridges, like Mosely bowstring pony truss spans, in the 1870s. Once a common county type that figured prominently in the improvement of county roads, only 11 metal truss bridges survive in the county, and all but one of them are limited to pedestrian use or are located on lightly travelled roads. The exception is the 1891 pin-connected double-intersection Pratt thru truss bridge at S. Clinton Avenue over Amtrak in Trenton proper (1149162). Five are thru truss spans built between 1882 and 1896, and six are pony truss spans that are evenly divided between Pratts and Warrens. Those whose history is documented are all examples of the work of local and national bridge fabricating companies who marketed their products to the freeholders through agents.

The 1880s and 1890s were a period of experimentation and evolution in metal truss bridge design and construction, and this characteristic is reflected in some of the surviving metal truss spans in Mercer County. There is variety of truss type and construction details. Because some of the bridges are relatively early examples of their type, like the King Iron and Manufacturing Company Pratt thru truss spans built 1882 and 1885 respectively (1100060, 1100072) and the ca. 1882 Wrought Iron Bridge Company pony truss bridge on

Groveville-Allentown Road in Hamilton Township (1100028), they have details that make them technologically significant. The out-of-phase floor beam verticals and prong-like connectors on the two King bridges are details that are not found on later spans, and the patented T section used for the verticals on the Groveville-Allentown Road bridges is a rear early detail. The 1896 Ward Avenue Bridge in Hightstown (1100034), fabricated by Trenton's New Jersey Steel and Iron Company, is an early example of an uncommon truss type, the double-intersection Warren. The 1891 S. Clinton Avenue bridge derives its engineering significance from the fact that it is a skewed double-intersection Pratt truss with pinned field connections.

With the exception of the Groveville-Allentown Road span, the pony truss spans exhibit fewer unusual details. The Province Line Road Warren pony truss bridge (1105302) and the pin-connected Pratt half-hip span on Hunter Road at Howell farm in Hopewell (1100068) are distinguished for their completeness of setting and integrity of original design.

Concrete bridge technology is not well represented in Mercer County. Developed in the late 1890s, and enthusiastically embraced in many areas in the early 1900s, arch and slab bridges or reinforced concrete were an alternative to metal truss technology. Only two reinforced concrete arch bridges survive in the county (1100021, 1129153). The largest use of slab bridges was the 1916-1920 Delaware & Raritan Canal Feeder abandonment project of the Pennsylvania Railroad. The company built low-rise slab spans to replace its many movable bridges over the feeder in Trenton and Ewing.

Less than 10 highway bridges built between 1900 and 1918 survive. This is attributed in part to (1) the reliance on rail for movement of heavy loads until World War I and (2) the fact that many roads in the county were taken into the state highway system after 1917 and subsequently upgraded. It was this upgrading of crossings with substandard metal truss bridges that resulted in their preservation. Three pony truss bridges, Fackler Road (1154319), Groveville-Allentown Road (1100028), and Iron Bridge Road (1106704), were either salvaged from upgraded crossings or were bypassed by realigned section of highway in the 1920s.

The bridge type that is best represented in the county, on both county and state-system roads, is the concrete-encased rolled stringer span. The earliest surviving stringer bridges have jack arches between the stringers to evenly distribute the live-load and to support the deck. Both the 1889 Ewingville Road span (1100012) with brick jack arches and the 1905 CR 518 span (1100040) with concrete jack arches have been significantly altered, but they illustrate how early the rolled stringer bridge type was used in the county. An early example of an encased stringer is the 1907 Whitehead Road over Assunpink Creek bridge adjacent to the historic Whitehead Rubber plant in Trenton (1100066).

The encased stringer came into its own after World War I, and it became the favorite bridge type of the State, which was improving many state routes in the county, and the

county itself. Harry Kersey, County Bridge Engineer from at least 1925 until after 1941, used it almost exclusively in the era between the two world wars. The 1931 example at Clarksville Road in Grovers Mill (1100032) is finished in typical fashion with well proportioned concrete balustrades and is a representative example of the county design. State Bridge Engineer Morris Goodkind preferred the encased rolled I-beam stringer, and it is ubiquitous on state routes. Of the 111 pre-1946 bridges in Mercer County, 46, or nearly 42% of the total, are stringer bridges built between 1907 and 1938.

The 20th century bridge that best represents the presence of the railroad in the county is the plate girder bridge, both the deck and thru designs. Of the 20 deck and thru girder bridges built in the county between 1911 and 1942, 15 are railroad related (carrying either highway over rail or rail over highway). The girder was the favored bridge type for spans of 75'-100' because of its economy, rigidity, and ease of erection. It was used extensively for railroad grade-crossing eliminations from the 1890s on. Thru girder bridges were also used in highway applications like the 1922 span that carries Nottingham Way over Assunpink Creek in Trenton (1100057).

In summary, Mercer County has a strong legacy of historic bridge types spanning three centuries. Most impressive is its assemblage of 18th- and 19th-century stone arch bridges that chronicle the early transportation networks in the county. Owing to the convergence of several transportation systems (highway, canal, railroad), Trenton may well have more bridges than any other city in the state.

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MIDDLESEX COUNTY TRANSPORTATION HISTORY OVERVIEW

Middlesex County's transportation history has been shaped by its geographic position straddling the major historic routes between Philadelphia and New York City. From the colonial period to the present, the necessity of providing through connections to an ever growing number of travelers has placed the county at the forefront of New Jersey's transportation improvements and among the first to benefit from turnpikes, canals, railroads, and superhighways. Bridges have played a vital role in Middlesex's evolving transportation systems. The single largest geographic feature spanned by bridges is the Raritan River, which flowing from its fall line in the west to Raritan Bay in the east divides the county in two. The Raritan River has provided engineers significant challenges and prompted the construction of several of the state's longest span and most technologically distinguished bridges. Local traffic patterns have also influenced the location and construction of Middlesex County bridges. The landscape varies from rural in the south, to suburban in the northern communities, and to urban in New Brunswick and Perth Amboy. The numerous bridges carrying local roads and streets are similar in age and style to those found in like areas throughout New Jersey, although rapid growth has wiped out, with few exceptions, most of the county's pre-1900 spans.

New Jersey's colonial period was notable in the history of Middlesex County's transportation development for establishing the pattern of through travel from the Raritan River to the Delaware River. As early as the mid-17th century, Dutch traders discovered the Lenni Lenape's Assunpink Trail between the sites of present-day New Brunswick and Trenton. The trail, which followed much the same direction as present-day route NJ 27, was the first overland road across New Jersey's narrow waist, and by the beginning of the 18th century the trail had been improved for horses, wagons, and carriages passing between East and West Jersey. A branch of the road cut off southwest of New Brunswick for Burlington. In 1681 John Inian established the first ferry across the Raritan River near the present location of the Albany Street bridge (1217150, New Brunswick City) (Lane, pp. 16-17,38-39; Cunningham, p. 131).

Despite the Assunpink Trail's significance as an overland road, New Jersey's colonists remained reliant upon water transportation for most long distance travel and haulage. Early settlements such as New Brunswick, Perth Amboy, Woodbridge, and South River in Middlesex County were determined by their location bordering navigable streams such as the Raritan River, Arthur Kill, and their tributaries. Perth Amboy, in particular, was chosen as East Jersey's provincial capital because of its strategic location on Raritan Bay, and for most of the colonial period, it ranked as one of East Jersey's most significant ports of entry. In the early 1700s colonists spread out across the remaining portions of Middlesex County establishing farms and small villages. From 1705 to 1713 county road surveyors laid out no less than 35 different roads, most of which connected outlying communities with the locally important towns. Many of the road and bridge rights-of-way established in the colonial period remain in use to this day (Wall and Pickersgill, p. 75).

Throughout the 18th century economic forces were at work that made Philadelphia and New York City the centers of Great Britain's North American empire. In northern New Jersey overland trade routes between the two cities converged upon the rivers and bays such as the Raritan where shipment might be made by water across New York Harbor. By the mid-1700s the provincial government had established several alternative roads crossing New Jersey's midsection that served to foster rival stage and freight lines. All of the highways crossed sections of Middlesex County, and in addition to the old Assunpink Trail (Trenton-New Brunswick, NJ 27) included the King's Highway (Perth Amboy-Burlington Road) and the Old York Road crossing from the Delaware River above Trenton to Bound Brook (Somerset County) with branches to Perth Amboy and Elizabethtown (Union County) (Lane, pp. 50-51).

In colonial Middlesex County, as throughout all of colonial New Jersey, local officials directed the construction of roads and bridges. In most instances, smaller streams were forded and simple timber bridges built where necessary, although occasional allowances were made for more expensive stone arch bridges at heavily traveled crossings (Clayton, p. 562). Ferries crossed the Raritan River at several locations and prefigured the later establishment of bridges. In addition to the previously mentioned Inian's Ferry at New Brunswick, by 1716 ferries were in operation between Perth Amboy and Staten Island, New York, and from Perth Amboy to South Amboy (Wall and Pickersgill, p. 76). The earliest documented bridge to span the Raritan River in Middlesex County was the 1772 Raritan Landing bridge about two miles upstream from New Brunswick. The bridge, according to Brydon (p. 117), was the earliest covered bridge on record in New Jersey. It was destroyed by fire in 1894. In 1895 the covered bridge was replaced by a three span through truss, which itself was demolished in September 1991.

By the 1790s Middlesex County's highways, ferries, and bridges were no longer adequate for the increasing amounts of through traffic on the cross-state routes. Most local communities simply lacked the resources to keep up with maintaining the dirt roads for the convenience of through stages and freighters. An additional consideration was delays on the voyage between the Raritan River and New York City because of unfavorable tides, winds, and weather. An answer, in part, to the problems was the improvement of the New Brunswick-Newark Road, which connected to shorter ferry trips across New York Harbor from Newark (Essex County) and Paulus Hook (Hudson County). In 1795 the route was greatly improved with the completion of the first Albany Street bridge over the Raritan River at New Brunswick, a 14-span timber structure with masonry piers and a draw, a predecessor span to the extant 1893 Albany Street Bridge (1217150, New Brunswick City). The 1795 toll bridge proprietors received a state charter giving them exclusive rights to build a bridge over the Raritan River from Raritan Landing to Lawrence's Brook, a decision which in the mid-1830s temporarily blocked the New Jersey Railroad's efforts to span the river in the vicinity of New Brunswick. The Albany Avenue bridge was not taken over as a free bridge by the County Freeholders until 1875 (Lane, p. 125-126; Benedict, pp. 55-61).

The successful completion of privately-chartered toll bridges, like the Albany Street span, contributed to the New Jersey legislature's decision in the early 1800s to charter turnpike companies to own, operate, and maintain the state's most significant through roads (Lane, pp. 123-128). New Jersey's turnpike era was part of a national trend to improve internal communications, and the turnpikes were the first attempt to build relatively direct and well-surfaced roads between major towns and markets. Middlesex County's key geographic position on cross-state routes and its heavy density of traffic made it one of the most attractive locations to establish turnpikes. Between 1804 and 1816 no less than seven turnpike companies started operations in Middlesex, while numerous others were projected but never chartered or financed (Gordon, pp. 17-18).

The county's prominent turnpike companies were on the Philadelphia to New York corridor. The first, and perhaps most noteworthy, was the Trenton and New Brunswick Straight Turnpike (1804) that followed a straight-line path over the relatively flat terrain between the Delaware and Raritan Rivers and bypassed the old Assunpink Trail (NJ 27). Most through traffic immediately switched to the new turnpike. Alarmed citizens of bypassed towns formed their own turnpike companies, like the 1807 Princeton and Kingston Branch Turnpike, to improve portions of the old road and recapture some of its traffic. Still, the Trenton and New Brunswick Straight Turnpike proved so popular that to this day its original right-of-way is still largely followed by the route of US 1 (Lane, pp. 150-151).

Turnpikes like the Trenton and New Brunswick Straight Turnpike that constituted entirely new rights-of-way were relatively unusual. Most turnpike companies took over and repaired already existing roads as a means of reducing costs and eliminating competition from public roads. The 1806 New Jersey Turnpike (present Easton Avenue) passing through Somerset, Hunterdon, and Warren counties was the southernmost of several turnpikes designed to tap into the western trade of grain, beef, wool, iron, and coal, and the only significant turnpike in Middlesex County not on the southwest to northeast Philadelphia to New York route (Doughty, pp. 102-103). Other turnpikes in Middlesex County included the Essex and Middlesex Turnpike (1806, present NJ 27 north of New Brunswick) that improved the New Brunswick to Newark road and connected with the Trenton and New Brunswick Turnpike at the Albany Street bridge in New Brunswick; the Perth Amboy Turnpike (1808, present Amboy Avenue); the Bordentown and South Amboy Turnpike (1816, present Bordentown-Amboy Turnpike); and the Woodbridge Turnpike (1816, present Woodbridge Avenue).

In the 1810s the addition of convenient connections from turnpike stages to steamboats, faster and less hampered by wind and tide than sailing vessels, rejuvenated interest in the water routes from the Raritan River at New Brunswick and South Amboy to New York. For many years the steamboats remained a favored way of travel for many passengers (Gordon, pp. 17-18, Lane, pp. 148-149, 194-209).

Turnpike companies often rebuilt or replaced worn out or inadequate bridges. As in earlier periods, bridges were mostly simple timber construction, but occasionally turnpikes

expended funds for stone arch spans. In 1823 the New Jersey Turnpike Company constructed the Easton Avenue bridge (123B171, New Brunswick City), a 22'-span coursed ashlar barrel arch. The bridge, exceptionally well-preserved for its age, is the only remaining turnpike bridge in Middlesex County, and one of only a small handful of early-19th century turnpike-built bridges in New Jersey.

After the first quarter of the 19th century, several factors contributed to declining enthusiasm for turnpikes, including high maintenance costs, the failure to draw anticipated volumes of traffic in less populated areas, and most importantly competition from canals and railroads. In Middlesex County the level of travel between New York and Philadelphia made the county's turnpikes among the few in New Jersey to survive into the late-19th century despite parallel railroad services that bankrupted formerly prosperous stage lines. Nonetheless, the county's turnpikes after the 1830s entered a fifty year period of falling revenues that eventually led to abandonment and public take over. Despite their financial failure, the former turnpikes were among the first to be rebuilt in highway improvement campaigns in the early 20th century. At least eight Middlesex County bridges, although dating to the post-1900 period of highway construction, span streams over rights-of-way developed in the early 19th century by turnpike companies (Durrenberger, pp. 159-163; Lane, pp. 168-169).

Middlesex was among the first of New Jersey's counties to benefit directly from canals and railroads. As with turnpikes, the Philadelphia to New York routes were attractive for the development of new transportation technologies and warranted the type of large-scale investment and construction that accompanied canals and railroads. Competing business groups lobbied the Legislature for charters and loans causing a political impasse. As a result, a compromise was struck to jointly finance the Delaware and Raritan Canal and the Camden and Amboy Railroad, each holding monopolies on traffic across the state's midsection (Veit, pp. 22-23; Lane, pp. 253-263).

From the early 1830s to 1860s the Delaware and Raritan Canal and Camden and Amboy Railroad were the leading factors in the county's growth as a transportation and industrial center. The 44-mile long canal, completed from 1832 to 1834, connected Trenton and New Brunswick and specialized in the movement of coal between Pennsylvania's Delaware Valley and northern New Jersey (Lane, pp. 263-266). Only two miles of the Delaware and Raritan Canal bordering the Raritan River actually passed through Middlesex County, but its New Brunswick canal basin was arguably the most important transshipment point on the route. New Brunswick prospered from its strategic geographic position that gave it easy access to the canal, as well as turnpike roads and a navigable river. Artisans and merchants not only specialized in traditional industries such as textiles, shoes, and ironwork, but branched off into new areas such as rubber goods (Cunningham, p. 136).

The Delaware and Raritan Canal, 7' deep and 75' wide, was a large scale engineering accomplishment but level topography minimized the number of locks and stone arch aqueducts. None of the original pivot bridges that carried roads over the canal survive. The

canal reached its peak of operation in the 1860s, and in the 1870s traffic volumes decreased rapidly as railroads took over the canal's coal hauling functions. Finally, in 1934 the canal was placed in state receivership and as part of the abandonment large portions were incorporated into the regional water supply systems and as part of state and municipal parks. Two surveyed county bridges span the National Register listed canal right-of-way (1217150 and 3000169, New Brunswick City), but neither are directly related to the canal's construction or historically significant period of operation (Lane, pp. 262-265; Veit, p. 83).

In early 1833 when the Camden and Amboy Railroad opened its line from Bordentown (Burlington County) to South Amboy few foresaw the wide-ranging impact railroads would have on the future of New Jersey. If the 110,000 passengers the Camden and Amboy carried in its first full year of operation were any indication, however, one might have accurately predicted that within 50 years railroads would reach into every corner of the state to carry every type of passenger and freight. The Camden and Amboy's spectacular success at first may have been due to its value as a technological curiosity at a time when few had seen steam-powered locomotives. But it soon became clear that railroads offered greater capacity, speed, and directness over highway travel. The Camden and Amboy had a further advantage in its state-chartered monopoly of the Philadelphia to New York route through the heart of Middlesex County. The Camden and Amboy's early period of development was not plagued by insurmountable financial and technical difficulties because it could rely upon a steady stream of traffic between the nation's two largest cities (Lane, pp. 293-296).

The Camden and Amboy Railroad proved the economic viability of railroading in New Jersey. The Legislature chartered other railroads, but few initially enjoyed the same level of success. Throughout the antebellum period the Camden and Amboy jealously guarded its route in Middlesex County, and used its financial and political power to improve its Philadelphia and New York connections. In 1838 the New Jersey Railroad completed a line connecting Jersey City and New Brunswick via Newark. The Camden and Amboy entered into a favorable traffic sharing agreement with the New Jersey Railroad and in 1839-40 built a second line connecting end-on with the New Jersey Railroad in New Brunswick and continuing south to Trenton. The 1838 New Jersey Railroad bridge over the Raritan River at New Brunswick was a remarkable double-decker Long truss carrying railroad traffic above its top chord and highway traffic below. The bridge stood at the site of the present Amtrak Northeast Corridor (Pennsylvania Railroad) bridge (Brydon, pp. 117-118). In 1840 with the addition of the Philadelphia and Trenton Railroad's route in southeast Pennsylvania, the Camden and Amboy inaugurated the first all-rail service from Philadelphia to Jersey City (Burgess and Kennedy, pp. 241-263; Lane, pp. 293-296).

The Camden and Amboy Railroad stimulated agriculture and industry along the length of its lines. Most startling was the growth of commercial agriculture in southern Middlesex where farmers shipped thousands of tons of produce to the New York and Philadelphia markets. Several small towns raised the necessary capital to build short branch lines to

connect with the Camden and Amboy including the Freehold and Jamesburg Railroad (1851) from Freehold (Monmouth County) to Jamesburg and Monmouth Junction, and the Millstone and New Brunswick Railroad (1854) from East Millstone (Somerset County) to just southwest of New Brunswick. New roads such as Station Road in Cranbury Township were built to connect local communities with depots, while other communities such as Jamesburg and Monmouth Junction (formerly Dean's Pond) grew to local prominence because of their location on the Camden and Amboy's lines (Lane, p. 392-394; Clayton, pp. 868-869).

After the Civil War, the character of railroad operations in Middlesex County and the rest of New Jersey changed with the construction of integrated rail networks with regional and even national connections. In 1871 the Pennsylvania Railroad purchased the Camden and Amboy, New Jersey Railroad, and their branch lines as part of an ongoing expansion that would eventually give it control of routes from New York City to the Midwest. The Pennsylvania Railroad greatly improved the Camden and Amboy facilities, realigning and multiple tracking the line, and replacing the Raritan River double deck wood truss bridge with a stone arch bridge capable of carrying heavier locomotives and freight (Flagg, p. 1).

More significant to changing patterns of transportation in the county were rail lines built by the Lehigh Valley Railroad, Philadelphia and Reading Railroad, and the Central Railroad of New Jersey. In 1871 the Lehigh Valley Railroad originating in Pennsylvania's anthracite coal region decided to build a route across New Jersey to New York Harbor for the purposes of distributing coal to the New York markets. The line, chartered in New Jersey under the name of the Easton and Amboy Railroad and opened in 1875, cut across the northern part of the county from Bound Brook (Somerset County) to Perth Amboy. The railroad constructed a substantial waterfront terminal and transformed the sleepy Middlesex County town into a bustling industrial city (Cunningham, p. 138). In 1886-88 the line built an extension from South Plainfield to Jersey City (Hudson County), and afterwards devoted its Perth Amboy terminals to coal (Archer, pp. 104-110). In addition to the Lehigh Valley's terminals in Perth Amboy and the Pennsylvania Railroad's terminals in South Amboy, in 1878 the Philadelphia and Reading Railroad constructed a 20 mile branch line from Bound Brook to the Arthur Kill at Port Reading in Woodbridge Township. As with the Lehigh Valley, the terminals transferred coal and freight to boats for points around New York Harbor (Holton, p. 308). The rail lines accelerated industrial growth in the county leading to the construction and expansion of brick works, copper refineries, rubber works, and munitions factories (Cunningham, pp. 138-139).

The suburbanization of northern Middlesex County dated from the decades after the Civil War. With faster trains, separation of freight and slower passenger-service lines, and improved connections, middle-class families moved outward from cities to found new residential communities away from crowds and pollution. From the late 1870s through the 1910s northern Middlesex County was at the outer ring of northern New Jersey suburban development. Communities such as Dunellen and South Plainfield on the Central New Jersey's line crossing Middlesex County's northwest corner, and Colonia, Iselin, Menlo

Park, and Metuchen on the Pennsylvania Railroad's Main Line northeast of New Brunswick grew although not as quickly as suburbs in Union and Essex Counties (Clayton, p. 599; Cunningham, pp. 138-140).

Another significant development of the 1870s was the opening of rail lines through Middlesex County to Monmouth and Ocean County's growing shore resorts. The railroads played a leading role in the popularization of the Jersey Shore for vacations and recreation, and the most significant rail line from northern New Jersey was the New York and Long Branch Railroad opened in 1875 from Perth Amboy to Long Branch (Monmouth County). At Perth Amboy it made connections to branch lines of both the Pennsylvania Railroad and the Central New Jersey, and after 1883 the New York and Long Branch shared its tracks with trains of both railroads. The railroad offered superior service to the shore, and built the first bridge across the mouth of the Raritan River between the Amboys (Schmidt, pp. 39).

Railroads dominated Middlesex County's late-19th century transportation history, but not to the exclusion of highways. Throughout the 19th century the county freeholders led efforts to maintain roads and highway bridges, especially those routes that were vital links between local communities and rail stations. Prefabricated metal truss bridges were at their height of popularity during the period, and Middlesex County contracted with numerous bridge building companies for the purchase and erection of metal trusses, which often replaced worn out timber and masonry spans. Unfortunately, no 19th-century metal truss bridges survive in Middlesex County. All have been demolished and replaced in the 20th century as part of aggressive state and county bridge improvement campaigns.

Middlesex County's oldest surviving highway bridges date from the 1890s. The 1890 Albany Street Bridge (1217150, New Brunswick City) and the 1896 Main Street Bridge (124C105, Cranbury Township) are masonry arches, a popular bridge style throughout the 19th century. Neither bridge is technologically exceptional, and the Albany Street bridge although an impressive multiple-span structure has had extensive alterations and widenings. The Main Street bridge over Cranbury Brook is within the National Register-listed Cranbury Historic District, described as the "best preserved 19th century village in Middlesex County." The short, traditional masonry arch bridge is appropriate to the setting and a contributing resource (SHPO, National Register File: Middlesex County; Cranbury Historic District).

The first two decades of the 20th century marked the beginning of widespread changes to Middlesex County's roads and bridges. The introduction of the automobile and state-aid to local roads prompted counties throughout New Jersey to reexamine the administration and care of their highways. During this period most counties hired full-time college-trained engineers to oversee road and bridge improvements that included the hard surfacing of roadways and the introduction of new bridge materials and technologies. The survey evaluated eight county-built bridges dated 1900 to 1919 including three reinforced-concrete arch spans (e.g. 122B157, Raritan Avenue over Ambrose Brook, 1913, Middlesex Borough); three reinforced concrete slab spans (e.g. 124B079, Schalks Road over Devils

Brook, 1915, Plainsboro Township); one steel stringer span (124B090, Maple Avenue over Cranbury Brook, 1910, Plainsboro Township); and one steel pony truss span (125B055, Rue Road over Matchaponix Brook, 125B055, Monroe Township). The early 20th-century county bridges are representative examples of standard designs of similar age and type found throughout New Jersey. Only the c.1910 rivet-connected Warren pony truss Rue Road bridge (125B055, Monroe Township) warrants historical and technological distinction because it is the only example of its type and of the caisson-like piers in the county. Warren pony trusses were a popular short-span highway bridge type from about 1900 to 1920 but have become increasingly rare across the state.

After 1920 the county built standard steel-stringer and reinforced-concrete design bridges in increasing numbers. The State Highway Department took over major through routes allowing the county to focus on secondary roads and local streets. Road and bridge improvements were also part of county efforts to make the area an attractive place for residential developments and new large scale factories. Within the next 40 years available open spaces in the county's northern sections were largely taken over (Cunningham, p. 140).

The county government's post-1920 road and bridge building campaign is reflected by 28 medium to short-span county highway bridges identified in the Survey. Among the bridges are 16 steel stringer spans (e.g. 121B084, Gills Lane over South Branch of Rahway River, 1927, Woodbridge Township); five reinforced-concrete arch spans (e.g. 122B129, South Randolphville Road over Ambrose Brook, 1938, Piscataway Township); three reinforced-concrete slab spans (e.g. 125B131, Perrineville Road over Millstone Brook, 1934, Monroe Township); three thru girder spans (e.g. 122B137, New Market Road over Bound Brook, 1920, Piscataway Township); and one deck girder span (125B114, Buckelew Avenue over Manalapan Brook, 1926, Jamesburg Borough). The county's 1920s and 1930s highway bridges are representative of bridge types found throughout New Jersey and present no unusual or technologically noteworthy features.

Another category of bridges constructed in Middlesex County in the first decades of the 20th century were bridges eliminating grade crossings of railroads and public roads. In the 1900s New Jersey's railroads came under increased public pressure to ensure the safety of highway and rail travelers from collisions between locomotives and ever growing volumes of automobiles. The railroads undertook safety campaigns which included educating the public to "stop, look, and listen."

The earliest surviving grade separated crossing bridges in Middlesex County date from the 1900s and 1910s. Typical are the 1907 Monmouth Junction Road partially-encased thru girder bridge (1249163, South Brunswick Township) over the Amtrak's Northeast Corridor, the former Pennsylvania Railroad Main Line; and the 1912 Main Street encased stringer bridge (1251161, Sayreville Borough) over Conrail's Sayreville Secondary, the former Raritan River Railroad. An unusual bridge is the lattice-web deck girder span that carries Middlesex Avenue (NJ 27) over Conrail's Port Reading Branch, the former Philadelphia

and Reading Railroad (1218154, Metuchen Borough). The girder webs of the 1909 bridge are constructed of diagonally-riveted angle sections, a characteristic seen more frequently in late-19th century girder spans as opposed to 20th-century girder spans which usually employed steel plate webs.

The First World War represented a watershed in New Jersey's transportation history. After the war public policy shifted from railroads to meeting the demands of the automobile through increased state aid for county highways and more significantly the construction of an integrated system of state highways. Much of the pioneering legislation for a state highway system and a state highways department was created prior to World War I, but funding and construction activities did not reach full stride until the mid-1920s. By 1926 the State Highway Department had taken over Route 1 from Rahway (Union County) to New Brunswick (present NJ 27 north of New Brunswick); Route 4 from Rahway to the shore via the Amboys (present portions of NJ 35 and US 9) and Route 13 from New Brunswick to Trenton (present NJ 27 south of New Brunswick). Prior to 1925 improvements to the state highways consisted mainly of hard surfacing, and bridge construction was not a significant component of the work (NJ State Hwy. Comm., 1926, pp. 11-12).

After World War I, Americans took to the highways in unprecedented numbers. Trucks, buses, and cars offered an alternative to railway travel that appealed to America's sense of individualism. Local patterns of travel became more complex as Middlesex County residents drove longer distances to reach work, schools, and stores. Northern Middlesex County saw the beginnings of widespread suburbanization as a result of commuters no longer depending upon rail connections to reach work. The automobile allowed residents to move further from rail lines and still receive the same level of services. Patterns of through travel in the county still followed the Philadelphia-New York and the North Jersey-Jersey Shore routes, but the rising volumes of traffic soon exceeded the capacity of the new state highways, which in most cases followed rights-of-way little changed since the 18th and early-19th centuries. In Middlesex County, for instance, summer holiday traffic to the Jersey Shore on Route 4 increased from over 12,000 vehicles per day in 1921 to over 43,000 vehicles in 1926 (NJ State Hwy. Comm., 1926, plates 2 & 12).

A major problem in Middlesex County was that the state highways passed through the town centers on city streets. In 1926 the State Highway Engineer estimated that delays from congestion in New Brunswick and South Amboy cost travelers over four million dollars per year. A large portion of the Philadelphia-New York traffic still traveled sections of NJ 27 (old Routes 1 and 13). As early as 1912, the road had been included as part of the Lincoln Highway, a transcontinental route promoted by private automobile associations (Albion, p. 309). Portions of NJ 27 have been widened from two to four lanes but the highway retains much the same character it had in 1918 when the State Highway Department took over the route from the county. It has numerous intersections with city streets and passes through busy downtown New Brunswick. Five of eight bridges on NJ 27 date to before the First World War. The bridges, originally constructed by the county or the railroads, include a brick arch span (1217150, 1890, New Brunswick City); a reinforced-concrete arch span,

(1216158, 1904, South Brunswick Township); a lattice deck girder span (1218154, 1909, Metuchen Borough); a half thru girder span (1216161, 1903, New Brunswick City); and a thru girder span (1218153, 1914, Metuchen Borough). The wide variety of bridges illustrate the difficult task the first state bridge inspectors faced evaluating the adequacy of bridges taken over for state routes (NJ State Hwy. Comm., 1926, p. 5; NJDOT, 1988, pp. 113-118).

In 1926 the State Highway Department initiated plans to build superhighways that divided local from through traffic. After several years of careful study, officials of the Department believed this was the best means of easing congestion and meeting future traffic needs. Middlesex County's pivotal position on major cross-state routes placed it high on the Department's priority list, and State Highway Engineer William Sloan singled out New Brunswick and the Amboys as key trouble spots (State Hwy. Comm., 1926, p. 5). From 1926 to 1941 new highway and bridge construction in Middlesex County reached unprecedented levels buoyed by the infusion of New Deal works project funds in the 1930s. Routes built or significantly improved included portions of present-day US 1 (1928-1932); NJ 18 (1931-1933); US 130 (1934-1941); US 9 (1936-1941); and NJ 35 (1936-42). State Highway projects included 44 bridges, or over 40%, of the pre-1946 bridges evaluated in Middlesex County. A majority of the bridges are standard-designed encased steel stringer spans common to State Highways throughout New Jersey. Several bridges built over the Raritan River between 1926 and 1939 stand out as exceptional examples of highway engineering.

One of the first of the State Highway Department's bridge projects in Middlesex County was construction in 1926 of a new span over the Raritan River to connect the Amboys (NJ 35, 1223150, Perth Amboy City). The Raritan River crossing was a major bottleneck on old Route 4 (NJ 35) and especially prone to traffic jams during the peak summer vacation months when travelers headed to the beaches. The Victory Memorial Bridge, named to honor World War I veterans, measures just over one-half mile in length. The movable main span is a 360' cantilevered subdivided Warren thru truss swing span over the river's shipping lanes, while the approach spans are 16 deck girder spans and 36 concrete stringer spans. The swing span is center-bearing, meaning that it pivots by motor-driven rack and pinion gears upon a bearing situated at the middle of the center pier. The swing-span mechanism, which is exceptionally well-preserved, is representative of a type of movable bridge technology that reached its height from 1880 to 1910. Although a late example of its type, the Victory Memorial Bridge swing span is exceptional because of its long-span truss design, which ranks it as the largest swing span highway bridge in the state.

In 1929, the Route 1 open-spandrel reinforced concrete arch bridge (1203150) opened between New Brunswick City and Edison Township, and in 1939 the Edison Bridge (1209155) spanned the river between Woodbridge Township and Sayreville Borough. Both bridges reflected the State Highway Department's concern for separating local and through traffic patterns, and were part of superhighways that bypassed neighboring cities and towns offering shorter and quicker traveling times. The Route 1 span is a critical link for

highways between northern and southern New Jersey. The Edison Bridge (US 9), a high level multi-span deck girder bridge, crossed the Raritan River just upstream from the Victory Memorial Bridge. The high-level crossing eliminated time costly delays to automobile traffic from movable bridge openings and closings.

The Route 1 bridge, in particular, was one of the most technologically significant engineering accomplishments of the State Highway Department in the pre-WWII era. The bridge, completed in 1929 and dedicated to Morris Goodkind (1888-1968) in 1969, set the standard by which other state highway bridges were built and judged. The impressive 1902'-long bridge with its six reinforced-concrete open spandrel arches and nine closed-spandrel arches was the design of State Bridge Engineer Goodkind. The Goodkind Bridge with its graceful three-ribbed arches, classically-styled corner towers, concrete balustrades, and commemorative plaque met Goodkind's high criteria for excellence. From 1925 to 1955 he headed the Department's Bridge Division and insisted upon structurally-sound bridges that also had aesthetically pleasing designs. From 1930 to 1939 approximately ten additional open spandrel arch bridges were built over major river crossings in northern New Jersey including in Middlesex County NJ 18 over Lawrence Brook (1213150, 1931, East Brunswick Township).

Under Goodkind's tenure the State Highway Department also received recognition for its highway grade separation and intersection projects. The state's traffic and bridge engineers worked out a variety of arrangements for ramps, underpasses, overpasses, and turns that served to promote the comfort, speed, and safety of vehicular transportation. Department engineers believed that properly designed grade separations could relieve from 80 to 90 per cent of all traffic from interference with crossing or merging traffic.

Again, Middlesex County's heavily traveled through routes were among the first state highways to receive the Department's attention. In Woodbridge the intersection of Route 4 (NJ 35) and Route 25 (US 1 & 9) was one of the busiest in the state, and in 1928 the State Highway Department constructed New Jersey's first four-leaf clover intersection, a design that set national standards of superhighway construction. The four-leaf clover intersection consisted of eight ramps and a single-span encased steel stringer bridge that carried US 1 & 9 over NJ 35 (1260164, Woodbridge Township).

Another noteworthy intersection was at the merger of US 9 and NJ 35 in South Amboy City. In 1936 the State Highway Department constructed a two-span encased steel stringer bridge (1208150, South Amboy City) to carry the two highways over the city's Main Street. A ramp carrying the southbound traffic of NJ 35 connects to the bridge, and an attractive feature is the continuation of the bridge's balustrade the length of the ramp. The bridge and ramp are representative of the grade separated intersections built throughout the state, yet what sets them among the best examples of their kind is an exceptionally successful and careful attention to decorative detail. Morris Goodkind in consultation with architect Arthur Lichtenberg regularly used the Moderne style to accent the state's bridges, even the common encased steel stringer overpasses. The US 9 and NJ 35 bridge is architecturally

rich with its square fluted pilasters, stylized consoles, and concrete balustrades with paneled posts. The bridge's and ramp's detailing and excellent state of preservation make them among the best of their age and type in New Jersey.

In the late 1930s and early 1940s the completion of the State Highway Department's highways and bridges in Middlesex County brought to fruition the plans to provide an integrated and largely grade-separated system of highways linking northern and southern New Jersey. The event, in large part marked by the opening of the Edison Bridge in 1939, was the last major development in Middlesex County's bridge history prior to the Second World War. The War represented another watershed in New Jersey's transportation history, and post-war construction was dominated by the New Jersey Turnpike, the Garden State Parkway, and a system of interstate highways. In the late-1940s and 1950s as more Americans than ever took to the roads, Middlesex County would remain a bellwether of advances in New Jersey's highway and bridge development.

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MONMOUTH COUNTY TRANSPORTATION HISTORY OVERVIEW

The New Jersey Historic Bridge Survey evaluated 152 bridges in Monmouth County. The county has several historically and technologically significant bridges including metal truss bridges, reinforced-concrete arch bridges, and movable span bridges. Among the most exceptional of these bridges are the 1896 Mount Avenue over Grande Avenue concrete-steel arch bridge (130MT50, Atlantic Highlands Borough), perhaps New Jersey's finest example of a Melan-type construction, and the c.1898 Brielle Road over Glimmer Glass cable life bascule bridge (13000W9, Brielle Borough), a very rare example of an unusual rolling counterweight type bascule. The county also has several existing and potential historic districts that include representative examples of late-nineteenth and early-twentieth century bridge technology including metal truss, reinforced-concrete arch, steel deck girder, steel stringer, and steel thru girder bridge types. The earliest known surviving highway bridges in the county date from the last two decades of the nineteenth century, and the majority date from the post-1919 period of modern highway improvements.

The history of bridge building in Monmouth County began with the arrival of European settlers in the last half of the seventeenth century. Most of the early colonists were from neighboring Long Island, New York, and New England; they built farms and small villages in the Navesink region, and relied upon sailing vessels for trade and travel with other colonial communities. They also brought with them English traditions of governance, and by extension English traditions regarding the laying out, construction and maintenance of public highways and bridges for local travel. The improvement of preexisting Indian paths, and the surveying of roads was one of the first orders of business of local governance. Monmouth County ranked among the earliest of New Jersey's counties to make substantial efforts to improve roads and bridges (History of Monmouth, pp. 179-181; Nelson, pp. 390-393; Ellis, 369-376).

The minutes of the Monmouth County Court of Sessions and the Proprietors' Assembly record early colonial efforts to improve local roads. In 1679, for instance, the Court of Sessions ordered a bridge across the Swimming River "to be made new," and appointed a committee of overseers. In 1682 the Proprietors' Assembly appointed county road commissioners for "the making and settling" of highways, landings, bridges, and ferries. The commissioners regularly reported on the condition of county roads and ordered the laying out of new roads. Their reports made frequent reference to bridges with such local names as the Swimming River Bridge, Whale Pond Bridge, John Stout's Bridge, and Coales' Bridge. The bridges, among the earliest in New Jersey, were probably of simple timber construction, although the records rarely, if ever, mentioned construction details (Ellis, pp. 369-376).

Monmouth County's seventeenth and eighteenth century economy was predominately agricultural with seasonal fishing and whaling activities, and an occasional iron works. Geography played an important role in the county's growth. Bordered on the north by the

Raritan Bay, and on the east by the Atlantic Ocean, the northeastern portions of the county relied upon water transportation for ocean-borne commerce. The Navesink and Shrewsbury Rivers provided well-protected harbors, and the arable soil supported a large number of industrious farmers who sold their surplus grain and animal stock in exchange for commercial goods. The southwestern, or down county, part of Monmouth County also benefited from fertile soil, and by 1700 settlers had pushed westward from the Raritan Bay and eastward from the Delaware River to found Allentown and Imlaystown. The down county settlers relied more heavily upon roads and cartpaths for transporting their goods either eastward to the Raritan Bay, or westward to Trenton or Philadelphia on the Delaware River. Gristmills, located at advantageous waterpower sites, became centers of local commercial activity. The southeastern portions of the county, which had poor sandy soils unsuitable for farming, remained sparsely populated during the colonial period (Waldron, pp. 6-7).

Roads and bridges were an important part of the eighteenth century transportation system, and served to move people and goods between the inland towns and the navigable rivers and bays which connected Monmouth County with the greater colonial and Atlantic economy. By mid-century major roads appeared on colonial map surveys and ran from Shrewsbury to Amboy in Middlesex County (portions of present-day Kings Highway and NJ 35); from Shrewsbury to Tinton Falls (Sycamore Avenue, CR 13A) and onto Freehold (County Road, CR 537); from Freehold by way of Holmdel to Middletown (portions of present-day Dutch Lane Road, Conover Road, South Holmdel Road, Middletown Road, & Red Hill Road) and thence to the Atlantic Highlands (Kings Highway East); from Freehold to Englishtown and thence to Middlesex County (Freehold-Englishtown Road, CR 538); (Skemer; Ellis, p. 377). These roads formed the basis of many present-day state and county highways and established towns such as Shrewsbury, Middletown, and Freehold as important highway transportation hubs. For the most part, however, they avoided low-lying land and major stream crossings because of the cost of bridges and the hazards of flood and mud. No seventeenth or eighteenth century bridges are known to survive in Monmouth County.

The first half of the nineteenth century saw the beginnings of important changes in Monmouth County's economy and transportation systems. Agriculture continued to be the county's lifeblood; the discovery of marl, a geologic deposit of clay and calcium carbonate valued as a fertilizer, turned previously worthless soil into highly valued farmland; vegetables, especially potatoes, became increasingly important cash crops (Cunningham, pp. 222-224). Commercial fishermen grew in numbers, and marketed their catches in New York, Philadelphia, and inland New Jersey cities. The change with the greatest long term economic consequences, however, was the beginning of a summer tourist trade. Long Branch attracted wealthy seaside enthusiasts from Philadelphia, and by the first decades of the century had become so popular that local farmers were opening their homes to paying summer guests. The quickening local economy plus the recent development of steam ships and railways led to important changes in Monmouth County's transportation system (Waldron, pp. 9-10, 18-22).

Beginning in the late 1820s steam ships provided more reliable and frequent links with New York, and offered regular service to Sandy Hook, Keyport, Matawan, Oceanport, Red Bank, Eatontown, and Long Branch, greatly increasing the population and importance of those towns. The steamers attracted a growing number of seashore enthusiasts but relied upon the farm trade for their bread-and-butter, shipping a wide variety of goods including vegetables, lumber, and oysters (History of Monmouth, pp. 182-184). The increased economic activity motivated the county Board of Chosen Freeholders to take over a large number of roads and bridges, but maintenance, repair and new construction remained haphazard depending upon local political influence and the availability of funds. Bridges frequently washed out and muddy roads were impassable during long periods of the year. Timber bridge technology continued as it had in the previous one hundred years. There are no nineteenth-century records of covered bridges having been built in Monmouth County (Brydon, p. 104) Generally speaking, roads were not much better than they had been in colonial times.

In the 1840s and 1850s interest in turnpikes peaked in Monmouth and other shore counties as a means of improving roads without government expense. In theory, private individuals received charters from the state to collect turnpike tolls in exchange for offering the public improved roadways. In reality, the turnpikes were rarely profitable, and maintenance costs far higher than the turnpike owners could afford. Turnpike building had boomed between 1800 and 1820 in the northern parts of New Jersey, and Monmouth County's turnpikes were part of a short-lived mid-century revival of turnpikes in the southeastern part of the state associated with the growth of commercial agriculture and small industry. Several of Monmouth County's turnpikes connected interior agricultural areas with important Raritan Bay port towns such as Keyport and Port Monmouth where boats shipped produce to New York City and northern New Jersey urban areas or connected to other important turnpikes such as Middlesex County's Bordentown and South Amboy on the New York to Philadelphia corridor running down the center of the state to the west of Monmouth County. The turnpikes, which tended to takeover already established routes but improve road surfaces and straighten alignments, formed the basis of portions of several important state highway routes (NJ 79, NJ 33, NJ 35).

A popular type of turnpike in Monmouth County was the plank road, a highway with timber planks for the road surface. Between 1847 and 1856 at least three plank roads were constructed: the Monmouth County Plank-road from Freehold to Keyport (NJ 79); the Freehold and Howell plank road , chiefly for the use of marl wagons; and a third plank road from Middletown to Port Monmouth. The plank roads were the fastest and smoothest roads of their time, but as in other parts of the state and nation, they proved expensive to build and to maintain, and were abandoned after a few years. Gravel turnpikes were less expensive, and several of these were built in the county, usually over old highways. Among the most successful was a turnpike constructed in 1857 from Red Bank to Shrewsbury (NJ 35). Other turnpikes included the Manalapan and Freehold Turnpike (NJ 33), which also had branches to Englishtown (CR 527A) and to Morgantown (Tennent Road, CR 3). The

turnpike companies also presumably constructed and maintained bridges, although no records of turnpike company bridge improvements are located in the secondary historical sources. (Skemer; Wilson, pp. 765-770; Nelson, pp. 393-394, Ellis, pp. 377-378).

As an alternative to turnpikes and public highways, farmers and local businessmen endorsed and invested in railroads. In 1832 the Camden and Amboy Railroad passed through nearby Middlesex County on the New York to Philadelphia route, and its success motivated numerous imitators. In 1853, after several years of agitation, local farmers and businessmen completed the Freehold and Jamesburg railway with connections to the Camden and Amboy Railroad at Jamesburg. The next thirty years saw the construction of several other railways that like the turnpikes before connected central Monmouth County agricultural towns with main lines running to urban centers. The most notable of these lines included the Farmingdale and Squan Village Railroad Company (1867), the Pemberton and Hightstown Railroad Company (1867), and the Freehold and New York Railway (1875-78) (Ellis, pp. 378-384; History of Monmouth, pp. 185-188; Kobbe, pp. xi-xii).

The railroads wrought many changes in the county, not the least of which was the promotion of the tourist trade. In 1860 the Raritan and Delaware Bay Railroad, which had originally been chartered in the mid-1850s under the overly ambitious assumption that it was capable of competing with the Camden and Amboy by running through traffic from Port Monmouth on the Raritan Bay to a point near Bridgeton in southern New Jersey, opened a branch line to Long Branch and was encouraged at the increase in tourist traffic. Soon other railroads including the Long Branch and Sea-Shore Railroad Company (1863), which built its line from Sandy Hook down the beach to Long Branch, and the New York and Long Branch Railroad Company (1868), which ran from Amboy to Long Branch and eventually extended southward to Point Pleasant, were also offering passenger service and promoting seashore vacations. The older resort towns, such as Long Branch, grew as a result of the railroads, newer resort towns such as Asbury Park and Ocean Grove were founded coincidentally, and land speculators in the southern portions of the county actively sought the extension of the railways to planned resorts such as Spring Lake. By 1883, over 600,000 summer tourists were visiting Asbury Park and Ocean Grove alone. Some resorts offered religious camp meetings and "wholesome" family activities, others catered to exclusive wealthy patrons, and still others offered popular amusements and gambling. The railroads linked them all together, and even published travel guides describing each resort community's attractions. In the last quarter of the century the county's numerous branch lines were consolidated under the control of the Central Railroad of New Jersey and the Pennsylvania Railroad Company (Kobbe, pp. 1-59; Waldron, pp. 22-28, Cunningham, p. 225).

The railroads were among the innovators in iron truss bridge technology. Civil engineers employed by the railroads experimented with iron truss bridge design, and often branched off on their own to start bridge manufacturing companies. Iron truss bridges appeared in great numbers in the period after the Civil War, and bridge fabricators began to offer their bridges not only to the railroads but also to local governments as highway bridges. As early

as 1871, the Monmouth County Board of Chosen Freeholders had purchased an iron highway bridge to span Crosswicks Creek at Walns Mill in Upper Freehold Township. The newspaper reported on the bridge construction, proclaimed the beauty and functionality of the truss, and proudly pointed to the iron bridge as an important sign of the county's progress. The bridge was probably located at or near the present location of the Walns Mill Road pony truss with Phoenix Columns (1300U47, Upper Freehold Twp.), constructed in 1885 to replace the earlier 1871 truss. In the 1870s, 1880s, and 1890s, the Freeholders contracted for numerous metal truss bridges choosing from a large group of competitive bridge fabricators. For instance, in 1896 the Freeholders appropriated \$94,300 for bridge work including the construction of eight new bridges, of which at least four were specified to be iron bridges (MCHS, Bridge Vertical File).

At least one bridge manufacturing company is known to have existed in Monmouth County. The New Jersey Bridge Company of Manasquan operated from 1890 to 1907. The company was started by two gentlemen from Canton, Ohio, Mr. Wyckoop and Mr. Braly. The built a 300'-deep, 100'-wide shop in Manasquan on Atlantic Avenue, adjacent to the railroad tracks. At the height of their operation they employed 15 to 20 draftsmen and 100 men in the fabricating shop. A local history claims that the company "was the largest individual manufacturing facility ever to have existed in Manasquan." In 1904-1907 the company ran into financial difficulties after securing the contract to build a large swing span, Long Bridge over the Fore River, in Portland, Maine. Unable to meet its obligations and material deliveries, the company went out of business in 1907. The company went into bankruptcy at the end of an era of small, regional, independent, bridge manufacturers. The Manasquan Historical Society owns a series of photographs illustrating the company shops. At least three other New Jersey Bridge Company bridges are known to survive in New Jersey: New Bridge over Alloways Creek (1701399, 1906, Salem County, Alloways Twp.), a thru truss swing span; Port Republic Road over Nacote Creek (01PR007, 1903, Atlantic County, Port Republic City), a pony truss swing span; and the Delaware River Joint Toll Bridge Commission's Belvidere Bridge over the Delaware River (1904, Warren County, Belvidere Borough), a four-span double-intersection Warren truss. (Manasquan Historical Society, n.p.).

Despite the large number of metal truss spans constructed, the New Jersey Historic Bridge Survey identified only four surviving nineteenth-century metal truss bridges in Monmouth County. The Wainford Mill Road over Crosswicks Creek bridge (1300U47, 1885, Upper Freehold Twp.) is a Pratt pony truss with Phoenix Column compression members. The Province Line Road over Crosswicks Creek bridge (1300U53, 1891, Upper Freehold Twp.) is a well-preserved Pratt thru truss also with Phoenix Columns. The Phoenix Column, a circular hollow column of rolled wrought-iron segments with rivet-connected flanges, was a technologically significant advancement in the wide-spread adoption of structural iron in buildings and bridges. It was a patented invention of David Reeves of the Phoenix Bridge Company of Phoenixville, Pennsylvania (Burnham, pp. 223-226). Both Phoenix Column highway bridges in Monmouth County were fabricated at the Phoenix Bridge Company shops and erected on site by Dean and Westbrook, New York City engineers who acted

as highway bridge agents for the Phoenix Bridge Company. Dean and Westbrook were very active in Monmouth County, and in 1891 also began construction of the first Oceanic Bridge across the Navesink River, the predecessor of the present double-leaf bascule Oceanic Bridge (1300S31, 1939, Middeltown Twp.). The Monmouth county Phoenix Column trusses are two of fewer than ten surviving Phoenix Column trusses in New Jersey. Of additional note in terms of the widespread use of Phoenix Columns for structural purposes is a steel stringer bridge spanning the flood plane of Crosswicks Creek also on Walnford Mill Road (1300U48, 1893, Upper Freehold Twp.) The 1893 stringer bridge has unusual Phoenix Column bents with plate girder caps and is the only bridge in the Survey to use Phoenix Columns in a bridge substructure. The Phoenix Column bents are a small-scale example of the type of substructure found in several non-extant Phoenix Bridge Company late-19th century ocean piers and elevated railways such as the Atlantic City, Long Branch, and Cape May piers and the New York City Second Avenue Elevated (1878).

The Preventorium Road over Manasquan River bridge (130HL67, 1899, Howell Twp.) is Pratt thru truss constructed by the Wrought Iron Bridge Company of Canton, Ohio. Active from 1867 to 1901, the company was another regionally significant bridge builder and was also responsible for the 1886 Nevius Street double-intersection Pratt truss in Somerset County (18E0801, Raritan Borough). The fourth Monmouth County 19th-century truss, Tinton Avenue over Pine Brook (1300S13, c.1895, Tinton Falls Borough) is a pin-connected Pratt pony truss within the boundaries of the Tinton Falls Historic District.

The adoption of metal truss bridge technology coincided with a statewide movement for free improved roads. In the 1870s the condition of Monmouth County's turnpikes worsened and public sentiment turned against toll roads. For example, in 1872 the citizens of Long Branch held a mass meeting where they authorized the purchase of the turnpike on Broadway Avenue for \$7,000, citing the road's poor condition and a strong objection to the two cent toll. Throughout the last decades of the century the state legislature passed acts authorizing the abandonment of turnpikes, and by 1902 only fifty miles of turnpike remained in the state, and no turnpikes remained in Monmouth County. Public ownership did not immediately solve the problems of poor road conditions. Cost-conscious Freeholders were slow to authorize highway improvements when in Monmouth County the cost of a good gravel road with adequate drainage was estimated from one to three thousand dollars per mile (Wilson, pp. 774-775).

The first major steps toward improved roads were not taken until the 1890s and 1900s when the state legislature approved state aid for macadamized and gravel roads. Proponents for better roads included the wealthy and influential bicycle enthusiasts who frequented Monmouth County's shore resorts. In the 1890s a bicycle craze swept the country, and the Jersey Shore offered long and level stretches of road ideal for bicycling. The bicyclists joined "wheelmen's" clubs that organized tours, races, conventions, and agitated state and local government for improved roads. In 1893 Asbury Park played host to the national convention of the League of American Wheelmen, and published a map of local roads suitable for bicycling. Cyclists successfully lobbied state and local governments

for improved roads, and by the turn of the century significant gains had been made and state funding assured. In 1901 Monmouth County had 37.2 miles of improved roads, the most of any Jersey Shore county (Wilson, pp. 775-777, 789-800).

The influence of the wheelmen was but one part of the growing political and economic power of Monmouth's tourist trade. Public amenities, including better roads, trolleys, bathhouses, boardwalks, hotels, boarding houses, fresh water sources, life guards, parks, and marinas, were considered essential by the business people, landowners and real estate agents who attempted to attract vacationers to their particular resorts. Seasonal residents, often members of New York City's or Philadelphia's upper crust, expected their resort villages to provide modern conveniences. A sign of the new resort owners' desire to hold political independence from the county's old families was the movement to incorporate numerous seashore boroughs and towns. Bridges were an important part of the transportation infrastructure, and subject to the wants and aesthetics of the powerful resort owners. For instance, in 1872, shortly after the Long Branch and Sea-Shore Railroad established its right-of-way from Sandy Hook to Long Branch, the owners of a well-known hotel on Highlands Beach incorporated the Highlands Bridge Company and received a charter to build the first drawbridge across the Shrewsbury River between Highlands Beach and Atlantic Highlands (present site of NJ 36 over the Shrewsbury River, Bridge Number 1315150, Highlands Borough). The bridge replaced a small ferry operation, and made connections to a steamer landing in Atlantic Highlands. It was over 1450 feet in total length with king-post approach spans and an iron thru truss swing span of 186 feet length. It cost \$35,000, and was the most ambitious bridge project of its time in the county. In 1878 the bridge was rebuilt after a schooner rammed the draw, and eventually the county purchased the bridge, and removed the tolls (Eid, n.p.; Leonard, pp. 72-73).

Several surviving county bridges reflect the influence of the seashore resorts. Often the bridge builders used state-of-the-art technology or added extra embellishments and decorations suiting the wealth and tastes of nearby landowners. One of the most impressive and technologically significant of the bridges is the 1896 Mount Avenue over Grand Avenue bridge (130MT50, Atlantic Highlands Borough). The arch bridge is one of the earliest and largest of its type in the nation; it makes use of the Melan system of concrete reinforcing with embedded metal I-beams along the same lines as the arch intrados. The Melan system was an important step in the development of reinforced-concrete bridge construction. The bridge is also distinguished by its detailing; it has rusticated stone fascia, parapets, and pylons that reflect a late-Victorian aesthetic that was meant to blend the bridge with the naturalistic landscaping. A wealthy summer resident paid for the bridge, and took the liberty to name it "Oonuehkoi" after a long vanished Indian tribe (Leonard, pp. 473-475).

A rare technological survivor is the Brielle Road over Glimmer Glass bridge (13000W9, c.1898, Brielle Borough), a late-nineteenth century resort town in the southern part of the county. The movable bridge is a cable lift bascule with rolling counterweights, a bridge type that was constructed in small numbers in the period between 1890 and 1910. Other

examples of cable lift bascules are known to have been built in the late-1890s in New Jersey including several bridges by the Erie Railroad, but none are extant. The Brielle Road bridge may well be the only surviving cable lift bascule in the eastern half of the United States. The principle of the cable lift bascule is to use a curved track and rolling counterweights where the work expended in raising the leaf is equal to the energy released by the falling counterweight. The toe end of the movable span is linked by cables to cylindrical rolling counterweights. The connecting cable passes over a tower column with a curved track. Moving the counterweights along the curved track thus raises or lowers the bridge.

Other examples of bridge construction related to the development of Monmouth's shore communities include the First Avenue over Wreck Pond bridge (1300W27, 1916, Spring Lake Borough). It is a reinforced concrete arch constructed over a naturalistic water feature that forms part of the landscaping plan of the Spring Lake seashore resort community in southeastern Monmouth County. The arch is within the boundaries of the Spring Lake Multiple Property Historic District. Another bridge, the Sydney Avenue over the North Jersey Coast Line Railroad (1361163, 1917, Deal Borough), is a common bridge type, riveted steel plate thru girder, with the addition of extravagant decorative detailing. The overpass was located at Deal Beach, one of the most exclusive summer resorts; its brick abutments, pylons, flower boxes, entry gates, and terra cotta urns and scrolls were structurally unnecessary to the bridge, but spoke of the status and wealth of its patrons (Ocean Township, pp. 12-15).

In the first decades of the twentieth century federal, state, county, and local governments took increasing interest in roads and bridges, and expanded greatly upon earlier improvements begun by the resort promoters. The driving forces behind the good roads movement were America's newfound love of the automobile, and a progressive faith in government efficiency and planning. The leaders of the better roads movement were professionally trained engineers who advocated and staffed state highway and county engineering departments. State government supported activities varied from indirect financial aid to direct oversight of highway construction, and from the paving of city streets to the establishment of an interconnected highway system. New Jersey's county governments reacted with different degrees of enthusiasm to the state government's largess; increased funding also meant increased state supervision.

Monmouth County had hired private bridge engineers on a part-time consulting basis since the 1880s. The Board of Chosen Freeholders funded bridge work on a township by township basis with individual Freeholders exercising power to determine bridge costs and types. Engineers were hired for the larger bridge projects, but often the Freeholders dealt directly with bridge company agents or local contractors. A 1909 state statute required the Board of Chosen Freeholders to appoint a county engineer, but the Monmouth County Freeholders ignored the state law for almost ten years. In 1918 Monmouth County's Board of Chosen Freeholders belatedly complied with the statute and hired the county's first full-time engineer. Interested in attracting state highway funding, the Freeholders relinquished

most of the details of bridge construction to the state or county engineers' professional expertise (MCHS, Vertical File; Inventory of County Archives, p. 133).

The New Jersey Historic Bridge Survey evaluated 131 pre-1946 bridges in Monmouth County. Only 7 of 131 date to before 1900. Five of seven are metal truss bridges, one a Melan arch, and one a cable-lift bridge. Sixteen bridges date from between 1900 and 1919, and include four concrete arches, four pony trusses, four steel stringers, two T-beams, one deck girder, and one thru girder. The bridges built in the first two decades of the century are representative of period technology. The pony truss bridges, with one exception, have been altered and do not retain their integrity of design. The 5-span rivet-connected Warren pony truss, Locust Avenue over Claypit Creek (130MT21, c.1910, Middletown Twp.), is the county's best preserved example of a bridge type that was once very common.

The majority of Monmouth County's bridges, 108 of 131, date to the post-1919 period. Most of the post-1919 bridges are common bridge types, either designed by the county engineer's office or the New Jersey State Highway Department. Steel stringer bridges, one of the most common bridge types in New Jersey, account for 67 of 108 post-1919 bridges in Monmouth County. Other bridge types included ten thru girder bridges, nine concrete slab bridges, seven nail laminated timber slab bridges, five deck girder bridges, four double-leaf bascule bridges, three multi-girder bridges, two rigid frame bridges, and one single-leaf bascule bridge.

The age distribution of historic bridges in Monmouth County clearly reflects the significant influence of state funding for highway improvements in the 1920s and 1930s. During this period, most bridges on the county's primary roads and thoroughfares were replaced with more modern structures. The New Jersey State Highway Department took over the maintenance of numerous county roads as part of the creation of a state highway system. By 1928, the State Highway Department had created within the county Route No. 4 (from Matawan to Lakewood, present-day US Route 9), Route No. 33 (from Freehold to Asbury Park), Route No. 34 (from Matawan to Allentown), Route No. 35 (from Keyport to Manasquan), and Route No. 36 (from Keyport to Atlantic Highlands). The state upgraded the state routes with graded hard-surface macadamized or concrete roads and modern improvements including shoulders, safety rails, traffic signals, signage, traffic circles, and improved intersections (NJDOT, p. 11-12).

For the most part, the bridges on the state routes conformed to standard State Highway Department bridge types used throughout New Jersey. In the 1920s and 1930s at least seventeen similar encased steel stringer bridges with concrete balustrades were constructed on major state routes in the county (e.g. 1309150, NJ 34 over Gravelly Brook, 1929, Matawan Borough). Increased concern for automotive safety also led to the construction of numerous railroad overpasses to remove dangerous at-grade crossings (e.g. 1303150, 1938, US 9 over Freehold Secondary of Conrail, Freehold Twp.). The overpasses were usually encased stringer or thru girder bridge types; the State Highway Department built some railroad overpasses, and the railroad companies took the

responsibility for others. Once automobile ownership became an American way of life and highways became an attractive way of traveling to the shore, passengers increasingly abandoned the railroads which had originally connected Monmouth's seashore resorts with New York and northern New Jersey's urban centers. In the 30 years after World War II, freight traffic diminished to a trickle and all of Monmouth's passenger lines were abandoned, except for the Pennsylvania Railroad's New York-Long Branch Railroad that remains operated by New Jersey Transit.

The State Highway Department oversaw the construction of several of the county's largest bridges over navigable waterways. Between 1927 and 1932, state contractors completed the Route 35 over Shark River (1311150, 1927, Belmar Borough), Route 71 over Shark River (1321150, 1932, Belmar Borough) and Route 36 over Shrewsbury River (1315150, 1932, Highlands Borough) bascule bridges. The Route 36 over Shrewsbury River bridge, designed by well-known consulting engineers Waddell & Hardesty, is the best preserved and historically distinguished of the group, and is also noteworthy for its beautiful setting spanning the river between Atlantic Highlands and Sandy Hook on the Raritan Bay. The movable bridges spoke to the continuing importance of Monmouth's maritime economy and the growing importance of recreational boating along the shore (Waldron, pp. 18-20).

When the State Highway Department took over major through routes, the county government concentrated more of its financial resources on the improvement of secondary highways, many of which had not been greatly improved since colonial times. Bridge construction was often associated with roadway realignment, regrading, and resurfacing. Surviving plans and records at the county engineer's office show that the majority of county bridges constructed from 1919 to 1940 were steel or timber stringer bridge types. In Monmouth County the historic bridge survey evaluated over 30 post-1919 steel or timber stringer bridges (e.g. 13000N5, Old Corlies Ave. over Jumping Brook, 1925, Neptune Twp.). Another popular bridge type was the nail-laminated timber slab bridge (e.g. 1300R13, Tenth St. over Waackaack Creek, 1945, Keansburg Borough). The survey evaluated at least 7 of these bridges, mostly from the early 1940s. The county selected bridge contractors on a competitive basis, and several local and regional companies were very active including Schenck S. Thompson of Red Bank and Edward T. McNierney of Bradley Beach.

Most of the county bridges were simple bridge types built with function, strength, durability, and cost in mind. An exception to this rule were some bridges built on county roads in seashore resort towns. In the 1920s the shore communities, which had earlier sought greater political independence for the county, looked more frequently to county government for financial and technical assistance with road and bridge improvements. An example is the area surrounding Deal Lake where several county-built bridges were constructed contemporaneously with upper middle-class seasonal residential neighborhoods. Some of the bridges have decorative parapets, arched fascia, and landscaped approaches aesthetically befitting their setting. The most noteworthy bridges of this type are Grand Avenue over Sunset Lake (1300N14, 1922, Asbury Park City), an encased multi-girder;

Sunset Avenue over Deal Lake (1300O10, 1924, Asbury Park City), an encased deck girder; and Monmouth Road over Deal Lake (1300O13, 1929, Interlaken Borough), an encased thru girder (Ocean Township, pp. 11-14).

In the late 1930s, the county took advantage of the availability of federally-sponsored New Deal projects to complete two of its largest bridges, the Ocean Avenue over the Shark River bridge (1300W43, 1936, Avon-By-The-Sea Borough), and the Bingham Avenue-Locust Point Road over the Navesink River bridge (1300S31, 1939, Middletown Twp.), also known as the Oceanic Bridge. The federal government funded the largest portion of the bridges' cost as part of its attempts to create jobs and stimulate the economy during the Great Depression. The ridge over the Shark River is a double-leaf bascule designed by the prestigious firm of Ash-Howard-Needles and Tammen. One of the state's most active movable spans, the bascule portion was largely rebuilt in recent years. The Oceanic Bridge over the Navesink River is nearly 1-mile in length. It is a double-leaf bascule with multi-span deck girder and T-beam approaches. Also designed by Ash-Howard-Needles and Tammen, the Oceanic Bridge with its distinctive Moderne-style detailing is one of the most graceful and best-preserved of its type in New Jersey.

After 1941, the nation turned its attention to the Second World War. The pace of bridge construction in Monmouth County slowed. The only notable bridges built in the county during this time were three concrete slab railroad overpasses to carry munitions trains from the United States Naval Weapons Station Earle in central Monmouth County to warships docked at wharfs extending into Sandy Hook Bay. The overpasses cross Routes 34, 35, and 36 (1308151, 1313150, 1315151) and were built quickly in late 1941 and 1942 as part of wartime emergency efforts. The United States Naval Weapons Station Earle was one of several munitions depots active during and after the war, and the railroad overpasses, although adapted to munitions use, represented no historically significant technological developments.

In the postwar period federal and state funding became increasingly important to the history of transportation in Monmouth County. State government placed emphasis on the construction of divided, limited-access highways such as the Garden State Parkway, while the federal government planned and implemented the construction of a national highway system that included funds for the improvement of highways such as US Route 9, and the construction of interstate highways such as I-195. The highways helped to attract new residents and businesses to Monmouth County, and changed much of its character from rural to suburban. Old bridges continued to be widened, rehabilitated, rebuilt, or replaced to meet the changing needs of heavier traffic and safety. The history of bridge construction in the county continues to evolve, but the details of the events of the last fifty years are beyond the scope of this study.

In summary, the history of bridge building in Monmouth County is representative of national and state-wide trends. In the eighteenth and early-nineteenth century wood bridges predominated. In the late-nineteenth and twentieth centuries wood bridges continued to

be built, but were increasingly replaced by metal and steel. Between 1870 and 1920 the county contracted for numerous metal truss bridges, but few examples of the bridge type remain today. Beginning in the late 1890s bridge builders in Monmouth County began experimenting with concrete arch construction, and by the 1920s reinforced-concrete and concrete-encased steel bridges had become among the most popular bridge types. The county has surviving examples of all of the major bridge types that have been in use within its boundaries since 1890.

The county's geography also played an important role in determining choices of bridge technology. Among the largest and most ambitious of the county's bridges have been the movables that span the county's navigable rivers. In the late-nineteenth century the county had several swing bridges, but in the twentieth century most of these were replaced with trunnion bascules. The county's miles of sandy beach attracted wealthy part-time residents who were willing to experiment with new bridge styles and to spend money on aesthetics. Further inland, the county's fertile farm fields, rolling hills, and numerous small streams encouraged more conservative styles of bridge construction typical of other central New Jersey rural areas.

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MORRIS COUNTY TRANSPORTATION HISTORY OVERVIEW

Morris County's bridges demonstrate the technological evolution of common highway bridge types from the 1820s to the 1940s. The county has representative examples of masonry arch, metal truss, reinforced-concrete beam and slab, and steel stringer and girder bridges. While Morris County's bridges tell the story of changing bridge technologies, they also tell the story of wagon roads, turnpikes, canals, railroads, and modern highways. These transportation systems evolved as a means of moving people and goods to, from, and through Morris County. As such, they have had a determining role in where people worked and lived, and in the economic development of the county.

The patterns of travel in Morris County began development before the arrival of the first European colonists. Prior to the mid-1690s, the county's only inhabitants were native Americans. They traveled to the coast along well-established trails, the most significant of which were two branches of the Minisink Trail cutting across Morris County from the vicinity of Lake Hopatcong to Chatham. European colonists used the trails to enter Morris County from the east, and subsequently built towns such as Chatham, Hanover, and Morristown along the trails. Today, portions of NJ Route 24, NJ Route 10, and NJ Route 53 still closely follow the old trails (Lane, pp. 16-17).

From 1700 on, colonists improved the trails for the passage of packhorses and wagons. The county's steep mountain ridges and numerous streams made travel difficult, but Morris County had rich iron ore deposits, an irresistible economic lure. As early as 1710, a forge was in operation in the vicinity of Whippany, and by the 1750s the county was North America's leading iron producer. Forges and furnaces in Succasunna, Morristown, Hanover, and Rockaway sent pig iron as well as finished iron products east to New York Harbor. In 1738 Morris County was partitioned from neighboring Hunterdon County, a sign of the growing wealth and political influence of the iron masters. Over the next 150 years, the iron masters were a leading force in the development of the county's transportation systems (Cunningham, p. 51; Perucci, pp. 16-25).

Iron-laden wagons and packhorses passed over colonial Morris County's streams on timber pile and bent or timber crib bridges. The Passaic River, which forms Morris County's eastern boundary with Essex County, was a significant natural barrier to be crossed on the wagon roads to ports at Acquackanonk (Passaic), Hackensack, Newark, Rahway, Elizabeth and Perth Amboy. Many Passaic River crossings were established prior to the 1730s, and they continue as such today with later-generation joint-county bridges including, for example, Hanover-Cook Bridge (070M063, Old Mount Pleasant Road over Passaic River, 1920, Livingston Twp., Essex Co.); Pine Brook Bridge (1403151, Bloomfield Avenue over the Passaic River, 1940, Montville Twp., Morris Co.); and Two Bridges Road bridge (070M060, 1928, Fairfield Twp., Essex Co.) (Brydon 1974, pp. 176-182).

By the end of the colonial period a rudimentary road network existed that included the predecessor routes to most of today's major highways. Through roads from the east and south such as Whippany Road, Madison Avenue (NJ 24), and Morristown Road (US 202) converged at Morristown, making it the county's leading market town and county seat. Roads continued westward from Morristown to Warren and Sussex counties (Skemer, p. 5). Local roads, lanes and driftways connected small villages, farms, mines, and forges. These roads, often privately owned and built, later became public roads recognizable in the present network of county highways. Bridges were built only where necessary, and fords remained the most common means of crossing over shallow streams. Morris County lay close enough to New York Harbor to make agricultural and industrial growth attractive, but far enough away to make transportation difficult, especially given the state of overland travel by wagon, horseback, and foot (Lane, pp. 53-54).

The growth of the iron industry placed Morris County at the forefront of New Jersey's antebellum internal improvements movement. Transportation problems related to moving pig iron and finished iron products to market existed as did an efficient means of moving the heavy raw materials from the mines and forests to the furnaces and forges. In the first third of the 19th century Morris County's iron masters took the lead promoting privately-chartered companies for the building and financing of turnpikes. Additionally, starting in 1824, they participated with finance New Jersey's first cross-state canal, the Morris Canal, which was completed to Newark in 1831. These turnpikes and the canal placed Morris County at the center of east-west trade from the Upper Delaware Valley across northern New Jersey and through the county to New York Harbor.

No other county in New Jersey boasted such an extensive system of turnpikes as Morris County. In 1801 the State Legislature granted New Jersey's first toll road charter to the Morris Turnpike Company, founded by Morristown's leading iron merchants. The turnpike ran from Elizabethtown, entered Morris County at Chatham and passed through Morristown, Mount Freedom, and Succasunna following present-day NJ Route 24. By 1810 the turnpike was paying a dividend to investors. It had a crushed stone roadbed of up to 20 foot width, ideal for the passage of heavy freight wagons (Perrucci, p. 49; Lane, pp. 146-147). Soon other turnpikes were in operation including the Union Turnpike (1804), the Newark and Mount Pleasant Turnpike (1806), the Washington Turnpike (1806), the Paterson and Hamburg Turnpike (1806), the Newark and Pompton Turnpike (1807), the Parsippany and Rockaway Turnpike (1809), the Newark and Morris Turnpike (1811), and the Columbia and Walpack Turnpike (1819) (Gordon, pp. 17-18; [History of Morris County 1882](#), pp. 66-67). The new turnpikes all lay along the east-west routes into and through Morris County. Today, many former turnpike rights-of-way have been incorporated into county and state highways. Although no known early turnpike bridges survive in Morris County, no less than 13 bridges evaluated by the Survey span rivers at or near locations where turnpike bridges once stood.

The turnpikes were at best a short-term solution to Morris County's antebellum transportation problems. Beginning in the 1820s most of the turnpikes faced financial

difficulties, in part because toll revenues could not keep up with high maintenance and capitalization costs. In 1822, for instance, the Parsippany and Rockaway Turnpike reverted to public ownership, and in 1823 the Washington Turnpike sold at sheriff's sale. Furthermore, the turnpikes did not solve a fundamental problem of the iron industry; a reliable alternative supply of fuel to replace Morris County's forests that had been stripped of timber for charcoal. In 1822 George P. McCulloch of Morristown struck upon the idea of building a canal to bring anthracite coal to Morris County from Pennsylvania's Lehigh Valley (Kalata, pp. 10-13).

The 1824-1831 Morris Canal ranks as one of New Jersey's greatest antebellum civil engineering achievements. The canal, which followed a 90-mile course from Phillipsburg to Jersey City, revived the languishing iron industry and provided a valuable new source of home heating fuel for growing northeastern cities. The canal rose to over 900 feet above sea level and used a combined system of locks and inclined planes to lift and lower canal boats. It entered Morris County from the east at Lincoln Park and ascended through Boonton, Rockaway, and Dover before reaching its height near Lake Hopatcong on the county's western border. From Lake Hopatcong it descended down the Musconetcong Valley to Phillipsburg (Lane, pp. 227-250; History of Morris County 1882, pp. 68-69).

Bridges were among the most prominent structural engineering features of the Morris Canal. Stone arch and timber aqueducts carried the canal over water features, while a variety of bridge types including queen post trusses, king post trusses, swing bridges, rolling lift bridges, and vertical lift bridges carried highways and railroads over the canal (Lee, pp. 32,59,80,84,90-91). The Survey evaluated one highway bridge associated with the canal's original construction. The 1826 North Sussex Street bridge (1401021, Dover Town) is a three-span coursed-ashlar arch bridge over the Rockaway River. The Morris Canal and Banking Company built the bridge to replace a nearby crossing demolished as a result of canal construction. The bridge is within the Blackwell Street Historic District that includes structures related to Dover's growth as an industrial and commercial center after the arrival of the Morris Canal.

The Morris Canal reached its peak operating years in the 1860s, and afterward declined due to competition from railroads. In 1924 the canal closed, and from 1924 to 1928 civil engineer Cornelius C. Vermuele directed an extensive abandonment project that converted the canal to public uses such as water reservoirs and parks. In 1929 he reported that 192 bridges had been demolished while 67 bridges had been taken over by other government or private agencies (Kalata, p. 634). The former canal right-of-way is listed in the National Register, but few structures associated with the canal's historic period of activity remain. Its primary significance to New Jersey's transportation history lies in the industrial and urban development of northern New Jersey.

Two bridges evaluated by the Survey that span the abandoned canal right-of-way are the 1907 Landing Road bridge (1400073, Roxbury Twp.), and the 1908 Morris Avenue bridge (1400082, Montville Twp.). A third bridge, the 1926 NJ 183 over Musconetcong River

bridge (1426151, Netcong Borough), was built as part of the canal abandonment project that included the redevelopment of the Lake Musconetcong Reservoir. The single-span reinforced-concrete T-beam bridge is historically significant as part of the larger water retention facility encompassing gatehouse, dam, spillway, and surrounding park.

The antebellum period was one of high expectations for Morris County's community leaders, and in the mid-1830s they turned their attention to supplementing canal service with railways. The Morris Canal was a great economic lift to business and industry, yet the older and more densely populated towns of Morristown, Madison, and Chatham lacked direct access to the canal. Local rivalries were intense, and the older communities resented the success of the new canal towns such as Landing, Port Morris, Port Oram (Wharton), Dover, and Boonton, which had sprung to life where only small hamlets or open farmland had existed before. In 1834 the businessmen of Morristown planned to build the county's first railroad.

In 1838 the Morris and Essex Railroad inaugurated regularly-scheduled service from Newark to Morristown by way of Orange, Essex County. In 1848, after financial and technological difficulties not atypical of early railroads, the Morris and Essex extended its route from Morristown to Dover increasing its share of the iron trade. Not until after the Civil War did the company meet the challenge of building westward over the mountains to the Delaware River at Phillipsburg to become a serious competitor to the Morris Canal's anthracite coal trade (Casey and Douglas, pp. 69-79; Lane, pp. 381-384; Cavanaugh et. al., pp. 61-64).

The Morris and Essex Railroad offered faster service than either wagon or canal boat to Newark and Jersey City. The shortened travel time placed Morris County within a half-day's journey of New York City. As a result, Morristown, Madison, Chatham, and the surrounding countryside became an increasingly popular part-time residence of influential New York families who constructed large mansions and estates. The trend of up-scale development accelerated after the Civil War and continued into the 20th century. This upper-class style of suburban life was one of the main contributions of the railroad to Morris County's history (Cunningham, pp. 57-58; Cavanaugh, pp. 102-145).

After the Civil War, Morris County's railroad development followed a pattern familiar throughout the state. Beginning in the late 1860s railroad companies began integrating the formerly discrete short lines into more efficient through trunk lines for the movement of long distance passenger and freight. In 1868 the Delaware, Lackawanna and Western Railroad (DL&W) acquired the Morris and Essex and invested heavily in upgrading track and equipment. In 1870 it completed the Boonton Branch from Denville to Hoboken greatly reducing the running time for all through passenger and freight traffic from points as far west as Buffalo and Chicago.

Other major railroads also built into Morris County including the New York, Susquehanna and Western Railroad (NYS&W) and the Central Railroad of New Jersey (CNJ). The

NYS&W paralleled the Pequannock River Valley and specialized in hauling Pennsylvania coal from Wilkes-Barre/Scranton while also serving local freight and passenger traffic in Morris County's northern townships. In 1881 the CNJ acquired the Ogden Mine Railroad, a short line built in 1865 to carry iron ore from mines in Jefferson Township to the Morris Canal. The CNJ connected the Ogden Mine Railroad with its main line in Hunterdon County. The new branch line ran southwest through Wharton, Succasunna, Olive Township, and Washington Township (Lane, pp. 245-246,381-383; History of Morris County 1914, pp. 12-13; New Jersey Transit, p. 37-44).

The railroads were New Jersey's leading 19th-century bridge builders, pioneering most advances in metal truss and long-span bridge technologies. The New Jersey Historic Bridge Survey did not evaluate Morris County's railroad bridges, however replacement and abandonment make the survival of early undocumented examples unlikely. New Jersey Transit's Historic Railroad Bridge Survey (1991) has inventoried bridges on the former DL&W's Boonton and Morristown branches. Bridges on these lines date from c.1904 to c.1935, and almost all are replacements of earlier spans. One rare example of an early Morris County railroad bridge is the 1878 Phoenix column Pratt thru truss that once carried the CNJ's Hibernia Mine Railroad in Rockaway Township. In the 1890s the CNJ relocated the bridge to carry a rural road over its South Branch line in Hillsborough Township, Somerset County (1852160, Mill Lane). The Mill Lane bridge is one of the oldest and most technologically significant wrought iron truss bridges in New Jersey.

Prior to 1916, responsibility for the construction and maintenance of highway bridges in New Jersey remained with the county and township governments. In Morris County, as in other New Jersey counties, the Board of Chosen Freeholders established bridge committees on an ad hoc basis. The committees allocated funds, chose bridge contractors, and oversaw the progress of bridge projects. The freeholders generally took a conservative approach to bridge construction. Until the last quarter of the 19th century, local contractors built most bridges using traditional methods of masonry arch, timber stringer, and timber truss construction. After 1875 the freeholders turned increasingly to numerous regional bridge building companies for prefabricated metal trusses. Most bridges performed locally-important functions carrying city streets and rural roads over streams. The road network connected outlying farms and villages to general stores, grist mills, railroad depots and larger towns, while the railroads served most through and long distance travel.

Among the oldest surviving highway bridges in Morris County are eleven masonry arch bridges dating from 1822 to 1893. Examples of short-span stone arch construction were found in most northern New Jersey counties where stone was available from nearby quarries. Stone arch bridges were more costly than timber construction, and were generally chosen for those crossings where a permanent bridge was desirable because of frequent flooding or heavy traffic. Morris County ranks with those New Jersey counties having the greatest number of surviving 19th-century masonry arch highway bridges. Nonetheless, nearly half of the county's arch bridges have been significantly altered by widening, incompatible repointing, or other modifications.

Among the best preserved of Morris County's stone arch bridges are the c.1830 Hacklebarney Road bridge (1401250, Chester Twp.); the c.1840 East Main Street bridge (1400976, Rockaway Borough); and the 1876 Schooley's Mountain Road bridge (1401229, Washington Twp.). The bridges are each rubble-coursed, multi-span examples that enjoy integrity of setting. For example, the c.1830 Hacklebarney Road two-span bridge is notable for its location adjacent to a pristine 19th-century grist mill, stone dam, and rural mill village. The c.1840 East Main Street three-span bridge is at the heart of the proto-industrial iron village of Rockaway. And, the handsome flat-arch 1876 Schooley's Mountain Road bridge is in the National Register-listed German Valley Historic District.

Two noteworthy masonry arch bridges are the 1893 Windmere Avenue bridge (1400855, Mount Arlington Borough) and the 1891 US Route 202 bridge (1404155, Morristown Town). Both are finished with rusticated ashlar spandrel and wing walls. The Windmere Avenue bridge is a single-span, random-coursed, stone barrel arch bridge with square voussoirs, flared stepped wing walls, and parapets. The bridge is within Tanglewood Glen Park, a wooded park and recreation area adjacent to large private mansions bordering Lake Hopatcong. The US Route 202 bridge over the Whippany River is a skewed, 52'-long single-span brick arch that ranks as one of the largest and technologically most significant examples of the design in the state. It is within the Speedwell Village Historic District including the ruins of the Speedwell Iron Works and the extant Vail factory where the electromagnetic telegraph was perfected.

In the last quarter of the 19th century, metal truss bridges became the dominant highway bridge type in Morris County, supplanting stone arch and timber bridge types. Railroads pioneered efforts in early metal truss bridge construction, but in the 1860s and 1870s a growing number of bridge companies began marketing their metal trusses to county and local governments for highway uses. Metal truss bridges came in a variety of types depending upon the arrangement of truss members and connections. Early examples of the bridge type were built of wrought and cast iron, but after about 1885 steel became an increasingly preferred material, replacing iron altogether by 1900 (Darnell, pp. vii-ix).

In Morris County the Survey evaluated 13 metal truss bridges dating from 1887 to 1910. Eight of the 13 bridges are Pratt or Pratt half-hip pony trusses, while the remainder include two Warren pony trusses, two Warren deck trusses, and one Pratt deck truss. Pin-connected Pratt pony trusses were common for short-span highway bridges. They were characterized by verticals in compression, diagonals in tension, and lack of upper lateral bracing. Extant examples of pin-connected Pratt pony trusses are found in most northern New Jersey counties. The best preserved of Morris County's Pratt pony trusses are the 1887 Pleasant Plains Road over Great Brook bridge (9050001, Harding Twp.) erected by local bridge builders J. P. Bartley and Sons of Washington Township; the c.1895 Washington Valley Road over Whippany River bridge (1400684, Mendham Twp., builder undocumented); and the 1903 Openaki Road over Den Brook bridge (1400779, Denville Twp.) fabricated and built by the Dover Boiler Works of Dover. The Dover Boiler Works

was established at Dover in 1874, and manufactured a general line of steel plate work for tanks, flues, stills, dryer bins, and ash hoppers. They also made steel shapes, like angles, channels, and I beams as well as bolts, rivets, and castings. Bridges fabricated by the company have been documented through 1919, although they are listed in The Industrial Directory of New Jersey as manufacturing bridges through at least 1927.

Two exceptional metal truss bridges are the 1887 Two Bridges Road bridge (1400273, Lincoln Park Borough) and the 1895 Washington Street bridge (1400084, Boonton Town). The Two Bridges Road over Pompton River bridge is a double-intersection Warren pony truss. The two-span bridge is an early example of rivet-connected construction, a technology that did not become widely used in metal truss highway bridges until after 1900. The double-intersection Warren truss type, where the diagonals intersect at their midpoints, is a relatively rare truss configuration for pony truss highway bridges, and was usually reserved for longer span through trusses.

The 1895 Washington Street over Jersey City Reservoir bridge ranks as one of the most technologically distinguished truss bridges in New Jersey. The 480'-long five span bridge consists of four pin-connected Pratt three-quarter deck trusses and one short stringer span. The structure is one of only two pin-connected deck truss highway bridges in the state (the other is 1600022, Union Avenue over the Passaic River, 1890, Little Falls Twp., Passaic County). The Canton Bridge Company, a nationally-recognized builder from Canton, Ohio, built the bridge, and in 1909, it underwent strengthening including adjustment of the lower chords, diagonals and pins, and the addition of mid-chords under the direction of internationally-recognized bridge engineer J. A. L. Waddell.

The era of Morris County's metal truss highway bridges ended in the 1900s. By 1905 the county freeholders had hired a county engineer to oversee and design the county's highway bridges. In the 1900s and 1910s most New Jersey county's retained the services of civil engineers. The trend was part of a widespread progressive reform that attempted to place government activities on an apolitical, professional basis. County engineers led the systematic improvement of local roads and bridges, instituted the first bridge inspection programs, and advised county and local officials on the latest technological improvements in bridge design and construction.

Coinciding with the introduction of the office of the county engineer was the introduction of the automobile. By the 1910s the automobile was beginning to radically change the way Americans traveled. Mass-produced cars such as Ford's Model T placed affordable and individualized travel within the reach of many middle-class Americans, although several decades passed before automobile volumes surpassed rail as the most popular means of travel. Cars and trucks because of their weight and speed placed greater demands on local roads and bridges. With the assistance of state-aid funds counties graded, widened, realigned, hardsurfaced, and added official signage and guard rails to short stretches of county highways. State aid was not available for bridges until after World War I.

Throughout New Jersey, the period from 1900 to 1919 was characterized by widespread adoption of new bridge materials, especially reinforced-concrete and steel I-beams. In Morris County, for instance, bridges from this period include five reinforced-concrete deck arch spans (e.g. 1400514, Smith Avenue over Passaic River, 1916, Chatham Borough); four steel stringer spans (e.g. 1451060, Rockaway Road over Dover and Rockaway RR, 1916, Rockaway Twp.); three steel pony truss spans (e.g. 1400724, Old Mill Road over Burnett Brook, 1910, Chester Twp.); three thru girder spans (e.g. 1400520, Mount Vernon Avenue over Passaic River, 1906, Chatham Twp.); and two steel stringer spans with concrete jack arches (e.g. 1463163, Morris Avenue over DL&W Iron Works Spur, 1905, Boonton Town).

The 1907 Landing Road bridge (1400073, Roxbury Twp.) and the 1916 Summit Avenue bridge (1400514, Chatham Borough) are distinguished examples of reinforced-concrete arch construction. The DL&W Railroad designed and built the 136'-long two-span Landing Road bridge to carry one of the access roads to its Lake Hopatcong Station over the railroad's main line and the adjacent Morris Canal. The DL&W was noted for its innovative use of reinforced-concrete bridge construction, especially for long-span bridges on the New Jersey Cut-Off (1908-1911) located in Sussex and Warren counties west of Lake Hopatcong. The Landing Road bridge predates the New Jersey Cut-Off and is one of the earliest DL&W reinforced-concrete arch bridges in New Jersey.

The 1916 Summit Avenue bridge between Morris and Union counties is the design of Morris County Engineer Frederick S. Smith and Union County Engineer Jacob Bauer. Its significant features include a graceful and well-proportioned low elliptical arch with closed spandrel panels. The balustrades have urn-shaped balusters and paneled rectangular posts continuing into splayed approaches. The bridge is one of Morris County's best preserved examples of a popular 1910s highway bridge type that also elegantly demonstrates county engineers' concerns for bridge aesthetics.

Another notable county highway bridge is the 1905 Morris Avenue bridge over the DL&W's Boonton freight station spur (1463163, Boonton Town). It is a 40'-long steel stringer span with concrete jack arches between the stringers and original three-high rail pipe railing with cast posts and ball finials. The bridge is the second oldest I-beam stringer bridge in Morris County, and its concrete jack arches are an example of an important transition in the technological development of bridge deck construction. Between 1880 and 1900 many stringer bridges had brick jack arches that served to distribute live load. About 1905 engineers began to substitute concrete jack arches for brick, and then after about 1915 concrete jack arches declined in favor of concrete slab decks. Stringer with concrete jack arch bridges are found in many New Jersey counties, but few have the integrity of the Morris Avenue bridge.

Prior to World War I, New Jersey government leaders began to develop public policies designed to meet the needs of automobile travel. In 1916 the Legislature passed an act providing for 15 state highway routes, and the following year created the New Jersey State

Highway Department to maintain and take over the routes from the individual counties. The war delayed action, but in the early 1920s the department began the most comprehensive highway and bridge construction program in the state's history. By 1927 the State Highway Department had taken over or had plans to take over state highways in Morris County including Route 6 from Pine Brook Bridge through Dover to Netcong (present US 46); Route 10 from East Hanover to Dover; Route 23 paralleling the Pequannock River on the county's northern border; Route 24 from Chatham to Morristown and west to Schooley's Mountain; Route 31 that traveled south to north across Chester and Mount Olive townships (present US 206); and Route 32 through Morristown, Boonton, and Lincoln Park (present US 202). The state highways often followed rights-of-way established since the colonial and antebellum periods. A major goal of the State Highway Department was hardsurfacing, widening, improving alignments, eliminating grade crossings with railroads, and adding signage and guard rails, all to standard State Highway Department specifications. A major component of the state highway program was construction of new bridges.

In Morris County the survey evaluated 49 bridges associated with state highway construction from 1921 to 1943. In addition to crossing water features, state highway and bridges engineers designed facilities to separate grade crossing (road and rail). Morris County state highway bridges include standard bridge types found throughout New Jersey. Of the 49 bridges 18 are encased steel stringer spans (e.g. 1407150, US 46 over Mill Race, 1921, Washington Twp.); 12 reinforced-concrete slab spans (e.g. 1417152, US 206 over Black River, 1928, Chester Twp.); seven thru girder spans (e.g. 1405156, NJ 23 over the Pequannock River, 1934, Kinnelon Borough); seven T-beam spans (e.g. 1417153, US 206 over Drakes Brook, 1928, Mount Olive Twp.); three steel stringer spans (e.g. 1401163, NJ 10 over NJ 53, 1933, Morris Plains Borough); and two reinforced-concrete rigid frame spans (e.g. 1402150, NJ 10 over Malapardis Brook, 1932, Hanover Twp.).

Most of the steel stringer, reinforced-concrete slab, and T-beam spans have concrete balustrades and Moderne detailing typical of 1920s and 1930s state highway bridges. State highway bridge construction began in 1921 with Route 6 (present US 46), and continued from 1928 to 1929 with Routes 24 and 31 (present US 206). In the 1930s New Deal public works funding increased the pace of bridge construction with projects that included Route 10 from 1931 to 1935; Route 23 in 1934; and the dualization of Route 6 (present US 46) from 1937 to 1941.

In the 1920s and 1930s state and federal aid gave Morris County government the resources to concentrate its bridge building efforts on secondary and local routes. These highways and streets connected businesses, farms, and residences to each other and served to distribute traffic to and from the state highways. County engineers also standardized bridge design as they attempted to economize and streamline the local bridge building process. The survey evaluated 42 county highway bridges constructed from 1920 to 1944. Of the 42 bridges, 27 (64%) are stringer spans (e.g. 1400937, Bloomfield Avenue over Den Brook, 1921, Denville Twp.), reflecting county engineers' preference for this economical and easily-built bridge type in the post-1920 period. Other post-1920 bridge

types include six reinforced-concrete arch spans (e.g. 1400431, Bloomfield Avenue over Rockaway River, 1922, Montville Twp.); four thru girder spans (e.g. 1400150, Newark-Pompton Turnpike over Pompton River, 1925, Pequannock Twp.); two reinforced-concrete slab spans (e.g. 1400156, Lake Driver over Canal, 1936, Mountain Lakes Borough); one deck girder span (1400119, Center Street over Whippany River, 1930, Morristown Town); one T-beam span (1400261, Change Bridge Road over Branch of Rockaway River, 1925, Montville Twp.); and one pony truss span (1400639, Roxiticus Road over North Branch of Raritan River, 1934, Mendham Twp.).

The 1934 Roxiticus Road pony truss bridge, the only post-1910 truss bridge in the Morris County survey, is noteworthy as an early example of all weld-connected construction, and it marks the introduction of electric arc welding to bridge construction. The five panel, 56'-long bridge is composed of rolled I- and channel-sections. In the United States, welding did not become the most important method of joining steel until after the Second World War. The Roxiticus Road bridge is one of the best preserved of fewer than one dozen pre-1945 weld-connected highway truss bridges in New Jersey.

An improved system of state highways encouraged citizens to take to the roads in automobiles in numbers greater than before. The system of roads leading west into Morris County from New York City, Newark, and other northeastern New Jersey cities heightened the county's popularity as a tourist destination. In addition to the county's already well-known lake resorts and hotels, in 1933 the National Park Service dedicated Morristown National Historic Park, adding another important attraction. Resort communities such as Mountain Lakes, founded in 1911, grew rapidly in the 1920s with the influence of the automobile. Construction even continued in the depressed 1930s. The 1936 Lake Drive bridge (1400156, Mountain Lakes Borough) is a reinforced-concrete slab span that has unusual cobblestone fascia and parapets. It reflects the upper-class resort community's continued efforts to preserve and maintain its rustic appearance.

The post-World War II decades opened a new era of transportation history, highlighted by interstate highways, such as I-80 and I-287 in Morris County. Interstate highways introduced new bridge technologies, such as prestressed concrete beams, suited to the needs of high-speed limited-access, multi-lane highway construction. The postwar period also marked the final eclipse of the railroads as all purpose carriers, and the abandonment of large portions of Morris County's railroad trackage. In the last fifty years, Morris County has faced the pressures of increased suburbanization brought about, in part, by the automobile. The ease and flexibility of automobile travel has encouraged residential development and the movement of large corporations and businesses from the city to the countryside.

Morris County's historic bridges, by virtue of their continued active service carrying streets and highways, even to this day play a significant role in the ongoing evolution of the county's transportation systems. In summary, the bridges, dating as far back as the 1820s, are part of the county's transportation heritage from wagon roads, turnpikes, canals, and

railroads to state highways. While the majority of Morris County's more than 135 pre-1946 highway bridges are representative examples of common bridge types, a handful are historically and/or technologically noteworthy.

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OCEAN COUNTY TRANSPORTATION HISTORY OVERVIEW

During the colonial period, Ocean County was one of the least populated areas of the state because of its location along a remote section of the eastern shore. At the time of the Revolution its population numbered fewer than 2000. Most of the traveling and transporting was done by boat on the many streams emptying into Barnegat Bay and Little Egg Harbor. In the first decades of the 18th century, early settlers established towns along the navigable rivers. They earned their living by fishing, shipbuilding, and trading such goods as lumber, furs, salt fish, rye, oysters, and clams with New York City merchants. By the 1790s a number of iron furnaces and charcoal works had been built in the inland areas. The sandy soil of the Pine Barrens was too poor to support commercial agriculture (Cunningham 1973: 231-234; Heston 1924: 195-202).

Road and bridge building was not significant in Ocean County until the mid-19th century. None of the state's post roads passed through Ocean County, and the few roads that were legislated by the colonial assembly were nominal. The principal county road was the coastal highway connecting Tuckerton, Toms River and Manasquan, essentially the same route as portions of present-day US 9, CR 548, and NJ 70. The road was well-established by the 1740s, and an early county history mentions coast-road bridges at West Creek, Cedar Creek, Forked River, Toms River, and the Mansaquan River. The bridges were probably simple wood structures typical of most colonial-era bridges. Other roads led from Toms River to Freehold (US 9) and from Tuckerton to the West Jersey towns of Mount Holly and Trenton (portions of several present county routes). These were occasionally traveled by stages and wagons. Most other early roads, other than town roads, were a haphazard and poorly maintained network of meandering trails and wagon paths. No 18th-century bridges are known to survive in Ocean County (Salter 1890: 101,179,210,268,274; Heston 1924:208).

In the first half of the 19th century Ocean County experienced a boom in the pinewood and charcoal trades and in shipping and ship building. Around 1840 the earliest railroad on the New Jersey coast was built between Manchester and the south side of Toms River. It was used to transport charcoal from the kiln to boats, and had mule-drawn cars and track made of longitudinal wood bearers faced with strap iron. Land speculation was also on the increase, and a number of local men had successfully experimented with cranberry horticulture. In addition, small but growing numbers of travelers were risking the long and difficult route overland from Philadelphia and New York to take the salt air, fish, or hunt. By 1850 Ocean County had more than 10,000 residents, and was officially formed from the lower part of Monmouth County. (Heston 1924: 251-254).

Successful economic times encouraged the construction of new roads and bridges. One of the first acts of the newly created county government was the construction of a bridge across the Toms River between the town and South Toms River. The 200' single-span covered bridge was a Town lattice truss that replaced an open wooden bridge which gave

way under the weight of a coal wagon. The bridge was demolished in the 1870s, and was located near the current NJ Route 166 crossing of Toms River (1516151 and 1516152, Dover Twp.). It is the only highway covered bridge known to have stood in Ocean County (Brydon 1970: 42-43).

From 1850 to 1875 the shore towns and villages continued to grow rapidly. The towns were connected with one another by straight roads when possible, and transportation was no longer in so great a degree by boat. Many bridges were replaced, but the bridge building technology remained largely one of local craftsmen using traditional wood construction methods. Where the new bridges might impede river navigation, such as at Upper Landing in Barnegat, wood draws were built. The County Board of Freeholders took increasing responsibility for the construction and maintenance of bridges but the individual townships continued to take care of many of the county's roads and bridges. Metal truss bridges were not bountiful, although a handful, for example a 4-panel Warren pony truss (c.1880) at Toms River, are known to have existed. No 19th-century highway bridges are known to survive in the county. (Barnegat Historical Society 1980: 28; Heston 1924: 257-258; Miller 1971).

In the last half of the 19th century the supremacy of seafaring transportation was increasingly challenged not so much by highways as by railroads. In 1862 the first steam-powered railway was completed across the western portions of the county through Bricksburg (later renamed Lakewood) by the Raritan and Delaware Bay Railroad Company, later reorganized as the New Jersey Southern Branch of the Central Railroad of New Jersey (Nelson 1900: 404-405). Of greater significance to the county's history was the establishment in 1866 of the Toms River and Waretown Railroad. The sea captains of Toms River, Forked River, Waretown, and Barnegat built the branch from Manchester to Toms River with wealth they had acquired during the Civil War. The line made connections with the Raritan and Delaware Bay Railroad at Bricksburg. In 1871 a joint group of Tuckerton and Philadelphia capitalists built the Tuckerton Railroad from Whiting to Tuckerton, running through Barnegat, Manahawkin and West Creek. At Whiting it connected with a branch of the Camden and Amboy railroad. The Toms River and Waretown Railroad and the Tuckerton Railroad were later absorbed respectively by the Central Railroad of New Jersey and the Pennsylvania Railroad (Heston 1924: 257).

One of the most important influences of the railroads was the promotion of the beach resort towns. The success of Atlantic City spurred imitators up and down the New Jersey Coast. At Forked River, Barnegat, Waretown, and Tuckerton entrepreneurs enlarged hotels and boarding houses for the summer folks who came in larger numbers each year. In the early 1880s land developers began to build resort hotels and summer homes on Island Beach and Long Beach Island. Land speculation was not limited to the shore; in 1879 New York capitalists bought 19,000 acres of land at Bricksburg in the hopes of growing orchards. Finding the soil unsuited to fruits, the investors started one of the nation's earliest winter health resorts and renamed the town Lakewood. Among the New

Yorkers in search of the healthful effects of the pine air were George Jay Gould and John D. Rockefeller, both of whom built large mansion houses (Cunningham 1973: 237-238).

Until the 1880s, a major obstacle for vacationers was the absence of bridges between the mainland and the beach resort islands. Travelers transferred at Toms River or Manahawkin from the trains to ferry services. In 1882 the Pennsylvania Railroad constructed a long timber trestle across Barnegat Bay to Seaside Park on Island Beach. The railroad then traveled up the beach to Point Pleasant, joining the New York and Long Branch Railroad. The trestle remained in service until 1946. In 1886 the Philadelphia & Beach Haven Railroad Company built a bridge across Barnegat Bay from Ship Bottom on Long Beach to Manahawkin where the line connected with the Tuckerton Railroad. The bridge consisted of a timber pile trestle between the mainland and Cedar Bonnet Island, and a manually-operated half-through steel and timber Howe truss swing span between Cedar Bonnet and Long Beach. The trestle had an extremely low profile and was rebuilt in 1912 and closed in the late 1930s (Brinckmann 1973: 165-166; Brick Township Historic Society 1980: 52).

The automobile, more than any other factor, led to permanent improvements in the county's roads and bridges. Beginning in 1900 the county's seaside towns incorporated and broke away from the larger townships to insure use of local taxes for the development of the resort facilities. The demand for good roads was heard ever more loudly, and the resort developers lobbied the state and county governments for better roads. Yet, compared to Monmouth County to the north and Atlantic County to the south, Ocean County was relatively slow to take advantage of state aid for road improvements. In 1900 where neighboring Atlantic and Monmouth Counties each had upwards of 30 miles of improved gravel roads, Ocean had none (Nelson 1900: 398).

Until the first decade of the 20th century, road improvements were largely left up to the individual townships. A number of townships, Dover Township being the leader, built good gravel roads but this was the exception rather than the rule. In 1904 the county Board of Freeholders took over the work of building good gravel roads on the main thoroughfares, and the first road was completed from Lakewood to Point Pleasant on the route of present NJ 88. Over the next several years the county also improved the Main Shore road (US 9), the road from Lakewood to Lakehurst (CR 547), and roads running the length of the island beaches. The county also established a policy of aiding the townships with the construction of less important roads. In 1909 the county complied with state legislative enactments requiring a county engineer, and appointed its first county engineer to survey the county roads and bridges. Among the engineer's other duties were specifying work to be done and submitting itemized details of the cost of completed work to the Board of Freeholders and the State Highway Commissioner (Heston 1924: 260; New Jersey Historical Record Project 1940: 137).

Of the 34 bridges evaluated by the historic bridge survey, only 4 dated from the pre-WWI period of road building. Two bridges, the New Guinea Road and the Cows Head Road over

Cedar Creek bridges (3367150 and 3367151, Berkeley Twp.), were probably privately built bridges. They were within the Double Trouble Company's cranberry bogs and spanned spillways associated with the bog dams. The Double Trouble bridges probably were built c.1909 when the cranberry bog water system was improved, but documentation has not been located to verify construction dates. Today, the Cows Head Road Bridge is within the boundaries of the Double Trouble Historic District, a cranberry bog, cranberry processing, and immigrant-laborer village within Double Trouble State Park. The Cows Head Road Bridge is a 2-span reinforced concrete arch that contributes to the historic district and to the important story of commercial cranberry growing in the county. The New Guinea Road bridge is also located within the state park but is outside the boundaries of the historic district. It is a wood and steel stringer bridge that has been significantly rebuilt. Two bridges, the US 9 over Watering Place Brook (1504151, Lakewood Twp., 1908) and the Lakehurst Road over Toms River bridge (1507001, Manchester Twp., 1913), were undistinguished reinforced concrete arches built by the county.

The advent of the new highways opened up markets to the county's farmers and brought increasing numbers of automobiling vacationers to the shore. The summer residents stimulated the construction of highway bridges across Barnegat Bay to the islands. Unable to persuade the state and county governments to act quickly, businessmen in the shore towns applied for toll bridge charters and paid for the construction of the new bridges. In 1914 the Long Beach Turnpike Company completed a timber pile causeway with Warren truss bascule span across Barnegat Bay between Manahawkin and Ship Bottom on the route of present NJ 72. The bridge ran parallel to the Philadelphia and Long Beach Railroad bridge. In the late 1910s a second toll bridge, called the Barnegat Bay Bridge, was constructed by the Island Heights and Seaside Park Bridge company spanning the bay between the mainland and Island Beach on the route of present NJ 37. In 1921 both bridges were incorporated into the state highway system. The Barnegat Bay Bridge was demolished in 1950 to make way for the present NJ 37 eastbound bascule span (1508150, Dover Twp.) The Long Beach Island bridge was demolished in 1957-58 and replaced with the NJ 72 high-level span (1513152, Stafford Twp.) (Heston 1924: 259; Wilson 1954: 844).

In the late 1910s and 1920s the system of state highways gradually extended into Ocean County. The first state road was Route 4 (redesignated NJ 70/88, US 9), which entered the county via the Manasquan River bridge at Point Pleasant, crossed to Lakewood, and from there to Toms River and down the Shore Road to Tuckerton. By 1923 fifteen miles of the road were paved with concrete. In the mid-1920s county residents began a campaign to hard-surface the sand and gravel state road from Camden to Toms River. The furthest of the seaside resort areas from Philadelphia and New York City, Ocean County's beaches were the last to have improved cross-state highways. The United States Navy, which opened a Naval Air Station at Lakehurst during World War I, was also anxious to have an improved road but construction was slow. An uninterrupted paved concrete highway across Ocean County to the west was not completed until the mid-1930s. The route was known as NJ 40, later redesignated NJ 70 (Heston 1924: 260; Wilson 1954: 843-844).

The majority of the historic bridges surveyed in Ocean County were constructed in the 1920s and 1930s. Of a total of 34 bridges, 30 dated from the post-1920 era of road building. Most of the post-1920 bridges were representative examples of common bridge types. Of the 30 bridges, 13 were steel stringer bridges, 6 reinforced-concrete slab bridges, 3 wood stringer bridges, 2 reinforced-concrete T-beam bridges, 2 single-leaf bascule bridges, 1 swing span bridge, 1 deck girder bridge, and 1 thru girder bridge. The importance of the state highway system was reflected in the high proportion of state highway bridges in the survey. Of the 30 post-1920 bridges, 22 were constructed as part of state highway routes.

Ocean County's popularity as a tourist destination led to increasing use of navigable waterways for recreation. In the 1910s an inland waterway with six feet of water the whole distance was constructed from Cape May to the head of Barnegat Bay, and in 1924 the Point Pleasant Canal from Barnegat Bay to the Manasquan River was completed, largely for the use of amateur yachters. Where highways crossed the navigable water features adequate clearance to boats was always a consideration. From 1914 to 1920 Ocean County's first-generation moveable bridges were swing spans. In addition to the swing spans on the Long Beach (1914) and Barnegat Bay (1919) causeways, highway swing spans were built across the Manasquan River at Old Squan Road (1914) and Richmond Avenue (c.1915) in Point Pleasant Borough, and Mantoloking Road (c.1914) in Brick Township. The only surviving swing span in Ocean County is the 1933 Beaver Dam Road over Beaver Dam Creek bridge (1506002, Brick Township). The bridge was the last of its type constructed in the county, and probably one of the last in the state. It was not technologically innovative for its time, and has numerous modern alterations.

From 1930 to 1960 Ocean County's first-generation swing spans were demolished to make way for bascule spans, which offered faster openings and closings and wider and clearer channels. In 1938 a single-leaf bascule (1511150, Point Pleasant Borough) replaced the swing span on Old Squan Road, which had been taken over as NJ 4 (present NJ 70) in 1920. The 1938 bascule survives but has been significantly rebuilt. Another 1938 bascule, Mantoloking Road over Barnegat Bay (1506006, Brick Township) replaced a 7-panel Warren truss swing span. The Mantoloking Road bascule, unlike several other operating bascules in the region, has not been significantly rebuilt or rehabilitated. The prominent engineering firm of Ash-Howard-Needles and Tammen based in Kansas City designed the bridge, which was constructed by the Eastern Engineering Corporation.

In conclusion, more than other New Jersey counties, Ocean County residents relied upon water transportation the longest. Efforts at road and bridge building were haphazard and decentralized until the 20th century, and even then major improvements such as hard surfacing were slow to arrive. The history of bridges in the county was at first dominated by real estate developers and local businessmen who paid for and built the first railroad and highway bridges across Barnegat Bay to the beach. Their efforts to attract summer vacationers had far reaching consequences for the county's future. Beginning in the 1910s the county and state governments took increasing responsibility for the roads and bridges.

Emphasis was placed on the completion of the state highway system, and the inventory of historic bridges in the county reflects a high degree of New Jersey State Highway Department bridge types.

In the last 50 years highway improvements have continued with the construction of the Garden State Parkway and Interstate 195. Increasingly, the resorts and coastal towns have become the full-time homes of retirees and suburban commuters who find that the highways provide them with easy access to friends, family, and jobs in distant cities (Patterson 1991). The county's historic bridge inventory has decreased as older bridges, many of them timber stringer bridges, have been replaced, and as others have been widened, reinforced, or rebuilt in-kind. The few remaining movable span bridges are a testimony to the county's maritime traditions, largely carried on by weekend and summertime fishermen and sailors.

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PASSAIC COUNTY TRANSPORTATION HISTORY OVERVIEW

The history of Passaic County's bridges is told through the historical development of its transportation systems. From the colonial period to the Second World War, Passaic County's bridges have carried wagon roads, turnpikes, canals, railroads, local roads, and state highways over the region's streams and rivers. In turn, each transportation system has created new man-made barriers to be spanned and, at times, connected to successive developments.

Passaic County, incorporated in 1837 from portions of Essex and Bergen counties, stretches from the heavily populated areas of northeastern New Jersey to the lightly developed highlands of the northwest corner of the state that borders New York state. Its transportation history thus shares the characteristics of both the urban industrial counties to its east and the historically rural agricultural counties to its west. Passaic County's historic bridge inventory reflects its highly varied history with bridge types ranging from movable bridges over the upper navigable portions of the Passaic River to simple steel stringer spans over the swift running streams of the mountainous northwest. Turn-of-the-century bridges in Paterson and Passaic reflect a technological state-of-the-art urban sophistication while post-1920 bridges found in the more rural areas of West Milford and Ringwood reflect a more conservative approach of simple, well-tried, and utilitarian construction.

Although the earliest surviving highway bridges in Passaic County date from the 1880s and 1890s, the history of the transportation routes that determined the location of the bridges and the patterns of travel within and through the county dates from the 17th century. It is during the colonial period that the history of Passaic County's bridges begins.

In the colonial period, water transportation was the most effective means of transporting people and goods long distances. A limiting factor in Passaic County's growth was lack of direct access to a deep water port. The southern portion of the county was one of the last sections of northeastern New Jersey to be settled by Dutch colonists, and it was not until the last quarter of the 17th century that the Dutch did push west from the vicinity of Hackensack and claim land in the area of modern-day Passaic City, then known as Acquackanonk Landing. In the succeeding fifty years, settlers of Dutch and English origins moved up the Passaic River and its tributaries the Pompton, Ramapo, Wanaque, and Pequannock rivers to establish small communities and farms throughout most of the area of modern-day Passaic County. The mountainous northwestern areas of the county, however, generally offered poor rocky farm land and remained thinly populated.

Acquackanonk Landing, at the head of navigation of the Passaic River, was the county's leading colonial town, and it served primarily as a transfer point for goods and people either headed downstream to market at Newark or across the river to the Hackensack Road and beyond to the Hudson River at Paulus Hook (Jersey City). As in other New Jersey

counties, the first routes of overland travel in Passaic County were the Indian trails, improved by European colonists for the passage of pack horses and wagons. The most significant of the early roads included a road bordering the Passaic River from Passaic to Newark (present River Road), a road west from Passaic and passing through the Great Notch of Garret Mountain (Van Houten Avenue, Notch Road), and a road northwest from Passaic to Paterson (Lexington Avenue, Vreeland Avenue). In southern Passaic County numerous narrow farm roads called driftways connected local farms with the main thoroughfares and eventually formed the rudimentary basis for the rights-of-way of many of today's secondary roads and bridges. In northern Passaic County the discovery of iron deposits in the vicinity of Ringwood prompted in the mid-18th century the construction of wagon roads for the movement of iron ore to furnaces at Pompton by way of Ringwood Road (Lane, pp. 16-18; Nelson, pp. 163-166; Hessler, pp. 47-49; Clayton, pp. 556, 561, 565; Skemer, *Reprod. of Faden Map of 1778*; Cunningham, pp. 61-63).

Passaic County's swift-running streams made cross-river communication difficult, and most colonial roads passed over minor rivers at advantageous fords. The Passaic River, which flowed eastward across the county before plunging over the Great Falls and continuing southward to Newark Bay, was a formidable barrier cutting the lower portion of the county in two. As early as the 1730s colonists erected the first recorded bridge to span the Passaic near the foot of what is now Bank Street in Paterson adjacent to the present West Broadway Avenue bridge (1600017, Paterson City). In 1741 residents of Acquackanonk Landing (Passaic) built a foot bridge over the river and in 1766 petitioned the Legislature to authorize the erection of a draw bridge, a predecessor span to the 1906 Gregory Avenue swing span bridge (1600002, Passaic City). According to county records, the early bridges were simple timber stringers resting on timber pier bents or timber cribs filled with stone. Floods and ice regularly damaged the bridges, and upkeep was a constant source of concern for local officials. No colonial-era bridges are known to survive in Passaic County (Hessler, p. 48; Nelson, pp. 169-174; Brydon 1974, pp. 176-185).

The same waters that destroyed Passaic County's bridges were also a tremendous source of power to drive waterwheels and mills. In 1791 under the leadership of Alexander Hamilton, the Society for Establishing Useful Manufactures (S.U.M.) chose the Great Falls of the Passaic River for the establishment of one of the United States' first planned industrial communities at Paterson. By the mid-1820s the S.U.M. had successfully constructed a system of raceways to feed water power to more than two dozen cotton mills. Over the following decades Paterson and surrounding communities such as Little Falls grew into historically significant centers of manufacturing with textiles, iron, silk, and machine building among the leading industries (Brady, pp. 22-29). Despite often severe economic depressions, Paterson prospered and the factories continued to expand into the first decade of the 20th century with the construction of a hydroelectric generating plant in 1912-1914 marking the last major S.U.M. effort to develop the potential of the Passaic River's water power. The water-power systems, factories, and buildings of the S.U.M. and the Great Falls have been listed in the National Register of Historic Places for their historical significance in the development of American engineering and industry (ONJH,

National Register File, S.U.M. Historic District, pp. 8:1-3). Several city streets spanned the S.U.M.'s raceways and one surveyed bridge, Spruce Street over Middle Raceway (1600390, Paterson City), a 1903 reinforced-concrete arch, was built at the latter end of the district's period of historic significance. The bridge, an early reinforced-concrete arch using Monier-type wire mesh for reinforcing, is also in and of itself a document example of a technologically distinguished type.

Manufacturers were initially attracted to the Great Falls in hopes of exploiting its water power, but many other factors including access to transportation were keys to Paterson's success. In the first half of the 19th century industrialists and merchants were among New Jersey's earliest promoters of turnpikes. Like the business leaders of other northern New Jersey towns and cities, they sought to make their communities regional centers of commerce and trade by linking themselves to raw materials and markets. From 1806 to 1815 the Paterson and Hamburg Turnpike Company, the Newark and Pompton Turnpike Company, Ringwood and Longpond Turnpike Company and the Paterson and Hackensack Turnpike Company received state charters to build toll roads through portions of Passaic County. The turnpikes were four of more than four dozen authorized statewide during the initial two decades of New Jersey's turnpike era (Gordon, pp. 17-18).

The turnpike roads, which concentrated in northern New Jersey, were built primarily to carry the products of farm and mine - grain, beef, wool, and iron - to market towns. They represented the first concentrated efforts to improve through traffic and a significant transition from the locally organized efforts of the colonial period. In exchange for the privilege of charging a toll, private turnpike companies usually took over already existing freight and stage routes and improved them with straighter alignments, wider roadways, gravel surfaces and foundations, and bridges. In Passaic County, for instance, the Paterson and Hamburg Turnpike running from Passaic through Paterson and westward to Sussex County developed the rights-of-way followed by present Main Avenue, West Broadway Avenue, Hamburg Turnpike, and NJ 23 north of Pompton; the Newark and Pompton Turnpike developed portions of the route of NJ 23 in Wayne Township; and the Ringwood and Longpond Turnpike Company developed the right-of-way later followed by the present Greenwood Lake Turnpike in northern Passaic County. Among the most significant bridge crossings established by the turnpike companies included in 1822 the Paterson and Hamburg Turnpike's bridge over the Passaic River (no longer extant but adjacent the West Broadway Avenue bridge, 1600017, Paterson City) and in 1826 the Paterson and Hackensack Turnpike's Market Street Bridge over the Passaic River (presently site of a post-1946 structure adjacent to the I-80 crossing) also in Paterson City. None of Passaic County's surviving highway bridges date to the turnpike era, but the turnpikes' legacy is still visible in at least 14 surveyed bridges spanning streams at crossings historically associated with the turnpikes (Nelson, pp. 166-173).

By 1820 Passaic County had a system of local roads, turnpikes, and bridges that served to connect the county's residences, farms, and businesses with each other, as well as with sources of raw materials in western New Jersey and with river ports and ferries at Passaic,

Newark, Hackensack, and Paulus Hook. The turnpike roads are still visible in the modern day pattern of city streets, county roads, state highways, and their associated bridges. Following the 1820s, however, emphasis in transportation technologies shifted from highways to canals and then railroads. The turnpike roads proved expensive to maintain, traffic never reached anticipated volumes, and over the long run owners chose to sell-out or abandon their routes due to poor financial performance. In the 1850s, for example, portions of the Paterson and Hamburg Turnpike became a county charge after the company decided that the railroads had captured most of its former freight and passenger traffic. The construction of city cross streets also eventually made collection of tolls impossible and raised public interest in free public roads. Of greatest concern to the industrialists of Paterson, however, was the inability of turnpike wagons to cheaply haul the large quantities of bulk raw materials such as coal and iron needed in manufacturing processes. In the late-1820s and 1830s canals and railroads appeared to hold the key to the future growth of southern Passaic County's industrial promise (Lane, pp. 160-162, Nelson, p. 171).

In 1831 the Morris Canal between Phillipsburg (Warren County) on the Delaware River and Newark (Essex County) opened primarily to haul anthracite coal from the Pennsylvania coal fields to the New York City markets. Coal was a significant industrial raw material and home-heating fuel that contributed to the growth of northern New Jersey's urban areas, and had the additional effect of reviving the state's languishing iron forges and mills in portions of Warren, Sussex, Morris, Passaic, and Essex counties. In Passaic County the canal roughly paralleled the Passaic and Pompton Rivers north of the falls and passed through Pompton Lakes, Wayne, Little Falls, West Paterson, Paterson, and Clifton, aiding the growth of industry and the expanded use of coal-fired steam-powered machinery. The Morris Canal firmly established a pattern of east-west transportation across northern New Jersey with the Passaic Valley a significant transportation corridor. The canal was an engineering achievement that climbed more than 750' above sea level and required numerous locks and inclined planes to lift the canal barges. In Passaic County prominent canal structures were the aqueducts carrying the canal over a number of rivers lying in its path. The 80'-span stone arch bridge over the Passaic River at Little Falls and the 236'-long 10-span wooden aqueduct over the Pompton River (neither is extant) were among the most technologically distinguished bridge engineering accomplishments in antebellum New Jersey (Gordon, p. 26; Lane, pp. 224-250).

The Morris Canal reached its peak operating years in the 1860s, but afterwards it fell into precipitous decline as integrated railroads such as the Delaware, Lackawanna & Western (DL&W) and the Lehigh Valley Railroad took over most of the coal trade from eastern Pennsylvania. In 1923 the State purchased the antiquated canal and organized an abandonment project that included destroying the major canal aqueducts, converting portions of the canal and its reservoirs for fresh water supply and flood control, and draining and filling in other portions of the canal. The canal right-of-way remains a significant feature on the Passaic County landscape, and in Clifton and Paterson sections of the Garden State Parkway and NJ 20 are constructed on the old canal route. After 1923

the State also inherited canal company agreements to maintain highway bridges over the canal. A bridge historically associated with the canal's abandonment was the Dawes Highway over the Ramapo River bridge (1600503, Pompton Lakes Borough). In 1928 the reinforced-concrete deck arch bridge, which ranks as one of the major structures constructed as part of the abandonment project, replaced a narrow wooden bridge that had been maintained by the canal company since the mid-1830s (Lane, p. 246; Murphy, p. 106; Kalata, pp. 609-637).

Passaic County's railroads began in the early 1830s at the time of the opening of the Morris Canal, yet due to financial and technological difficulties took several years to develop extensive operations. The county's first railroad, the 4.5 mile Paterson and Hudson River Railroad, opened in 1832 from Paterson to Passaic. It had horse-drawn cars and specialized in passenger traffic. Within a decade, it had grown into a steam railroad carrying passenger and freight traffic and had extended its line from Passaic to the Hudson River docks at Jersey City. In 1852 the Paterson and Hudson River Railroad was one of the first of New Jersey's short lines to be integrated into a major trunk railroad when the Erie Railroad leased the right-of-way as part of its plans to provide New York Harbor with a direct connection to Upstate New York and the Midwest.

Industries in Paterson benefited greatly from access to rail transportation, and by 1850 the city's Rogers Locomotive Works was turning out more than 100 locomotives per year. The Erie Railroad led to the declining importance of Passaic as a river port, however enterprising citizens took advantage of rail access to expand factories and mills along the line (Scott, pp. 255-261; Lane, pp. 373-378; Cunningham, p. 72).

Other portions of Passaic County were not crossed by railroads until a major period of construction following the Civil War. Unlike portions of neighboring Bergen and Essex counties that took on large-scale suburban residential land-use patterns due to railroads, southern Passaic County communities such as Clifton, Little Falls, Totowa, and West Paterson took on mixed-use industrial and residential patterns that represented more of an expansion of the county's established manufacturing base than the movement of middle-class commuters from Newark, Jersey City, and New York City. The Erie Railroad remained the county's leading line and in 1868 constructed its Newark Branch from Paterson through Newark to Jersey City. From 1868 to 1870 the Delaware, Lackawanna, and Western Railroad (DL&W) put into operation its Boonton Branch that passed through Clifton, Passaic, Paterson, West Paterson, Totowa, and Wayne before entering Morris County. The Boonton Line handled much of the DL&W's passenger service and also led directly to the expansion of industries along its route such as in Clifton the Athenia Steel Company, in Passaic the Manhattan Rubber Works, and in Paterson the Passaic Rolling Mill (Shriner 1890, p. 188; Hessler, pp. 50-51, New Jersey Transit, p. 44). Freight was hauled on the DL&W's main line.

The railroads had a significant impact on the changing character of northern Passaic County. In 1874 the Montclair Railroad began operations on a route extending northwest

from Newark entering Passaic County in Little Falls and Wayne Townships before crossing into Morris County and reentering Passaic County in Pompton Lakes Borough and continuing northerly to Ringwood and Greenwood Lake. In 1878 the Montclair Railroad reorganized as the New York and Greenwood Lake Railroad under title to the Erie Railroad. The New Jersey Midlands Railroad also started running its trains through Passaic County in the early 1870s with a route that went from the Hudson River through Bergen County to Paterson and then back into Bergen before entering northern Passaic County in Pompton Lakes Borough and continuing westward along the Pequannock River. In 1881 the New Jersey Midlands merged into the New York, Susquehanna and Western (Susquehanna) and eventually extended to Wilkes-Barre, Pennsylvania and Upstate New York.

The New York and Greenwood Lake and Susquehanna railroads served the numerous small agricultural communities on their routes and led to the expansion of commercial dairy farming and the establishment of some factories such as the Laflin and Rand powder works in Wayne. The railroads did little to end the continuing decline of the region's iron mines and furnaces, but the New York and Greenwood Lake Railroad especially promoted tourism. A direct result of the railroad was the growth of lakeside summer resort communities in the vicinity of Greenwood Lake (Condit 1980, pp. 62-63; Shriner 1890, p. 5; Cunningham, p. 73).

The primacy of the railroad for through passenger and freight traffic relegated most wagon roads to local uses, and among the most significant bridges constructed during the period were the railway bridges crossing major rivers such as the Passaic. Still, the county, city, and township governments continued to build and maintain highway bridges throughout the 19th century and they remained important links in the county's transportation system. The continued expansion of Paterson and surrounding communities, such as Haledon, Prospect Park, and Hawthorne on the opposite side of the Passaic River, required the laying out of new roads, the filling in of city street grids, and construction of several new river crossings including the predecessor spans to the Main Street Bridge (1600016, Paterson City) and the Fair Lawn Avenue Bridge (1600009, Paterson City).

Prior to 1870 timber remained the preferable material for bridge construction, as it was generally less expensive than masonry. Among northern New Jersey counties Passaic was notable for several early covered timber truss bridges (non-extant) including the Little Falls Covered Bridge (c.1850), a highway bridge located alongside Beattie's Mill near the site of the present Union Avenue Bridge (1600022, Little Falls Township); the 1827 Passaic Falls Covered Bridge (Clinton Bridge), built primarily as a tourist attraction above the Great Falls, Paterson City; and the 1833 Paterson and Hudson River Railroad Covered Bridge, Clifton City (Brydon 1967, pp. 118-119).

Throughout New Jersey changes in bridge construction styles occurred after the Civil War with the widespread introduction of iron truss bridges. From 1865 to 1900 a host of regional bridge building companies competed for bridge contracts and marketed their iron trusses

for the highway construction needs of local and county governments. Passaic County was no exception, and in 1869 Paterson bought its first iron truss highway bridge erected at West Street (non-extant but a predecessor span to West Broadway Avenue, 1600017, Paterson City). The concentration of skilled mechanics and iron works in Paterson made it an attractive location for bridge manufacturing and several of New Jersey's most significant bridge builders established factories there. Among the builders were the Watson Manufacturing Company (1869-1876) and the Riverside Bridge and Iron Works (1889-1899), relatively small manufacturers of bridges of which no documented examples survive in New Jersey (Darnell, p. 33).

The largest bridge manufacturer in the city was the Passaic Rolling Mills located on Straight Street. From small beginnings in 1869 the company grew to become in the last quarter of the 19th century one of the nation's largest producers of rolled iron and steel sections. The Passaic Rolling Mill's work extended not only to the manufacturing of bridge materials but to the design and erection of bridges and buildings including such notable landmarks as New York City's elevated railroads and the Washington Bridge over the Harlem River. In New Jersey few bridges surveyed have been identified as the company's work, and these are mostly deck and thru girder bridges. A noteworthy exception is the 1890 Union Avenue Bridge (1600022, Little Falls Township), a rare single-span wrought-iron rivet-connected Pratt deck truss over the Passaic River. The bridge ranks as one of the most historically significant in New Jersey not only because of its association with a local manufacturer of national importance but because of its location in a historically appropriate setting next to the well-preserved Beattie Carpet Mill complex (Shriner 1890, pp. 187-188; Darnell, p. 33).

In addition to the Union Avenue Bridge in Little Falls, the Historic Bridge Survey evaluated only two other 19th-century metal truss bridges in Passaic County. The 1898 Hillery Street Bridge (1600039, Totowa Borough) is a four-span rivet-connected Pratt pony truss, technologically distinguished as one of the only multi-span examples of its type remaining in the state. County engineering records do not document the pony truss's designer or builder. A second metal truss bridge bordering the county is the joint-county Union Avenue bridge in Passaic City. The 1896 thru-truss swing span constructed by New York City engineers Dean and Westbrook was evaluated as part of the Bergen County portion of the Survey (0200011, Rutherford Borough).

Metal trusses were not the only bridge type available to 19th century builders, and in northeastern New Jersey's urban areas, arch bridge construction, visually pleasing to Gilded Age tastes, was sometimes preferred as a fitting symbol of a local community's wealth and sophistication. In Bergen, Essex, Union, and southern Passaic counties were found a wide range of masonry, reinforced-concrete, and steel arch bridges, many of which demonstrated an advanced understanding of engineering and which were often sited at highly visible public places such as parks. In Passaic and other neighboring counties among the earliest of the bridges were brick arches usually measuring less than 40 foot span and often richly detailed. Passaic County has three of more than a dozen 19th-

century brick arch bridges in the region (1600050, Passaic Street over Weasel Brook, 1892, Passaic City; 1600081, Kingsland Road over Third River, c.1885, Clifton City; and, 1600124, Haledon Avenue over Molly Ann's Brook, 1875, Haledon Borough). The best preserved and most complete of the group is the 1892 Passaic Street bridge. The bridge's rusticated-finish coursed ashlar spandrel walls, ashlar ringstones, and bluestone capped parapets are typical of similar bridges of the period.

Prominent among Passaic County's arch bridges are two spans over the Passaic River below the Great Falls in downtown Paterson. The 1897 West Broadway Avenue (1600017, Paterson City) and 1900 Main Street (1600016, Paterson City) bridges when constructed stood as outstanding examples of the two of the most progressive and unusual styles of arch bridge construction. The Main Street bridge is a three-span ribbed three-hinge steel arch with classically-detailed castings and spandrel columns. The three-hinged metal arch, consisting of two semicircular arch segments hinged at the crown and springing points, was introduced to engineers in the United States as early as the late 1860s as one of several means of overcoming the difficult problems of determining and compensating for bending forces in metal arch bridges. In the 1880s and 1890s it enjoyed a brief and limited period of popularity primarily for use in train sheds and highway bridges (Condit 1968, pp. 135-36,151). The Main Street Bridge, although neither the earliest or longest span of its type in the nation, is the most distinguished of its type in New Jersey. It is further set apart by the high level of craftsmanship demonstrated in the castings, unparalleled in other turn-of-the-century bridges in the state. The bridge builder/designer was the Frank R. Long Company of Hackensack, a regionally prominent contractor responsible for numerous bridges in the northern section of the State.

The West Broadway Avenue bridge, upstream from the Main Street bridge, is a Melan-type concrete-steel arch consisting of steel I-beams bent to the profile of the arch and embedded in concrete. The Melan-type bridge, patented in the United States in 1894 by Viennese engineer Joseph Melan, represented a different line of technological development from the three-hinged arch, yet was equally if not more innovative. In the late 1890s American engineers built the first Melan-type arches as part of early experiments with the use of concrete. The Melan-type arch eventually led to a growing acceptance of concrete as a bridge material and evolved into more modern forms of reinforced-concrete construction. When completed in 1898, the West Broadway Avenue bridge was the second longest Melan-type bridge in the country and received careful attention in professional engineering journals. It ranks as one of the most technologically significant spans in the northeastern United States. Edwin Thacher, consulting engineer for the West Broadway Avenue bridge, designed many other important Melan-type arches including a span in Newark's Branch Brook Park (0700101, 1905, Newark City, Essex County). The West Broadway Avenue and Branch Brook Park bridges are the only two of at least six New Jersey Melan-type arches attributable to Thacher.

In the history of Passaic County's bridges the year 1903 stands out as a landmark date. On October 10, 1903 the largest flood in local history destroyed or damaged over 60

bridges leaving the county's transportation system crippled. Only a few bridges, such as the West Broadway Avenue, Main Street, and Union Avenue (Passaic City) bridges, survived the flood accounting for the low number of 19th-century spans in Passaic County. Perhaps more than any other New Jersey County, Passaic's unique geography made it prone to flooding because of the large volumes of water passing through the relatively restricted passages of the Little and Great Falls. Intense industrial development of the river further complicated and blocked the natural flow resulting in a disaster of unexpected severity (Freeholders Minutes, October 1903, pp. 83-89; Brydon 1974, pp. 214-245).

The County Freeholders within weeks responded to the 1903 flood by authorizing funds for the rebuilding and repairing of the county's most heavily trafficked bridges. In some cases a temporary structure was erected until the time that a more permanent bridge could be built, and in a few cases because of high costs it was several years before reconstruction was complete. Prior to the flood the Freeholders had retained the services of a county engineer to evaluate, consult, and design bridges. From 1903 to 1906 William Whitmore served as county engineer and he led the efforts to initially assess flood damage and to recommend a priority list of bridge projects (Freeholder Minutes, October-November 1903, pp. 83-137).

Replacement spans reflected the early 1900s period of transition in bridge building that moved away from prefabricated metal trusses in favor of other bridge forms. County engineers such as Whitmore used their influence to standardize highway bridge design with increasing use of reinforced-concrete, steel stringer, and girder bridges. After the 1903 flood Whitmore oversaw bridge contracting by submitting plans and bids to the Freeholders for approval, and he chose to replace most spans under 100' long with steel stringer or girder spans. The survey evaluated 18 county bridges built from 1903 to 1907, including eight steel stringers, three thru girders, three thru trusses, two reinforced-concrete arches, one deck girder, and one swing span. Whitmore designed all of the thru and deck girder bridges and at least five of the eight steel stringer bridges (the remaining three steel stringer spans were undocumented but matched the style of other Whitmore bridges). His bridges reflected then current thinking in highway bridge design and were similar to those promoted by county engineers in other parts of the state. For instance, the thru girder spans used concrete jack arches to support decks and had cantilevered sidewalks with metal railings. The stringer bridges, usually measuring from 20' to 45' long, were frequently encased with concrete.

An outstanding example of a Whitmore-designed encased steel stringer bridge that has not been widened or otherwise altered to meet modern traffic concerns is the 1904 Diamond Bridge Avenue bridge (1600104, Hawthorne Borough). It crosses a stream in a small municipal park (Goffle Brook Park) bordering a late-19th century residential area, and its custom detailing of bush-hammered texture fascia panels and balustrades reflect continued civic concerns for aesthetically pleasing bridges in public spaces. The bridge is one of the least altered of several dozen of its age and type remaining in the state.

After the 1903 flood Whitmore had confidence in steel stringer and girder bridges to meet Passaic County's traffic needs on short and medium span bridges, but for the several lengthy bridges over the Passaic River he chose to recommend long-span steel trusses. Well-known bridge companies such as Dean & Westbrook, Berlin Construction Co., Cyclopean Iron Works, F. R. Long Co., and the Canton Bridge Co., presented plans and bids in the usual manner with the contract in most instances going to the lowest bidder (Freeholders Minutes, Nov. 1903, p. 171). The Survey evaluated three long-span steel trusses built as part of the post-flood reconstruction including the 1905 Fair Lawn Avenue bridge (1600009, Paterson City), the 1905 Arch Street bridge (1600015, Paterson City), and the 1907 Straight Street bridge (1600014, Paterson City).

The three bridges, each a different truss pattern, offer a striking contrast illustrating the wide variety and quality of bridges available through bridge building companies. The Fair Lawn Avenue bridge is a two-span pin-connected Pratt thru truss with attractive lattice railings. By the turn of the century, pin-connected construction had largely been replaced by riveted field connections, and the Fair Lawn Avenue bridge is an unusually late example of a truss form that was most popular in the last third of the 19th century. The Arch Street bridge, erected in 1905 by the Owego Bridge Company of New York, is a single-span 185'-long pin-connected Parker truss, a variation on the Pratt truss with a polygonal top chord. It is a late example of pin-connected construction found most frequently on late-19th century rail lines rather than city streets. The Straight Street bridge in comparison to the other two bridges is a heavy rivet-connected Pennsylvania thru truss, a variation on the Parker truss with the addition of sub ties and sub diagonals. The bridge, also a standard type for railroads, reflects an exceptional live load capacity and was probably intended to handle freight wagons from nearby Paterson factories.

A special category of Passaic County bridges damaged by the flood were the movable spans over the Passaic River in Passaic City. In the 19th century the growth of Passaic and neighboring Rutherford on the river's opposite bank in Bergen County resulted in the construction of new bridges linking the two communities. Below Eighth Street the bridges were movable spans providing vertical clearance for the declining number of sailing craft still using the river. Although the railroads had captured much of the river's former freight and passenger traffic, barges and small cargo ships were still economical means of moving some types of bulk industrial materials to Passaic's riverfront factories. As late as the 1930s the Army Corp of Engineers dredged the river channel in efforts to keep it free from silt and pollution hindering navigation (Brydon 1974, p. 172).

In the late 19th century all of the movable spans over the Passaic River between Passaic City and Rutherford were metal truss swing spans that pivoted on center piers to provide a clear channel for shipping. Prior to the first decade of the 20th century, swing spans were the dominant movable bridge technology and in New Jersey crossed over most navigable streams. Several fine examples of the bridge type survive in the state including the 1896 Union Avenue Bridge between Passaic City and Rutherford (0200011, Rutherford Borough, Bergen County). During the 1903 flood the Union Avenue bridge was displaced from its

bearings but survived intact. The Gregory Avenue bridge was also damaged and in 1906 replaced with a new thru truss swing span fabricated by the Owego Bridge Company (1600002, Passaic City). The latter bridge has had its operating machinery removed and no longer functions as a drawbridge, limiting its historical and technological significance.

In the early decades of the 20th century when movable spans needed to be replaced engineers turned away from swing spans and to other movable bridge technologies, especially bascule bridges. Although these bridges date to a later period of modern highway improvements, they also stood as reminders of an earlier period when waterborne transportation stood supreme. In Passaic the 1915 Eighth Street Bridge (1600004, Passaic City) is a rare well-preserved example of a Strauss overhead counterweight bascule bridge. The Strauss Bascule Bridge Company was the nation's leading designer of bascule bridges, and innovations pioneered by the company's founder Joseph B. Strauss helped make the type economical and practical. Counterweights could be mounted either overhead or underneath the Strauss bascule, and another Passaic County bascule bridge, the 1930 Market Street Bridge (1600003, Passaic City), demonstrates the underneath variation that was considered more popular because its counterweight was hidden from view. In recent years both the Eighth Street and Market Street bridge have been welded in place due to the disappearance of river traffic, however, they both remain technologically significant examples of a historically important movable bridge technology that was refined from 1900 to 1910. Passaic County's movable spans are but one part of a larger group of movable bridges bordering Newark Bay and New York Harbor in Bergen, Essex, Hudson, and Union Counties. This group forms one of the most remarkable concentrations of movable spans in the nation.

The pace of bridge construction in Passaic County dropped to normal levels after the extraordinary efforts required to replace the bridges damaged in the 1903 flood. From 1908 to the First World War the geographic center of road and bridge building remained in the county's urban industrial southern section where over seventy per cent of the inhabitants lived. In 1908 Garwood Ferguson followed William Whitmore in the position of county engineer. Ferguson's background, a college degree from Columbia University in civil engineering and experience with the Erie Railroad, was similar to other New Jersey county engineers of the period. He continued his predecessor's efforts to standardize and update the county's bridge inventory ("Garwood Ferguson," pp. 1,6).

In the first ten years of his more than thirty-year tenure Ferguson concentrated on the macadamization and gravel surfacing of county roads and the replacement of outdated and dangerous bridges. The Survey evaluated at least 14 county-built bridges dating from 1908 to 1919, all standard bridge types including seven steel stringers, three reinforced-concrete arches, two reinforced-concrete slabs, one single-leaf bascule, and only one pony truss. The rivet-connected pony truss span, Magee Road over West Brook (1600404, Ringwood Borough), is undocumented to date of construction and builder, but in style appears to date from circa 1915. It is also one of only three pre-WWI bridges located north of Pompton Lakes, further indication that in the county's rural sections bridge construction moved at a

slower pace and bridge types that were considered inadequate for the needs of southern Passaic continued to be used.

The traditional lack of attention to northern Passaic County ended after the First World War. One factor contributing to the growth of the northern townships was the automobile, allowing people to travel further and more quickly from cities like Paterson and Passaic. The mountains, which had long acted as significant barriers to wagons, railroads, and trolleys, were more easily negotiated by automobiles, and communities such as Wayne Township and Pompton Lakes attracted an increasing number of residents and businesses. The automobile also opened up the lakes and summer resorts, which had long been accessible only by railroad, to an expanding group of vacationers and part-time residents who traveled to the mountains to enjoy their beauties and recreational features (Murphy, p 118).

A second factor contributing to the growth of northern Passaic County was the development of its water resources. As early as the 1870s Passaic County's Pequannock and Wanaque rivers had been the envy of Newark and several other Essex County and Hudson County municipalities as potential sources of fresh water reservoirs. Since the 1880s Newark had gradually extended its water rights, and in 1900 the city won a court battle that gave it control over the Pequannock watershed. Following the 1903 flood, government officials and concerned citizens realized that prevention of future flooding lay in the control of watersheds in the county's sparsely inhabited north. Essex, Hudson, and Passaic county officials began a long series of negotiations and legal maneuvers that eventually resulted in a 1918 agreement to build the massive Wanaque Reservoir to control the flow of flood waters and to provide water to the growing urban and suburban populations of northeastern New Jersey. The construction of the reservoir began in 1920 and was completed in 1930 attracting a significant number of workers to the region (Cunningham, pp. 65-68; Brydon 1974, pp. 205-207).

The geographic distribution of post-1920 bridges in Passaic County clearly reflects a bias toward the northern portions of the county. The period was exceptionally significant in the development of the northern section's local and secondary routes, many of which had not been greatly improved since the turnpike era. Of 35 county-built bridges dating from 1920 to 1941, only eight are located south of the Passaic River. Of the remaining 27, ten are in Wayne, Haledon, West Haledon or Hawthorne, residential communities that developed quickly in the 1920s. The other 17 are all located north of Wayne in the highlands of Pompton Lakes, Wanaque, Ringwood, and West Milford. Over three-quarters of the bridges are standard design encased or partially encased steel stringer spans, usually bordered by either simple concrete balustrades or metal railings (e.g. 1600146, Doty Road over Post Brook, 1920, Wanaque Borough).

Of all the post-1920 secondary route bridges the only one that merits special consideration is West Brook Road over the Wanaque Reservoir (1600491, Ringwood Borough). The multi-span reinforced-concrete T-beam bridge was built in 1926-1928 as part of the

historically significant reservoir project that included the construction of eight dams and flooded over 2300 acres of land. The West Brook Road bridge over the central portion of the six mile long reservoir maintained a locally important route across the midsection of the northern part of the county. It is a long-span but technologically representative example of T-beam construction.

In southern Passaic County the automobile posed greater highway engineering problems than the upgrading of the north country's rural roads. In particular, the automobile contributed to already crowded conditions on Paterson and Passaic city streets heightening existing traffic control and safety concerns. As automobiles gradually took over passenger traffic from the railroads, old through road and turnpike routes proved incapable of adequately handling traffic volumes. Passaic County's efforts to modernize its highways were similar to efforts throughout the state and barely seemed to keep up with the rising number of automobile owners taking to the roads. Beginning in the early 1900s increased state funding combined with local efforts at road and bridge improvement. After the First World War the State Highway Department became a full fledged partner taking over the construction and maintenance of major through roads in an integrated system of state highways.

One of the earliest expressions of concern for traffic safety in southern Passaic County was the elimination of railroad grade crossings. In 1902 the first coordinated grade separation campaigns in New Jersey occurred in Newark, Essex County, and soon spread to other urban and suburban parts of the state. In the 1900s and 1910s Passaic County's grade separation projects were generally piecemeal and involved technologically unexceptional thru girder and reinforced-concrete arch bridges (e.g. 1651161, Minisink Road over DL&W Totowa Spur, 1916, Totowa Borough; 1661152, Hazel Street over Erie Main Line, 1915ca., Clifton City). Although several rail lines traversed Passaic County, the Erie Railroad passing through downtown Paterson presented the most significant problems and the city government desired the elimination of grade crossings. The Erie's management agreed to grade separation in principle but disagreed over the division of costs and delayed for more than 15 years before beginning construction in 1924 (New Jersey Transit, p. 62).

The Paterson project used thru girder bridges partially encased in concrete as an aesthetic consideration to city officials that preferred concrete bridges similar to those used by the DL&W in Newark and South Orange, Essex County. Thru girders were the bridge of choice of most railroads, and, other than the encasing, the Erie's bridges had no significant technological features. The Erie's Main Line grade crossing elimination bridges in Paterson were not evaluated by the Survey (they are included in the New Jersey Transit Historic Bridge Survey, 1991) but their concrete encased design was copied for surveyed bridges spanning railroad lines and spurs in other sections of Passaic County (e.g. 1650160, Madison Avenue over Passaic Spur, 1929, Paterson City; 1650161, Piaget Avenue over Passaic Spur, 1926, Clifton City; 1660163, Broadway over Erie Main Line, 1926, Passaic City; and, 1601461, Barclay Street over DL&W Railroad Relief, 1927, Paterson City). The

late 1920s grade crossing eliminations were followed from 1935 to 1940 by additional grade separated crossings associated with the construction of state highways. These later bridges, also girder designs, demonstrated few technological difference from earlier bridges except that concrete encasing when applied sometimes included Moderne details such as stepped pilasters and concrete parapets similar to State Highway Department bridges (e.g. 1604159,60 Boonton Line over NJ 23, 1935, Wayne Township).

State aid to Passaic and other New Jersey counties for the construction of gravel and macadam roads began in the late-1890s and expanded throughout the early 1900s. Early state efforts to improve major through roads only extended to financial aid and approval of plans. In 1917, however, the State Legislature created the State Highway Department to take over, maintain, and construct a system of integrated state highways. The act was a landmark event in the State's transportation history and laid out the 15 routes that formed the nucleus of the system of modern state highways. In Passaic County routes included in the original 15 were Route No. 8 through Wayne and Pompton Plains; Route No. 10 from Paterson to the Fort Lee Ferry, Bergen County on the Hudson River; Route No. 11 from Paterson to Newark; and Route No. 12 from Paterson to Little Falls and west. (NJDOT, pp. 10-11).

The First World War and problems in organizing the newly-created State Highway Department delayed take over and construction of the new routes until the mid-1920s, by which time the problems of providing highways for the smooth flow of traffic in congested urban areas had become particularly acute. Throughout the 1920s State Highways in Passaic County underwent several route reorganizations and renumberings as highway engineers attempted to sort out the difficulties of providing a system of roads to carry traffic to points on the Hudson River opposite New York City, and from Passaic County to points further west without becoming bogged down on city streets. As of 1926 the State Highway Department had failed to take over any routes connecting through Paterson or Passaic (NJ State Highway Department, plate 14). Among the first State Highway projects in Passaic County were replacement and realignment of spans for Route No. 8 (redesignated NJ 23 in 1926) in the northern part of the county. The encased steel stringer spans with concrete balustrades (e.g. 1605161, NJ 23 Southbound over Pequannock River, 1924, West Milford Township) and encased thru girder spans (e.g. 1600029, Paterson-Hamburg Turnpike, Old NJ 23, over Pequannock River, 1925, Bloomingdale Borough) were all typical of standard 1920s State Highway Department designs used for highways throughout New Jersey.

While several State Highways including NJ 3 and NJ 4 offered travelers in Passaic County alternate routes to New York City, the centerpiece of State Highway Department efforts was the NJ 6 (present US 46) expressway linking Paterson and points west with the George Washington Bridge over the Hudson River (1931). The problems of expressway engineering characterized by separated grade crossings and limited access entry and exit ramps were not as acute in Passaic County as some of New Jersey's other major transportation hubs such as Newark, Jersey City, Camden, and Keyport-Perth Amboy. By

the time construction was underway in 1936-1940, State Highway Department engineers were using well-trying highway and bridge engineering designs already in use on such routes as the Route 1 Extension in Hudson County.

The survey evaluated 22 bridges constructed as part of the NJ 6 project including 18 encased steel stringers, three open spandrel arches, and one thru girder. The encased steel stringer spans, which carry the highway over or under city streets, other state highways, and railroads, have Moderne-style concrete pilasters and balustrades that lend a sense of coherent design to the route, but are not in and of themselves technologically or architecturally significant. The emphasis on bridge aesthetics and the moldable qualities of concrete was a hallmark of 1920s and 1930s New Jersey State Highway Department bridges, and the NJ 6 bridges mirror motifs seen on bridges in other parts of the state.

The bridges that carried NJ 6 over the Passaic River and adjacent highways received special attention from the State Highway Department Bridge Division. The Passaic River crossings were among the most distinguished and elaborate bridges in the state due to the decision of former State Bridge Engineer Morris Goodkind to build reinforced concrete open spandrel arch bridges over the river. The graceful and elegant bridge form displays both structural efficiency and architectural style. The three NJ 6 open spandrel arch bridges (1606158, US 46 over Passaic River and Riverview Drive, 1939, Little Falls Township; 1607168, US 46 over Passaic River, 1937, Paterson City; and, 1607163, US 46 over Lakeview Avenue, 1939, Clifton City) have such embellishments as tile mosaics of the State seal, battered light standards, and stepped pilasters.

Goodkind served as State Bridge Engineer from 1922 to 1955 and had first used the open spandrel arch form in his 1929-30 US 1 bridge over the Raritan River (1204150, New Brunswick City, Middlesex County). In the 1930s he repeated the bridge form several times for major river crossings in the northern half of the state, and received numerous awards from his peers for his designs and leadership. The NJ 6 bridges marked the last major pre-World War II development in Passaic County's bridge history.

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SALEM COUNTY TRANSPORTATION HISTORY OVERVIEW

The history of Salem County's bridge has been closely linked to its transportation development. From the 17th century through the mid-19th century, Salem County's transportation history was dominated by maritime concerns. Bordered to the west and south by the Delaware River, most transportation within the county occurred by boat along the river and its tributaries: Salem River, Alloways Creek, Oldmans Creek, and Stow Creek. Colonists founded the earliest settlements along the rivers, and reliable and permanent land communications between the towns were slow to develop. Tide-flooded meadows and fresh-water swamps punctuated the county's uplands and further hindered overland transportation. It was not until the latter part of the 18th century that the citizens of the county formed "Meadow Companies" to build dikes and drain the low-lying areas for additional farm land (Cushing:330-331; Heston:484-485).

The first roads of importance in the county were the King's Highway (1681) between Salem and Burlington, and the Salem and Morris River Road (1707) between Salem and Greenwich, but these were inaccessible in inclement weather and difficult to maintain. The earliest bridges in the county were for the most simple wood structures. Where roads crossed navigable waters, such as at Quinton on Alloways Creek lying along the Salem and Morris River Road, the bridge was a movable wood draw span (non-extant but near the present location of NJ 49 over Alloways Creek, 1708151, 1925, Quinton Twp.) (Cushing:330).

Early in the county's history bridges were not generally high on the list of the county's economic and political concerns. Primarily an agriculturally-based economy, grains, produce and livestock moved down the county's creeks in schooners, shallops, and barges, and manufactured goods returned. Salem City, the county seat, developed as a prosperous commercial center trading by packet with New York, Wilmington, Philadelphia, and points abroad. Regular steamboat service between Salem and Philadelphia was established in 1827. Shipbuilding was a major industry at Alloway, and numerous merchantmen were launched into tiny Alloways Creek. Fishing was also a source of income for some county residents.

New Jersey's antebellum internal improvements movement, which was noted for the establishment of turnpikes, canals, and railroads, largely bypassed Salem County. For the most part, southern New Jersey followed decades behind northern New Jersey in its efforts to improve overland transportation. Two short tidal canals were built in Salem County, Denn's Canal and the Salem Creek Canal (c.1820), both as cutoffs of the Delaware River. The canals proved of marginal utility due to silting and fell out of use by the 1890s. In 1863 the Salem Railroad connected Salem with Camden, but not until after the Civil War did railroads offer serious competition to schooners and steamboats (Cunningham:185-92; Cushing:330-342; Heston:484-485; Baer:52).

After 1865, the railroads contributed to the expansion of commercial agriculture, especially the cultivation of fresh fruits and vegetables, and to the growth of local industries, especially glass manufacturing. Increasingly, Salem County found itself tied to a larger market with Philadelphia-Camden at the hub of a regional rail system. Local concerns turned to improving local roads and bridges, especially those linking farming communities with railroad depots. The late-19th century saw the first major improvements to Salem County's roads and bridges since the colonial period. Still, the Salem County Board of Freeholders continued as they had for over 100 years to approve bridge and road projects on a bridge by bridge, road by road basis, with decisions made by ad hoc committees, final approval subject to the entire Board.

Since Salem County's largest streams were navigable, the most historically significant long-span bridges in the county were typically movable spans providing clearance for boats. Swing spans were the dominant movable bridge technology from the last-half of the 19th century to the first decade of the 20th century. In 1900 the county had at least 7 swing spans, many of them fabricated and erected by bridge building companies specializing in the construction of metal trusses. All of Salem County's surviving movable bridges, whether swing spans or other movable type, are known to have replaced preexisting swing bridges.

Unfortunately, none of Salem County's pre-1900 swing span bridges survive. However, the two oldest bridges in the Survey, the 1905 Mill Road over Oldmans Creek (1700199, Oldmans Twp.), and the 1905 New Bridge over Alloways Creek (1701399, Lower Alloways Creek Twp.), are typical of through truss, center-bearing swing span bridges of earlier decades. The two spans are similar in construction with polygonal top chords, center towers, and man-powered operation. The Mill Road over Oldmans Creek bridge is sealed to navigation and so highly altered to render it a poor candidate for preservation, but New Bridge over Alloways Creek is a better preserved example of the bridge type and ranks as one of the most technologically distinguished movable bridges in the state. Adding to New Bridge's historical distinction is the fact that it is one of fewer than a half dozen bridges statewide constructed by the New Jersey Bridge Company of Manasquan, New Jersey, a small regional builder.

No 19th- or 20th-century metal trusses, other than the two 1905 swing spans, are known to survive in the county. The number of fixed-span timber or metal trusses in the county does not seem to have ever been significant. A 1935 report noted that only 4 steel truss bridges existed in the county at that time. Fenwick Bridge (1923, Bridge No. 1704150) in Salem City replaced the last covered bridge in the county. Most county bridges were simple short-span timber stringers and log cribs (Salem County Board of Freeholders, 1935).

In the 20th century, with the advent of the automobile, the improvement of roads and bridges became an even greater concern for the Board of Freeholders. Salem County reached an important transition point in the development of its roads and bridges in 1914 when the Board of Freeholders appointed its first county engineer, Howard B. Keasbey, to help them with the ever increasing task of maintaining the county's roads. Keasbey held

a 2-year law degree from New York Law School, and practiced law, surveying, engineering, and real estate from his offices in Salem City. He had begun working for the county in 1906 as a supervisor of road construction. The late 19th- and early-20th centuries were a time of professionalization for engineers, and like many of his contemporaries, Keasbey had learned his trade from practical experience rather than formal training. He was increasingly active in professional organizations, a past President of the New Jersey Society of County Engineers, and a member of the New Jersey Society of Professional Engineers and of the American Society of Civil Engineers.

In 1918 the Board of Freeholders discharged its numerous standing and ad-hoc committees on roads and bridges, and for the first time, appointed a single committee to oversee all bridge construction in the county. The committee relied heavily upon the professional opinions of the county engineer, and streamlined the political decision making process regarding bridge improvements. In 1919 Keasbey was reelected county engineer, a post he was to hold until 1934, and James B. Sparks was elected the county's first assistant engineer, in recognition of the expanding duties of the engineer's office. Sparks was a self-taught engineer, who over the next 15 years took considerable interest in the county's bridges, most notably overseeing the construction of the Penns Neck bascule bridge (NJ 49 over Salem River, 1707150, Salem City) (Salem County Board of Freeholders, 1914-1919; Salem Sunbeam, 1962 & 1964).

The hiring of a county engineer, and reform of the political process regarding roads and bridges, inaugurated Salem County's golden age of highway building. After World War I the county was prepared to take advantage of increased state aid to systematically improve its highways, making it a leader among southern New Jersey counties. In 1923 it was proudly noted that the county had over 40 miles of newly hard-surfaced roads. Reinforced concrete and steel bridges rapidly replaced timber bridges. In 1935 the county engineer reported that the county owned 94 reinforced concrete bridges, all constructed within the past twenty years, and only 28 timber bridges remained (Heston:484; Salem County Board of Freeholders, 1935).

The Survey identified 36 county bridges built from 1914 to 1945 including 19 T-beam bridges, 14 steel stringer bridges, two reinforced-concrete slab bridges, and one reinforced-concrete arch bridge. The T-beam bridges with concrete balustrades (e.g. 1700449, Memorial Lake Bridge over Memorial Lake, 1922, Woodstown Borough) and the steel stringers with concrete balustrades (e.g. 1700200, Hawk's Bridge Road over the Salem River, 1937-38, Carney's Point Township) demonstrate the influence of county engineers over the standardization of local bridge specifications. The T-beams show a remarkable uniformity of design and are one of the greatest concentrations of the bridge type in New Jersey.

An interesting feature of the Salem County bridges is the frequent association of bridges with spillways and dams. Twelve of the bridges surveyed were structurally connected with spillways and dams. The association is common in the South Jersey bridge complex and

has been noted in other counties such as Cumberland and Gloucester. The lakes and reservoirs created by the spillways and dams historically have served a variety of purposes including uses as sources of fresh drinking water, water power, and irrigation water; recreational water features for parks and residential developments; and flood and water control measures. Some bridges incorporate a design where gates are built into the side of the bridge to control water levels, while others simply span a spillway. A few near the coastline act as tidal barriers to keep brackish tidal water from intruding upon fresh water creeks.

Local and regional contractors constructed most of the short-span bridges in Salem County. The survey identified at least 9 different contractors active in county bridge construction in the period between 1911 and 1944. The most active included C. Fiske Campbell of Bridgeton, William H. Shough of Alloway, George A. Charlesworth of Elmer, and Joseph W. Rogers of Succasunna. One contractor, Samuel Campbell of Pennsville, stands out as undertaking many of the county's largest and most ambitious bridge projects including the 1923 NJ 45 over Fenwicks Creek bridge (1704150, Salem City); the 1925 NJ 49 over Alloways Creek swing span (1708151, Lower Alloways Creek Township); the 1927 NJ 49 Penns Neck bascule bridge over the Salem River (1707150, Salem City), and the 1931 Pointer-Auburn Road deck girder bridge over Salem Creek (1704000, Pilesgrove Township). Campbell, like most other contractors, was also involved with real estate development and building construction (Salem Standard and Jerseyman, 1932).

The county's efforts to improve the roads and bridges under its purview corresponded with the development of the state highway system. Throughout New Jersey, and the United States, in the period between 1919 and 1941, a concerted effort was made to improve roads and bridges at the local, state, and federal levels through revenue sharing, the creation of interlocking highways, and investigations of better road and bridge building technologies. Early proponents of the highway improvement campaigns saw the roads and bridges as an important link in the development of farm to market roads. They hoped that better roads would end the cultural and social isolation of rural dwellers, and would provide a recreational outlet for automobile-owning city dwellers. The roads brought perishable goods, such as milk and vegetables, to the cities, and were one factor leading to the expansion of specialized agriculture in rural Salem County (Seely:1-15).

The first state-aided road in the county was in 1896, and while only 3 miles long, was a forerunner of more state-aid to come. In 1912, the first State Highway System was legislated, and included Route No. 6 from Camden to Bridgeton and Salem along portions of current routes NJ 45 and NJ 49. Other state highways soon followed and included NJ 18 (now US 40) in 1924, NJ 17 (subsequently NJ 44 and now US 130) in 1926, and NJ 45 and NJ 49 in 1927 (NJDOT 1972: 10-11; NJDOT, 1988). Improvements to the county's major through roads included hard-surface pavement, widening, realignment, signage, and the construction of new bridges and culverts.

The Survey identified 13 state highway bridges in Salem County dating from 1923 to 1941. The bridges included 9 steel stringer bridges, one thru girder bridge, one single-leaf bascule bridge, one swing span bridge, and one vertical lift bridge. The steel stringer bridges are representative of standard New Jersey State Highway Department designs found throughout the state. The moveable bridges, however, demonstrate some noteworthy historical and technological details related to changes in moveable bridge technology in the first three decades of the 20th century.

The NJ 45 over the Salem River (Penns Neck Bridge, 1707150, Salem City) is an operating, well-preserved example of a Strauss Bridge Company overhead counterweight type bascule bridge. Constructed in 1927, the bridge is a local landmark, and was probably the most ambitious bridge project ever undertaken by Salem County. Strauss bascule bridges were a popular movable bridge type patented by Chicago engineer Joseph B. Strauss. The hallmark of the Strauss design was the maintenance of the center of gravity of the bascule leaf and counterweight at the same point during the opening and closing of the bridge. The bridge type was one of the most popular early-20th century movable bridges, but has become increasingly rare. Historic documentation of the Penns Neck Bridge construction at the county engineer's office is outstanding. The bridge is the only known surviving bascule lift highway bridge in the county.

US 130 over Oldmans Creek (1710152, Oldmans Twp.) is a Waddell-type vertical lift bridge constructed in 1936. It is located on the Gloucester/Salem County line and is one of three vertical lifts constructed along old NJ Route 44 by the State Highway Department between 1935 and 1940 (the others are NJ 44 over Mantua Creek, 0806141, Paulsboro Borough, Gloucester County; and US 130 over Raccoon Creek, 0817151, Logan Twp., Gloucester County). As a group, the bridges are a noteworthy collection of similarly designed bridges having structural-steel towers supporting sheaves and wire ropes, overhead operators houses and machinery, and thru girder superstructures. The Waddell-type vertical lift bridge was patented by noted bridge engineer J. A. L. Waddell in 1893, and the NJ 44 vertical lift bridges were designed by the firm of Ash, Howard, Needles, and Tammen, a direct descendent of a firm established by Waddell. The vertical lift bridges demonstrate the New Jersey State Highway Department Bridge Division's reliance upon outside consulting engineers for its movable bridge projects. Although the Oldmans Creek vertical lift is no longer operable, the bridge is a good representative example of a technologically significant bridge type with its original operators house. The Oldmans Creek vertical lift bridge marked the last major pre-1945 bridge construction project in Salem County.

An overview of the development of bridges in Salem County would not be complete without a mention of the Delaware Memorial Bridge, the longest twin suspension bridge in the world, spanning the Delaware River between Deepwater, Salem County, and New Castle County, Delaware. Due to its dates of construction (the first of the two suspension spans was constructed in 1947-51 and the second in 1964-68), the Delaware Memorial Bridge was beyond the scope of the Historic Bridge Survey, yet, it is historically distinguished both as an engineering achievement and for its impact on the development of the Mid-Atlantic

Region. The bridge is the southernmost crossing of the Delaware River and is a major link in the metropolitan northeastern corridor. It connects the southwestern termini of the New Jersey Turnpike and New Jersey I-295 with the Delaware Turnpike and Delaware I-295. As of 1975 over 300 million automobiles had passed over the bridge. The bridge has also influenced the growth and development of Salem County. In 1951 the bridge replaced ferry service between New Castle, Delaware, and Pennsville, New Jersey, further severing the county's links to water transportation. And, while the eastern and southern portions of the county have grown modestly in the last 40 years, the area surrounding the bridge has been the site of the county's most rapid population growth and commercial land development (Miller:11,100; Cunningham:193).

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SOMERSET COUNTY HISTORIC BRIDGE NARRATIVE

The New Jersey Historic Bridge Survey evaluated over 185 bridges in Somerset County. The distribution of the type and style of historic highway bridges in the county is consistent with national and state-wide trends in bridge-building technology, and reflects the historical development of Somerset County from a primarily agriculturally-based society in the 18th and 19th centuries to an increasingly suburban society in the 20th century. Notably, the county contains at least half-a-dozen of the earliest surviving 18th and early-19th century stone arch bridges in the state. It also has over 20 late-19th and early-20th century metal truss highway bridges, some of them exceptionally well-preserved and of state-wide and national significance. The majority of highway bridges surveyed date from the first-half of the 20th century and are associated with the automobile era of county- and/or state-sponsored highway improvement projects. Most of these bridges are common types of steel or reinforced concrete construction, a few are exceptional for their association with a historic district or for their architectonic features. The story of Somerset County's bridges is told through the development of its transportation systems.

Rich soil, temperate climate, rolling hills, and abundant water resources predisposed the county's earliest European settlers to farming. In the 1680s the colonists followed the county's primary river system, the Raritan River and its principal tributaries the Millstone, North Branch of the Raritan, South Branch of the Raritan, and Lamington Rivers, into the region. Colonists established communities along the natural waterways and existing Indian trails that served as the first transportation routes (Woodruff 1930:22).

Early in the county's history, farmers produced enough agricultural surplus to sell to local and regional markets. The county was always characterized by a fairly diversified agriculture with a wide range of cash crops including grains, vegetables, apples, and livestock products. Population patterns reflected the stable agricultural economy with moderate growth and fairly even distribution. At first, the roads were probably little more than foot or bridle paths with river crossings at natural fords least likely to be affected by freshets and floods. With the growth of an agricultural economy reliable roads and bridges for moving produce from farm to market became a priority. Many of these early roads still form the basis for modern state and county highways. They include the Old York Road from Bound Brook to Three Bridges; the Assunpink Trail or Old Dutch Road that follows the course of New Jersey Route 27; the Old Middlebush Road, present-day County Route 514, from New Brunswick westerly to Middlebush and Millstone and then southwest to Rocky Hill; the Peapack Road from Bound Brook to Peapack; sections of present-day Amwell Road from New Brunswick to Hillsborough Township; and portions of US Highway 206 from Bedminster through Rocky Hill to Princeton (Schmidt 1973:50-51; Doughty 1919:98-100; Cawley and Cawley 1965:3).

The county's roads and bridges were maintained by the county through its governing body, the Board of Chosen Freeholders. Unfortunately, most of the early county records were lost

in a fire, and so little is known of the very first roads and bridges. From the remaining records, it appears that most bridges were either timber or combination timber and stone. Stone arch bridges were built far less frequently, and usually reserved for the most prominent locations. Wood truss bridges came into use in the first quarter of the 19th-century, but were not built widely until the second quarter. Typically, the Freeholders provided for the construction or upkeep of a bridge by appropriating a fixed sum of money and delegating a committee of one or more board members to oversee each individual bridge project. Local craftsmen and farmers provided the necessary skills and materials for most bridge construction efforts (Kudless and Kudless 1977:6).

The only known surviving 18th and early-19th century bridges in the county are stone arch bridges. The oldest of these is a partially buried stone arch bridge (c.1730-1760) along the old right-of-way of the Old York Road in Bound Brook. Other early stone arch bridges are the 1798 Kingston Bridge over the Millstone River (joint-county bridge, listed in Mercer Co. survey); the c.1800 Zion Brook Road bridge (18B0301, Montgomery Twp.); the c. 1800 Mill Pond Road bridge (18E0302, Montgomery Twp.); and, the 1822 Opossum Road Bridge over Bedens Brook (18E0201, Montgomery Twp.). A National Register Multiple Property Nomination has been completed for Somerset County's early stone arch bridges; it contains more detailed information about this period of the county's bridge building history.

Beginning in the 1830s, canals and railroads grew in importance relative to roads, and offered the county's citizens quicker and more reliable means of carrying both people and heavy loads longer distances. Somerset County benefited earlier than some parts of New Jersey from the new transportation systems because it was on one of the overland routes between New York City and Philadelphia. It was also strategically located across the route between the urban industrial centers of the northeast and the Pennsylvania coal and iron fields. Canals and railroads had a significant impact on the county: they provided opportunities for access to urban markets; they stimulated the development of industrial manufacturing in the proto-industrial towns along the Raritan River; they led to the creation of new communities at canal towns and railroad depots; and, they directly and indirectly influenced the building of roads and bridges.

The Delaware and Raritan Canal was completed in 1834 and connected the Delaware River near Bordentown with New Brunswick on the Raritan River. Approximately 15 miles of the canal passed through Somerset County, paralleling the course of the Millstone River before bearing to the southeast along the Raritan River near South Bound Brook. The greatest part of the freight that passed along the canal was Pennsylvania coal, a commodity critical to New Jersey's industrial development, but the canal also offered a means of shipping agricultural and processed goods to and from the county (Snell 1881:108-110).

The canal made extensive use of stone arch aqueducts to carry it over streams and rivers; some of the aqueducts, like the c.1834 Six Mile Run Aqueduct (18G0403, Franklin Twp.), also carried a parallel road, Canal Road, across the stream. Roadway crossings of the

canal were made by numerous movable bridges. No early examples of the timber A-frame swing span bridges used by the canal are known to survive. The only known extant movable span on the canal in Somerset County is a non-operable steel deck-girder bobtail swing span (1920) at Main Street in South Bound Brook (3000168, South Bound Brook Borough). The swing span was built late in the canal's operation (the canal closed in 1933), probably as a response to heavy highway traffic, and is not representative of the type of movable span usually associated with the canal. The Delaware and Raritan Canal is a National Register listed property.

The railroads, even more than the canal, stimulated the development of the county. Although at first they grew more slowly, they eventually proved to be much more successful, even taking away a large part of the canal's coal hauling business. In 1839 the Elizabethtown and Somerville Railroad, later reorganized as the Central Railroad of New Jersey, pushed through its tracks to Somerville, linking the county by rail to New York City via steamboat at Elizabethport on Newark Bay. By the 1850s the tracks had been completed across the county and into eastern Pennsylvania with direct links to the anthracite coal fields and iron mills. When the Camden and Amboy Railroad's monopoly on cross-state rail lines from New York to Philadelphia expired in the late 1860s, Somerset County was so important a geographic link that four new railroads were chartered or actually built in the county. The local lines were eventually merged or acquired by ever-larger and expanding companies. By 1900, in addition to the Central Railroad of New Jersey, the systems of the Lehigh Valley Railroad, the Pennsylvania Railroad, the Reading Railroad, and the Delaware, Lackawanna, and Western Railroad either owned or operated track in the county (Haussamen 1984:1-18; Snell 1881:110-112).

The railroads influenced almost every aspect of life in Somerset County. They provided a means for local manufacturers to ship their goods and thereby expand their markets, increase their production levels, and hire more laborers. In the 1880s manufacturers in the Bound Brook-Raritan area were making a wide range of goods including woolens, lubricating oil, hose, paint, compressed air pumps, car heating apparatus, brick, clothing, packed pork, wood shingle, braid, home, and agricultural implements. The railroads attracted new populations to the county. In the area around Peapack-Gladstone, Far Hills, and Bernardsville, New York City's wealthiest citizens built summer homes and estates because of the beautiful setting and the proximity by rail to the city. In North Plainfield and Green Brook the county's first suburban communities grew into existence because of the quick commute to urban centers like Elizabeth, Newark, and Jersey City.

Even in the western and southern portions of the county, which remained largely rural, the railroads drew the farming communities ever closer to national and regional markets. Farmers shipped their products more quickly and without fear of spoilage, and in return received a vast array of manufactured goods. Depot towns, such as Flaggstown, Neshanic Station, and North Branch Station grew prosperous as a result of the railroads. In North Branch Station the Central Railroad of New Jersey was directly responsible for the construction of two highway bridges to improve the flow of traffic to and from the depot.

The first is a 1848 brick arch on Station Road (18D0904, Branchburg Twp.), and the second a 1886 timber stringer overpass with cast iron piers (1861159, Branchburg Twp.). By 1920 the county boasted over 30 freight and passenger stations with regularly scheduled trains (Mustin 1930: 8-15; Snell 1881:684-686).

Metal truss bridge technology played a significant role in the development of the rail and road transportation network within the county in the late-19th and early-20th centuries. In order to take advantage of the railroads, farmers and businessmen needed to move their wares to and from the rail depots by road. Without advances in bridge building to meet the need of carrying heavy loads over the county's many streams and rivers, the county's development would have been decidedly less prosperous.

In the last third of the 19th-century, the county Freeholders gradually made a shift from timber and stone bridge construction to iron bridge construction. In 1872 the Freeholders authorized the construction of the county's first iron truss bridge at Weston (non-extant). Within the next five years, at least five other iron truss bridges are known to have been built. The Freeholders expressed pleasure with the iron truss bridges, but cost was always an important consideration and they usually accepted bids for spans of all lengths and types. They continued to authorize the construction of an eclectic assortment of bridges including timber and iron trusses, timber and iron stringer bridges, and stone and brick arches. The tendency, however, was toward the adoption of metal bridges, and by the 1890s iron and steel had clearly gained the ascendancy over other bridge types (Freeholders Minutes 1872-1896 Vol. 4-6).

The Historic Bridge Survey evaluated 29 metal truss highway bridges in Somerset County. The bridges dated from c.1885 to 1927, and included 10 through trusses and 19 pony trusses. Among the truss bridges were 25 bridges built for the county, and 5 bridges built as highway overpasses by the railroads. The two oldest known surviving metal through truss highway bridges in the county are the 1878 Mill Lane over the Lehigh Valley Line bridge (1852160, Hillsborough Twp.) near Neshanic Station, and the 1886 Nevius Street over the Raritan River (18E0801, Raritan Borough). The Mill Road bridge, although abandoned, is the county's only remaining example of a wrought iron bridge built with Phoenix Columns. The Nevius Street Bridge is a 300'-long two span, double-intersection Pratt through truss built by the Wrought Iron Bridge Company of Canton, Ohio. It is also the only remaining example of its type in the county.

The metal truss highway bridges are scattered throughout the county, and tend to be most frequently found in less congested or rural settings where heavy traffic demands have not led to their replacement. Interestingly, seven of the nine 19th-century trusses are through truss spans, and five are still in active use as vehicular bridges. Five are Pratt trusses or a variation of the Pratt. Of the 20 20th-century metal truss bridges in the county, only three are through trusses. The other 17 are pony trusses. The reasons for the infrequency of 20th-century through trusses is not that the technology was waning, but rather that those crossings needing long, multi-span bridges had probably already been improved in the

late-19th century. Of the 17 pony trusses, 10 are rivet-connected Warren trusses and 4 are rivet-connected Pratt trusses.

By the 1880s agents for both regional and national bridge building companies were making deep inroads into local bridge building traditions. The Freeholders Minute Books record that some of the nation's largest fabricators attempted to secure and often received county bridge contracts. Bridge building companies active in Somerset County included the Wrought Iron Bridge Company, the Berlin Iron Bridge Company, Dean & Westbrook of New York, Canton Bridge Company, Toledo Bridge Company, Youngstown Bridge Company, Boston Bridge Company, and Horseheads Bridge Company of Horseheads, New York (Freeholders Minutes 1896 6:214). A number of examples of trusses fabricated by nationally-recognized bridge builders survive in the county and include the Berlin Iron Bridge Company's 1896 lenticular truss at Elm Street over the South Branch of the Raritan River (18C0601, Hillsborough Twp.), the Wrought Iron Bridge Company's 1893 Pratt through truss at Higginsville Road over the South Branch of the Raritan River (18A0605, Branchburg Twp.), and the Penn Bridge Company's 1886 pin-connected Pratt pony truss at Canal Road over Ten Mile Run (1852160, Franklin Twp.).

Although the large bridge building company agents dominated the competition for the longer spans, a number of local contractors also successfully secured contracts for county bridges. Several local builders, like J. W. Scott, purchased the rolled section members from manufacturers like the Phoenix Iron Company in Phoenixville, Pennsylvania, and merely assembled the spans. Examples of the work of local builders include J. W. Scott's 1901-02 Pratt through trusses at Woodfern Road over the South Branch of the Raritan River (18B0511, 18B0512, Branchburg Twp.)

Four of the surviving metal truss bridges not previously mentioned in the narrative are highly significant and infrequently found examples of bridge building technology. The 1888 Province Line Road bridge over Bedens Brook (18C0104, Montgomery Twp.) is innovative in that it is a very early example of a totally rivet-connected span, and the earliest documented example of a Warren truss in the county. Generally, rigid (riveted) field connections were not common until the mid-1890s. Instead of the top chord and vertical being composed of built-up members, the bridge is built entirely of angles.

The 1889 3-span Howe pony truss bridge at Skillman (1850160, Camp Meeting Road, Montgomery Twp.) is the oldest and most significant railroad grade elimination project in the county. The Howe truss type is not a common late-19th century bridge type. It works on the opposite arrangement of the more common Pratt truss and has the diagonals in compression and the verticals in tension.

The 1909 Parker pony truss on Burnt Hill Road (18D0207, Montgomery Twp.) is the most significant 20th-century pony truss in the county due to its early use of bolts for field connections and its truss type, which affords economy of material and gives strength to the

center of the truss, where it is most needed. The Parker is an uncommon highway truss type in New Jersey.

The 1918 Bridge Street rivet-connected Warren through truss (1850167, Manville Borough) is a good example of the stiff through trusses that dominated the middle decades of the 20th-century. The bridge was constructed by the Reading Railroad as a grade elimination project, and it is the only 20th-century rivet-connected through highway truss bridge in the county. Composed of deep-section built-up members, its dimensioning reflects the scale of bridges designed to carry heavier loads over longer, wider spans.

Somerset County began to take on an increasingly suburban character in the first decades of the 20th century. One of the primary factors influencing the rapid growth of the county was the introduction of the automobile and the construction of new modern highways. The new transportation system not only made it possible to more easily reach the urban centers to the east, but it also made it possible to travel to a greater variety of places at any time. Shopping centers and new businesses followed the new suburban residents out from the cities, and placed even greater demands upon the county infrastructure. The areas of highest suburban development remained the eastern and central portions of the county, especially Warren and Bridgewater Townships, but all parts of the county experienced growth. Actual and anticipated population increases prompted county and local officials to begin adopting wider zoning ordinances and developing plans to bring some order to the expansion. The greatest efforts were placed into improving roads, bridges, schools, parks, corrections facilities and other civic services (Mustin 1930:29-39).

The better roads and bridges campaigns were carried on at a state and county level. The beginning of the automobile age coincided with the Progressive Era, a time that was characterized by the rapid development of government bureaucracies, and a high regard for the values of professional expertise and efficiency. In 1909 the State of New Jersey created a State Highway Commission, and in 1912 established an integrated system of state highways. The commission was authorized to acquire rights-of-way and existing roads where convenient, and hired engineers to prepare plans for durable, high-speed highways. By 1928 the state had designated the following routes in Somerset County: Route No. 12 from Three Bridges to Raritan (portions of current US 202); Route No. 27 from New Brunswick to Princeton (forming the southeastern border of the county and included in Middlesex County for survey purposes); Route No. 28 from Plainfield through Somerville to Phillipsburg (including western portions of current US 22); Route No. 29 from Three Bridges to the vicinity of North Plainfield (including eastern portions of current US 22 and southern portions of current US 202); Route No. 31 from Bedminster to Princeton (portions of current US 206); and Route No. 32 from Bedminster to Bernardsville (northern portions of current US 202) (NJDOT 1972:10-11.).

The creation of the state highways led to the large scale replacement and improvement of bridges along the county's major thoroughfares. The survey identified 16 bridges designed by the New Jersey State Highway Department Bridge Division from 1922 to 1929. Of the

16 bridges, eight were encased steel stringer spans (e.g. 1810158, US 206 over Pike Run, Hillsborough Twp.); three were concrete slab spans (e.g. 1810155, US 206 over Crushers Brook, Montgomery Twp.), three were reinforced-concrete arches (e.g. 1808150, US 206/US 202 over Peters Brook, Somerville Borough); and two were encased steel girder spans (e.g. 1809158, US 202 over Passaic River, Benards Twp.). The bridges are all standard New Jersey State Highway Department types. The largest of these bridges is the multi-span open spandrel arch bridge built across the Raritan River on NJ 31 (current US 206, 1810170, Somerville Borough). State Bridge Engineer Morris Goodkind chose open spandrel arch bridge designs for more than one dozen open spandrel arch bridges over major rivers in northern New Jersey including the six span, 1902'-long Morris Goodkind Bridge (US 1 over the Raritan River, 1203150, New Brunswick City, Middlesex County).

State highway improvements continued in the county in the 1930s and early 1940s, but at a somewhat slower pace. The most important projects were the widening of portions of NJ 28 and NJ 29 (current US 22 and southern parts of US 202) into four lane divided highways. The survey identified six bridges built during this period: four are reinforced concrete arches and two are encased steel stringer bridges. The most significant of the later bridges are the two 1942 multi-span reinforced concrete arch bridges built across the North Branch of the Raritan River on US 22 (1801153, 1801154, Branchburg Twp.) The US 22 arch bridges have many architectonic and decorative features including concrete pylons with fanciful tile mosaics that make them among the best examples of their type in the state.

During the first decades of the 20th century the county government also entered into a vigorous period of highway improvements. While state funds were available for the county's most important through roads, the vast majority of highway mileage remained solely under county supervision. As early as the 1870s the Freeholders had employed civil engineers on a contractual basis to help oversee road and bridge projects. The engineer's responsibilities usually included preparing bridge plans and securing the best price on materials. By the late 1890s the Freeholder's decided that the amount of highway work had grown so large and complex that a full-time county engineer was needed. They elected Joshua Doughty, Jr., the first County Engineer. Doughty remained County Engineer through 1920, overseeing a period of tremendous expansion of the county and state road system. The inter-position of a County Engineer and the introduction of state and then federally sponsored road programs removed the Freeholders from the intimate position of control which they had enjoyed earlier in their history. By 1930 the county permanently employed a large roads and bridges staff including a county engineer, a bridge supervisor, a roads supervisor, 5 foremen, and 35 laborers (Freeholders Minutes 1872-1897, Vol. 4-6; Mustin:28).

The new era of highway improvement also led to the introduction of new road and bridge materials. After 1900 macadam and eventually concrete roads became standard practice, while steel and reinforced-concrete increasingly became the most preferred bridge materials, although some other bridge types continued to be built. The replacement of

older structures and materials was rapid. In 1930 the Somerset County Board of Chosen Freeholders boasted in its promotional material that the county had "a modern, 806.62-mile road system, which is composed of coordinated, hard surfaced concrete main highways, secondary roads, and streets. They form a perfect network which ties in and makes accessible every remote part of the County and connects with the through routes of the excellent State Highway System." The county had also adopted a policy of systematically replacing older bridges with "new bridges of a permanent type" built of steel encased with concrete or reinforced concrete. The promotional literature proudly displayed photographs of the new bridges and took note that in 1929 the county had replaced its last covered bridge. The Freeholders claimed that the new bridge types did not sacrifice strength, increase costs, or lack beauty and artistry (Mustin:28).

The Historic Bridge Survey evaluated over 105 county-owned or built highway bridges dating from 1900 to 1946. The majority of bridges are an eclectic grouping of common 20th-century steel and reinforced-concrete types including reinforced-concrete arch, steel stringer, encased steel stringer, concrete slab, deck girder, through girder, pony truss, and T-beam bridges. Cost, material, suitability of preexisting substructure, expected traffic loads, height above mean high water, location, and length and width of span appear to have all been significant factors influencing the County Engineer's decision of bridge type and style. In general, the early-20th century bridges within the county show a pattern of increased standardization with encased steel stringer bridges becoming the preferred bridge type in the post-1920 period. Local contractors constructed most of the smaller spans while regionally and nationally recognized builders constructed many of the longer span crossings.

The most frequently found highway bridge type throughout the county is the steel stringer bridge. The survey evaluated over 55 county-owned or built steel stringer bridges. The oldest is the 1899 steel stringer with brick jack arches on River Road located in the Rocky Hill Historic District (18E0104, River Road over Van Horn Brook, Rocky Hill Borough). Nearly half the bridges are encased steel stringers with incised parapets built between 1915 and 1929. A good example of the encased steel stringer bridge type is the 1927 River Road over Pike Brook bridge (18E0204, Montgomery Twp.), located in the River Road Historic District. The most significant 20th-century steel stringer bridge in the county is the 1930 Millstone Causeway over the Millstone River (18G0505, Millstone Borough). The American Bridge Company designed causeway is noteworthy because of its length and its many architectonic features including original light standards and lanterns.

Of the over 105 county-owned or built bridges, the survey identified 17 reinforced concrete arch bridges built from 1905 to 1933. Interestingly, all but four of the bridges were located in city parks or near country estates, thus indicating that the arch bridge type was often chosen for its aesthetic appeal. A number of the bridges have rusticated stone fascias, textured stucco exteriors, and fancy balustrades further reinforcing the early-20th century association of the arch form with naturalistic settings. The construction of reinforced concrete arch bridges in parks was a common practice throughout the United States, and

is seen frequently in New Jersey. None of Somerset County's reinforced concrete arches are technologically significant, although one 1911 bridge, US 206 over Dukes Brook (1810169, Hillsborough Twp.), is associated with the National Register eligible estate of tobacco baron James B. Duke.

Steel girder bridges were a common highway bridge type in the county from the first decade of the 20th-century onward. The survey evaluated over 25 steel girder highway bridges. The oldest known surviving steel girder highway bridges are three joint-county bridges built from c.1900-1905 spanning Green Brook between North Plainfield and Plainfield, Union County. The most significant of these is a well-preserved 1903 multi-deck girder with concrete jack arches on Gerard Avenue (18M0903, North Plainfield Borough). The bridge is a rare example of a bridge built by the Dover Boiler Works of Dover, New Jersey.

Railroads were responsible for the construction of many of the steel girder highway bridges in the county. From the late-1910s through the 1930s the bridges were built as railroad grade elimination projects under the direction of the Public Utilities Commission, the state regulatory agency. The heaviest concentration of the steel girder bridge grade elimination projects is along the Conrail New York Branch, former Reading Railroad, south of Manville in Hillsborough and Montgomery Townships (e.g. 1810156, US 206 over Conrail, New York Branch, Montgomery Twp.). The girder bridges demonstrate no unusual construction details.

In summary, the history of Somerset County has been influenced by its transportation networks as much as any other factor. The findings of the Historic Bridge Survey indicate that the county's surviving historic bridges reflect the county's changing transportation networks, and its development from a predominately rural agrarian society to a suburban industrial society. The county is unique for its large number of surviving 18th and 19th century stone arches. The surviving metal truss highway bridges chronicle as well as any county in the state the evolution of the technology from the earliest days of the Phoenix Column to the standardization of designs and construction in the late 1920s. The county also has some outstanding examples of early-20th century highway bridge construction in steel and reinforced concrete.

In more recent years a new type of transportation network has unfolded in the county with the completion of Interstate Highways 78 and 287. The area around the I-78 and I-287 intersection has become what one recent writer calls an "Edge City," with extraordinarily large shopping malls, corporate office campuses, and nearby densely developed suburban residential communities (Garreau:6-7). Just as in earlier periods, increased pressure has been placed on older roads and bridges. At the same time, the modern multi-lane highway bridges and overpasses of highly specified prestressed concrete and welded girder design and construction represent a new transportation history in the making.

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SUSSEX COUNTY TRANSPORTATION HISTORY OVERVIEW

The bridges of Sussex County are part of a regional transportation system that began its development in the mid-17th century. Located in the mountainous northwest corner of the state, the county is distant from navigable waterways and would seem to have been one of the least likely places in early colonial New Jersey to have improved roads. Nevertheless, in the 1640s, Dutch colonists were drawn to Kittatinny Mountain north of the Delaware Water Gap in search of mineral wealth, especially the high quality native copper in the vicinity of Pahaquarry, Warren County. By the 1650s they had established a 140-mile road, known as the Old Mine Road (portions of present day Old Mine Road and Delaware Mine Road, CR 521 in Sussex County), between the western slope of the Kittatinny Ridge and the Delaware River from Pahaquarry north to Duttonville and hence to Kingston, New York on the Hudson River (Hine, pp. 1-12; Cunningham, p. 11). The Old Mine Road and related resources from Montague in Sussex County to Pahaquarry in Warren County were designated a National

The Old Mine Road was Sussex County's earliest, and perhaps most famous, example of a through road built to deliver the rich mineral resources of the county to points on the Hudson River. Dutch settlers followed the road into the area and became the county's first permanent European inhabitants in the Delaware and Walkkill River valleys. After 1700 the Dutch were joined by English, Scotch, and Irish immigrants making their way northwest over the steep mountain ridges from the vicinity of Morristown and the Passaic Valley. The latter made use of one of the notable Indian trails in the region, the Minisink Trail, which connected a large Lenni-Lenape settlement on the Delaware River at Minisink Island with points as far east as the Navesink Highlands in Monmouth County. Present-day routes NJ 15 and US 206 follow much the same direction as the Minisink Trail (Hine, pp. 4-5; Cunningham, pp. 11-12; Lane, p. 16).

Sussex County, despite its early access by road, was, until the last third of the 18th century, a thinly inhabited region because of its distance from the New Jersey colony's population centers on the Hudson and Delaware Rivers. After the French and Indian War, non-resident landowners holding claims to large tracts of Sussex County property encouraged immigration for the purpose of clearing and improving farm land. Most settlers traveled the Minisink Trail and established homes in the valleys separating Sussex County's mountain ridges. After 1760 county population increased steadily peaking in the 1820s at about 20,000 where it leveled off for the rest of the 19th century (Snell, p. 163).

The period from 1760 to 1820 was among the most significant in the county's history for the establishment of local roads and bridges. As in other northwestern New Jersey counties, the rural landscape of scattered farms was connected by a system of winding roads that met at small towns, such as Walpack Center, Flatbrookville, Sussex, and Sparta, where basic goods and services were available to the inhabitants. Newton, the county seat, emerged as the largest market town and the hub of the county's major

northeast-southwest and northwest-southeast through routes (present-day US 206 and NJ 94).

The roads and bridges, locally maintained and constructed, were seasonably passable, and although poor by modern standards formed the basis of many of the state and local routes still in use today. Bridges of timber and occasionally expensive stone arch construction were probably typical of other northwestern New Jersey counties. The Delaware River, on the county's western border, was crossed by at least two ferries, one at Dingman's Ferry and the other at Montague, opposite Milford, Pennsylvania. The ferries were important features of the transportation system. They were replaced in the 1830s by privately financed and built toll bridges; predecessor spans to the bridges still in use today carrying CR 521 (see 4100001, Dingman's Ferry Bridge, Sandyston Township) and US 206 (Delaware River Joint Toll Bridge Commission Bridge, Montague Township) (Snell, p. 163; Cummings, pp. 19-20; Lane, p. 127; Skemer, n.p.).

By the first decade of the 19th century Sussex County and neighboring counties were producing an agricultural surplus. A concern to local farmers was moving grain, wool, beef and produce to markets in northeastern New Jersey, but more significant to the county's future transportation development was the discovery of rich iron ore deposits and the establishment of iron furnaces and forges at Andover, Stanhope, Franklin, and Hamburg. The production of mine and foundry warranted better through roads to the Hudson River and Newark Bay. Within the period of five years from 1801 to 1806, New Jersey merchants and investors enthusiastically supported several turnpikes that under state charters took over existing through roads and improved them with wider right-of-ways, crushed stone and gravel surfaces, straighter alignments, and new bridges. Sussex County was among the early leaders in New Jersey's "turnpike era" (Lane, p. 145; Cummings, pp. 4-7).

Several of New Jersey's most successful turnpike companies had their western termini in Sussex County, including the 1801 Morris Turnpike, New Jersey's first turnpike, from Elizabethtown to Newton (present US 206 and Morris Turnpike Road south of Branchville Borough to Stanhope Borough); the Union Turnpike (1804-06) from Morristown to Sparta with an extension westward through Culvers Gap to Milford, Pennsylvania (present NJ 15 and US 206 north of Branchville Borough); and the Paterson and Hamburg Turnpike (1806) from Passaic to Milford, Pennsylvania (present NJ 23 east of Sussex Borough, and Deckertown Turnpike, CR 647, west of Sussex Borough). The turnpikes led directly to the establishment of regular stage services and freight wagons from Sussex County to Passaic, Paterson, Newark, and Elizabethtown, and proved the economic importance of a system of improved through roads in New Jersey. They also firmly established Milford, Pennsylvania as a landmark on the routes west from New Jersey to Eastern Pennsylvania and Upstate New York. Still, despite some early achievements, the turnpikes proved expensive and difficult to maintain. Toll revenues rarely met investors' expectations. After 1830 the turnpike companies abandoned routes or deferred maintenance, and in the late-19th century Sussex County purchased back the remaining toll roads for free public use.

Not until the 1920s would Sussex County again see a sustained effort at improving major through roads (Lane, pp. 146-147).

In the late 1820s Sussex County's iron founders turned to canals and then in the 1830s to railroads as better means of transporting raw materials to and finished products from their forges. The topography of Sussex County precluded the construction of any canals within its borders, but the Morris Canal (1826-1831), built to carry Pennsylvania anthracite coal to New Jersey's languishing iron industry in Warren, Sussex and Morris Counties, was connected to Lake Musconetcong and Lake Hopatcong on Sussex's southeastern boundary and contributed greatly to the revival and growth of the mines and foundries in nearby Andover.

The Morris Canal awakened Sussex's iron masters to the benefits to be gained from improved transportation of bulk goods, especially access to cheap coal, and in the mid-1830s several plans were developed for the construction of railroads. The first was a mule-drawn railroad extending a short distance from mines at Waterloo to the Morris Canal. Difficulties in receiving state charters and raising construction capital precluded construction of more and longer railroads until 1847, the year the Sussex Mine Railroad from Andover to the Morris Canal opened. It was owned by Cooper, Hewitt and Company, New York City iron and bridge merchants and investors in the Andover mines.

Following the opening of the Sussex Mine Railroad, renamed the Sussex Railroad Company in 1853, railroad construction in Sussex County increased at a slow but steady pace. By the 1850s New Jersey's iron industry was already facing stiff competition, especially from Pennsylvania iron mills, and the ability to invest in capital intensive railways was limited. From 1853 to 1869 the Sussex Railroad crept northward to Newton, Branchville, and Franklin Furnace. In the late 1850s it made connections with the Morris and Essex Railroad just over the southern county line in Morris County, thus giving it a direct rail route, albeit over another company's lines, to New York Harbor and bypassing the Morris Canal. In 1864 Morris and Essex Railroad stockholders purchased the Sussex Railroad, eventually merging it as a branch line of what would become the Delaware, Lackawanna, and Western Railroad (DL&W), a major anthracite coal hauling railroad originating in eastern Pennsylvania.

Prior to 1870 northern New Jersey's major main line railroads, such as the Erie, DL&W, and New Jersey Central (CNJ), had bypassed Sussex County in favor of other routes in part due to the county's difficult topography and relatively isolated geographic position. The Sussex Railroad served the central and southeastern portions of the county, but other parts of the county remained distant from railroad stations, and towns such as Deckertown and Hamburg were vocal in their desires for railroad connections. Between 1870 and 1895 several new railroads traversed Sussex County. They were not designed, however, so much to meet local needs as they were to offer competitive alternate through routes for the transportation of Pennsylvania anthracite coal to the eastern seaboard.

The most locally significant coal-hauling railroad was the New York, Susquehanna and Western Railroad (NYS&W), organized in 1881 out of the bankrupt remains of a series of railroads including the New Jersey Midlands Railroad, which in the early 1870s had connected Oswego, New York and Jersey City. The line passed through Deckertown, Hamburg, Ogdensburg, and Snuffstown in Sussex County. In 1882 the NYS&W extended its lines southwesterly from Ogdensburg across Sussex and Warren Counties to the Delaware Water Gap and by the early 1890s to Wilkes-Barre, Pennsylvania. It became a prosperous coal-carrying route and passenger line for Sussex County residents. The Lehigh and Hudson Railroad (1881) and the financially-troubled Lehigh and New England Railroad (1882-1893) passed northeasterly through Sussex County paralleling the mountain ridges and were originally built as routes to connect the mines and industries of eastern Pennsylvania with the mid-Hudson River and New England while bypassing the congestion of New York City (Lucas, pp. 5-7; Kulp, pp. 13-16). By 1895 most of Sussex County's larger towns, except for those west of the Kittatinny Ridge on the Delaware river, were connected by railroad.

In Sussex County, as in other rural New Jersey counties, railroads shortened travel times and prompted the growth of commercial agriculture. Sussex County farmers turned to dairy farming due to the ease and profitability of shipping milk and milk products to northeastern New Jersey's urban areas. Unlike Bergen, Passaic, and Morris Counties, Sussex County lay too far west of New York City to experience suburban growth from railroad commuters. Neither did the railroads stimulate large-scale industrial growth. A short-lived boom occurred in the iron and mining industries, especially in the extraction of rich iron and zinc deposits near Sterling Hill, but by the 20th century these had for the most part played out (Dunn and Kozykowski, pp. 370-371). The coal-hauling railroads also showed little interest in promoting tourism in Sussex County's picturesque mountains, and although a few hardy summer vacationers established lakeside retreats in the late-19th century it remained for the 20th century and automobile travelers to discover the area's natural beauty (Johnston, p. 71; Cunningham, p. 16).

Road and bridge building in Sussex County in the latter half of the 19th century mirrored other northwestern rural New Jersey counties with an emphasis on wagon roads that connected farms with nearby railroad depots. County Freeholders and township governments remained responsible for the construction and maintenance of roads and bridges, but interest in expensive improvements to major through highways waned when the railroads more than adequately served local purposes. In the 1880s and 1890s Sussex County Freeholders, like other New Jersey County Freeholders, had a wide, and probably at times bewildering, choice in metal truss highway bridge designs. More often than not they chose a balance of economy and strength and offered bridge contracts to one of the scores of regional bridge companies that specialized in metal truss construction. The pin-connected Pratt truss was the one of the most popular late-19th century highway bridge truss types, and the record of surviving bridges suggests that this too was the dominant metal truss in Sussex County.

The survey identified seven single-span pin-connected Pratt pony trusses dating in style from circa 1890 to 1900 and ranging from 37' to 70' span lengths. As a whole, the pony truss bridges made use of standard rolled iron or steel sections and showed no unusual or extraordinary design features. Four (1900W06, 1900D07, 1900E10, 1900P01) of the seven trusses were noteworthy for their integrity of design and state of preservation. The remaining three examples (1900H05, 1900V27, 1900J02) had either been significantly altered or recently removed because of structural inadequacies. Unfortunately, five of the seven trusses did not have builders plaques and were undocumented to original fabricator and date of construction. One of only two documented trusses, the Main Street bridge in Walpack Center (1900W06, Walpack Township), a five-panel Pratt pony truss, was fabricated by the Groton Bridge and Manufacturing Company of Groton, New York, a company that grew in the 1890s from a regional builder of small highway spans to one of the nation's large bridge-building firms. It is within the boundaries of the Walpack Center Historic District, a 19th-century market town that has little changed since the turn of the century. The only other documented truss, Smith Hill Road bridge (1900D07, Frankford Township) was erected by I. P. Bartley and Company, a small builder of which little is known.

Other than the seven Pratt pony truss bridges, the only additional metal truss bridge evaluated by the Survey in Sussex County was the Dingman's Ferry Bridge (4100001, Sandyston Township). The privately-owned toll bridge spans the Delaware River, and is still operated under an 1834 charter. It is a three span Baltimore thru truss with wrought iron Phoenix Section upper chord and end posts. According to bridge company sources, the circa 1890 bridge was originally part of a five-span bridge over the Susquehanna River at Laceyville, Pennsylvania. Portions of that bridge were destroyed in a flood, and in 1900 three of the surviving trusses were bought by the owners of the Dingman's Ferry Bridge and reerected over the Delaware River. The bridge remains in a remarkable state of preservation and is a rare extant example of the Baltimore truss type, a Pratt truss variation used occasionally from circa 1870 to 1910 for long-span bridges. A report on the Dingman's Ferry Bridge exists in the Historic American Engineering Record collection (Deloney, p. 149).

In the late 19th century metal truss bridges were often less costly than timber or stone arch bridges of similar span. Trusses rapidly replaced worn out bridges, but a small number of traditional bridge types continued to be built by local craftsmen for several decades. Masonry arch bridges, in particular, were often built or maintained for aesthetic reasons and Sussex County has at least two surviving examples of stone arch construction, the 1875 CR 631 over Walkkill River bridge (1900E06, Franklin Borough) and the 1915 NJ 15 over Beaver Run bridge (1922150, Lafayette Township). Both bridges have been widened and altered to meet modern traffic conditions and in comparison to other stone arch bridges in neighboring counties (e.g. 2101607, the 1860 Stephensburg Road over Musconetcong River bridge, Mansfield Township, Warren County) are late and undistinguished examples of the bridge type even though they are the only surveyed examples of their type in Sussex County.

From 1900 to the first world war many New Jersey counties began campaigns to improve roads and bridges, but Sussex County records show that efforts to update highways with gravel and concrete surfaces and to build modern steel and reinforced-concrete bridges remained sporadic and uncoordinated until after 1920. The only county-built highway bridge in the survey dating from 1901 to 1919 was the NJ 15 over Beaver Brook bridge (1922150, Lafayette Township), a traditionally-constructed stone arch span. While in other New Jersey counties the automobile was gaining popularity, in more conservative rural Sussex County the railroads maintained their dominance and even continued to lead in the area of bridge improvements.

Minor railroad bridge projects simply provided for the maintenance and upgrade of spans carrying local roads and farm lanes over railroad cuts and were typical of other overpass bridges built in New Jersey. Representative examples of overpasses included the 1905 CR 625 (Silver Lake Road) thru girder with concrete jack arch span over the NYS&W (1900J05, Hardyston Township), and the 1911 West Mountain Road timber stringer span over the NYS&W (1900Q25, Sparta Township), the latter one of the only remaining timber stringer bridges in the northwest portion of the state. The Lehigh and Hudson Railroad elevated its tracks on a fill through Hamburg Borough and in 1908 constructed a thru girder bridge (1903158, Hamburg Borough) over the former Paterson and Hamburg Turnpike (NJ 23).

By far the largest railroad construction project undertaken in Sussex County in the pre-World War One period was the DL&W's 1908-1911 New Jersey Cut-Off. The DL&W's management had for many years been dissatisfied with its route across Western New Jersey because of the numerous curves and two tunnels in Warren County that caused frequent delays and bottlenecks. Originally constructed in the mid-19th century, the DL&W's right-of-way was unsuited to carrying upward of fifty Pennsylvania coal trains eastward per day. In 1908 the DL&W decided to build a whole new line called the New Jersey Cut-Off that would shorten its route west of Stanhope, Sussex County to the Delaware River by eleven miles and eliminate sharp curves and extreme grade changes. Engineers surveyed a right-of-way that cut across the southern tip of Sussex County from Stanhope Borough to Andover Borough and through Green Township before entering Warren County. The New Jersey Cut-Off was a challenging civil engineering project requiring huge earthen fills and large bridges, two over 1000' in length, to span the mountains and valleys. The DL&W gained much publicity by its decision to build all of the route's bridges and culverts from reinforced-concrete, a bridge material never before used in such quantity by an United States railroad (Taber and Taber, pp. 34-37). The New Jersey Cut-Off project was completed in 1911.

In Sussex County one of the most impressive portions of the New Jersey Cut-Off was the 3.12 mile-long Pequest Fill that rose to a height of 110 feet above the Pequest Valley and included over six and one-half million cubic yards of fill. From atop the Fill railroad passengers received a magnificent view of the rolling hills and farmland. The survey

evaluated seven Sussex County bridges associated with the New Jersey Cut-Off. One 1910 reinforced concrete arch bridge (1911155, Andover Borough) carries a portion of the Pequest Fill over US 206. Four other 1911 bridges (1900K07, CR 605, Hopatcong Borough; 1900C17, Roseville Road, Byram Township; 1900G13, CR 611, Green Township; and, 1900G12, Henry Road, Green Township) are distinctive reinforced-concrete deck arch overpasses conveying local roads over the New Jersey Cut-Off. Two reinforced-concrete culverts (1911154, US 206 over Branch of Pequest River, 1910, Andover Borough; 1900C18, Roseville Road over Wolf Lake Inlet, 1910, Byram Township), although not individually impressive structures, demonstrate just how extensively the New Jersey Cut-Off impacted the Sussex County landscape requiring the realignment of numerous local roads and streams, and even creating new lakes and water features (Taber and Taber, p. 36). The New Jersey Cut-Off was the last major railroad project undertaken in Sussex County.

After 1920 New Jersey shifted into the golden age of highway building, but major improvements did not come to Sussex County until the last half of the decade. In northwestern New Jersey, as in other of the more isolated parts of the state, the State Highway Department, created by a legislative act of 1916, led the way taking over many of the county's most important through routes and upgrading them for automobile traffic. Farmers bought mass produced and inexpensive cars such as Ford's Model A, and groups such as the Dairyman's Association lobbied local and state government to improve the county's roads. The automobile in combination with improved highways ended rural reliance upon railroad transportation and brought increasing numbers of urban and suburban vacationers to Sussex County campgrounds, forests, lakes, and outdoor recreational areas. One site associated with the growth of tourism is the Wheatsworth Company factory in Hamburg. The factory, which ground whole wheat flour for biscuits, was expanded in the 1920s and early 1930s with a medieval style reinforced-concrete addition and a Gingerbread Castle amusement park to attract travelers from the nearby state highway. Part of the construction included an encased steel stringer bridge (1900H92, Hamburg Borough) with medieval style railings to match the factory.

The 1916 act authorized the State Highway Department to establish 15 State Highway Routes, including Route 8 in Sussex County (portions of present NJ 23 from Stockholm to Sussex, and present NJ 284 from Sussex to the New York State Line). World War One delayed appropriations of highway funds and major improvements did not get underway on Route 8 until 1921. Construction included two State Highway Department designed encased steel stringer bridges over branches of the Wallkill River (1907152 & 1907157, NJ 284, Wantage Township). In Sussex County the State Highway Department's efforts were slow at first, reflecting the time it took to efficiently organize and concentrate the efforts of the new Department. In 1926 Route 8 was still under construction from Stockholm to Beaver Lake and from Hamburg to Sussex.

In 1927 the Legislature expanded the State Highway System to 50 primary and secondary routes. The State Highway Department took over existing county roads and improved them

with wider and straighter roadways, bridges, berms, permanent and semi-permanent paving, signage, and guard rails. New routes in Sussex County were a redesignated Route 8 from Huntsburg to Newton (present NJ 94); a renumbered Route 8-North from Sussex to the New York State Line (present NJ 284); Route 23 from Stockholm to the New York State Line at Port Jervis (present NJ 23); Route 31 from Stanhope through Newton, Hamburg, and Vernon (present US 206 south of Newton and NJ 94 north of Newton); and Route S-31 from Newton to the Delaware River opposite Milford, Pennsylvania (present US 206 north of Newton). The additional routes worked to Sussex County's benefit and inaugurated a period of rapid State Highway construction that continued under New Deal programs of the early 1930s. The largest concentration of State Highway bridges dated from 1926 to 1931 and included four encased steel stringer spans (e.g. 1912160, US 206 over Big Flat Brook, 1929, Sandyston Township), three reinforced-concrete slab spans (e.g. 1904153, NJ 23 over Branch of Wallkill River, 1926, Wantage Township), one encased thru girder span (1923150, NJ 94 over Wallkill River, 1929, Hamburg Borough), and one encased multi girder span (1903154, NJ 23 over Branch of Franklin Lake, 1928, Franklin Borough). The State Highway bridges in Sussex County were similar to those found throughout the state and demonstrated no unusual technological features. They are predominantly encased rolled steel I-beam, or stringer, spans on reinforced concrete substructures.

State Highway construction coincided with renewed efforts to eliminate busy and dangerous railroad grade crossings. Prior to the Depression the railroad companies usually paid for and designed overpasses to promote safety, but after the early 1930s the financially strapped railroads usually left grade elimination projects to government agencies. From 1927 to 1941 at least five railroad overpasses were constructed in Sussex County, all of them associated with improvements to State Highways. The 1927 NJ 23 over the NYS&W multi-span deck girder overpass (1903152, Hardyston Township) and the 1931 CR 631 (Old NJ 23) over NYS&W multi-span thru girder overpass (1900E07, Franklin Borough) were designed by the engineering department of the railroad company and were similar to others in the northern part of New Jersey. The 1934 NJ 94 over NYS&W steel stringer span (1923151, Hamburg Borough), the 1940 US 206 over DL&W RR multi-girder span (1912150, Branchville Borough), and the 1941 NJ 23 over Lehigh and New England Railroad multi-girder span (1904154, Wantage Township) were State Highway Department designed overpasses with standard concrete balustrades and encased beams. The construction of railroad overpasses, primarily for the convenience and safety of automobiles, also marked the beginning of the end of the dominance of railroads in Sussex County's transportation system. The railroads' financial problems continued after the Second World War and in Sussex County were severely harmed by a decline in the anthracite coal trade. In 1961 the Lehigh and New England Railroad ceased operations, in 1979 trains last ran on the DL&W's New Jersey Cut-Off, and today only portions of the former NYS&W and Lehigh and Hudson lines carry freight traffic.

Sussex County relied heavily on the financial assistance of the state and federal governments for improvements to county and township roads. Many wealthier New Jersey

counties were able in the 1910s and 1920s to undertake extensive building campaigns on their own, but in Sussex County a period of coordinated and systematic county road and bridge construction did not occur until after 1932 when New Deal public works project funding became widely available. Over one-half of the nearly 50 county highway bridges evaluated by the Survey dated from 1933 to 1941. During the Depression county engineer Harvey Snook headed local bridge building efforts, and the Survey identified 15 encased steel stringer bridges (e.g. 1900G02, Springdale-Tranquility Road over Pequest River, 1939, Green Township) and 10 reinforced-concrete slab bridges (e.g. 1900X01, Roy Road over Papakating Creek, 1939, Wantage Township) attributable to Snook. County engineers such as Snook employed standard textbook designs for most of their bridges, yet often chose a single detail, usually the railings but sometimes other features, to distinguished their county's bridges from those of neighboring counties. In Sussex County the signature feature was a plain two rail concrete railing. The Depression-era bridge building campaign marked the last major development in the pre-1946 history of Sussex County bridges. It also marked the completion of an integrated system of state and county highways, and the end of Sussex County's "golden age of highway building."

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UNION COUNTY TRANSPORTATION HISTORY OVERVIEW

Located within the New York metropolitan region with water frontage on Arthur Kill and Newark Bay, Union County's developmental and transportation history reflects its proximity to Manhattan proper and the influence of the transportation networks servicing the city. Created in 1857 from the south half of Essex County, Union County contains the oldest English settlement in the state (Elizabeth), yet it is the youngest of New Jersey's 21 counties. It ranks as one of the top five industrial counties in the state with much of that industrial development, and thus increase in population and improvement of the road system, coming in the mid-20th century.

This transition from bucolic, agricultural area and small, proto-industrial towns to industrial prominence and metropolitan suburb this century is reflected in the bridges in the county. Of the 106 surveyed bridges in the county, only six (one metal pony truss, three brick arches, two stone arch spans) date to the 19th century. Three major railroad lines cross the county (Lehigh Valley Railroad, Central Railroad of New Jersey, Delaware, Lackawanna, and Western), and 16 bridges in this survey are railroad-related, including the only thru truss bridges in the county. Many other railroad-related bridges are included in the 1991 NJT survey. But by far the greatest number of pre-1945 bridges are those built by the county and the state as part of their 20th-century improvement campaigns. The historic transportation hub of the county was Elizabeth (town and port), an early port and the business and industrial center. Although eclipsed by Hudson County and Newark as a late-19th and 20th-century transportation terminus, Elizabeth benefited early on from its situation on Arthur Kill, and it was included on early transportation routes (water-borne, colonial-era great roads, and early turnpikes), and the area continued to attract industry and development and was sufficiently congested to require major highway improvements well into this century.

Union County is located in the northeast portion of the state. It is bounded by Arthur Kill and Newark Bay on the east, Essex County, of which it was formerly a part, on the north, Morris and Somerset county on the west, and Middlesex County on the south. While the uplands are well-drained and fertile, the land between Rahway and Elizabeth on the coast (Linden Township) is low and marshy. The area, like most of the region, was initially occupied by the Lenni Lenape Indians, and the Minisink Trail passed through the county. The Dutch were the first Europeans to come, arriving in the area prior to 1664, but in that year the territory fell to the British as part of the Dutch surrender of Manhattan.

English settlers from Long Island had established a small settlement on Achter Kol (Arthur Kill) by the time Philip Carteret, a cousin of George Carteret who had been given half of New Jersey by the Duke of York, arrived in the summer of 1665. Elizabeth developed as a port and a center of leather tanning. Settlers pushed out to the west from Elizabeth, and other early towns in the county include Scotch Plains, Rahway, New Providence, Westfield, Plainfield, and Springfield.

Essex County was decidedly agricultural, and its rival cities, Elizabeth and Newark, were about 1,000 inhabitants each at the end of the Revolution. By the first decade of the 19th century, however, Newark was ascending as the more significant city of the two. Even Elizabeth's leather industry was migrating to Newark, and in 1807, the county courthouse was erected in Newark (Cunningham, p. 109). Rivalry between the two cities culminated in 1857 with the separation of Essex into two counties; Essex with Newark as the county seat and the other, Union County, with Elizabeth as the county seat.

Both cities were served by the Old York Road, an important intrastate route that linked New York with Philadelphia. It passed from Newark south to Elizabeth, on to Westfield, Scotch Plains, Plainfield, and then into Somerset County. The Morris Turnpike, the 1801 toll road to Morristown, had its initial deepwater port terminus at Elizabeth, which was a prosperous fishing and oystering center. It was also site of ferry service linking the south portion of Essex County with New York City and Staten Island. The first steam ferry service was introduced in 1810 (Condit, p. 64).

Elizabeth's future seemed bright during the early days of railroading in the 1830s and 1840s. A group of New York businessmen obtained a charter for the Elizabeth & Somerville Railroad. It was slow to be developed, and only in 1835 was horse-drawn service inaugurated between the port area of Elizabeth on Newark Bay and the commercial district to the west. That same year the railroad platted and began to develop an area at the port named The Manufacturing Town of Elizabeth Port. The rail line was completed to Plainfield in 1839 and Somerville in 1842. It was never financially successful, and in 1849, the local line merged with the Somerville & Easton line to form the Central Railroad of New Jersey (CNJ). Although the CNJ never fulfilled the initial expectation of becoming a major coal-hauling line, its influence in the development of the county was great, as were two other lines, the Lehigh Valley Railroad and the Delaware, Lackawanna & Western Railroad (DL&W), both coal-hauling lines that crossed the county en route to terminal facilities in Hudson County.

Although the CNJ was a through route with access to the rich eastern Pennsylvania coal business, it was apparent that Elizabeth was not the optimum terminus for the line. To have access to the New York market, the CNJ had to reach Jersey City. Elizabeth, on the west side of Newark Bay, was simply too remote to be a viable port for the New York trade. The CNJ had the choice of crossing the bay at Elizabethport and then going up the Bayonne peninsula (Hudson County) to Communipaw, or develop a route through the difficult Bergen Hill to the Jersey City waterfront. The former was done in 1864 with a movable span bridge across Newark Bay, and ferry connections to New York from Communipaw. This solution kept the CNJ main line running through Elizabeth.

In 1844, Elizabethport was spoken of as a "new and thriving place" (Cunningham, p. 110). Several small machine manufacturers were located there. Other towns in the county had small paper mills. Rahway was noted for its antebellum-era production of fine carriages,

and Plainfield for felt hats and clothing. The most significant boost to manufacturing in the county occurred in 1873 when the Singer Manufacturing Company consolidated several separate sewing machine plants into one large facility at Elizabethport adjacent to the CNJ railroad yard. Reaching an employment level as high as 7,000 at its over 100-acre facility, the company was by far the largest in the county, and it did much to focus national attention on the meadow land available for big industry in Union County (Ibid.).

The meadow lands south of Elizabeth and north of Rahway, today one of the most highly industrialized corridors in the state, however, developed slowly. In 1890, Linden was still dominated by agriculture. The trend was away from farms to more profitable truck farming of fruits and vegetables to supply nearby urban markets. But during the next two decades, the industrial prominence of the area was established. Three-In-One Oil, developed in 1894, established its production facility there, as did George Merck for his drugs and chemicals in 1900-1903. About the same time Standard Oil of New Jersey moved from its congested facilities at Bayonne and Jersey City and built a pumping station, and in 1909 it opened its refinery at Rahway. It grew into one of the largest in the world (Cunningham, p. 111). Graselli's chemical production plant was also an early industry in the area, which was serviced by the CNJ (right-of-way paralleled by the New Jersey Turnpike) and Pennsylvania railroads.

The industrialization of the county continued through the first half of the 20th century with Union County leading the state for new industry for the five years following World War II (Ibid.). So dramatic was this industrial increase that the county population quadrupled from 99,353 to 398,138 between 1900 and 1950.

Because so much of the development within the county is early- to mid-20th century, little in the way of 19th-century infrastructure survives. Highways and railroads were upgraded to accommodate 20th-century load requirements. What few 19th-century bridges that do survive are in 19th-century industrial centers, like Rahway, or on historic roads.

In contrast to the industrialization and urbanization of the Elizabeth-Rahway area is the suburbanization of the rest of the county. Starting just after the Civil War, both the DL&W and the CNJ railroads recognized the value of commuter traffic, and both became important commuter lines servicing New York City. Improved ferry service and train travel brought New York City within an hour's commute of large portions of the county, and both the CNJ and the DL&W promoted home ownership in fashionable burgeoning suburbs like Fanwood, Summit and Cranford which were located along their routes. They built handsome passenger stations in the communities that lined their rights-of-way and established schedules to accommodate the commuter. The CNJ was even a land developer, buying farm land and subdividing it into house lots. In 1889 the railroad produced a pamphlet entitled "Why Not Own Your Own Home on the Line of the Central Railroad of New Jersey?" to extol the advantages of suburban living and riding to work in the "comfortable seats in luxurious, well-ventilated passenger coaches" that are the "beau ideal of comfort and convenience."

The CNJ ran two divisions of its suburban system to service Union County. The first division ended at Roselle and passed through Elizabethport, Elizabeth and El Moro. The second division extended to Dunellen (Middlesex County) passing through Cranford, Westfield, Fanwood, Netherwood, and Plainfield. To further enhance its commuter appeal, the CNJ built a large, handsome passenger and ferry terminal in Jersey City in 1887-1889. Cranford, one of the largest and architecturally most complete late-19th and early 20th-century residential districts in the state, was established in 1871, and it was serviced by over 120 trains a day in 1913. Advertising itself as "the Venice of New Jersey" because of its orientation to the picturesque, meandering Rahway River, it was only 35-45 minutes from New York City, including the ferry (Cranford Board of Trade).

Another important suburban route that affected the development of the county was the DL&W Railroad. The line established its own route across New Jersey in 1868 by gaining control of the Morris & Essex Railroad which had its terminal at Hoboken. The main line passes through the northwest corner of the county, servicing Berkeley, Murray Hill, New Providence, and Summit. Once a haven for seasonal visitors, the area developed during the last quarter of the 19th century and into this century as desirable suburbs attractive to commuters to New York City and Newark as well as local industries and laboratories like Bell Telephone's laboratory in Murray Hill or Ciba Pharmaceutical Company's plant in Summit. By using its more northerly route from Boonton to Hoboken for its long, slow freight trains, the DL&W was able to provide fast, frequent service to the affluent suburbs west of Newark on its old main route. To attract commuters, the line was improved with comfortable, architectonic passenger stations, like the 1890-91 Murray Hill station. Thus, like so much of Bergen and Essex counties, the affluent suburban character of large portions of Union County is a response to the presence of the railroads.

Many of the residential areas that the railroads pass through were developed after the railroad rights-of-way were established, and the roads were laid out accordingly with a minimum of overpass bridges. In more congested areas, increased train and vehicular traffic, both horse drawn and motorized, mandated separating traffic, and major grade crossing elimination campaigns were undertaken by the CNJ in Plainfield in 1907, in Westfield in 1917, and in Cranford in 1928-29 and by the DL&W in Summit in 1905, and by the Pennsylvania Railroad through Rahway about 1913. In addition to the campaigns, other grade crossing elimination bridges were built by the railroads throughout the county piecemeal through the 1930s. The CNJ built at least eight bridges over or under its main line to Elizabeth between 1907 and 1926. The bridges represent the two types that were the most common used in the county for grade crossing eliminations; the thru girder with floor beams bridge built up of riveted plate and angle stock, and the riveted thru truss bridge.

Developed in the late-1840s by a railroad bridge engineer, the girder bridge, built up of wrought-iron plate and angles riveted together, was immensely popular because of its capacity, rigidity, economy of maintenance, and fact that it could be assembled off-site and

easily installed with the assistance of a crane. The bridge type was immensely popular for grade crossing eliminations and water-feature crossings well into this century, and it is the most common type of railroad-related span in Union County and the state. Eleven built-up thru or deck girder bridges built between 1907 and 1934 were included in this survey.

They are common as one-span bridges on reinforced concrete substructures and as three-span bridges with built-up steel curb bents. In the three-span configuration, the short approach spans over sidewalks are deck girders while the main span over the wider roadway is a thru girder.

For clear-span lengths greater than the 100', the railroads often used riveted construction thru truss bridges. Four such bridges were built by the CNJ between 1911 and 1926 (2050150, 2050151, 2050161, 2050162) over its main line. The bridges are all similarly designed Warren thru trusses, and combined with the plate girder bridges, they represent the strong presence of the railroads in the county. None of the railroad bridges are technologically innovative, but they are representative examples of the types and designs of spans the railroads preferred and built with great frequency in the northern part of New Jersey.

The roads and bridges in the county reflect the relatively recent development of the county. Only six bridges in the county date to the 19th century, and five of them are masonry arches dating from about 1875 (2003006, 2003045, 2006151, 2012150, 2013010). Three of them are located in Rahway (2006151, 2013010, 2013051), and they illustrate the prominence of the community in the early history of the county. NJ 27 over Robinson's Branch (2006151) of the Rahway River carries the historic Great Road over the feature, and the other two are located in the city which thrived on its water-powered industries, like carriage manufacturing. The Lincoln Avenue brick arch in Cranford (2003045) and the Morris Avenue stone arch in Springfield (2012150) were built by the county in areas of burgeoning residential development. While not generally technologically innovative, all the arch bridges were well detailed, and they are representative examples of the most common mid-19th century bridge type for "permanent" structures built at major crossings or in developed areas. Brick arches are common to northern New Jersey from the last quarter of the 19th century while extant stone arch bridges in the state date to as early as the 1790s.

Like in other counties, roads were the responsibility of the officials of the town in which they were located. The concept of through roads being a shared obligation among the various towns and counties was not developed until about the turn-of-the-century. Bridges, however, were a county freeholder charge, and the body made all decisions concerning them until the appointment of the first county engineer in 1896. Jacob L. Bauer (b. 1868) was born in Linden and attend the two-year civil engineering program at Rutgers. From 1889 until 1896 he worked as an assistant in several different engineering offices, and in 1896 he was appointed engineer for Union County. Rather than working solely for the county, he maintained his own office in Elizabeth. He served in the capacity of county

engineer until 1922 (Honeyman, p. 267) and was responsible, at least in part, for the development of the county's infrastructure as it is known today.

It is assumed that metal truss bridges were built in the county prior to 1905, but only one example survives. The ca. 1890 Wrought Iron bridge Company Pratt half-hip pony truss span on East Inman Avenue over the South Branch Rahway River at Rahway (2013013) has been extensively altered, but it does illustrate that the bridge type was used in the county.

The earliest county-designed and built bridges are a group of reinforced concrete deck arch spans. Seven built between 1907 and 1917 survive with the earliest, New Church Road over Robinson's Branch Rahway River in Rahway (2013022) being the most historically distinguished example of the type. Introduced in this country in the 1890s, the bridge type quickly became a favorite owing to its low maintenance and rigidity in comparison to metal truss bridges. By 1906 reinforced concrete deck arch bridges, as well as a host of other bridge and structure types in concrete, were common in New Jersey. The material and designs were adopted as quickly as any earlier technology, and the plastic qualities of concrete were utilized to achieve aesthetically pleasing bridges in Union County as well as all across the state. One other reinforced concrete deck arch bridge was built in the county after 1917 (2016013 built as a joint-county span with Somerset County in Scotch Plains in 1920), but after World War I, the rolled I-section stringer became the span type of preference.

Over forty-five, or approximately 44% of the pre-1946 bridges in the county, are stringer bridges. Their predominance is due in part to the relatively recent development of the county and the infrastructure needed to support that development. The industrial and residential expansions within both the county and the state after World War I mandated that roads and bridges be constructed to handle the increased usage and load requirements. Because of its location within the New York metropolitan region and along the heavily trafficked routes to the Jersey Shore, Union County benefited from major state highways, like the Route 1 Extension to accommodate Holland Tunnel traffic, and Route 1 itself, the main highway from Newark, through Elizabeth to New Brunswick and Trenton. The route was dualized and grade crossings eliminated in the late-1920s. US 22, old NJ 27 and NJ 28, was dualized and grade crossings eliminated around 1940.

The bridge type that came to the fore as the one best able to meet the demands of capacity, economy, rigidity, low-maintenance, and ease of erection was the rolled I-section stringer, both encased and exposed, on a reinforced concrete substructure. It was promoted by the State Highway Department, and it was equally as popular with the county engineer. Stringer bridges were built in the county by the county and the state almost to the exclusion of other bridge types (a few slab spans and thru girders were built) by both the state and the county. Most were finished with nicely proportioned concrete balustrades. Technologically the stringer spans are not individually significant, and they are virtually undistinguishable from other examples throughout the state.

Two of the most notable spans in the county are movable bridges located at the mouth of the Elizabeth River on Newark Bay in Elizabeth. Once an industrial area, today the river sees only limited barge and pleasure boat traffic, but the 1907 Strauss overhead articulated counterweight single-leaf bascule bridge at South First Street (2004002) and the 1920 Strauss heel trunnion single-leaf bascule bridge at South Front Street (2004001) are significant remnants from the halcyon days of industrial development in Elizabeth. Both are valuable examples of their type and design, which are becoming increasingly rare in both New Jersey and the country as a whole. The 1907 overhead counterweight span is one of only about five remaining in the state and is one of the earliest (only 1906 Federal Street over Cooper River in Camden County is older;043B008). It was damaged in a 1984 fire that claimed the operator's house and controls, but otherwise it appears to be a reasonably complete example of first-generation movable bridge technology. The design was patented by J. B. Strauss of Chicago in 1905.

The other movable span is also a Strauss design. Erected in 1920, the heel trunnion bridge is one of only two documented highway examples of its design in the state (0208150, the Belleville bridge over the Passaic River between Hudson and Bergen counties), and it is a complete and operating example of its design. The bridge type was popular with railroads, and several examples are located on rail lines used by NJT (see NJT 1991 Bridge Survey). Both bridges are significant in conveying the historical development of the county, and the evolution of movable bridge technology in the statewide context.

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WARREN COUNTY TRANSPORTATION HISTORY OVERVIEW

Warren County, bounded by the Delaware River on the west, Sussex County on the north, Morris County on the east, and Hunterdon County and the Musconetcong River on the south, was not created until 1824 when it was partitioned from Sussex County. Its bridge history is best understood in the context of the county's transportation systems (trail, water-borne, canal, railroad, and highway), all of which figure into the historical development and present-day character of the county. Located far interior from the original areas of colonization and among the last points of settlement in New Jersey, overland routes were slow to be developed in the region through the colonial period. Indian paths, most notably the Lenni-Lenape's Allamatunk Trail which passed through the county between the South Branch of the Raritan River and the Delaware Water Gap, offered limited access to trappers. The Old Mine Road, which followed the Kittaniny Mountains from the Delaware Water Gap to Kingston, New York, was developed in the 1650s by Dutch miners who came to the region for the small seams of native copper. It was abandoned a decade later and never developed into an important settlement route.

From 1725 to 1790 settlers of English, Scotch-Irish, and Dutch ancestry pushed into the region to establish farms in the relatively rich river valleys, especially the southernmost Musconetcong Valley. Rafts and flat-bottom Durham boats carrying grain, lumber, whiskey, and livestock plied the Delaware River, but direct passage beyond Trenton was not possible because of the falls. The area that developed as the trading center of the region was Easton, Pennsylvania, situated at the confluence of the Lehigh and Delaware rivers, and Phillipsburg, located directly across the river from Easton. The towns grew into regionally important commercial centers because of their initial dominance of the river trade and the subsequent influences of other transportation systems. Ferry service linked Easton and Phillipsburg since the early days of settlement, and in 1806 a privately financed 550' long covered wood truss bridge between the two towns was completed. It was the first long-span bridge in northwestern New Jersey (Brydon, P. 122), and the span did much to establish Phillipsburg's stature as an important market town and, later, manufacturing center. Like counties downstream, the success of the 1806 Phillipsburg-Easton bridge, prompted other river towns in the county to lobby the New Jersey and Pennsylvania legislatures for bridge charters. Bridges were built at Riegelsville, Belvidere, and Columbia, but none of those communities achieved the success and size of Phillipsburg.

As early as 1742 iron masters built furnaces at Oxford to take advantage of the county's iron ore deposits and established a regionally important industry, but most towns, such as Washington, Belvidere, Riegelsville, and Hackettstown remained small agricultural settlements well into the 19th century. Growth was slow but steady, perhaps in part due to the fact that large tracts of land were owned by non-residents, who, while they encouraged immigration for the purpose of improving their lands, declined to sell it off in small lots for the purposes of homesteading (Cunningham, pp. 21-24; Wacker, pp. 132-142).

The development of roads in Warren County is not unlike that in other parts of the state, although it is slightly later owing to the slow growth of the county. Colonists improved Indian paths for the passage of wagons, but roads remained poor and seasonably passable through the 18th and 19th centuries. By 1790 roads were open to move farm products and pig iron to markets located to the south and east and those routes form the rudimentary basis for the present-day network of state and county highways. The first major route connected Phillipsburg with Bloomsbury on the Musconetcong River, the boundary between Hunterdon and Warren counties and then on to Pittstown, connecting with roads south to Trenton or east to Somerville (today US 22 Alt., NJ 173, US 22). Other early county routes included the road along the course of the Musconetcong River from Bloomsbury to Asbury and New Hampton (CR 623); the road from Phillipsburg to Washington and Hackettstown (NJ 57) and continuing eastward over the mountains to Morristown in Morris County (US 46); and the road from New Hampton to Washington and on north to Oxford Furnace and Hope, ending in Newton, Sussex County (NJ 31, CR 519), with a branch connecting to Columbia (NJ 94) (Lane, p. 53; Wacker, pp. 153, 161).

A seasonal problem was crossing the county's many swift streams. Most of the rivers were fordable in dry weather, but, as one traveler recorded in his diary in April 1789, they were sometimes so high in wet weather that they could not be crossed under any circumstances. Spring floods made the construction of permanent bridges impractical when annual freshets threatened to wash them away, and even simple timber structures were not built in great numbers by the Board of Freeholders until after 1770 (Lane, p. 127; Wacker, pp. 136-137).

The period of turnpike construction in the first decade of the 19th century marks an important turning point in the history of Warren County roadways. Previously roads were built by local inhabitants to serve local needs. The turnpikes were financed and built by city merchants and investors, as through roads to reach out to capture the natural resources and products of the countryside. They were the first of several examples of transportation systems built by merchant capitalists building routes in search of profits in Warren and surrounding counties. The privately financed roads, however, did follow the development pattern established in the 18th century with Phillipsburg as the western terminus.

Both the 1806 Washington and the 1806 New Jersey Turnpikes tapped the Delaware Valley for the benefit of New York City area merchants and stimulated agricultural growth in staple goods such as wheat, corn, rye, oats, flax-seed, and beef (Lane pp. 147-149). The Washington Turnpike went east from Phillipsburg to Morristown (NJ 57) where it connected with other turnpikes leading in the direction of New York Harbor. The New Jersey Turnpike headed east from Phillipsburg on the route to Somerville and New Brunswick on the Raritan River (US 22, NJ 28). Generally, the turnpike companies took over existing roadways and improved them with crushed stone surfaces and foundations.

In the long run, Warren's turnpikes, like most others of the period, were financial failures. Agricultural freighting and livestock droving was seasonal, and traffic in the sparsely settled

region never reached anticipated volumes. Additionally, construction and maintenance costs on the lengthy turnpikes far outstripped toll receipts, and shunpikes, or public roads that bypassed toll houses, were common. In 1823 the Washington Turnpike was sold at sheriff's sale to pay debtors, and in 1838 the New Jersey Turnpike surrendered its Warren County sections in an attempt by the stockholders to remain solvent (Gordon, pp. 257-259; Brydon, p. 122; Lane, p. 161).

Ironically, the abandonment of turnpikes occurred just as the iron merchants of north central New Jersey were searching for a better means of transporting anthracite coal from eastern Pennsylvania into the region. In the 1810s several iron masters had successfully used anthracite coal fuel for ore reduction, indicating that coal, not charcoal, would be the fuel of the future. But the problem remained of how to economically and efficiently move the volumes of coal from Pennsylvania to isolated iron ore deposits and furnaces in north and central New Jersey (Kalata, pp. 1-20).

In the early 1820s the iron merchants joined forces with New York City investors to finance the building of the Morris Canal across northern New Jersey from Phillipsburg to Newark. Construction of the 90-mile long canal began in 1825, and after numerous financial and engineering difficulties, it was completed in 1831. The canal's main trade was the anthracite coal shipped to Easton via the Lehigh Coal and Navigation Company canal (1826-1829), then across the Delaware River and into the Morris Canal at Phillipsburg. In Warren County the canal ran in a northeasterly direction from Phillipsburg through Washington and Hackettstown roughly paralleling the Musconetcong River (Gordon, pp. 23-26; Veit, P. 35).

The Morris Canal brought to prominence the trade route leading directly across the state from Newark to Phillipsburg, and in 1866, its peak year of operation, the canal carried over 459,000 tons of coal and 290,000 tons of iron ore (Kalata, p. 641). It revived the local iron industry and had the secondary effect of stimulating Warren County's agricultural production of flour, feed, and meal which were shipped to eastern urban markets. The canal also required men to operate the locks and inclined planes, canal houses to service boatmen and travelers, and led directly to the growth of Phillipsburg, Bloomsbury, Washington, and Hackettstown and the creation of several canal villages including Port Murray and Rockport.

The prosperity of the canal era ended suddenly in the early 1870s due to competition from railroads. By the 1880s coal and iron canal traffic had decreased to a trickle, and usage was mostly for local purposes. In 1922 the State of New Jersey took over the failed canal, and from 1924 to 1928 drained and dismantled most portions of the route while converting some reservoirs for water supply and flood control (Veit, pp. 55-56). The Morris Canal right-of-way is listed in the National Register of Historic Places, but in Warren County few structures remain to mark the route. No highway bridges historically associated with the canal were identified.

The same economic forces that produced the Morris Canal also prompted the development of railroads. The railroads, however, did not complete routes through Warren County until the 1850s for a variety of reasons including high capital costs, investment in new steam and rail technologies capable of handling heavy loads over long distances, and difficulties in negotiating state charters and adequate public and private financing. Like the canal, Warren County's railroads were not locally owned. They were either extensions of existing lines expanding west from eastern cities such as Newark or Elizabeth, or of lines building east from Pennsylvania coal mining districts to reach the New York market.

Warren County lies along the path favored by railroads for moving coal from northeastern Pennsylvania to the New York market, so its land is traversed by several once-prominent railroads. The Central Railroad of New Jersey (CNJ) led other railroads in the early development of Warren County right-of-ways. In 1852 it completed the first east-west route across the state with its line from Elizabeth to Phillipsburg, passing through the southern tip of Warren County. In 1851 the CNJ entered into an agreement with the Delaware, Lackawanna, and Western Railroad (DL&W) to build the Warren Railroad from a junction with the Central New Jersey at New Hampton (Hunterdon County) northwesterly to the Delaware River and a junction with the DL&W's line through the Delaware Water Gap north of Columbia. The DL&W used the CNJ lines to run its freight east to New York Harbor. Completed in 1857, the Warren Railroad was entirely within the boundaries of Warren County and included the first timber railroad bridge crossing of the Delaware River in the region at Delaware Station, Knowlton Township (Lane, p. 127).

A poor competitor of the CNJ was the Morris and Essex Railroad. Originating in 1835 in Newark, the undercapitalized line did not reach Hackettstown until 1854. In 1860 the company began its final extension to Phillipsburg via the Pohatcong Valley, but because of the Civil War (1861-1865), the route's completion was delayed until 1865. The Morris and Essex's fortune changed in 1868 when it was leased by the DL&W so that the company could have its own line to the metropolitan area rather than continuing to use CNJ connections. The DL&W began extensive improvements of the M&E's right-of-way to eliminate steep grades and poor alignments with the result that it soon had a first-class line from Hoboken to Washington in Warren County where trains switched back to the Warren Railroad for trackage to the west and north.

In 1875 Pennsylvania's Lehigh Valley Railroad constructed a coal hauling line, the Easton and Amboy Railroad, from Easton-Phillipsburg across the southern tip of the county and eastward to Perth Amboy. The Lehigh Valley had previously relied upon transferring its traffic to either the CNJ or the Morris Canal, which it had leased in 1871 but found inadequate. The continued competition caused the decline of the CNJ, and in 1877 the weakened company, outmaneuvered by the DL&W and the Lehigh Valley, fell into receivership only to be purchased by the Philadelphia and Reading (Reading) Railroad, which wanted the CNJ's strategically important Jersey City (Hudson County) terminals for its Philadelphia to New York route.

Two other railroads figured in the development of the county; the Belvidere Delaware Railroad and the Lehigh and Hudson Valley Railroad. The Belvidere Delaware Railroad, constructed from 1850 to 1854, paralleled the east bank of the Delaware River from Trenton to Milford. It had connections with the DL&W at Manunka Chunk north of Belvidere and provided an important alternate route for passenger and coal trains southbound to Trenton, which was developing as an important manufacturing center and transportation center. The Bel-Del, as the line is known, was a subsidiary of the Camden and Amboy Railroad, and in 1876 it was assigned to the Pennsylvania Railroad which leased and took over control of the Camden & Amboy Railroad. The Lehigh and Hudson Valley Railroad, originating at Phillipsburg and following the Pequest Valley to the northeast, was completed in 1881 as part of an alternate route for Lehigh Valley coal and iron headed for New England and bypassing the congestion of New York Harbor (Snell, pp. 486-489; Lane, pp. 244-245, 381-387).

For a sparsely developed county, Warren County has a surprisingly high number of railroad related bridges (25%). This is due to the fact that so many rail lines cross the county. One of the historically and technologically distinguished of all the railroad improvement campaigns in the state, the Delaware, Lackawanna & Western Railroad's ambitious and innovative New Jersey Cut-Off is located, in part, in the county. Although disused after 1979 and overgrown, the route appears to retain its original structures and integrity of setting that is uncommon in railroad rights-of-way. The cut-off is a technologically significant engineering accomplishment noted for its use of reinforced concrete, and it illustrates the history of the DL&W, one of the largest coal railroads that contributed to the transportation-driven economic growth of the northern half of the state.

Because of the lucrative nature of coal hauling and the fact that the DL&W's route across northwestern New Jersey was the 1860s Morris & Essex right-of-way with numerous curves and steep grades, the company wanted to develop a more efficient and less circuitous route through Warren and Sussex counties and across the Delaware River to Slateford, Pennsylvania. The entirely new line, built 1908-1911 and known as the New Jersey Cut-Off, shortened the DL&W's route by almost 13 miles. The New Jersey Cut-Off was a remarkable achievement traversing the county's mountains and valleys by massive cuts, fills, and viaducts with a total vertical rise and fall of only 248 feet and a maximum grade of 60.2 feet per mile. All structures along the route, including stations, culverts, viaducts, and bridges were of reinforced concrete, a state-of-the-art material with yet unknown capabilities. It was the first time any railroad chose to build an entire line of reinforced-concrete bridges (Taber and Taber, pp. 34-39).

The largest structures on the route are two impressive multi-span open spandrel arch viaducts that spanned over the Delaware River and the Paulins Kill Valley. The Delaware River Viaduct (2114159, Knowlton Township) a nine-span structure, is 1,450 feet long with the five middle spans 65' above the river. The Paulins Kill Viaduct in Hainesburg (Knowlton Township) is a 1100 feet long, seven-span structure noted for its elegant proportions that complemented the picturesque valley setting. Where highway bridges were needed to

cross the tracks, the DL&W engineers chose reinforced concrete deck arch bridges, a type that was capable of relatively long spans while providing dynamic and graceful forms. Seven are single-span reinforced-concrete deck arch overpasses (2153160, 2153161, 2153162, 2153163, 2153164, 2153165, 2153166 in Frelinghuysen, Blairstown, and Knowlton Townships). Where large earthen fills crossed over preexisting roads and small streams, the DL&W built concrete arch tunnels that also helped support the embankments. Over 35 concrete arch tunnels were built along the line, and three are Wasigan Road (Frelinghuysen Township, Milepoint 63.81), Simpson Road (Knowlton Township, Milepoint 72.98), and NJ 94 (2117152, Knowlton Township, Milepoint 71.10).

The DL&W's innovation in the field of reinforced-concrete did not end with the New Jersey Cut-Off, and in the following decade under the leadership of Chief Engineer A. Burton Cohen, the company also undertook smaller improvement projects including the installation of precast-concrete T-beam and slab overpasses. The bridges span the former Morris and Essex line to Phillipsburg built in the early 1860s. The 1913-1916 bridges, four T-beams and one slab (2154162, North Main Street, Greenwich Township; 2154163, Buttermilk Bridge Road, Washington Township; 2154165, Brick Yard Road, Mansfield Township; 2154168, Dirt Road, Mansfield Township; 2154169, Dirt Road, Mansfield Township) are nationally significant survivors from the era of experimentation with precast bridge components. Precast concrete beams did not become a prevalent bridge technology until after World War II.

Railroads, like the turnpikes and canal before, were designed to carry through traffic, but they also helped Warren County to grow, if not rapidly, at least at a steady pace. Agriculture continued as the county's primary pursuit with farmers hauling their produce to nearby railroad depots for shipment to urban markets. In the 1870s farmers in the county's northeast corner drained the Great Meadows Swamp (Independence) to create fertile fields for the cultivation of truck crops such as lettuce and celery. In other parts of the county farmers turned to dairy farming in the knowledge that the railroads could quickly ship perishable milk products (Cunningham, p. 27). Dairy farming remains one of the leading industries in the county.

Industry in Warren County remained relatively limited in size and scope despite access to rail transportation. The iron industry, profitable through the third quarter of the 19th century, benefited most directly from cheap coal, and Oxford on the Warren Railroad remained one of New Jersey's leading iron manufacturing towns with furnaces, forges, rolling mills, nail factories, and nearby mines.

Only in the area of Phillipsburg did access to rail transportation attract a more diversified base of industries, the most important of which were compressed air and hydraulic machinery, cast iron pipe, paper, and silk. Cooper, Hewitt Co. of New York City, established iron foundries nearby. In the 1890s several large portland cement manufacturers, including Thomas A. Edison, established plants east of Phillipsburg in

Alpha and New Village due to extensive outcroppings of high quality cement rock, but also in part because of the proximity of major rail lines (Mustin, pp. 10-16).

Railroads ended Warren County's isolation, but local highways played an important role in the movement of people and goods. Township committees took responsibility for the majority of local roads and streets. In 1880, for instance, Greenwich Township divided its roads into 32 districts each with a different volunteer supervisor (Snell, p. 596). The county freeholders oversaw the more important county routes, such as the former Washington and Morris Turnpikes, and they undertook most bridge improvements. The freeholders began authorizing the construction of numerous stone arch bridges after the county was created in 1824.

Throughout the state, stone arches were the most common pre-1860 bridge type, and Warren County is no exception to the trend. Built by local masons using readily available materials, stone arch bridges offered the most permanent means of spanning water features. In Warren County stone arch bridges continued to be built into the first decade of the 20th century, and in 1931, the county reported over 1000 masonry arch construction bridges and culverts still in use with about another 770 having been replaced recently with bridges of more modern construction (Mustin, p. 38). Nine stone arch highway bridges of over 20' span dating from ca. 1836 to 1900 have been documented in the county. The oldest is the multi-span ca. 1836 South Bridgeville Road over Pequest River bridge (2102303, White Township). Other noteworthy examples of stone arch bridge technology are the ca. 1860 Brugler Road over Paulins Kill bridge (2101311, Knowlton Township), known locally as the Warrington stone bridge, and the 1860 Stephensburg Road over Musconetcong River bridge (2101607, Mansfield Township). The former is individually listed in the National Register of Historic Places, while the latter is listed as a contributing element of the Miller Farmstead.

Metal truss bridge technology for highway bridges was evolving in the mid- to late-1860s in New Jersey, and Warren County claims one the earliest documented and thus historically and technologically significant such bridges in the entire state. The 1868 Shoddy Mill Road Bridge over the Musconetcong River between New Hampton (Hunterdon County) and Washington Township (2102225), a joint-county bridge, is the product of the collaboration between noted bridge engineer Francis C. Lowthorp (1809-1890) from Trenton and William Cowin (1825-1874), a talented foundryman from Lambertville. The two did much to promote the early use of metal truss bridges in the region with Cowin, an Englishman who came to Lambertville around 1850, presenting plans for metal bridges to the Hunterdon County Board of Chosen Freeholders as early as 1858 (Freeholders Minutes 9/16/1858). Photo documentation from various sources including Hunterdon County histories and photographs preserved by the Delaware River Joint Toll Bridge Commission (Morrisville, PA) shows that Lowthorp's Pratt pony truss bridge design, with its massive cast iron end posts and cast iron verticals and upper chords, was built in several location throughout the region, but the 1868 Shoddy Mill Road bridge is the oldest

surviving example. It is individually listed in the National Register of Historic Places. Two other 1870 examples survive in Hunterdon County (10XXONI; 10XXG63).

By the last decade of the 19th-century metal truss bridge technology was well established. Excluding the early 1868 Shoddy Mill Road truss bridge, a total of 16 other metal truss bridges built between 1892 and 1902 survive in the county. An additional three welded pony truss bridges survive from the 1930s. Three of the truss bridges were built by the railroads and 13 were county-built. None exhibit the technological significance of the Shoddy Mill Road span, but some of them are distinguished by their setting and state of preservation. Additionally, the historical background of the bridges reflects how and by whom metal truss bridges were promulgated during the late-19th and early 20th centuries. Most of the spans are documented as being the product of bridge companies from out of the region who were represented locally by agents who marketed the goods to the county freeholders. While no locally produced metal truss bridges were documented, it is known that some bridge fabricators were located in Warren County. Tippet and Wood of Phillipsburg began building iron bridges at its shops in Phillipsburg in 1868, and it continued in operation for over thirty years making stand pipes and boilers. A late 19th-century Tippet and Wood pony truss spans the Musconetcong River in Union Cemetery, Hackettstown, but it is not included in the survey because it is privately held. The Phillipsburg Manufacturing Company also constructed bridges for a short period in the early 1870s (Darnell, p. 34).

The most popular early truss design for local highways was the pin-connected Pratt truss because of its economy and simplicity of fabrication and erection. The oldest is the 1892 Church Street bridge in Bloomsbury, (2100718, Greenwich Township). The bridge is a 105'-span Pratt thru truss fabricated by the Toledo Bridge Company of Ohio. Another noteworthy one is the 1896 Station Road over Paulins Kill pony truss bridge (2101312, Knowlton Township) by the Havana Bridge Works of Havana, New York. The span is a fine and complete example of its type by a fabricator that is not well represented in the state. The ca. 1900 Still Valley Road bridge (2102002, Pohatcong Township) is a pony truss that contributes to its setting, the National Register-listed Hixson/Skinner Mill Complex, a 19th century grist mill and miller's dwelling. The River Road over Pohatcong Creek bridge (2102015, Pohatcong Township), is a good example of a once-common bridge type that was instrumental in the development of good roads effort.

The transition from pin-connected to rivet-connected bridge construction is an important historic context for at least seven surviving riveted spans dating to around 1900. After 1890 advances in portable pneumatic riveting technology made available the means of performing field riveting. A new generation of truss designs developed rapidly, the most popular of which for use on local New Jersey highways was the Warren pony truss. The Warren truss is distinguished by diagonal members designed to carry both tensile and compressive forces and the transfer of those forces at the panel points. James Warren, a British engineer, patented the truss design in 1848, but it was not built widely in the

United States until the availability of good field riveting to make the rigid panel point connections.

Warren County's rivet-connected bridges chronicle the development of the riveted bridge technology. The oldest documented example is the ca. 1890 wrought-iron Welsh Spur Road lattice girder bridge (2160152, Greenwich Township). One of less than five lattice girders documented statewide, it has lattice webs composed of rolled T-section diagonals and plate verticals riveted to the angles that make up the top and bottom flanges. Lattice girders were fabricated with shop rivets and shipped as a single unit to the erection site.

The transition from pin connected to riveted field connections is marked in Warren County by the 1898 Pine Hollow Road bridge (2160153, Greenwich Township) and the 1902 Buttzville Road bridge over the Pequest River (2102307, White Township). The two bridges are examples of double-intersection Warren thru trusses, an uncommon truss design. Four riveted Warren pony truss bridges built between ca. 1900 and 1902 (2102335, 2101313, 2145167, 2151161) also survive.

In Warren County, as in other parts of New Jersey, the 1910s and 1920s brought increased emphasis on highways as the most significant part of the state's and nation's transportation systems. F. W. Salmon was appointed the first county engineer in 1911, marking the beginning of the modern period of county road and bridge administration and maintenance with the appointment of professional engineers and engineering staffs. He advised the freeholders on bridge construction, prepared standard specifications, supervised the bidding and contracting process, systematically inspected bridges, and started on-going efforts to replace earlier stone arch and metal truss bridges with up-to-date steel and reinforced concrete bridge types. Warren County's highway improvements were a representative example of the type of efforts designed to "get farmers out of the mud" and end rural isolation. Financing for better roads was a combination of state-aid and local funds that were used primarily to improve (pave) existing routes. Work included building concrete and macadam roadways with sufficient widths, altering road alignments to avoid dangerous curves and sharp angles, and replacing inadequate and narrow bridges.

Nineteen county-built bridges dating from 1911 to 1918, including seven reinforced-concrete deck arches, seven steel stringers with concrete jack arches, four encased steel stringers, and one reinforced concrete slab were documented. Many county bridges from that period have pipe railings with concrete posts and paneled concrete parapets marking the approaches.

Two early county bridges stand out as unaltered and well-preserved examples of Warren County's initial efforts to modernize its bridge inventory. The 1913 Sarepta Road bridge (2102302, White Township) is a well-proportioned reinforced concrete deck arch, and the earliest extant non-railroad related concrete deck arch in the county. The 1914 Cemetery Road bridge (2101202, Independence Township) over the Pequest River is the

best-preserved of seven steel stringers with concrete jack arches. Prior to World War I concrete jack arches were a common technique for supporting bridge decks. Both the Sarepta Road and Cemetery Road bridges embody design details of local significance including distinctive pipe railings.

New bridge construction accelerated after 1920, and the county government boasted of designs that achieved "beauty of structure without sacrifice of strength or increase of cost" (Mustin, p. 38). Forty-three county bridges dating from 1920 to 1946 were surveyed, and included 37 steel stringers, 3 welded pony trusses, 1 reinforced concrete arch, 1 reinforced concrete slab, and 1 steel arch. Contractors active in Warren County were the New Jersey and Asphalt Paving Company of Jersey City, Beck Brothers and Beck of Hainesburg, S. S. Thompson and Company of Red Bank, A. R. Geist Construction Company and M. A. Carty of Phillipsburg. New road and bridge construction in Warren County was supplemented by the efforts of the county's Shade Tree Commission that in the late 1920s planted over 1500 trees, mostly maples and elms along important county routes. The trees were intended as a beautification measure, and are indicative that even in the 1920s Warren County officials cooperated to leave a "pleasing impression" on automobile travelers (Mustin, p. 37).

In 1916 the State Legislature designated a state highway system that included several routes in Warren County, but improvements to those routes did not begin until 1921-1924 when state funds were used to pave Route 12 (NJ 57) from Phillipsburg to Hackettstown. After the completion of Route 12, other state highway system expansions and improvements followed quickly and included Route 6 (US 46) from 1924 to 1933, Route 9 (NJ 173) in 1925, Route 8 (NJ 94) from 1929 to 1931, Route 31 (NJ 31) from 1930 to 1931, and NJ 24/28 (US 22) in 1938.

Bridges were an important component of the state highway routes, and numerous county bridges were taken over and subsequently replaced. The bridge types and designs the State Highway Department used in Warren County were the same as in other counties with concrete encased rolled steel stringer spans on concrete substructures dominating. Railroad grade crossings with the state highways were eliminated, usually with encased thru girder or slab spans. Thirty-two state highway bridges dating from 1924 to 1945 were identified. Sixteen are encased stringer bridges, six are concrete slab spans, five are thru girders, two are rigid frames. Most bridges had standard design features and were historically and technologically unexceptional. None were evaluated as significant.

From 1921 to 1941 Warren County, like the rest of New Jersey, experienced a golden age of highway building that forever changed the cultural landscape. Although not entirely anticipated at the end of the first world war, highways, not railroads, became the transportation system that dominates the 20th century. The economy and flexibility of trucks and cars for moving commodities, goods, and people demonstrated during World War I caused the rapid decline of the railroads and the eventual abandonment of numerous lines. Trucks took over the railroads' role as a long-distance carrier. In 1952 US

22 and US 46 were dualized in some sections of Warren County as major east-west corridors, and in recent years the completion of limited access I-80 (1972-73) and I-78 (1989) continue Warren County's almost 200 year old tradition of continued improvements to assist with the flow of goods and people to and from the greater New York metropolitan region.

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