THE HISTORY AND HERITAGE OF CIVIL ENGINEERING IN VIRGINIA

J. C. Hanes
J. M. Morgan, Jr.

1973

Virginia Section
American Society of Civil Engineers

Price $5.00

FOREWORD

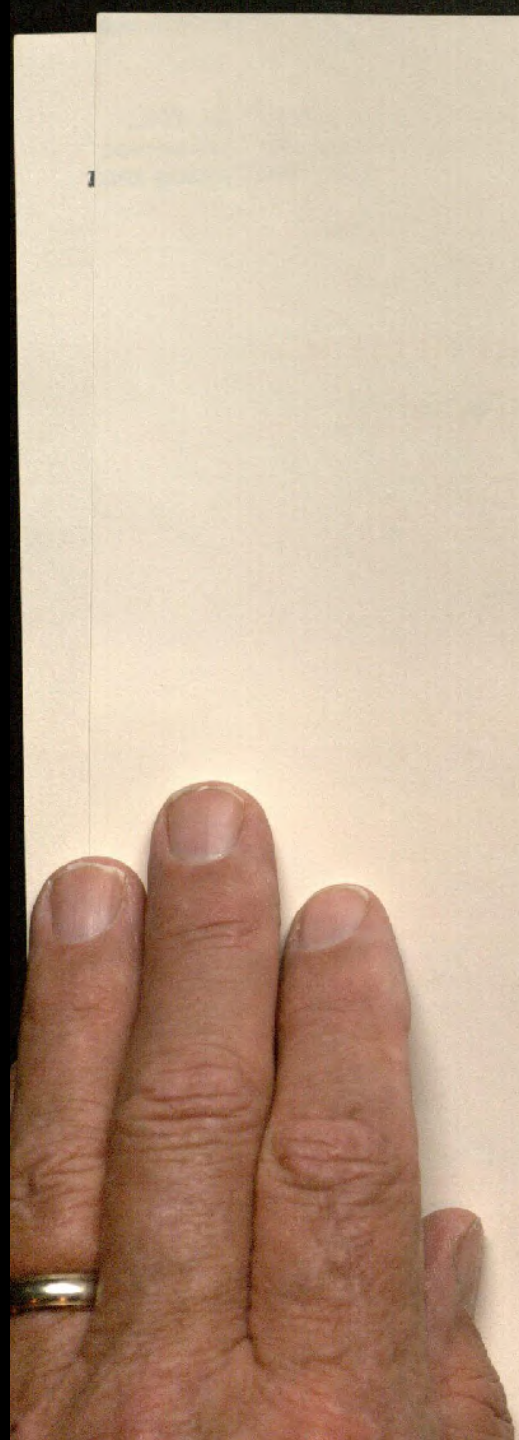
At the request of the officers of the Virginia Section ASCE, an effort has been made to write a brief history of the Section and at the same time incorporate a historical account of a number of interesting engineering accomplishments in Virginia. The effort is divided into two parts. The first part is the brief history of the Section and the second is a description of seven engineering projects of interest to the general reader.

Unfortunately, the early records of the Virginia Section of the American Society of Civil Engineers are incomplete. An unsuccessful attempt was made to uncover the minutes of meetings held from the founding year 1922 until 1937. Regretfully, they have been misplaced. Should the records be resurrected at some future time this brief history in the first section of this paper can be rewritten.

In November 1966, the Virginia Section appointed a Committee on the History and Heritage of American Civil Engineering with special emphasis on the Commonwealth of Virginia, as a part of the accumulation of national records, to be recognized by the parent Society with appropriate markers or commendation. The chairman of the committee selected seven engineering works which date back to the 18th century. The most recent project is on its way to completion. Not included are other works, which may quite well be recommended by officers or members of the Section and made a part of this limited record, such as the Blue Ridge Railroad Tunnel near Rockfish Gap the construction of which had close association in the 19th Century with Claudius Crozet, the fourth Principal Engineer of the Virginia Board of Public Works.

J. C. Hanes
J. M. Morgan, Jr.

Lexington, Virginia
July 1973



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PART I

The Virginia Section of the American Society of Civil Engineers is a vigorous, healthy organization providing for its members a professional engineering affiliation of the highest order at the State and local level.

—Douglas B. Fugate
Report of the President
December 1960

THE AMERICAN SOCIETY OF CIVIL ENGINEERS

On November 5, 1852, twelve engineers met in the office of the Chief Engineer of the Croton Aqueduct Department, New York City. This meeting marked the beginning of a professional engineering movement in the United States under the name of American Society of Engineers and Architects with membership open to "Civil, Geological, Mining, and Mechanical Engineers and Architects and other persons who, by profession are interested in the advancement of science." The Society had as its objective "the professional improvement of its members, the encouragement of social intercourse among men of practical science, the advancement of engineering in its several branches, and of architecture, and the establishment of a central point of reference and union for its members."

As special branches of the profession developed other societies came into being in the new fields—architectural in 1857, mining in 1871, mechanical in 1880, electrical in 1884, and chemical in 1908. Today with more than one million engineers in the country there are more than 200 professional and technical engineering societies of varying size and effectiveness.

In order to maintain and foster "the encouragement of social intercourse among men of practical science," as membership increased in size and dispersion it became necessary to decentralize the Society. Today, there are four geographical Zones, each encompassing several states, 14 Regional Councils, 79 Sections and 109 Branches. In addition there are 183 Student Chapters in engineering colleges across the nation.

In its centennial year 1952, the American Society of Civil Engineers boasted a membership of 35,000; today 120 years after founding, membership stands at 66,600. With a membership active in all phases of the profession the Society and its constituent Sections look forward to a bright future.

THE VIRGINIA SECTION

The Virginia Section of the American Society of Civil Engineers, founded in 1922, has been a bulwark of the Society for half a century. The Section was founded seventy years after the parent organization was organized and today is one of 79 Sections constituting the parent organization. During the past half-century, the Virginia Section has grown in membership, in importance, and particularly in service to the engineering profession. The first fifty years have been a period of development during which civil engineering reached a peak of importance not dreamed of by its charter members.

The object of the Virginia Section of the American Society of Civil Engineers is the "advancement of engineering knowledge and practice, the cultivation of friendly relations with all engineers, the maintenance of high professional standards, and cooperation with other societies, with a view of promoting the general welfare of the engineering profession and the American Society of Civil Engineers." That purpose is being carried out by today's officers and members.

As the first organizational meeting was held in 1922, the annual meeting in December 1972, in Richmond, can be said to mark the 50th anniversary of the Virginia Section. At one time the Section comprised all of the geographical boundaries of the Commonwealth. Today, the present boundaries include all of the Commonwealth except the City of Alexandria and the Counties of Fairfax and Arlington which have been assigned to the National Capitol Section.

From an original membership of less than 50, the Section grew to approximately 100 by 1932, to some 300 in 1942, almost to 600 in 1952, to 700 ten years later, and today the current membership of the Section comfortably tops the 1,100 mark. The Virginia Section enters its sixth decade as a strong and viable organization.

The strength of any organization lies in its purpose, membership, officers, and particularly in its student members who are rising to enter its ranks. Those who have served as officers, particularly

the presidents, the hard-working secretaries and treasurers, and the devoted service of countless others, have formed an organization of which all members can be justifiably proud.

Five past Section presidents have served as national Directors and members of the national Society's Board of Direction. These officers have been:

	Virginia Section President	*National ASCE Director*
F. L. Nicholson	1926-1927	1928-1931
J. A. Anderson	1923-1924	1938-1940
W. R. Glidden	1942-1943	1951-1952
T. E. Shelburne	1953-1954	1958-1960
D. H. Pletta	1965-1966	1970-1972

Two members of the Virginia Section have served as national presidents of the American Society of Civil Engineers. Mr. Edgar M. Hastings, Section President 1930-1933, held the second highest national ASCE office in 1943-1944 and capped his service as Society president in 1947. Mr. William Roy Glidden, whose other service is listed above, was vice president of the Society in 1951-1952 and served effectively as president of the Society in 1955. The Section is justifiably proud of its past presidents who have performed so capably as Directors and in the highest national offices.

To effect closer contacts and to improve communications between Sections and the Board of Direction of the Society, a number of regional councils have been developed and organized according to the Society's Constitution and By-Laws. The councils are encouraged to participate constructively in public and legislative affairs of interest and concern to civil engineers within the geographical, state or interstate areas of council jurisdiction. The Virginia Section, which is located in Zone II, the southeastern zone of the Society, is a member of District 6 Council, founded in 1951, which now includes the Nashville, North Carolina, Tennessee Valley, Virginia, and West Virginia Sections. In earlier years, the Virginia Section had association with portions of eastern Ohio, the Pittsburgh Section, and the South Carolina Section. Virginia has, in

the past, also been aligned with the District V Council which included the National Capitol and Maryland Sections. Geographical boundaries of the Councils change as a result of Section membership totals. The Society reviews boundaries of the Councils every ten years or so.

In the half century of its development, and like its parent, the Section has found it expedient to diversify its organizational structure and establish branches in strategic locations throughout the Commonwealth. Maintaining and developing professional interests among civil engineers in Virginia has thereby been encouraged by shortening distances for members to gather frequently and exchange ideas through presentation of papers on local projects or to hear speakers of national distinction. The branches have been quite active in attracting additional memberships and generating professional interests among young civil engineers.

The Virginia Section participated actively in the fund raising campaign for the United Engineering Center in New York City. The campaign was organized on a local level through the three branch sections and there was a campaign to reach the members of the Virginia Section not belonging to a branch section. The latter effort was organized directly among the directors and officers of the section. The Virginia Section's goal for this endeavor was $13,300. By 1960, the goal was met by the outstanding work on the part of the Section membership, particularly those from the Richmond Branch. A major contribution to the fund was made by Charles E. Via, Jr., a President of the Virginia Section in 1957-58.

The business of the Section is carried on in meetings of the Board of Directors. Officers give of their time to attend these meetings which are held throughout the state and which invariably extend into a program scheduled by a local Branch or an annual meeting. The interest and zeal with which the officers carry out their duties is a credit to themselves and to the Virginia Section which they represent. The annual meeting may be held between November 1 and March 1 and at such time and place as the Board of Directors designates. Other meetings are called at the discretion of the Board of Directors; a written request of at least 10 members is required for the President to call a special meeting.

Officers of the Section

As each successful organization must have dynamic leadership, the Virginia Section has been fortunate in having energetic and reliable men serve as officers. The list of presidents and other officers contain names prominent in civil engineering circles in the Commonwealth. Of particular interest to those in the highway field is the fact that three of the presidents—General James A. Anderson, Henry G. Shirley, and Douglas B. Fugate—have been Highway Commissioners.

According to the current Article IV of the Constitution which will be found in Appendix A, the officers of the Section shall be a president, first vice president, a second vice president, a third vice president, a secretary, and a treasurer. The officers, the latest living past president, and two directors elected from among the members at large constitute a Board of Directors in which the governance of the Section is vested. The two directors, normally selected on a rotation basis, are elected for terms of two years with service commencing at the close of the annual meeting. One director is elected each year so that their terms will not be concurrent. The directors have frequently been selected from among faculty advisers of the Student Chapters of the four engineering colleges. Officers are elected at an annual meeting for terms of one year and these terms begin at the close of the annual meeting and continue until their successors are installed. Only members of the Section are eligible for election. In addition, the presidents of each Branch within the Section are members of the Board of Directors. Normally, once elected to the third vice presidency, the elected member is advanced to the other vice-presidential positions and finally to president. As the immediate living past president is a member of the Board of Directors of the Section, such an arrangement provides continuity and results in strong, continuous leadership.

The secretary-treasurer position on the Board of Directors was longest occupied by Mr. P. A. Rice of Richmond. His service

in an appointed capacity—from 1931 until late in 1945—spans the longest period of any single officer according to the records available. The early records and minute books were painstakingly kept by him and they serve not only as factual history but as an excellent guide for other Section secretaries. In a pencilled note at the end of the 9 November 1945 minutes of the annual Fall meeting in Roanoke, attended by one of the authors of this work who spoke on the topic "G.I. Joe Returns to College," Mr. Rice wrote, "It is with regret that I feel compelled to give up the office of Secretary-Treasurer which I have held for fifteen years. It has been a source of much pleasure to me as in this way I have become acquainted with most of the membership and have made many friends in this way. I am sure a new secretary-treasurer will be better for the Section." Mr. Rice, affectionately known as "Perley" by almost all of the membership, later served as vice-president and president. No one who knew or worked with him could wholeheartedly agree with his last sentence.

At the annual meeting in December 1955 it was decided to alter the method of appointing the secretaries and treasurers. These offices are now separate and the persons filling them are elected annually on the same ballot as are other officers.

With the aid of many persons, and the extant records, it has been possible to reconstruct a chronological list of Section presidents, Branch presidents, secretary-treasurers, assistant secretary-treasurers, secretaries and treasurers. These lists will be found at the end of the paper as Appendix B.

Branches

As far back as the Fall meeting of 1940, there was a discussion as to the appropriate ways and means to further the activities of the Section in the western part of the state. Mr. E. S. Thomas, later President of the Virginia Section in 1941-42, was appointed chairman of a committee to study and report. Thus was born the idea of "sub-section" or branches as they are now known. The Board of Directors for many years held business meetings in Roanoke which coincided with the annual Fall meeting of the Section.

Today, one of the noteworthy features of the Section is the professional and business-like operation of the several branches. But, for 33 years the business and activities of the Section were carried on solely at the December annual meetings and other seasonal meetings held throughout the several geographical regions of the state. However, when the membership had reached approximately 600 it was evident that the Section was not meeting the best interests of its loyal members solely with annual and seasonal meetings. The officers of the Section encouraged active members in several geographical regions to organize other interested members in their areas who would then petition the Section to form geographical units known as branches. To meet the technical and professional needs of the members at the local level and assist them in accomplishing the purposes of the Section, the officers of the Virginia Section, with appropriate approval from the national Society, encouraged the formation of six branches, three in the 1950's and three in the 1960's, to serve members at one or more centers of engineer population.

Therefore, in 1955, the Section was geographically subdivided to provide branches in only three areas of the Commonwealth. Successful formation of these branches at that time in Norfolk, Richmond, and Roanoke later led to the establishment of the Peninsula Branch in 1966 to include the Hampton, Newport News, Williamsburg areas. In 1967 the Blue Ridge Branch was organized to serve both sides of the mountain range from whence its name, as well as Charlottesville, Harrisonburg, Lexington, Staunton, Waynesboro, and portions of the Shenandoah Valley. Two years later, the sixth branch to be organized was successfully chartered in Northern Virginia as the Bull Run Branch.

The geographical boundaries of the several branches include:

Norfolk—Counties of Accomack, Greenville, Isle of Wight, Nansemond, Northampton, Southampton, Surry, Sussex, and the Cities of Norfolk, Virginia Beach, Chesapeake and Portsmouth.

Roanoke—Counties of Alleghany, Bath, Bedford, Bland, Botetourt, Buchanan, Campbell, Carroll, Craig, Dickenson, Floyd, Franklin, Giles, Grayson, Henry, Lee, Montgomery, Patrick, Pitt-

sylvania, Pulaski, Roanoke, Russell, Scott, Smyth, Tazewell, Washington, Wise, Wythe, and the Cities of Roanoke and Salem.

Richmond—Counties of Amelia, Appomattox, Brunswick, Buckingham, Charles City, Charlotte, Chesterfield, Cumberland, Dinwiddie, Fluvanna, Goochland, Halifax, Hanover, Henrico, Louisa, Lunenberg, Mecklenberg, New Kent, Nottoway, Orange, Powhatan, Prince Edward, Prince George, and the City of Richmond.

Peninsula—Counties of Gloucester, James City, King and Queen, Lancaster, Mathews, Middlesex, Northumberland, York, and the Cities of Poquoson, Williamsburg, Newport News, and Hampton.

Blue Ridge—Counties of Albemarle, Amherst, Augusta, Clarke, Culpeper, Fauquier, Frederick, Greene, Highland, Loudoun, Madison, Nelson, Page, Prince William, Rappahannock, Rockbridge, Rockingham, Shenandoah and Warren.

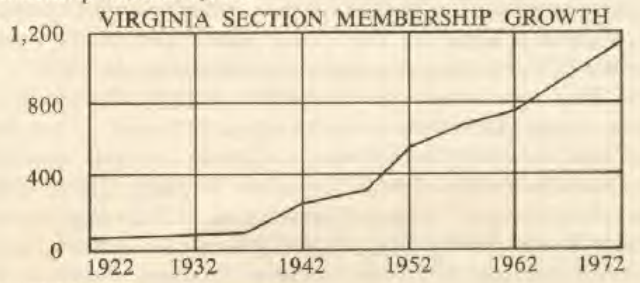
Bull Run—All remaining counties except Fairfax and Arlington and the City of Alexandria.

Each branch elects a President, Vice President, Secretary and Treasurer or Secretary-Treasurer in accordance with its Constitution and By-laws for the orderly and efficient conduct of its business of professional and technical affairs. A list of presidents of the branches will be found in Appendix C.

The branches have become the mainstays of our organization. They provide our members monthly or periodic contacts with ASCE. By personal contact and guest attendance at branch meetings they stimulate interest in ASCE among non-Society engineers. Local participation in branch affairs has strengthened interest in ASCE and the activities of the branches have greatly increased Section membership and heightened interest in the Society as a whole.

Membership Growth

The Section did not grow rapidly in its early years. Starting with less than fifty members in 1922, growth was quite slow for the first fifteen years and the total membership probably never exceeded 100. Thereafter, the section grew quite steadily until 1962. Since then the membership has shown remarkable strides and the great increase is surely a direct result of the increased professional and technical activities at the branch level. The following chart plots the membership growth since 1922. At the end of 1972 the membership stood at 1,113.



Annual Meetings

Annual meetings of the Section have been held, generally during the months of November, December, January or February, at various geographical locations throughout the state. Since World War II the practice has been to hold the annual meeting in Richmond, generally in the gracious surroundings of Hotel Jefferson. However, annual meetings have also been held at the Hotel John Marshall. The Fiftieth Anniversary meeting was successfully conducted at the Executive Motor Hotel on West Broad Street; the session was held there because of a conflict of scheduling dates at the Hotel Jefferson.

Annual meetings have often been gala affairs. Business and/or technical sessions have frequently been scheduled in the afternoons followed by a social hour and banquet in the evening. There have been several occasions, when these two affairs have been combined, but this practice has been rare.

From an inspection of the available minutes and copies of annual programs it has been amazing how diversified the programs have been. Topics have always been timely. Many of the Section members have been annual banquet speakers or presented papers

at the technical sessions. In addition, speakers of state and national prominence have addressed the annual meetings. To show the great diversity of speakers, a sampling of over the years includes: William H. Wisely, Executive Director, American Society of Civil Engineers; Eugene T. Jensen, Regional Director, Federal Water Pollution Control Administration; Frank C. Murray, Australian Consul in New York City; Honorable David E. Satterfield, III, Member of Congress, Third Congressional District of Virginia; Edward J. Ward, Chief, Engineering and Research, Northeast Corridor Transportation Project; Honorable Mills E. Godwin, Lieutenant (and later) Governor of Virginia; Thomas C. Boushall, President, Bank of Virginia; Reverend A. D. Hudgins, Pastor of the Franklin Baptist Church, Franklin, Virginia; Hal H. Hale, Executive Secretary, American Association of State Highway Officials; Wilbur Smith, Consulting Engineer of Columbia, South Carolina; William N. Carey, Executive Secretary, American Society of Civil Engineers; Honorable W. Stirling King, Mayor of the City of Richmond; Gustav J. Requardt, Consulting Engineer of Baltimore, Maryland; and Thomas Lomax Hunter, "The Cavalier."

No less than ten national presidents and past presidents have visited the Virginia Section on official occasions and have spoken, some in prepared talks and others briefly, at annual meetings. In addition to Virginia's own two ASCE Presidents, Edgar M. Hastings and William Roy Glidden, these gentlemen have visited with our Section: Donald H. Sawyer in 1939; Frederick H. Fowler in 1941; Carlton S. Proctor in 1952; and Samuel S. Baxter in 1971.

A highlight of the annual meeting of 1959, held at the Hotel Jefferson in Richmond, was the presence of the Executive Committee of the Board of Direction of the American Society of Civil Engineers. Present in Richmond and attending the banquet of the annual meeting of the Section were:

Francis S. Friel, President, ASCE
Louis R. Howson, Past President, ASCE
Mason G. Lockwood, Past President, ASCE
Waldo G. Bowman, Vice President, Zone I, ASCE (later President)
Paul L. Holland, Vice President, Zone II, ASCE
Lloyd D. Knapp, Vice President, Zone III, ASCE
Samuel B. Morris, Vice President, Zone IV, ASCE

The principal address was given by President Friel. Past President Louis R. Howson then awarded certificates of Life Membership to George K. Davis, Earl O. Heaton, William D. Henderson and Eugene S. Thomas.

While not attending an annual meeting, two other ASCE presidents have officially visited Virginia while holding office. Dean Dan V. Terrell attended a District 6 Council meeting at Hotel Ingleside, Staunton, in July 1954, and Richard H. Tatlow, III, in September 1968 visited with the Richmond Branch to speak on "Education and Civil Engineers."

A highlight of the 1965 annual meeting in Richmond was the presentation of a talk, "Richmond Subsoil Properties as Affecting Design and Construction of Foundations." The paper, authored by the eminent Dr. L. Casagrande, Professor of Soil Mechanics and Foundations, Harvard University, was considered to have such import and local interest that the firm of Froehling and Robertson of Richmond published and distributed the talk.

Liaison With Other Societies

Since its very earliest days, the Section has had very close liaison with other engineering clubs and organizations throughout the Commonwealth. The first document in the earliest Section minute book, which begins in 1937, is an announcement published by the Engineers Club of Hampton Roads which outlines the fact that ASCE, AIEE (forerunner of IEEE), ASME, AIA, the Hampton Roads Chemists Club and the Engineers Club of Hampton Roads would hold a joint meeting at Hotel Monticello in Norfolk on Friday, 30 April. These joint meetings were the forerunner of the continuing and highly successful conferences known as the Joint Meeting with Virginia Engineering and Technical Societies which have more recently been generally scheduled at Hotel Chamberlain, at Old Point Comfort, in the month of June.

The joint meeting format in 1937 was quite similar to those of recent years. Business meetings of the various state sections were scheduled. Founder Societies sponsored a broad ranging scope of technical sessions and an evening banquet was capped with an address of general interest. In 1937, Mr. Charles F. Goodrich, Chief Engineer of the American Bridge Company, had as his topic, described so carefully in the announcement, "The San Francisco-Oakland Bay Bridge, accompanied by sound motion pictures and stereoptican slides."

At the joint meeting in the following April, also held in Norfolk, it was proposed by the Engineers Club of Hampton Roads that the joint meeting of the various societies should be held elsewhere in the state other than Norfolk. Action was taken on this proposal and in January 1939, the joint meeting was held in Richmond. A group of some 350 engineers were in attendance and the assemblage was welcomed by Governor James H. Price at the John Marshall Hotel. The following year the joint meeting returned to Norfolk; there is no record to reveal that this joint meeting has since been scheduled away from the Tidewater area.

The Section continues its association with the Engineers Club of Hampton Roads and in more recent years has held its annual September meeting with that organization.

During Engineers Week, which normally is that week in which George Washington's birthdate falls, the Section has, in some recent years jointly been a sponsor for and participated in the Richmond Area Engineering and Science Banquet. Also in Richmond, over the years there have been a number of joint meetings, normally in the spring, with the Central Virginia Engineers Club.

Junior Forums

Under the personal sponsorship of Colonel Robert A. Marr, Jr., Professor and Head of Civil Engineering at VMI, a number of highly successful meetings, called Junior Forums, were held in the early 1950's. The meetings, devoted to timely topics of interest to young engineer members of the Section, were held at several locations throughout the state. The young engineers then had the

official ASCE membership designation of "Junior Members." The practice of sponsoring such meetings waned after some 10 years when the title "Junior" was dropped and the designation associate member came into vogue. The last two such affairs, which were designed to promote the interest and participation of young engineers in the Section, were held at Langley Field in September 1959 and in Richmond in the Reynolds Metals Building in 1961, also in September.

Communications

After several years of attempting to publish a Section *Newsletter*, success was achieved in 1965 when Hyman J. Fine of Norfolk, later a Section President, carried through the task he had promised the Board of Directors he would accomplish. He was succeeded in that task by Charles E. Echols, also later a President. Brooke B. Chamblin assisted Mr. Echols in 1967 and carried on capably until 1971 when John W. Flora became the Editor.

The Newsletter has proven to be highly successful and has served as a medium to keep the Section membership informed of important and pressing matters. It has been well received and serves as an interesting and important means of communication for the membership.

In the Fall of 1951, *The Virginia Engineer* was first published. At that time, or shortly thereafter, members in good standing of the Virginia Section ASCE were put on the mailing list. The name of the publication published monthly by the Virginia Society of Professional Engineers, was changed on 1 January 1970 to *The Virginia Professional Engineer*. The attractive publication has greatly helped increase communications among the membership of all engineering societies in the Old Dominion and those who monthly read the magazine can keep well abreast of matters of engineering importance.

Committees

The Virginia Section has been exceedingly fortunate in having dedicated engineers who have performed faithful, diligent and

important work in various committee assignments. Committees have been established to provide constructive activity at the Section level. Some committees have been of an *ad hoc* nature, formed to answer specific questions or provide continuity to a project of only several years' duration. Others have been of long standing for specific purposes. At one time there was even a Committee on Committees whose charge was to review the organization, administration, and operation of all committee activities of the Section, and to recommend specific improvements for better service to the membership.

As in any organization, however, committee work has waxed and waned with the interest of members assigned these duties. The Board of Directors always devotes much attention to the work and performance of the Section technical committees. In some cases, committees that were appointed annually in the various technical fields of Section interest simply did not function. In 1960, the Board, facing the obvious, declared a moratorium on technical committees. Following that action, small, workable committees in certain restricted fields were reconstituted and given goal-oriented and attainable objectives. Thereafter, the committee structure and effectiveness appeared to improve.

Committees deemed necessary for the operation of the Section may be appointed from time to time by the President. Only four committees are currently required by the Constitution to be appointed each year: Program, Membership, Hospitality, and Public Relations.

Many members will recall their service on a single or a number of committees whose roll call is a long one. Literally thousands of man-hours have gone into their productive deliberations. An inspection of the record reveals the following partial list of activity since 1937 by specific committee title: Assistance to Student Chapters, Awards and Prizes, Building Codes, Committee on Committees, Constitution and By-Laws, Council of Engineers and Architects, Direct Assistance to Veterans (following World War II), Economic Status of the Engineer, Employment Conditions, Engineering Education, Engineer Training, Engineers Joint Council,

Engineers Council for Professional Development, Field Trips, Fiftieth Anniversary, Financial Study of Branch and Section Operations, Fluid Mechanics, Highways, History and Heritage, Hospitality, Junior Members, Legislation, Legislative, Legislative Involvement, Masonry and Reinforced Concrete, Membership, Model Law for Dams, Nominating, Planning Commission District Personnel Review, Post War Planning and Construction (following World War II), Program, Programs and Goals, Public Affairs, Public Relations (or Publicity), Publishing of Newsletter, Registration of Geologists, Representation of Members, Railway Engineering, Sewage and Industrial Wastes, Soil Mechanics, Structural Members, Student Affairs, Student Chapters, Surveying and Mapping, Technical Papers, Transportation Policy, Water Planning Committee, Water Pollution Control, Water Resources, and Water Supply, and so forth.

As President Charles E. Echols so forcefully stated in his annual report in 1971, ". . . there are many hidden pearls of capability and gems of incentive hidden in our members. This latent talent is desperately needed to keep our internal structure vigorous and to provide the public the fruits of our resourcefulness in the many political and social spheres that don't know enough about our engineering potential to plead for our services." So, we have strength in our organization and, "the immediate need of the Virginia Section is to determine the meaningful ways we can continue our strength and build on it. Individual member skills, interests and direction need to be crystallized and cultivated in this context."

Engineering Education

Engineering education in Virginia is a fascinating subject. The first engineering courses were offered in the Commonwealth at the University of Virginia in 1827. Ten years later, according to the University *RECORD* of 1836-37, individual course listings were published under the heading of a "School of Engineering" although the "School" may have been more like a department of engineering today. The Virginia Military Institute has offered

courses in civil engineering since 1839 and Virginia Polytechnic Institute and State University since 1872. Old Dominion University first offered junior-level engineering courses in 1964, having been authorized the year before to establish a school of engineering.

As opposed to courses, the initial engineering degree in the state was awarded by the University of Virginia in 1869 when the first four-year course was completed after the end of the Civil War. VMI followed suit the next year but limited the awarding of a degree to distinguished graduates only in civil engineering. A mining engineer degree was the first awarded in 1885 at VPI&SU and the first baccalaureate engineering degrees at Old Dominion in 1966.

The four cited institutions of higher education are the Commonwealth's state-supported colleges with engineering curricula accredited by the Engineers Council for Professional Development. Jointly they have graduated thousands of civil engineers over their respective periods of history. Many of the civil engineering graduates of these outstanding engineering colleges have risen to national prominence. Washington College, shortly after the end of the Civil War under the leadership of General Robert E. Lee, instituted a civil engineering curriculum which flourished until the mid-1930's when the department was abolished. Washington and Lee University still teaches basic engineering courses and its graduates so interested participate in a "3-2 Program" spending three years in Lexington and then attend other participating engineering colleges; the successful graduate of the program receives a W&L bachelors degree in science and another bachelors degree from the second college in engineering, often civil.

In 1961, there was considerable discussion in engineering circles concerning the desirability of establishing a fourth engineering curriculum in Virginia, namely, at the then Old Dominion College. The Board of Directors of the Virginia Section took the matter under advisement and the president of the section appointed a special committee consisting of five members. There were two members at large on the committee and three others representing the western, central, and eastern portions of the Commonwealth.

The committee carefully reviewed all of the pertinent information before it, including voluminous studies by federal and state agencies as well as by private individuals. Ultimately, the committee unanimously voted that it was the sense of the group that the facts presented amply demonstrated the desirability and feasibility of the establishment of a four-year engineering curriculum at Norfolk.

In the matter of credentials of engineering administrators in educational institutions, the Virginia Section took a positive position in 1969. Following much discussion, the Section went on record to recommend to the presidents of the four engineering colleges in Virginia that whenever engineering department heads or deans of engineering were to be appointed or selected that these individuals be carefully chosen and that they also be experienced professional engineers. When the District 6 Council met in Virginia in 1970, the Council took similar action urging all sections within the Council to make similar recommendations within their geographical jurisdictions.

Student Chapters

Student Chapters of ASCE are intended to be an excellent means to help the civil engineering student prepare himself for entry into the engineering profession and to the Society. The student organization serves as a fine medium for introducing the student to professional contact with the engineering world. Chapter members gain experience by preparing, presenting and discussing papers, they conduct meetings and chapter activities, hold office, invite and entertain guest speakers, visit construction sites, prepare society report, and have access to Society publications.

Interest in student activities in Civil engineering was evident early in Section affairs. The Virginia Military Institute organized its Student Chapter in 1921, the year before the Virginia Section was formed. The University of Virginia and Virginia Polytechnic Institute and State University both chartered student chapters the next year coincidental with the year of the Virginia Section's formation.

In 1955, the first-and second-year engineering students at the

then Norfolk Division of William and Mary-VPI initially affiliated in ASCE matters with the VPI Chapter and two years later the Norfolk students formed a branch of the VPI Chapter. This relationship continued until 1965 when a national charter for a separate Chapter was granted to the engineering students of what by that time had emerged as Old Dominion College and is now known as Old Dominion University.

Many of the outstanding members of the Virginia Section are graduates of these four distinguished engineering colleges.

The Student Chapter of the Virginia Military Institute has gained national prominence in ASCE affairs. In 1966, that Chapter was awarded the first Robert Ridgway Student Chapter Award as the "single most outstanding Student Chapter of the American Society of Civil Engineers." In addition, the VMI Student Chapter holds the national record of outstanding performance, having won the National President's annual certificate of achievement for a total of 34 times, a number several times greater than any other Student Chapter in the United States.

To foster competition among the several student chapters, the Society has encouraged the formation of organized student chapter conference groups. The Virginias Conference now has five Chapters in its membership—Old Dominion University, VMI, VPI&SU, University of Virginia and West Virginia Institute of Technology. Each spring, one Chapter acts as host to the others and arranges at least a full-day activity. The meetings include a brief business session, student paper competition, and an appropriate field trip to a nearby engineering facility already completed or one under construction. In addition, every Fall, the Virginia Section, in cooperation with either the Blue Ridge Branch or the Roanoke Branch, invites the four chapters located in the Commonwealth to its regular Fall meeting. At the annual meeting of the Section, generally held in Richmond, the Virginia Section invites each Student Chapter to submit technical or professional papers for competition. The papers received are independently judged by the Section without reference to source, and the student declared

the winner is invited to appear on the program at the Section's annual meeting and is awarded a cash prize.

Therefore, through the following efforts student interest is kept high and interest in the Society and the Section is engendered. (1) Annually, the Section makes an award of twenty-five dollars to the outstanding Civil Engineering graduate, as selected by the head of the Department at each of the four engineering schools. (2) Annually, at the Spring Student Chapter Conference, which rotates among the four schools, papers are presented on engineering subjects by student members and the most outstanding oral presentation receives the Hardy Cross Award. This award, which was originally donated by the Norfolk Branch consists of a silver cup for the individual and a large silver bowl to be retained by the school until the award is won by a student from another school. The late Hardy Cross, who was born in the Tidewater area, taught at Norfolk Academy before he became a nationally recognized engineer in his work in moment distribution of column analogy. His last home was in Virginia Beach, Virginia. (3) Annually, as a part of our annual meeting, papers are prepared by senior students on an engineering subject and judged by a team of qualified engineers. The winner presents his paper at the annual meeting, at which time he receives a twenty-five dollar award.

Four persons play vital roles in all Chapter activities. The head of the departments of civil engineering in the four engineering colleges give encouragement. The Chapter faculty adviser is the driving force behind civil engineering student activity and these gentlemen are truly the unsung heroes to whom so many plaudits are due. Finally, each Student Chapter in Virginia has two assigned members of ASCE who are engaged in engineering practice and who serve as contact members or associate contact members. These practicing engineers, who are appointed by the ASCE Board of Direction upon recommendation of the District Director, work closely with the chapters.

The minutes through 1937 are not complete in all respect with awards presented individual students or the names of the chapters receiving the annual coveted ASCE certificates of commendation.

For the record then, there is listed in Appendix D all of the awards since the year 1966-67, the date of the first Hardy Cross Award, and the first full year of activity after the Old Dominion University received its national charter as a Chapter in 1965.

The record of receipt of Certificates of Commendation is particularly noteworthy as the Virginia Student Chapters compete against some 38 other Chapters in Zone II. Usually only ten or eleven certificates are presented annually. The Section has every right to be proud of outstanding record of competition in this endeavor.

Comments by Past Presidents

In anticipation of the preparation of this work, all living past presidents of the Virginia Section were invited by President Dischinger to make any comments they believed pertinent as the Section made plans for its 50th Anniversary. Those officers listed below made comments which are worthy of incorporating in the official record of the first half-century of the Section.

Donald S. Wallace, President, 1948-49. "When I was President in 1949 we held quarterly meetings in Richmond, Norfolk, etc., with the annual meeting in Richmond in January. The establishment of the Branches has met a need but I think the result of such activity spread over the State has reduced interest and attendance at our annual meeting. As you know it has been difficult to draw together our membership scattered over Virginia and not too many can take the time, and perhaps the cost, of a long drive to Richmond for an overnight stay. It seems now the annual meeting draws mostly from the city and nearby areas, except for officers of the Branches.

"One outstanding event we had in 1949 was a summer meeting, July 23, 1949, at Buggs Island Dam. John Roberts, Secretary-Treasurer, and I made arrangements with the Corps of Engineers at Norfolk and we issued invitations to a number of other engineering groups and allied organizations. Colonel George T. Derby of Norfolk was most helpful and I invited General Lewis A. Pick, Chief of Engineers, to attend and speak. We had a large crowd,

as I recall nearly 400, at least several hundred, (actually 176 members of the Virginia Section and 284 members of other engineering groups from Virginia and North Carolina), and this was considered to be one of the largest meetings of engineers ever held in Virginia. General Pick gave a good talk as well as Colonel Derby. The Corps of Engineers provided luncheon at the cafeteria, after which we inspected the construction project.

"General Pick was a happy choice for honored guest since he grew up in Brookneal and was graduated from VPI. As you may recall, there were engineers who questioned the justification of the vast river basin development proposed by the Corps of Engineers. Private power companies opposed public power competition, railroads opposed subsidized navigation and at that time Virginia political heads took a dim view of the New Deal policies and Federal domination over the states. But the meeting proved to be quite successful, brought many engineers together, and provoked thought even though not all engineers may have been persuaded as to the economic justification of the project.

"How effective do I feel the ASCE and the Virginia Section have been? I do think we have succeeded fairly well but doubt we have achieved many brilliant accomplishments, particularly in the field of public relations. Engineers, with some exceptions, are a cautious and inarticulate group; we do not excel in sophisticated arguments, like lawyers. We try to avoid bitter controversy or we hesitate to get involved and we are scared of politicians. So, I guess we have to make haste slowly. Perhaps we have improved from 1922 to date. I hope so."

P. H. McGauhey, President, 1950-51. "My objective as President was twofold. First, to get together with my friends from time to time and enjoy the fellowship for which the Section was then (and I trust, still is) famous. My second objective was to convince NSPE that ASCE was good for another hundred years, and, having objectives which NSPE could not possibly embrace, would have to be permitted to stagger on into the future. You will recall that in those times it was thought that the medical profession was strong because it had only one parent professional organization,

rather than because it controlled the enrollment to medical schools and had a special relationship to the citizen that a similar engineering organization could not inherit. I do not know whether my modest efforts had anything to do with the outcome. More likely the glacier-like inertia of ASCE (not the Virginia Section) was the real force. In any event ASCE continued to serve its goals and so the time of my presidency saw its goals accomplished either by our efforts or by history. In later years I joined NSPE and was active in its local section here in California for a while. Meanwhile, I continued active in ASCE, which I found more to my liking. I say these things not to belabor NSPE, which has made its significant contributions, but to suggest that our objectives in the Section in 1951 still strike me as sound."

L. S. S. Smith, President, 1958-59. "I have a general comment on the effect of the Section through the years. It has and does promote professionalism in the State and in its members and has promoted the civil engineer to the citizens of the Commonwealth although not to the degree that the doctors and lawyers do.

"As I remember my year, it was a continual effort to raise our quota for the campaign for the United Engineering Center in New York. Many good Virginians couldn't see handing out their hard earned dollars for a project up in Yankee New York! My annual report stated that we had raised only 49% of our goal of $13,300 or $6,475—a dismal showing.

"You probably remember—I'll never forget—at the Board meeting on December 4, 1959, at the John Marshall Hotel I was vainly trying to conduct the proceedings while being bothered by Charlie Via on my right. I finally listened to him and heard him ask what was the latest figure on the balance due. He then personally pledged the remaining, some $6,700. It broke up the Board meeting. He was true to his pledge. You remember he died about two months later. This was a most generous and unprecedented gift."

D. H. Pletta, President, 1965-66. "Unfortunately we have not done as much professionally as we should have. As a result, we have seen vast new private and governmental bureaucracies de-

velop. These are now formulating policies and forcing their decisions on American industry. I need only point out the impact of Nader's criticism of the automotive industry, or of the development of anti-pollution agencies sired by our federal government.

"During the intervening years, ASCE has initiated an entire new dimension in its service to members. I refer here particularly to the professional activities sphere and the work that is being done to enhance unselfish professional service to the public, to improve the image of the society and the profession in the public sector, and to enhance the professional stature, employment conditions, and economic status of the members.

"These professional activities are only now beginning to bear fruit for it has taken three years to organize the committee structure and provide the necessary financing to launch this new major effort of ASCE.

"Professionalism is now being taught in our engineering colleges much more effectively than it was years ago, the stifling effect of collective bargaining on professional behavior is being discussed and curtailed, and the opportunities for continuing education through society efforts have been immensely expanded. Professionally and technically, ASCE is now a far greater service to society and has just initiated more effective means for dealing with societal problems than we even dreamt possible a decade ago.

"This effort has required thousands of man hours which were cheerfully donated by ASCE's members. I fear the time has come, however, for all members of the society now to provide the additional treasure in the way of added dues to realize these objectives and to provide mankind with the professional leadership it so badly needs."

Hyman J. Fine, President, 1968-69. "During my term of office, I was fortunate in having an energetic Board of Directors with whose help I feel great progress was made in membership participation. The five branches of the Virginia Section met regularly, and (a) discussed subjects of technical interest, (b) worked successfully toward the formation of the Bull Run Branch, (c) vigorously supported the successful candidacy of Dan Pletta for the

office of National Director, (d) stressed and encouraged student participation through various competitions and awards, and (e) partially defrayed the cost of meals for students at the annual meeting."

W. S. G. Britton, President, 1969-70. "During my term as president, my greatest concern was toward the recognition and encouragement of the Student Chapters. This is where we secure not only our future ASCE membership but the future Civil Engineers who will represent the profession and continue the heritage of Civil Engineering. This is a continuing major activity of the Virginia Section and I hope it will always continue. I gained a great deal of satisfaction from my visits to all of the Student Chapters."

What's Where in Civil Engineering in Virginia

In 1962, the 40th anniversary year, the Board of Directors, in response to a request to all local ASCE sections throughout the western hemisphere, authorized a poll among the membership which sought to select the outstanding civil engineering achievements in the Old Dominion. The effort was known nationally by the title "What's Where in Civil Engineering." During the summer of 1962 more than 50 members of the Section, about one for each two Virginia counties, were asked to nominate the outstanding engineering accomplishments in their geographical areas. In a magnificent response, 135 nominations were proposed. In September, ballots listing the nominations were mailed to the entire membership and were received in gratifying numbers by mid-October. The ballots were canvassed at the Fall meeting in Roanoke and the Board authorized the publication of a 40th anniversary souvenir picture pamphlet which described in detail the following engineering accomplishments arranged alphabetically:

CHESAPEAKE BAY BRIDGE-TUNNEL
DULLES INTERNATIONAL AIRPORT
GEORGE P. COLEMAN MEMORIAL BRIDGE AT YORKTOWN

HAMPTON ROADS BRIDGE-TUNNEL
JOHN H. KERR DAM
NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY
THE PENTAGON
RICHMOND-PETERSBURG TURNPIKE
THE SKYLINE DRIVE
VIRGINIA INTERSTATE HIGHWAY SYSTEM

Other engineering feats receiving many nominations but not described in the pamphlet were:

BLUE RIDGE PARKWAY
DAN RIVER MILLS
OLD JAMES RIVER AND KANAWHA CANAL
REYNOLDS METALS BUILDING IN RICHMOND
WALLOPS ISLAND MISSILE LAUNCHING SITE

Since the foregoing selections were made, many other noteworthy engineering achievements have been realized among which these are considered outstanding:

THE RICHMOND COLISEUM
THE ROANOKE CITY AUDITORIUM COMPLEX
THE NORFOLK CONVENTION CENTER
THE HAMPTON ROADS CONVENTION CENTER
THE BIG WALKER MOUNTAIN TUNNEL (Interstate 77)
THE FAIRFAX WATER AUTHORITY FILTRATION PLANT

Outstanding Engineering Achievements

The Virginia Section was honored to have the Chesapeake Bay Bridge-Tunnel receive the ASCE Award as the outstanding engineering achievement in 1965. Dulles International Airport was nominated for the same recognition and received the ASCE Award of Merit in 1964.

Life Members

Currently, a Life Member is one who has reached age 65 and who has been a dues paying member of ASCE for 30 consecutive years.

Before 30 November of each year the ASCE headquarters staff prepares a list of those members of the Society who will qualify in this membership category at the end of the calendar year. Individual certificates of life membership are transmitted to the secretaries of the several sections and are presented, if practicable, at section affairs, often the annual meetings. If a presentation at a section meeting is not practicable, the certificates are preferably delivered personally by an officer or member of the section, otherwise the certificate is mailed.

A detailed review of all extant Virginia Section records was made, national headquarters was also queried, and as complete a list as possible of Life Members whose certificates have been presented through the Section has been prepared. The list, shown as Appendix E, is arranged alphabetically. It is regretted that a more complete list could not be uncovered.

Epilog

In his remarks at the annual meeting in Richmond, in 1966, President D. H. Pletta was both prophetic and optimistic in his remarks.

"Despite the fact that the achievements of the Virginia Section are significant, we members would be remiss in our calling if we did not continue to search for solutions to the pressing technological problems which are only now beginning to plague mankind as the world population nears a critical size. We need only think of the solutions that must be found in transportation, automotive safety, pollution, and noise control abatement to appreciate the tremendous magnitude of our job. At the same time it offers a challenging opportunity to serve mankind. I can only hope that all of us will continue to exert our best efforts in seeking solutions to these problems."

So, it is surely correct to say the Virginia Section ASCE, at the end of its first half-century, continues to advance the professional status of civil engineering and to improve man's surroundings in general in a manner which the founders of ASCE envisioned some 120 years ago at the parent organizations' beginning. Growing in numbers and in engineering leadership throughout the Old Dominion as well as in service to its members, the Virginia Section enters its second half-century with optimism and confidence.

APPENDIX A

Revised 1972

VIRGINIA SECTION
AMERICAN SOCIETY OF CIVIL ENGINEERS

CONSTITUTION

* * *

Article I—Name and Object

Section 1. The name of this organization shall be the Virginia Section, American Society of Civil Engineers.

Section 2. Its object shall be the advancement of engineering knowledge and practice; the cultivation of friendly relations with all engineers, the maintenance of high professional standards; and cooperation with other societies, with a view of promoting the general welfare of the engineering profession and the American Society of Civil Engineers.

Article II—Membership

Section 1. The members of the American Society of Civil Engineers of all grades, subscribing to the Constitution and By-Laws of the Virginia Section, as evidenced by the payment of current dues of the Section shall be members of the Section. All members of the American Society of Civil Engineers of all grades, whose addresses are within the boundaries of the Section, as defined by the Society shall be allocated Members of the Section.

Article III—Dues

Section 1. There shall be no entrance fee.

Section 2. The dues of each member shall be not less than $1.00 per year nor more than $5.00 per year.

Article IV—Officers

Section 1. The officers shall be a president, a first vice president, a second vice president, a third vice president, a secretary, and a treasurer. The officers, the latest living past president, and two directors elected from among the members at large shall constitute a Board of Directors in which the government of this Section shall be vested.

In addition, the presidents of each branch section within the Virginia Section shall be a member of the Board of Directors.

Section 2. Officers shall be elected at an October Meeting for terms of one year, which terms shall begin at the close of the Annual Meeting and continue until their successors are installed. Only members of the Section shall be eligible for election. Their duties shall be those usual for such officers.

The two directors shall be elected at an October Meeting for terms of two years, commencing at the close of the Annual Meeting. One director shall be elected each year so that their terms will not be concurrent.

Article V—Meetings

Section 1. The Annual Meeting shall be held on such dates between November 1 and March 1 and at such place as the Board of Directors shall designate. Other meetings shall be called at the discretion of the Board of Directors, or by the President upon written request of at least ten members.

Article VI—Amendments

Section 1. (a) Amendments or additions to this Constitution shall be initiated only at a regular meeting of the Section by the affirmative vote of the majority of members attending such meeting, to be voted on by the membership at large under the following procedure:

(1) The proposed amendment shall be voted upon by letter ballot by a majority of the members of the Section.

(2) It shall receive an affirmative vote of not less than two-thirds of the members voting.
(3) To become effective, it shall receive the approval of the Board of Direction of the Society.

Article VII—By-Laws

Section 1. The section may adopt By-Laws consistent with this Constitution for the guidance of officers and members.

Article VIII—Branch Section

The Board of Directors may authorize the formation of Branch Sections within the territorial jurisdiction of the Virginia Section, provided the organization and Constitution of the Branch Section is also approved by the Board of Direction of the American Society of Civil Engineers.

* * * *

Revised 1964

VIRGINIA SECTION
AMERICAN SOCIETY OF CIVIL ENGINEERS

BY-LAWS

* * * *

Article I—Dues

Section 1. The annual dues for members of the Virginia Section shall be $3.00 for all grades of membership payable in advance on January 1.

Article II—Nomination and Election of Officers

Section 1. The Nominating Committee shall consist of the three last living available past presidents.

Section 2. The nominating committee shall choose for the office of the president, first vice president, second vice president, third vice president, secretary, treasurer, and director, one candidate for election to each of these offices and shall obtain consent of the nominee to serve if elected.

Section 3. The secretary shall send a letter ballot, containing the list of official nominees and a space for a write-in vote for another candidate for each office to each member of the Section at least 20 days previous to an October Meeting.

Section 4. Ballots returned to the secretary up to the time of counting shall be opened and counted at an October Meeting by three tellers appointed by the President. For each office, the candidate receiving the highest number of votes cast shall be declared elected.

Section 5. Assistants to the secretary and the treasurer, if deemed necessary by the Board of Directors, may be appointed by the Board of Directors.

Article III—Committees

Section 1. Committees deemed necessary from time to time shall be appointed by the President.

Section 2. The following committees shall be appointed each year: Program, Membership, Hospitality, and Public Relations.

Article IV—Meetings

Section 1. In addition to the Annual Meeting, at least two meetings shall be held each year at regular intervals, one of which shall be in October.

Section 2. Notice of each meeting of the Section shall be sent to each member of the Section.

Article V—Amendments

Section 1. (a) Amendments or additions to these By-Laws may be initiated only at a regular meeting of the Section by the affirmative vote of the majority of the members attending said meeting to be voted on by the membership at large under the following procedures:

(1) The proposed By-Laws or Amendment shall be voted upon by letter ballot by members of the Section.
(2) It shall receive an affirmative vote of not less than a majority of the members voting.
(3) To become effective it shall receive the approval of the Board of Direction of the Society.

* * * *

APPENDIX B

OFFICERS OF THE VIRGINIA SECTION

Presidents

1922-23	J. C. Carpenter	1949-50	S. J. Mahaffey
1923-24	J. A. Anderson	1950-51	P. H. McGauhey
1924-25	Allen J. Saville	1951-52	W. Calvert Roberts
1925-26	W. P. Wiltsee	1952-53	John W. Roberts
1926-27	F. L. Nicholson	1953-54	Tilton E. Shelburne
1927-28	R. B. H. Begg	1954-55	C. S. Mullen
1928-29	Henry G. Shirley	1955-56	James A. Rives
1929-30	F. F. Harrington	1956-57	Stanley R. Navas
1930-33	E. M. Hastings	1957-58	Charles E. Via, Jr.
1933-34	J. E. Crawford	1958-59	Livingston S. Smith
1934-35	R. Keith Compton	1959-60	Douglas B. Fugate
1935-36	W. D. Tyler	1960-61	John E. Krome
1936-37	C. W. Ogden	1961-62	James M. Morgan, Jr.
1937-38	Wilson T. Howe	1962-63	Henry P. Sadler
1938-39	C. W. Johns	1963-64	Frank G. Louthan, Jr.
1939-40	E. W. Saunders	1964-65	R. Kenneth Weeks
1940-41	Gamble M. Bowers	1965-66	D. H. Pletta
1941-42	Eugene S. Thomas	1966-67	J. E. Watlington, Jr.
1942-43	W. R. Glidden	1967-68	J. Stuart Franklin
1943-44	Thomas W. Roby	1968-69	Hyman J. Fine
1944-45	Richard Messer	1969-70	W. S. G. Britton
1945-46	R. A. Marr, Jr.	1970-71	Charles E. Echols
1946-47	R. Stuart Royer	1971-72	Xenophon D. Murden
1947-48	P. A. Rice	1972-73	H. C. Dischinger
1948-49	Donald S. Wallace		

Secretaries—Secretary-Treasurers

1922-23	Lee H. Williamson, Sec.	1954-55	F. G. Louthan, Jr., Sec.
1923-24	J. C. Carpenter, Sec.	1955-56	F. G. Louthan, Jr., Sec.-Treas.
1924-31	Albert C. Dunn, Sec.-Treas.	1956-60	F. G. Louthan, Jr., Sec.
1931-45	P. A. Rice, Sec.-Treas.		

1946-50	J. W. Roberts, Sec.-Treas.	1960-61	Ray S. Gordon, Sec.
		1961-66	W. S. G. Britton, Sec.
1950-52	S. R. Navas, Sec.-Treas.	1966-70	J. M. Wray, Jr., Sec.
1952-54	S. R. Navas, Sec.	1970-	H. Gordon Larew, Sec.

Treasurers

1952-55	E. L. Coile	1963-66	James W. Whitt
1956-57	R. K. Duey	1966-70	W. R. Pully
1957-63	J. E. Watlington, Jr.	1970-	J. P. Bradshaw, Jr.

Assistant Secretary-Treasurer

1948-49	Stanley R. Navas	1949-51	Stuart Loughborough

APPENDIX C

BRANCH PRESIDENTS—VIRGINIA SECTION ASCE*

Blue Ridge	*Blue Ridge*	*Norfolk*	*Peninsula*	*Richmond*	*Roanoke*
		J. A. Rives		F. G. Louthan, Jr.	J. S. Franklin, Jr.
		D. B. Fugate		H. P. Sadler	J. S. Franklin, Jr.
		T. B. Hutchinson		C. S. Mullen	R. F. Watson
		R. K. Weeks		A. W. Maner	R. L. Little
		J. W. Midkiff			M. T. Ward
		X. D. Murden			H. P. Bigler
		W. D. Marshall		R. S. Gordon	B. W. Kingery
		C. J. Robin		C. E. Kinder	B. W. Kingery
		Y. W. Buhr		A. M. Dreelin, III	W. R. Snapp
		H J. Fine		L. F. Spaine and T. J. Ogburn, III	B. H. Barksdale
		S. T. Terrett		Leo Cantor	W. L. Williams
		A. A. Shisman		W. R. Pully	C. W. Riggsbee
		L. Kreshin	G. J. Viertel	C. B. Miller	J. P. Bradshaw, Jr.
S. Krewatch		J. W. Fowler	H. C. Dischinger	Roy Holte	C. B. Malcolm, Jr.
J. T. Warren	J. S. Hodge	C. R. Lee	K. B. Patrick	J. T. Loftus	G. Barringer
H. G. Larew	J. V. Kerr	C. D. Matthias	Charles Tudor	C. A. Palmer	R. M. Stiff
W. L. Patrick	J. V. Kerr	R. H. Bigelow	R. H. Feldhousen	J. H. Norman, Jr.	W. L. Rossie, Jr.
F. B. Glick	P. E. Bengston	W. J. Thompson	R. H. Feldhousen	J. C. Hobbs	W. S. McKay, Jr.
J. B. Dungan	E. B. Constantine	E. L. Fulford	C. T. Cochran	R. S. Solomon	C. E. Kabrich
W. J. Osborne					

*As Branch election years may have varied somewhat, the actual year of service has not been listed. The Presidents have been placed in the order in which they served. Corrections should be reported to the Secretary of the Virginia Section.

APPENDIX D

ASCE STUDENT CHAPTER CERTIFICATES OF COMMENDATION AND INDIVIDUAL AWARDS

Certificates of Commendation

	Old Dominion University	*University of Virginia*	*Virginia Military Institute*	*Virginia Polytechnic Institute and State University*
1966-67	Certificate	—	Certificate	Certificate
1967-68	Honorable Mention	Certificate	Certificate	—
1968-69	Honorable Mention	Certificate	Certificate	Certificate
1969-70	Certificate	Honorable Mention	Certificate	Certificate
1970-71	Certificate	Certificate	Certificate	Honorable Mention
1971-72	Certificate	—	Certificate	Certificate

Hardy Cross Awards

1966-67	Cadet R. L. Green, VMI
1967-68	Harold E. Costley, VPI&SU
1968-69	Chris Dieterich, VPI&SU
1969-70	John Graham, ODU
1970-71	Rick McCormick, West Virginia Institute of Technology
1971-72	Cadet L. S. Welker, VMI

Winner of Student Chapter Technical Paper Contest

1966-67	James A. Jordan, Jr., VPI&SU
1967-68	Vince H. Derr, UVa
1968-69	Edward Hardy, UVa
1969-70	Baxter R. McElroy, UVa
1970-71	Cadet Chris Tompkins, VMI
1971-72	Cadet G. A. Straughn, VMI

Outstanding Senior ASCE Student

	Old Dominion University	*University of Virginia*	*Virginia Military Institute*	*Virginia Polytechnic Institute and State University*
1966-67	Russell M. Row	G. E. Glahn	Cadet J. J. Burgess, Jr.	James Brenneman
1967-68	Carl Betterton	H. E. Harrison	Cadet Dean A. Kershaw	J. K. Turpin
1968-69	D. D. Loendorf	Robert Skinner	Cadet R. A. Heely	R. D. Swartout
1969-70	D. J. Fallon	K. H. Greene	Cadet R. R. Costigan	Charles Earnest
1970-71	Martin S. Lang	T. A. Scott, Jr.	Cadet M. T. North	William Hogan
1971-72	Dale A. Campbell	Miguel P. Dengo	Cadet L. M. Preas	Miss Faith Jean Kelly

APPENDIX E

LIFE MEMBERS

Kingsley S. Anderson	1973	Earl O. Heaton	1959
James A. Anderson	1955	R. Henderson	1959
John Bayliss	1931	William D. Henderson	1959
Ralph N. Begien	1940	Maurice Hewett	1955
A. H. Bell	1954	Floyd W. Hough	1960
Paul A. Blackwell	1941	Russell Hummel	1960
Guy Bonney	1954	C. Morris Hunter	1947
George D. Brooke	1941	H. R. Hortenstine	1942
Allyn P. Bursley	1962	Frederick C. James	1956
James C. Causey, Jr.	1973	W. Martin Johnson	1971
George A. Chester	1973	Fontaine Jones	1950
H. M. Church	1952	G. P. Jones	1943
John N. Clary	1973	Walter C. Kerlin	1971
George M. Cornell	1971	C. H. Locher, Sr.	1947
John D. Cosgrove, II	1973	Albert M. Luhrs	1963
William J. Cox	1962	Eugene E. Lundquist	1973
J. E. Crawford	1943	Gordon MacKellar	1969
H. Velpeau Darling	1971	Col. John H. C. Mann	1971
Walton Darwin	1942	Albert C. Matthews	1955
George K. Davis	1959	William R. McCann	1949
Charles E. Dexter	1948	Richard Messer	1947
Edward Digges	1966	Crosby Miller	1946
Harry K. Dimelow	1955	Robert Morrison	1955
Donald H. Dowe	1973	C. W. Murdough	1971
Chalkley DuVal	1970	Harold A. Murphy	1967
James D. Fauntleroy	1940	Daniel Noce	1965
Hyman J. Fine	1972	Chester Ogden	1955
Philip D. Freeman	1969	Lester C. Overstreet	1956
Chapman J. French	1945	Donald W. Parsons	1973
Douglas B. Fugate	1973	Robert L. Pettigrew	1957
L. M. Gray	1947	Dan H. Pletta	1973
Michael C. Grenata	1964	V. B. Poulsen	1956
G. M. Harbert	1952	John E. Pruitt	1973
E. M. Hastings	1945	Robert F. Pyle	1967
Joseph M. Hatchett	1971	Frederick C. Ray	1973

Lewis N. Riggan	1973	William F. Tompkins	1964
Henry W. Roberts	1971	R. D. Trimble	1943
William C. Roberts	1967	F. P. Turner	1943
Walter Rowland	1942	Robert G. Vawter	1958
R. Stuart Royer	1947	Donald S. Wallace	1966
John C. Russell	1971	Carl J. Wallin	1971
William St. Clair	1968	W. J. Ware	1973
George C. Scherer	1940	Frank M. Weakley	1947
Arthur E. Searles	1969	Charles R. Wentworth	1964
Donald H. Selvage	1971	John L. Wentworth	1961
C. W. Smedberg	1956	Omar W. White	1971
Lawrence T. Smith	1968	James W. Wright	1971
Charles H. Spilstone	1944	Robert D. Wright	1970
A. F. Stem	1973	T. Judson Wright	1947
George Stone	1951	F. K. Woolley	1973
Jonathan E. Teal	1948	R. B. Worthy	1956
Eugene S. Thomas	1959	S. N. Yoder	1973
Miles H. Thomas	1971		

PART II

A Lock of the James River and Kanawha Canal, on the James at Balcony Falls (with the James River on the left and Sallings Mountain in the far background), taken circa 1874)—courtesy Mr. E. Douglas McClure, Glasgow, Virginia

The James River Canal (1785-1880)

The Revolutionary War, with the attendant problems of transportation and communication required in the movement of troops and supplies in areas and over distances not theretofore appreciated, accelerated the demand for provision of such means. Most of those involved in campaigning had been removed from a life limited in movement; exposed to conditions incidental to such removal; and awakened to opportunities abroad and available to those of willing disposition, and thus were loosened from home ties to travel westward and the development of trade. Movement of individuals by horseback and family by light vehicles was easy over rough trails, but it was necessary to return the raw materials of trade by the simplest natural available routes, or waterways, leading to the improvement of these and to canals as the returning trade became bulkier and heavier.

The French writer, Michel Chevalier, in his "Society, Manners and Politics in the United States, Being a Series of Letters on North America", states in his letter XXI, Buffalo, September 7, 1835, "The spectacle of a young people, executing in a short space of 15 years, a series of works, which the most powerful States of Europe with a population three to four times as great, would have shrunk from undertaking is in truth a noble sight. The advantages which result from these enterprises to the public prosperity are incalculable." Almost a century later Wayland Fuller Dunnaway, in his "The James River and Kanawha Company" observes, "In his investigation of this subject the author has been struck by the misconceptions existing on the part of such writers as have made reference to this enterprise. It seems to be conceived of very generally as merely a canal project of small importance and is ordinarily dismissed as such with a certain unwarranted contempt."

For a period just short of a hundred years the James River Canal occupied the thought, the economy and the politics of the citizens of Virginia, varying from the idealistic to this single tangible project of prime importance in State financing. Many water routes were spawned within this State, and enjoyed fleeting popu-

larity in most instances, but the James River and its major tributaries reached almost entirely across the eastern part of the then political unit, while the Kanawha River with its eastern tributaries reached almost to the western of the James' branches, and could thus deliver heavy trade items down the Ohio and the Mississippi to the Gulf of Mexico and the open sea lanes. Much of the life and times of the James River Canal included attempts to wed the two great river systems, both lying in the same State until West Virginia established its own political entity.

Lieutenant Governor Alexander Spottswood, of the Colony of Virginia, after his explorations through the western country in 1716 suggested the connection of the Atlantic seaboard with the west via the James River, over the Alleghenies and down the Kanawha. In 1748 George Washington, then a sixteen year old lad but surveying the holdings of Lord Fairfax in the valley of the Alleghenies, made a similar recommendation, and again in 1754 carried this idea to Governor Dinwiddie and his Council upon his return from contact with the French forts in the west. The House of Burgesses in 1765 passed an act to improve navigation of the James River and Washington supported this objective. In 1784 Washington, now a mature soldier, agriculturist and political scientist, strongly urged Governor Benjamin Harrison to extend transportation, communication and unification of this State by this means of development. On recommendation of the Governor a charter was issued in 1785 to the James River Company with Edmund Randolph as acting President, vice Washington who declined to serve. The 100 shares of the Company donated to Washington in recognition of his service, were endorsed by him over to the Liberty Hall Academy, in Lexington, Virginia, and the College, heir to the Academy, enjoyed the yearly dividend until the shares were retired by the State in the early years of this century.

Legislative conditions of 1785 provided for the collection of tolls; maintenance of navigation at all seasons for boats of one-foot draft; and outlined plans for improvements. It did not include extension over the Alleghenies to the Ohio, but navigation was to be provided as far west as Crow's Ferry at the mouth of Looney's

Creek (now Buchanan). The first issue of 500 shares, at $200 per share, was increased by 100 shares at once, probably the donation to Washington.

It was 1795 before the first seven miles, to Westham, was ready for navigation by boats of one-foot draft, and improvements for navigation to Crow's Ferry were reported by 1801, and a 3% dividend was declared. Branches were extended from the James up the Rivanna and North Rivers over the next four years and full tolls collected, indicating acceptance of the work, and stock sold at par by 1806. Albert Gallatin, Secretary of Treasury, in his report of 1808, "Public Roads and Canals" referred to the James River Canal as one of the most successful internal improvements in the country, with a 25-foot canal width and locks 80 feet long with 3-foot depth, but he was quite critical of the maintenance on the River. It may be noted here and later on that canals were cut only as required and that improvements in widths and draft continued with the same criteria.

Subsequent to the Gallatin report, although probably not affected thereby, the State appointed a Commission to view and report on the extension of this route westward, but nothing was done. A year later a 22-member Commission, including John Marshall as head, James Breckinridge, William Lewis, James McDowell, William Caruthers and Andrew Alexander, was appointed and began its travel by boat from Lynchburg September 1, 1812, to Crow's Ferry; to Dunlop's Creek, head of navigation; thence overland locating a road as they went; past Bowyer's Sulphur Springs (now White Sulphur); to Anderson's Ford at the mouth of Howard's Creek on the Greenbrier River, the head of western navigation, to its mouth; thence down the New and Gauley Rivers to the Great Falls of the Kanawha; which they reached September 28, 1812. The report of this Commission rendered in 1816 urged this route, estimates of cost varying from $190,000 to $600,000. The War of 1812 delayed action on the Canal for the duration but the James River Company was the strongest corporation in Virginia at this time.

The report of the Commission in 1816 led to an act to create

a fund for internal improvements; establishment of a Board of Public Works and to empower it to appoint a Principal Engineer, a Secretary and such other administrators as deemed necessary. L. Baldwin, the first Principal Engineer, made a more detailed survey of the route traversed by the Commission, and the first report of the Board of Public Works recommended this project under the cooperative efforts of the Federal government, and the States of Ohio, Indiana and Kentucky. Inhabitants along this route petitioned in support of the recommendation in 1817, and Washington College, recipient of George Washington's shares in the James River Company, joined, with the added request for a more efficient plan for the improvement of the James River itself.

The Attorney General of Virginia brought suit in 1818 against the Company to enforce the terms of the charter as to maintenance and improvements, although some work had been done on the branches up the Willis, Rivanna and North Rivers. Thomas Moore was employed to make a more detailed survey of the route than had been by Baldwin, and was aided by Isaac Briggs as a consultant, and this extended from Richmond to the Kanawha. As a result of their report Governor Edmund Randolph urged action as ". . . The subject is now mature for the decision by the Legislature" (House Journal 1819-24, page 144). The cost estimates submitted by the two engineers varied from $1,927,067 to $1,945,446, to include 3-foot drafts for boats; a road from Dunlop's Creek to the Great Falls of the Kanawha at $100,000; and ". . . ample accommodations to the trade on the south side of the (James) river.", (Virginia Acts 1819-20, Section II, page 40.) Provisions for toll charges to pay the 12% dividend for 12 years and thereafter 15%, were passed. Although practically State owned because of State funding it was only in the Virginia Acts of 1822-23 that the charter was taken over by the State, with operations continuing in the hands of the James River Company.

Claudius Crozet, a former soldier under Napoleon, more recently Professor of Mathematics and of Engineering at the United States Military Academy and just appointed Principal Engineer, in 1824, of the Board of Public Works made an elaborate survey

of the Canal routes assisted by Benjamin Wright, builder of the Erie Canal. As a result of this survey and report the General Assembly authorized a canal through the Blue Ridge. In spite of reports of completion and of work on the Canal only 34 miles had been completed, within the then specifications, and an imperfect road of 100 miles opened, and the clearing of the Kanawha River had been planned by 1824. James Madison presided at the "Internal Improvements Convention", held in Charlottesville in July 1828, and while the Canal continued to be the largest corporation in the State and the extension to the Kanawha was the most important item on the agenda, no action resulted due to overriding sectional politics. The turnpike from Dunlop's Creek over the Alleghenies to the Ohio was completed in 1829 at a total cost of $192,874.78 for the 208 miles of its length. The cross section was a roadway 22 feet in width, with a crown in the center, and sloped ditches. The bridges over the Greenbrier and Gauley Rivers were considered as excellent and cost $18,000 each.

Crozet took a strong position in support of railroads, then coming into use, believing that these would supplant water transportation through central Virginia. His associate, Wright, took the opposing view holding that a combination of canal with railroad would serve best, and this difference confused the public, delaying action, and the James River Company languished. By 1832 expenditures on the Canal had amounted to $1,349,709.57, and a joint venture of public and private funding was incorporated as The James River and Kanawha Company. Under this new organization there would be a canal to Lynchburg, with railroad connection to an appropriate point on the Kanawha, thence improvements on the latter as far as the Ohio. The standard cross section of the canal was to be trapezoidal, a 35-foot bottom width by 50 feet at water line and a depth of five feet, with suitable tow-paths. A later recommended location was to extend the Canal to Covington (Dunlop's Creek). The Chief Engineer of the Company was Benjamin Wright with Simon W. Wright, Daniel Livermore and Charles Elliott as assistants. Surveys were completed and 73 miles of canal construction advertised for bids to be opened in December 1835,

anticipating completion by July 1838. The 120 miles from Maiden's Adventure to Lynchburg were divided into 201 sections for construction and 161 were let by the end of 1836. The turnpike to the Great Falls of the Kanawha being found in need of repairs, this was undertaken. Benjamin Wright resigned at this time his position as Chief Engineer to enter into private practice as a consultant.

Construction on the Canal continued in spite of the panic of 1837, strikes on the line and replacement of Irish labor by slaves. Work was completed to Lynchburg by 1840, and continued onward towards Buchanan (Crow's Ferry), through the Blue Ridge, and its connection in Richmond to tidewater. The Richmond to Lynchburg division of the Canal contained 58 locks, 11 aqueducts, 191 culverts and 133 farm and road bridges. Committees from both Houses of the General Assembly examined the work and found it well done and economical, and the administration conscientious, although it was criticised for initiation of the extension beyond Lynchburg before other stated priorities were underway. Recommendation by the Legislature that administrative salaries be reduced was disregarded by the stockholders. The greatest flood since that of 1795 occurred in 1842 breaking the Canal in 103 places and the James River overflowed its banks for 24 miles. The second auditor's report of 1844 showed the total accumulated costs to date to have been $7,153,370.79.

A controversial resolution for a continuous rail line versus a canal and railroad beyond existing construction was passed at a stockholders meeting in December of 1845, and while this brought about changes in the Company management through resignations of those not favoring the railroad, State funds were made available to complete the tidewater connections in Richmond and to extend the Canal to Buchanan. Connection at the latter location was completed in November 1847, adding 50 miles to the Canal and containing 38 locks, 4 stone and 7 timber dams on the River, 8 culverts and 48 square drains, 17 miles of towpath and 2 farm bridges, and a vehicular bridge in Lynchburg. The cost of this division was $2,422,566. The distance from Richmond was 196½ miles,

with 36¾ miles in slack water navigation, costing $8,259,184 (no explanation is given for the divergence of total cost here with the sum of the costs of the two divisions except the figures came from two different researchers), exceeding the Erie Canal cost of $7,143,789 which had a section of 28 feet bottom width, a 4-foot depth, and a 40-foot water line width versus the James River Canal of 35-foot bottom width, 5-foot depth, and 50-foot water line width.

The Company unwisely began work on the third division of 47 miles to Covington in 1851, and which had 10 locks, 3 aqueducts and a 1,900-foot tunnel in it. The construction was abandoned in 1856 after an expenditure of $638,058.58 was made, practically a total loss to the Company. Several laterals along as many feeder rivers had been undertaken between 1837 and 1858. The Kanawha extension suffered neglect under management of both Companies, expenditures on its improvements being $91,666.72 and $61,170.40 by the James River Company and The James River and Kanawha Company respectively. Contracts for the work were loosely controlled in that "dog chutes", to permit draft, were zig-zag regardless of currents or types of boats and passage in some places at limited water flows only. Major freight on the Kanawha in 1854 was some 3,000,000 bushels of salt, worth $1,000,000, and in 1855, 20 coal companies near Charleston were shipping coal. Boats for transportation were supplied by the user while the Canal Company provided the right of way, unsatisfactory at times, but profitable.

The turnpike road from Dunlop's Creek to the Big Sandy River, headwaters of the navigation westward, was an obligation of both Canal Companies since it was a necessary link overland between the two river basins, but was never appreciated due to its costly administration and maintenance. From 1852 it gradually decreased in importance as other overland routes developed. In spite of the fact that beginning in 1854 railroads made increasing inroads into canal freight haulage, as late as 1859 tonnage through the Canal was in excess of three times that of the Richmond and Danville Railroad, the most important rail line in the

State at the time, and 2,500 tons more than the combined tonnage handled by the four railroads entering Richmond.

The James River and Kanawha Company was in 1860 still the most powerful corporation in Virginia, a State more dedicated to agriculture than industry, and to politics than to commerce. The Company consistently made profits, and was as consistently ". . . handicapped by sectional animosities and jealousy of rival interests . . . (Dunaway, "The James River and Kanawha Company), and while almost entirely State owned, for this very reason was most sensitive to Legislature influence. It was criticised by the users, but having to construct, and at times to operate on borrowed capital at high interest rates kept it heavily involved.

The continuous docks at Richmond were 4,100 feet long by an average of 100 feet wide. As contracts were activated under Wright's plans 1,400 were employed on the Maiden's Adventure Dam to Lynchburg division in 1836 increasing to 3,300 by 1837. Most of the labor was by Irish immigrants, but a cholera epidemic on the section from Lynchburg to Balcony Falls caused a strike and although promised a 20% wage increase if they remained to completion, some 200 left for work in the west, and their places were taken by slaves although such work was far from as efficient. Property of the Canal Company as the second division, from Lynchburg to Buchanan was completed, consisted of 75 deck boats, 66 open boats, 54 batteaux which required 425 mules and horses and 900 men to operate. Freight rates were the same up or down stream at 6½¢/hundedweight. Six packet boats made the trip from Richmond to Lynchburg in 33 hours and the return in 31½ hours; fare being $7.50 each way, including meals, berth and canal tolls; children and servants were carried at half fare; bar service was available on board; separation of men and women at night was by curtains across ship, with berths along the walls and mattresses on table tops. Horses or mules were changed every 12 miles and while the rate was fixed at four miles per hour, with five miles if approved, this was often and illegally exceeded with races between boats, terminating at times in "free-for-alls" at canal-side grog houses where "fuel of strong stimulant stoked their pugilistic

fires." A pone of corn bread left by the winner at upper locks was an open invitation to continue the race with fisticuffs. Among others of like temperance mind, Gen. John H. Cocke, of Bremo Recess, erected a pipe and delivery of cold spring water to the Canal side at Bremo Bluff, but this soon furnished "chasers" rather than taking the place of strong drink.

William Dean Howells made the observation "Canals in 1837 were a greater achievement than railroads in 1897." Desmond Fitzgerald, early President of the American Society of Civil Engineers, says of the canal builders, "What they did not understand they conquered by diligent study, unwearied zeal and sound common sense." These statements apply wholeheartedly and completely to this great Canal and its engineers and builders.

At about this time the Chief Engineer of the Company, E. Lorraine, called attention to the growing alienation of western Virginia due to the lack of communication between the east and the west, and by some authorities, it was thought that had eastern and southside Virginia suppressed their opposition and had proceeded with opening up transportation with the middle west, as had been dreamed of by Washington, Marshall, Madison, Breckinridge, and other statesmen, that with the completion of the Canal West Virginia might not have seceded and the Civil War been avoided, or otherwise ended.

In 1859 a French combine, owning 300,000 acres in western Virginia, proposed the purchase of the James River and Kanawha Company, and to complete the waterway from Richmond to the Ohio. On March 29, 1861, with the enthusiastic support of Governor John Letcher, the Legislature approved the sale of the holdings of the Company to the French combine, Virginia Canal Company, subject to certain controls. The secession of Virginia from the Union on April 18, 1861, interfered with the consummation of the sale. Negotiations resumed in 1866, with the Legislatures of both Virginia and West Virginia concurring in legislation to permit the sale, but the French had lost interest.

During the first years of the Civil War the Canal rendered great service to the Confederacy, although the coastal blockade

effectively cut off overseas trade. Repairs became increasingly difficult in the second year of the War in spite of contral government aid in funds, discount on purchase of equipment, and use of impressed and slave labor, until in 1864 when foremen and mechanics were called to active army duty the operations were practically shut down. On March 6, 1865, General Philip Sheridan, U.S. Army, entered Scottsville and with the troops under his command proceeded to destroy the Canal works for some 90 miles, or to within 30 miles of Richmond. The burning of this City after April 3, 1865, led to the destruction of most of the Company records. The new State of West Virginia had confiscated, on May 15, 1862, the portion of the works in that State, transferring ownership to the counties through which these passed, and although some attempt was made to improve navigation on the Kanawha it was ineffectual.

The Richmond Times of February 2, 1867, stated "The Canal seems to be gravitating from bad to worse with constantly increasing rapidity . . . Half a century or more of thought, labor, and distinguished administrative and engineering ability has left it almost in the articles of death. . . . It has a talent for sinking into a state of hopeless bankruptcy . . . A broken down, impoverished concern like the James River and Kanawha Company cannot afford to maintain this army of well paid officials." This obviously had to do with attempts at reorganization and resumption of operations. The 31st Annual Report of the James River and Kanawha Company carries indication of its search for continuity, "The argument for the constitutionality of the act erecting West Virginia into a separate State is not convincing, and would carry no more weight with people of any State today, in the event that a disgruntled minority should appeal to it. Furthermore, it is difficult to see the difference in principle involved in the secession of a section of a Commonwealth and in that of a section of the country at large. Wherein lies the force of the reasoning that it is right in one case and wrong in the other?"

Sale or transfer to private enterprise, with Virginia herself deeply in debt, the aid of the Federal Government was sought to

complete an artery of communication so important to national development and welfare. In 1868 the General Assembly of Iowa voted a memorial in its behalf; a national commercial convention, with representatives of 28 States met in Louisville, Kentucky, October 12, 1869, memorialized Congress in favor of completion of the all-water route; another of 1870 in Cincinnati, continued the effort; the Ohio Legislature, on April 16, 1870, strongly urged the President, Congress, and Governors of adjacent States to this support that same year; the States of Virginia and West Virginia joined in these petitions; Kansas, on January 17, 1873, added its voice; and President Grant, in his message to Congress in December 1870, and again in 1872, referred to the James River and Kanawha Canal as among the three routes best suited to reduce transport costs of agricultural products to the Atlantic.

Apropos to the several requests through Congress, Maj. W. P. Craighill of the Army Engineers, made a survey of a continuous navigation between Richmond and the Ohio and the report, referred to the Committee on Commerce of the Congress, on February 11, 1871, proposed a summit level tunnel through the high point of the passage through the Alleghenies at an estimated cost of $47,622,267. Subsequently further surveys and Congressional hearings resulted in favorable references by the several Committees, with the final estimate of cost not to exceed $60,000,000. The panic of 1873 closed this financial avenue. The flood of 1870 had not aided in this decision.

Railroads continued to compete and reduce Canal tonnage after 1875, but the James River and Kanawha Company managed to obtain a charter for the Buchanan and Clifton Forge Railway Company, on March 27, 1876, the location and survey being made by Maj. Peyton Randolph in May and construction beginning in 1877, utilizing a large force of convicts furnished by the State. Then the flood of 1877 sounded the death knell of the Company although repairs were partially successful, until another flood in 1878 obstructed efforts once more.

The General Assembly of 1877-78 passed the act of incorporation of the Richmond and Allegheny Railroad Company au-

Viaduct Crossing (location known)—Preston Leech.

Viaduct Remains (location unknown)—Preston Leech.

Stonework at Canal Lock of James Below Buchanan—Preston Leech.

Railway Crossing a Lock Wall (location unknown)—Preston Leech.

The Little River Turnpike (1802-)

The earliest map of the northern neck of Virginia was credited to John Warner, one of the surveyors of the Fairfax tract in the years 1736-37. Daniel Jenings drew the map of Fairfax County circa 1745-48 with the purpose of dividing it into two Parishes, and while Alexandria was not itself laid out until 1749 it did show an existing road system. In 1748 George Washington, then age 17 and employed by the Surveyor of Fairfax County, drew up the 60-acre layout of the new town, so named by the Virginia General Assembly in providing for the survey and layout, and quite possibly so named since it contained the properties of John and Philip Alexander, as well as that of Hugh West. Shortly thereafter, in a 1755 version prepared by Joshua Fry and Peter Jefferson (father of Thomas), showed the newly established town of "Belhaven or Alexandria" with roads linking this new seaport with developing Falmouth and Fredericksburg to the south, and to the rich agricultural lands in the Shenandoah Valley to the northwest. In 1798 George Gilpin drew a map of Alexandria showing 14 east-west and 20 north-south streets, and whereon was shown the "Main Post Road" entering the city via Duke Street. (from "Alexandria: City and Suburb", Library of Congress, Geography and Map Division)

"An ACT to incorporate a Company for establishing a turnpike road from the intersection of Duke Street in the town of Alexandria, with the southwest line of the District of Columbia, to the ford of little river where the turnpike road crosses it.", was passed by the Virginia General Assembly as Chapter LXXXIII, under date of January 28, 1802. It provided for the opening of books to receive subscriptions on 200 shares to be pledged at $100 per share, with $10 down paid to specifically named commissioners: two each from the Counties of Fairfax, Loudoun, Berkeley, Jefferson, Frederick and Shenandoah. Thereafter, and upon published notices, the remainder of the pledged amounts would be paid over to the elected president, treasurer and four directors of the Company as required. If not paid at that time the subscriber forfeited the already invested amount.

thorizing it to purchase the property and franchise of the James River and Kanawha Company. After legislative and political discussions and adjustments the James River and Kanawha Company holdings, including the Buchanan and Clifton Forge Railway Company were sold to the Richmond and Allegheny Railroad Company. Most of the trackage of the railroad was laid on the towpath of the Canal—a sort of tragic justification of the recommendations of the fourth Principal Engineer, Claudius Crozet.

Sources of Information:

Virginia Historic Landmarks Commission
Virginia State Library
William E. Trout, various publications and advice—excellent
"The James River and Kanawha Company", Wayland F. Dunnaway
"Old Towpaths", Alvin F. Harlow
"The Long Haul West", Madeline Sadler Waggoner
"Canals and American Economic Development", Carter Goodrich
Mr. E. Douglas McClure, grandson of R. H. Brown, lock-tender at Stevens Dam, some 2½ miles west of the Balcony Falls. Resides at Glasgow, Va.
Mr. Preston Leech, of 3233 Ledgewood Ave., S.W. Roanoke, Va., 24018 Who walked over most of the Canal from Eagle Rock to Richmond, Virginia, in the early 1950s, taking photographs of the remains of works at that time.
Mr. Anthony Perrins, Director of Market Planning, Reynolds Metal Company, Richmond, Virginia. This Company has cleaned and partially restored Locks 4 and 5 of the Tidewater Connection of the Canal, and maintains a large library of data on this and other canals.

The Ship Lock, Tidewater Connection, at Richmond, Va.—Preston Leech.

Stone Tablets on the Ship Lock, Tidewater Connection — Preston Leech.

Only Chimneys Remain of Lock Tender's House, near Pemberton, Virginia, with Old Slipway in the Foreground—Preston Leech.

C & O Railway Crossing a James River Canal Aqueduct, near Hardware, Virginia—Preston

Viaduct Crossing (location known)—Preston Leech.

Viaduct Remains (location unknown)—Preston Leech.

Stonework at Canal Lock of James Below Buchanan—Preston Leech.

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Besides the management organization, holding office for one year, the act authorized for condemnation of properties on the most direct right of way, and for obtaining suitable gravel, stone, wood or other materials necessary for the construction and maintenance; and to build bridges over the water courses. The road width was specified to be 30 feet, with a 20-foot vehicular way of select material as required, and ditches for drainage along each side. Condemnation of rights of way vested in the respective County Court with 12 disinterested freeholders as appraisers, and for materials, freeholders. Upon completion of the first 10 miles west of the District of Columbia line, and thereafter for like progressive distances, the Governor would appoint three "skilful persons" to review and examine the construction for compliance within "the meaning of the Act, and if satisfactory the Governor would permit erection of necessary gates or turnpikes every ten miles and to collect fees." Samples of fees were: every score of sheep, or hogs, 12 cents; score of cattle, 25 cents; a horse, 6 cents; two-wheel riding carriage, 12½ cents and a four-wheel unit, 25 cents.

It is of interest to note that at this early stage of highway development and traffic regulation for the best utilization of engineering knowledge, and the strength of materials, fair limits were placed on vehicular dimensions: every cart or "waggon", with tires of 4-inch width or less, 6 cents per horse drawing the same; but for those of 4-inch to 7-inch, 3 cents per horse. And there was a reasonable equalization of usage by animals, and to local needs: every ox or mule was assessed equally; no tolls were collected on returning vehicles unless they carried 500 pounds or more. The provision and assurance of maintenance was established and continued in effect for almost a century: an allotment of labor of five days per year was required of all residing within three miles of the road in Loudon and Fairfax; if repairs were not made within five days of complaint thereof, collection of tolls would cease and fines of $10 imposed on those responsible for such (the fines were to be divided equally between the poor and the one complaining). The turnpike was to be completed in seven years, and income from

tolls were to be established to return not less than 15%, net, to the shareholders. The Act went into effect March 1, 1803.

The Act of 1802 was clarified and broadened in control and protection of the road, probably as a result of experience and thought, in 1803. The roadway was widened from 30 to 50 feet, the paved width to remain at 20 feet while additional dimension would afford a "summer road" to be used by horse- and foot-traffic and excluded from vehicles between the end of October and the first of May and whenever weather had softened the way. No four-wheeled carriage or wagon was permitted on the "artificial" part of the road (apparently the paved width) between December and April with more than two and a half tons load, if tires were four inches or less in width; no more than three tons, with tires four-to seven-inch tire width; none with more than four tons between December and April; and never more than five tons at any time. The Company could install scales and require the driver to unload and weigh, but the operation was not to require an unreasonable time. Evasion of tolls could result in fines of from $3 to $10 for each offense. Vehicles were to keep to the right in passing except to pass slower moving units and maintain free passage way, under pain of a $2 fine, or in the case of a slave, not to exceed ten stripes on the bare back, unless the fine was paid at once.

The shareholders could increase the capital stock to not exceed $50,000 if required for completion of construction. Annual reports, beginning within one year of completion of the road, were required and if the net income was less than 6%, tolls could be increased but not to exceed 10%. Rules and regulations for the operation of the road could be promulgated by the President and Board of Directors; rates were to be posted at all toll gates; and toll gathers were to be appointed by the Company.

Under date of November 20, 1817, the first report of operations was made to Mr. Bernard Peyton, of the Board of Public Works, upon the urging of that body. The extent of the paved road was within a few poles of thirty four miles, work being initiated in October of 1802 and completed in December 1811, and

the Governor authorized, in January 1812, the erection of gates and the appointment of toll gatherers. The stock issue had been $150,000, and dividends of $11,101.77 and of $21,920.29 paid in January 1810 and 1815, respectively, from a gross income of $101,791.26½ collected between October 11, 1806, and January 1817. The stockholders voted to apply any balance, after current operation and maintenance and a 6% dividend, to reduction of grades and improvement of bridges along the road.

After this first report of 1817 others followed annually, President Phineas Janney and Secretary Jonah Thompson accounting for income and expense with occasional interesting insertions such as losses through acceptance of counterfeit notes. Reports include concise statements of the economic difficulties of early maintenance problems of road repair, "guaduating hills", and bridge construction and repair incidental to "freshes". In spite of appreciable costs of maintenance the Directors managed fairly consistent dividends of 6%, serving a rapidly developing country to the west and being free of serious competition for the early years.

Shortly after his appointment as Principal Engineer for the Board of Public Works of Virginia, Claudius Crozet reported in December 1824 on his inspection of the Turnpike, criticising the use of too large stone in some surfacing and insufficient gravel to soil in other places. Returning in January 1827 he found the road ". . . quite different from what it was two years ago. It will now be one of the best roads in the United States.", recommending its extension from Winchester to Ohio, and ". . . that it would obtain a great proportion of the western trade and traveling." Again, in 1828 he found "This road affords an excellent example of the necessity of attending carefully to the original location and make of such work; had this been done in the first instance, the expense now incurred in reshaping and graduating it would have been altogether saved."

Although Company officers appear to have been aware of these weaknesses and had persisted in "graduating hills" and in maintenance, it increased its efforts. Dividends were reduced or deferred in order to follow this advice. The art of road building

and maintenance practiced in the first years of the century was now giving way to the science of engineering introduced by Crozet. Appeal was made for more and appreciable State aid in 1832 after the preceding severe winter caused heavy repairs, the turnpike ". . . has been in fact the pioneer to all or nearly all turnpikes in Virginia, and consequently had to encounter a mass of difficulties, by overcoming prejudices of almost every description . . ." The Board of Public Works held only 125½ of the issue of 1,500 shares in the Company. The officers complained in 1835 of the loss of revenue due to crop failure in the west, and of the inroads from competition by the Chesapeake and Ohio Canal Company.

The State does not appear to have attended but conditions improved, with work and repairs of more permanent nature and the rapid expansion in western development. The report of 1838 states, ". . . in consequence of the grade of the hills having been reduced since the road was first opened for travel . . . it is now in the power of those using the road to convey on it with the same number of horses, as much additional load, as will pay every cent of the toll levied, consequently it may now with great propriety be said to be a free road. . . ."

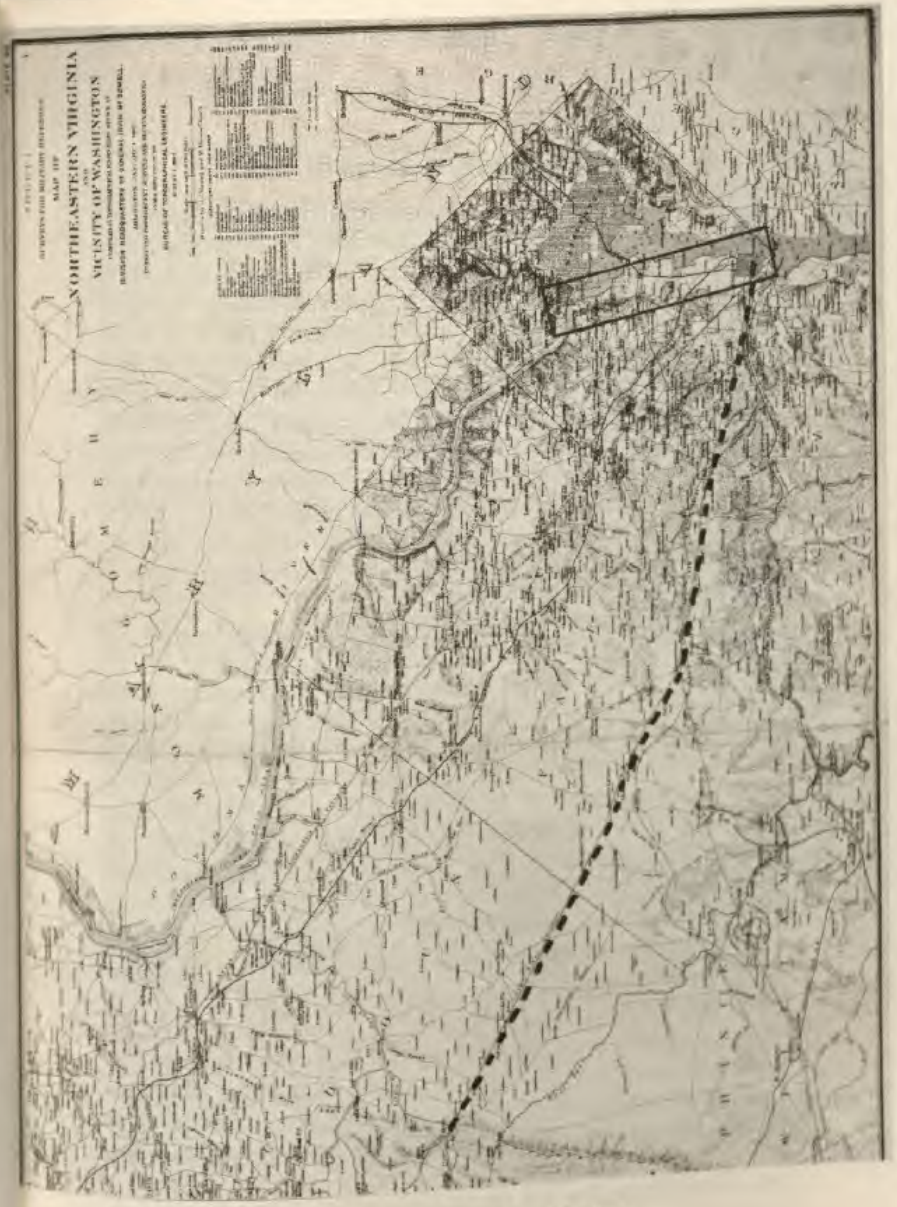
Many travel routes in Virginia had been opened in colonial times. An act in 1705 required roads connecting county seats and each county to Williamsburg, the capital; "rolling roads" permitting the rolling of tobacco hogsheads; and post roads after the Revolutionary War, but most were little better than trails, with poor maintenance, road building being a woodsman's art. America's first toll road was built in 1772 to connect Warm Springs with Jennings Gap near Staunton, and the nation's first turnpike company, the Fairfax and Loudon Turnpike Road, was chartered in 1795 to construct and maintain a road between Little River and Alexandria. It accomplished little until superceded in 1802 by the Little River Turnpike Company. Given broad powers and managed by individuals of limited experience but dedicated to their duty they built the road in some nine years and continued to improve it through its early years on a sort of hit-or-miss basis. Road building, an art developing slowly through the first of the nine-

teenth century, grew apace under the engineering science Claudius Crozet brought into its design and construction.

The Little River Turnpike became a model for other highways, remaining a toll road for some 90 years, and its location is followed today by Virginia Route 236 and U.S. Route 50. It stood a pioneer in road building, enjoying the beneficial advice from the first highway engineer in Virginia, Claudius Crozet, and even now maintains its identity in the details of the "Virginia 1973 Offical State Highway Map".

Sources of Information:

Virginia State Library
Virginia Department of Highways
"Alexandria: City and Suburb", Library of Congress, Geography and Map Division—including the attached photostat



LITTLE RIVER TURNPIKE (1785)—Alexandria to Aldie, 33.5 miles

ALEXANDRIA CANAL (1833-1843)—Joined to the Chesapeake and Ohio Canal at Georgetown and terminated between Montgomery and First Streets, in Alexandria, Virginia

The Alexandria and Georgetown Canal (1827-1886)

The Alexandria Canal, as it was designated in the resolution adopted by the freeholders of the Town and County of Alexandria in its conception in 1827, was chartered by the Commonwealth of Virginia in 1830 and the principal engineering feature, the aqueduct across the Potomac River, was completed in 1843. It was to be lateral to the Chesapeake and Ohio Canal and connected to it on the north bank of the River, and terminate on the west bank of the Potomac in Alexandria between Montgomery and First Streets at wharves appropriate to coastwise and ocean-going vessels. Thus, as envisioned by its stockholders, it would be a vital economic link in a transportation and communication system joining the important Chesapeake Bay and shipping from Alexandria with the then rapidly expanding agricultural, timber and mineral interests to the west.

This public work is important as a pioneering engineering project in its originality in the design and construction and the equipment required for its aqueduct across the Potomac, where excavation to foundation support for its piers were sunk through some 28 feet of water and mud, average, and under all sorts of weather conditions. Mud and gravel were over 17 feet deep in places and water depth of 16 feet even at low flow. At this stage of national development and academic progress engineering application was an art rather than a science, and the only precedent approaching the difficulty of work at this depth of water pressure was in London and accessibility was impracticable. Floods and intense cold were hazards to the laborers and dangers to the cofferdams. Leakage through the cofferdams were baffling, that at Pier No. 4 had to be emptied 22 times before masonry could start, and on one occasion ice on the River formed to a depth of 16 inches. Adding to the natural difficulties were delays due to the reluctance of the Chesapeake and Ohio Company to honor its commitment to build the abutment and connection with its Canal on the north bank of the Potomac.

The original plan was for 12 stone arches to be supported on

11 piers and two abutments; the arches to be 100-foot span of 11-centered curves by a 25-foot center rise; wall thicknesses at the spring lines were to be 12 feet at intermediate locations and 21 feet at the center and end abutments. Revised plans called for 350-foot north and 66-foot south abutments with circular wing walls 13 feet thick at the base, and eight piers supporting 125-foot spans and 12 feet thick at the water line. (A large number of ink drawings and sketches, as well as voluminous reports are in the files of the Office of Chief of Engineers, U.S. Army, showing stages of construction, design features, methods of construction and materials and equipment used, accessible through the Office of the Deputy Chief, Public Affairs.)

Bids based on limited detailed plans and dependent on the experience and ingenuity of the contractors, were received January 29, 1833, and varied in amounts from a low of $99,093.13 to a high of $247,909.63. The contract was let to Martineau & Stewart on June 29, 1833, but the letting of subcontracts for work were very slow with work beginning on September 21, 1833. The contractors abandoned work after the collapse of a cofferdam on December 21, 1833, and the Directors of the Alexandria Canal Company petitioned the Engineers to undertake the work, Major William Turnbull, of the U.S. Topographical Engineers, being in charge. Congress declined to finance the Canal aqueduct construction and this support continued from the citizens of Alexandria, the original stock subscription being for $250,000, but did continue its supervision.

Major Turnbull assumed direct supervision May 16, 1834, and there followed considerable detail of difficulties from the 18 feet of water and 17 feet 4 inches of mud at the site of Pier No. 2, to October 22, 1834 when six feet of mud had been removed; pilings sprung; bales on buckets broke; ropes stretched and other mishaps occurred. On November 5 leakages filled the cofferdam, but innovations in machinery, shoring and caulking permitted pumps to dewater 17 feet in four hours and a half. Then the weather turned very cold although work continued, until storms and floods coming between November 11 and 18 delayed opera-

tions as laborers refused to work and mechanics were put to work. This was the time when the cofferdam of Pier No. 4 had to be emptied 22 times; broken machinery and cold continued. On December 27 there was a snow fall of 17 inches and on January 4, 1835, ice on the River was thick enough to bear the weight of a man, but in spite of these conditions 15 cubic yards of masonry, laid in hydraulic cement, was placed on January 3. Weather had moderated by April 22 and work resumed under normal conditions. Stone was selected for size so the bedding exceeded the face exposure by from four to six times, and sand and cement mortar was used for laying to at least two feet above high water level, with sand-lime mortar in setting above this line. Pointing of joints was with a cement-sand mortar. The first pier was completed August 1, 1835, and expenditures for work amounted to $85,965 by December 7, 1835.

As late as January 1, 1836, Major Turnbull reported that he, along with Messrs. T. F. Mason, President of the Alexandria Canal Company, and W. M. C. Fairfax, Engineer for the same, conferred with the Mayor of the Town of Georgetown on the proposed aqueduct crossing with piers to serve the dual purpose of a vehicular bridge and canal support, and to be situated at right angles to the thread of the stream rather than at the oblique angle as had been proposed by Messrs. Wright and Roberts, of the Chesapeake and Ohio Canal Company staff. The suggestions, submitted to the councils of both towns, were not acted on for some time and so the original oblique location and single purpose piers were continued in construction. On January 16, 1836, the Directors of the Chesapeake and Ohio Canal Company directed their Engineer, Mr. C. B. Fisk, in cooperation with Major Turnbull to design and specify the northern abutment and turning basin for the Alexandria Canal.

In the course of the construction and one of the reports filed from Major Turnbull states, "A more difficult work has rarely been heretofore undertaken. It may with propriety be considered, for boldness of design and skillfulness of execution, as unprecedented among works of that kind. The great interest of the United

States involved in the Chesapeake and Ohio Canal, of which this connexion with the Potomac at Alexandria forms so important a link, and the amounts which the United States have devoted to the particular structure in question, have been considered sufficient to justify the detail of one of their engineers as superintendent of the work. It has been prosecuted with great and successful industry and skill, under the accidents and discouraging circumstances inseparable from works of this kind. Its success is now placed beyond doubt." The statement as to the Federal interest is borne out by a report "Chart of The Head of Navigation of The Potomac River, Shewing The Route of The Alexandria Canal, Made in Pursuance of a Resolution of the Alexandria Canal Company October 1838, Surveys by Lt. Col. Kearney, Maj. Turnbull, W. M. C. Fairfax, M. C. Ewing, Civil Engineers." and on page 168 there is the statement that the United States has put $1,000,000 in the Chesapeake and Ohio Canal and continues to provide supervision of the Alexandria Canal.

The message of President Van Buren to Congress on February 12, 1840, with work still under way by Maj. W. Turnbull, states, "But one pier, part of the northern abutment, now remain to be completed when the work will be ready to receive the superstructure or aqueduct trunk. . . . For boldness in design, success in execution, and economy of conduct, this work is, in my judgment, without a rival in our country, and need not fear a comparison with work of any other."

A further report of Major Turnbull, in February 1840, states that in that month ice 16" thick and moving at six miles per hour at break-up did not damage any pier ice-breaker. During the year a decision was made to use the "Kyan's Process" for timber treatment of the aqueduct, and tests were made on North Carolina heart pine and white oak as to absorption. Lumber costs were quoted as 7.5¢ per cubic foot and 13.8¢ per cubic foot for pine and white oak respectively. Labor received $1 per day and foremen $1.25.

In the course of a study of planned construction in 1857, Colonel Turnbull reported on the advisability of combining a ve-

hicular bridge with the aqueduct, using the "old piers" of the aqueduct, fearing that such vibration might be detrimental to the water tightness of the wooden aqueduct. His estimate of the cost of a wooden bridge might be $500,000, and stated that the work which he supervised in 1834-1840 cost $525,381.

The Federal Government confiscated the aqueduct and the U.S. Army, on May 23, 1861, drained the water from it and converted it to use as a vehicular and foot bridge for the movement of troops, artillery and munitions from Washington into northern Virginia. This bridge is credited as a way of salvage of much of the Union forces and equipment after the Battle of Bull Run. Later it served to supply the troops of McClennan, Burnside, Hooker and Grant as the struggle moved back and forth across this part of Virginia. The Canal was returned to Alexandria in 1868, but in a very dilapidated condition. Repairs were made, only for the entire Canal to be abandoned in 1886. It was a losing venture from the first.

For 30 years this aqueduct served canal boats, carriages, and pedestrians crossing the Potomac at Georgetown. *Inset:* A diagram of the aqueduct.

Chesapeake and Ohio Canal, looking eastwards towards the connection with the Alexandria Canal, with the tow path along the Potomac River side.

Top of the North Abutment of the Alexandria Canal with edge of Turning Basin and unloading slip, looking northward towards the Chesapeake and Ohio Canal.

North Abutment of the Alexandria Canal showing the vehicular arch with railroad passing through.

Nearer view of above.

Top of North Abutment and tow path looking towards Virginia across the Potomac with all that remains of the last visible pier, near

The Pentagon Building (1941-1943)

"The Pentagon, headquarters of the Department of Defense, is the world's largest office building. It is twice as large as the Merchandise Mart in Chicago and has three times the floor space of the Empire State Building in New York. The National Capitol would fit into any one of its five wedge-shaped section." according to the publication "THE PENTAGON", issued by the Department of Defense, April 1960, and since that date has had numerous additions, and expansions of services made.

By the summer of 1941 and during the time of preparation for national defense some 24,000 War Department personnel were housed in 17 buildings scattered through Washington and into nearby Virginia. In May a proposal had been under study for the erection of temporary structures on the outskirts of the City, and a $6,500,000 item had been included in the budget for this purpose and submitted to Congress early in July. Under this plan it appeared that expansion of personnel would increase dispersion, increasing the costs of transportation and communication both in time and money. The official concept of the Pentagon was initiated by Lt. Gen. Brehon B. Somervell, then Commanding Services of Supply, U.S. Army, who had the scheme for housing the entire War Department under one roof, and after discussing this with the Staff carried the idea to Virginia Congressman, Clifton Woodrum, who encouraged him, with the result that an item of $35,000,000 was added to the Supplemental Appropriations Bill for 1942. The greater ease of communication and swiftness of action had strong appeal to the military and it was ready to move towards such a realization, and the economy had Congressional appeal.

In spite of the production of the first basic plans and architectural perspectives in a matter of less than five days after the first indication of Congressional interest, followed by the approval of appropriation and the signature of the President, a delay of another month was experienced in the selection of a site. Various planning and fine arts commissions objected to its location in the Arlington Farms area, fearing comparison of a hurried construction of such an enormous building in the same panoramic view of much of the

Washington classical architecture. The first plan was for a three-story structure to reduce the profile and the projection as much as possible in such a comparison. President Franklin D. Roosevelt, himself, after first approving the Arlington Farms location then vacillated in acceptance, although the old Washington-Hoover Airport was here also. General Somervell had the approvals of Under Secretary of War Robert H. Patterson, and Generals Marshall and Moore, and of a Congressional Committee which viewed the site with him. He eventually swayed the Presidential objections and the removal of any Congressional disapproval by proceeding under the original Roosevelt acceptance and initiation of construction procedures under contracts made with John McShain, Inc., of Philadelphia, and Doyle & Russell and Wise Contracting Co., both of Richmond, Virginia. Capt. Clarence Renshaw, a graduate of West Point and career officer in the Corps of Engineers, was detailed as District Engineer in charge, under Gen. Leslie A. Groves, Deputy Chief of Construction.

The original layout on the Arlington Farms site was for a five-sided or pentagon shaped building accessible by five roads; a reinforced concrete structure of 5,100,000 square feet floor space including 300,000 square feet for records storage, a height of first three- then four-stories; and parking for 10,000 vehicles. These plans were modified, particularly after Pearl Harbor, by additional space and facilities, and these plans and specifications of changes were a continual bottleneck throughout construction. Work was beset from its beginning by squabbles of those with special interests: the President specified that the exterior should not be marble but had no objection to the limestone finally settled upon; the loudest uproar was that in the selection of steel sash over wood; another was a dispute as to the granite when Georgia appeared to be excluded because of color selection; and other less important items. The adherence to reinforced concrete not only satisfied the Office of Production Management but did save an estimated 43,000 tons of steel, probably enough for a battleship. A high accident rate plagued the work, as was natural with the

insistence and adherence to the plan for completion within fourteen months.

The overt attack on Pearl Harbor, 7 December, 1941, and national security directed every effort towards provisions for war at the greatest possible speed. As a result many lagging projects were revitalized, after that date, picking up miraculous action under the suspension of bidding regulations. The "Engineering News-Record" epitomized the change in the nation, editorializing, "Building for defense is a thing of the past. The construction industry's new standard must be emblazoned 'Building for Battle'. There is a difference. Time was short. Now there is no more time."

The site of the Pentagon installations was in most part a wasteland, swamp, and dumps, into which, after clearing and grading, was poured 5,500,000 cubic yards of earth fill and grading, and into which was driven 41,492 concrete piles. The dredging of the nearby Potomac River yielded 680,000 tons of sand and gravel and mixed with cement made 435,000 cubic yards of concrete poured into forms to support the structure. General Groves wanted to use brick for the interior walls as it would result in faster construction, but the principal architect, G. Edwin Bergstrom, insisted on architectural concrete, which eventually cost $650,000 more but it is generally agreed that the appearance is more pleasing with the architectural coherence in the structure. The estimated savings in rental with this single building was around $3,000,000 per year, which had considerable appeal to Congress. Another of the prime objectives, rapid communications with coordinated action, was a design so effective that although there are some seventeen and a half miles of corridors, any one point may be reached from another within the building by a walk of not more than six minutes.

The Pentagon building is a gigantic and lasting monument to the American spirit; unity in defense and war; the ingenuity of its architects and engineers; and the force and leadership of its builders. Although its population varies with the military effort and commitments of this nation, the Department of Defense con-

tinues to provide the facilities to enhance the capabilities of those housed in its confines, with additional spatial, transportation and communication means as the needs are realized or envisioned.

Most recent released statistical data available on the Pentagon building include the following, as measures of the principal features of this, the largest office building in the world as it was conceived and built:

A. The Site:

—Land, Government owned (acres)	296
Purchased or condemned (acres)	287
Total area (acres)	583
Cost	$ 2,245,000
—Area covered by the building (acres)	29
—Heating and ventilating plant area (acres)	1
—Sewerage structures, 3,200,000 gallons per day (acres)	1
—Access highways built (miles)	30
—Overpasses and bridges built	21
—Parking space for 10,000 vehicles (acres)	64

B. The Building—Gross floor area (square feet) 6,540,360

—Net floor space for offices	2,613,705
—Concessions and storage	1,091,692
—Volume, cubical contents (cubic feet)	77,025,000
—Central court area (acres)	6
—Length of each outer face (lineal feet)	921
—Height of building, 5 floors, mezzanine and basement	71′-3½″
—Total length of corridors (miles)	17½
—Number of stairways	150
—Number of escalators	19
—Number of elevators	13
—Rest rooms	280
—Drinking fountains	685
—Clocks installed	4,200
—Light fixtures, replacement 1,000 lamps per day	85,000
—Windows, area 309,276 square feet (7.1 acres)	7,748

C. Total cost of project as of April 1960 $83,000,000

D. Personnel—Occupants of offices (as of April 1960) 29,000

—Food service personnel (as of April 1960)	625
—Cleaning, guarding, maintenance, etc. (April 1960)	922

E. Construction chronology

—Budget item, first hearing	7/22/41
—President signed supplemental appropriation act	8/25/41
—Prime contract awarded	8/11/41
—Construction begun	8/11/41
—Mechanical contract awarded	9/ 3/41
—Grading contract awarded	9/24/41
—First occupants moved in	4/29/42
—Construction completed (original work)	1/15/43

Sources of Information:

Public Affairs Office, Office Chief of Engineers, U.S. Army
The Pentagon Building, Mrs. Annie Seeley
General Services Administration, Public Buildings Service
The Corps of Engineers: Construction in the United States by Dr. Jessie Remington and Dr. Lenore Fine, historians of the Corps.

SC 647804 Old Airplane Hangars on the Site of the Pentagon, 1941, -42, -43.

SC 647809 Construction of the Pentagon—Flooding of Excavation.

SC 647316 Construction of the Pentagon—Forming.

318 Construction of the
—Forming of Floors.

SC 647819 Construction of the Fifth Floor and the Bus and Taxi

SC 647320 Construction of the River Entrance to the Pentagon.

SC 647822 Construction of the Pentagon—Ramp and Overpass.

SC 647824 Construction of the Pentagon—Ramps up to Main Entrance.

236 An Aerial View of the
on and Adjacent Area.

Architect's Sketch of Pentagon Back After 28 Years—Secretary of Defense Melvin R. Laird (right) by Lt. Gen. William F. Cassidy, Chief of the Army Corps of Engineers, with B. H. Knobla, Architect in the Office of the Chief of Engineers who assisted in the design of the Pentagon.

Like a 20th-Century Colossus, the Chesapeake Bay Bridge-Tunnel stands astride the wide mouth of the Chesapeake Bay.

The American Society of Civil Engineers, impressed by the diverse and difficult problems that had to be overcome in order to create this gigantic, new fixed crossing—at the edge of the Atlantic Ocean where tides run strong and winds are high—has named the Bridge-Tunnel one of the seven wonders of the modern world. The ASCE choice was based on the seven projects' unusual engineering features, utility to mankind and size.

A complex combination of trestled roadways, bridges, man-made islands and tunnels, the 17.6 mile long Chesapeake Bay Bridge-Tunnel provides a two-lane highway between Cape Charles, on the eastern shore of Virginia, and the Norfolk-Virginia Beach area on the state's mainland. The Bridge-Tunnel closes the last water gap on the North-South Ocean Highway and cuts at least 90 minutes from the driving time between the New Jersey Turnpike and Jacksonville, Florida.

Too big to be built by a single firm, the Bridge-Tunnel is a result of the combined efforts of several leading engineering and construction companies. It was designed for the Chesapeake Bay Bridge and Tunnel Commission, the sponsoring authority, by Sverdrup & Parcel, St. Louis, Missouri, which also was the construction supervisor. Major contractor was a joint venture group consisting of Tidewater Construction Corporation, of Norfolk, Virginia; Raymond International Inc., of New York; Peter Kiewit Sons' Company, of Omaha, Nebraska, and Merritt-Chapman & Scott Corporation, of New York. The steel superstructure for the high-level bridges near the upper end of the crossing were made by American Bridge Division of United States Steel Company, Pittsburgh, Pennsylvania.

Although the individual components of the Bridge-Tunnel are not the longest or largest ever built, the total project is unique in the number of different types of major structures included in one crossing and the fact that construction was accomplished under the severe conditions imposed by hurricanes, northeasters and the

unpredictable Atlantic Ocean, according to Percy Z. Michener, Sverdrup & Parcel Project engineer.

The Chasapeake Bay Bridge-Tunnel consists of 12½ miles of low level concrete trestles, two one-mile tunnels, two steel bridges, four man-made islands, 1½ miles of earthfill causeway, and approximately 5½ miles of approach road. The roadway on the major portion of the project is 28 feet wide, with space for a parked vehicle next to the curb.

TRESTLE SECTIONS

The major portion of the Bridge-Tunnel is low level trestle over relatively shallow water, approximately 20 to 30 feet in depth, in areas where there are no established navigation requirements. The roadway on this structure is placed on a level grade at an elevation 30 feet above mean low water to accommodate small boat traffic and to keep the superstructure above wave action. The trestle structure consists of 858 precast, prestressed concrete spans of 75 feet each and precast bent caps supported on 54-inch-diameter, hollow, precast, prestressed cylindrical concrete piles. The hollow piles, which have walls five inches thick, were filled with sand to enable them to withstand the shock of collision by small boats or ice floes, which occasionally occur in this portion of the Chesapeake Bay. In fact, there have been two major accidents since the Bridge-Tunnel was put into service in 1964, the latest of which resulted from the storm of the first of October 1972 when the trestle structure was battered by a heavy steel barge which was lost in tow. However, repairs were made in record time and service reestablished without other incident.

Two primary considerations in the trestle design were duplication and ease and speed of fabrication and erection.

Trestle components were fabricated on an assembly-line basis at Bayshore Concrete Products Corporation, a special plant constructed at a cost of approximately 3½ million dollars at Cape Charles, Virginia. The trestle superstructure units were designed as simple spans; fabricated as four separate double "tee" sections

(TT), and tied together laterally with post-tension wire at the ends and third points of the span after erection. Curved spans were also precast as duplicates to fit a one degree curve and include super-elevation with transition from the level roadway section. The "tee" section girders were reinforced with straight, uncoated Seven-Wire Stress Relieved strands. Each strand was prestressed to 175,000 pounds per square inch. On all concrete structures an additional concrete cover of reinforcing steel was provided as insurance against possible chemical reaction on the concrete surfaces due to salt water exposure. All concrete in the superstructure units was designed for a compressive stress of 5,000 pounds per square inch.

The substructure bent caps were cast with exposed reinforcing steel for the connection to the piling. The prestressed 54-inch diameter cylindrical piles were cast by the "Cen-Vi-Ro" process in 4-, 8-, 12-, and 16-foot lengths. They were joined after curing by threading 12 prestressing wires (diameter .192") through each of the 16 holes formed in the 5-inch thick pile wall. The wires were prestressed to an average of 165,000 pounds per square inch by jacks; grout was forced into the holes under a pressure of not less than 100 lbs. per square inch. An epoxy was applied at the joints between sections as a seal.

The piles ranged in length from 80 to 172 feet and weighed from 800 to 1,000 pounds per foot of length. Approximately 2,600 of these pilings were used on the project.

The 54" piles were driven from a special DeLong type barge, nicknamed the "Big D." Seventy feet wide by 150 feet long, this "walking" pile driver was supported on four 100-foot long steel pipe spuds which could be raised or lowered into the sea bed by 500-ton capacity air jacks. This provided a fixed platform for the pile driving operation.

The precast caps which tie the tops of the piling together to form a rigid pile bent were placed from a traveling bridge 175 feet long with a stiff-leg derrick mounted at each end. The bridge called the "two-headed monster" moved forward on a wheel assembly mounted on bonnets which were temporarily placed on the

two outside piles of a bent. Steel railroad rails on the under side of the bridge moved over the wheel assembly as the bridge propelled itself forward with its deck hoist engines. The forward derrick handled the equipment for cutting off the piles to the correct elevation. After the cap was set in its final position, concrete was placed in the pile through a 9-inch hole in the cap over each pile.

Each "double-tee" slab section, weighing approximately 65 tons, was set in place on the bent caps by a 75-ton capacity, stiff-leg, self-propelled derrick mounted on a steel box girder which spanned the completed bents.

The length of piling required was determined from a soils profile developed from 120 exploratory borings at strategic locations along the project centerline, some to a depth of 300 feet. Data from the borings were supplemented by a sonar reflective survey which permitted interpolation of the boring data to indicate subsurface conditions for the entire crossing.

All piles were driven to bearing in the tertiary formation of the Miocene age. The average length of all piles driven was 110 feet; the longest pile was 172 feet. Each pile in the trestle was designed to carry 160 tons load. At selected locations along the project centerline, test piles were driven and loaded to twice the design capacity with 320 tons of concrete blocks as a static load. The test load was applied to the pile with a 500-ton jack in predetermined increments, and a pile was considered satisfactory if the net settlement was no more than ¼ inch after 60 hours of loading.

All low level trestle prestressed concrete "double-tee" superstructure units were seated on steel reinforced neoprene rubber bearing pads, to give resilience to the superstructure units and allow free expansion movement.

TUNNELS

The trench-type tunnels which are constructed under each of the two major ship channels are identical in construction details.

The Thimble Shoal tunnel has a portal-to-portal length of 5,738 feet and provides a 1,900-foot ship channel with a minimum

50-feet depth and a 2,500-foot channel with a 40-foot minimum depth. The Chesapeake Channel tunnel is 5,450 feet long and provides a 1,700-foot channel with 50-foot depth and a 2,300-foot channel with a minimum 40-foot depth. The maximum roadway grade in the tunnels is 4 percent. The roadway width is 24 feet plus a 2′-6″ sidewalk on one side and an overhead clearance above the roadway of 13′-6″.

The tunnel structure consists of prefabricated composite structural steel and reinforced concrete tube sections 37 feet in diameter approximately 300 feet long, sunk into place in a prepared trench and covered with a minimum of 10 feet of selective backfill material. The structural steel portion of the tube sections consists of a 35-foot diameter steel tube supported inside a 37-foot square box section. The double steel form shells were fabricated and the interior reinforcing steel tied in place at Orange, Texas, then towed approximately 1,700 miles to the fitting-out yard at Norfolk, Virginia.

At the fitting-out yard the two-foot-thick interior concrete stress ring and the roadway slab were poured and the tube section was sealed preparatory to sinking. Before towing to the tunnel site, sufficient exterior pockets between the interior and exterior steel shells are filled with ballast concrete to lower the tube to about 6 inches of free board. The tube was then towed to the construction site for sinking in its final location.

Prior to sinking, a trench was dug in the sea bed and shaped to the correct tunnel grade and alignment by placing a two-foot-thick layer of pea gravel on the trench bottom and screeding to the correct grade by dragging an oversized bulldozer blade along the surface of the foundation material. The foundation bed for the tube, which in some locations is approximately 100 feet below the Bay water surface, was finished to a tolerance of one tenth of a foot.

At the construction site the tube was placed between two railroad car ferry floats which supported two heavy bridge cross girders, fitted with lines and blocks for lowering the tube into the prepared trench. Additional ballast concrete was placed in the ex-

terior tube pockets to give the tube a negative buoyancy of approximately 250 tons. The tubes were guided into position on the instructions of deep-sea divers working on each side of the tube where the connection was to be made.

Executed at the time of slack water to insure a minimum of underwater current forces on the tube, the connection between tubes was made in this way: a 7-inch diameter fixed pin on the floating tube was guided into a slotted hole in a steel casting on a tube which had earlier been positioned in the trench. The positioned tube had a hood plate on the lower half which extended under the tube being placed. The tube to be placed had a hood plate on its upper half, which extended over the tube already in position. Thus, the tubes that make up a tunnel overlap.

With the tube in correct position in the trench, the remaining exterior pockets along its sides were filled with tremie concrete to give an additional 300 tons of negative buoyancy. The tube joints were further sealed on the exterior by pouring a thick concrete envelope around the joint. After that, the interior of the tube joint was sealed by welding together the overlapping hood plates and by completing the interior stress ring reinforced concrete to make all joints continuous. When the tubes were jointed in their final position, sand backfill was placed along the sides and to a minimum depth of ten feet over the top to insure permanent stability. Thirty-seven tunnel tube sections were placed in the construction of each tunnel.

After the tubes were placed and joined, the watertight bulkheads of each tube were cut out progressively from one end of the tunnel; the interior of the tunnel was finished with ceramic tile, lighting system and other appurtenances.

The tunnel ventilation was accomplished by a transverse distributional system which supplies fresh air uniformly along the tunnel length from a duct beneath the roadway, and removes air through a duct above the ceiling.

Tunnel roadway lighting is provided by two continuous lines of fluorescent tubes, with the intensities varied by zones to provide

control at the portals to help vehicle drivers adjust their vision from daylight to artificial light.

MAN-MADE ISLANDS

The ends of the tunnels are anchored on man-made islands constructed in 35 to 45 feet of water. These islands provide a transition from the trestle roadway to the tunnel tubes. Each of the project's four islands is approximately 1,500 feet long and 230 feet wide at the top, providing about 5½ acres of real estate at a cost of about 5 million dollars. The general surface of the islands is 30 feet above mean low water. A ventilation building, shaft and garage for an emergency crash truck are located on each island.

The islands were designed to resist the forces of a hurricane with 105 miles-per-hour wind velocity. Scale models in wave tank tests withstood hurricanes of 135 miles-per-hour wind velocity.

The islands were constructed by first placing hydraulic fill on the Bay bottom to an elevation of 17 feet below mean low water. A rock dike, approximately 10 feet in height, of ¾ inch to 6-inch stone then was constructed around the perimeter at elevation minus 17 in accordance with the planned shape of the finished island. The enclosure created by these dikes then was filled with sand to form the second lift of the island. A 4-foot thick layer of Quarry Run stone, ranging from 500 lbs. to 2,000 lbs, was then placed outside the previously constructed dike, followed by a 5-foot layer of heavy riprap stones weighing not less than 10 tons each. With some weighing as much as 25 tons each, these stones act as the protective armor surface of the completed island. The process of constructing dikes and placing hydraulic fill and outer layers of protective stone was repeated until the island reached its final elevation of 30 feet above mean low water. On the completed island the heavy armor stone extends from 20 feet below to 20 feet above mean sea level and subsequent severe storms have proven this protection more than adequate.

From elevation plus 16 to 28, a reinforced concrete splash wall with a return lip was constructed around the perimeter of the island to protect against possible wave overtopping.

NORTH CHANNEL BRIDGE

Although only a relatively small part of the total project, the 3,800 foot long North Channel bridge provides a single navigation opening of 300 feet horizontal clearance and 75 feet vertical clearance above mean high water to accommodate the local fishing fleets. The approach grades are 3 per cent.

In addition to the main truss span, the approaches on each side consist of two, four-span, continuous riveted steel deck plate girder units with reinforced concrete roadway surfaces. The bridge is located in water up to 60 feet in depth in an area where there are many variations in the Bay bottom due to shifting channels. The piers consist of metal cans filled with tremie concrete from 5 feet below the water surface to the bottom of the pier, supported on 14 inch steel bearing piles 130 feet long driven into the sea bed to 80 tons bearing capacity each. The piers were constructed without cofferdams. This was achieved by excavating to an elevation slightly below the theoretical bottom of the pier. A precast template supported on temporary timber piles was placed in the excavation at the exact pier location. The 14 inch steel bearing piles were then driven to the required bearing capacity through holes which had been precast in the template allowing about 10 feet of the piling to project above the top of the template.

After the pilings were driven, a steel shell can, with all reinforcing steel tied in position on the inside, was lowered and secured to the top of the precast template on the exact pier alignment. The openings in the concrete template through which the steel piles were driven were sealed with steel plates by a deep sea diver and the steel shell was filled with tremie concrete.

When the pier was completed to the water surface, the remainder of the structure above water was completed by standard construction methods.

FISHERMAN INLET BRIDGE

The 460-foot long Fisherman Inlet Bridge is over one of the U.S. Inland Waterway dredged channels. The center portion of this structure consists of a three-span, continuous, all-welded steel deck plate girder with reinforced concrete roadway surface. The center span of 175 feet provides an opening of 110 feet horizontal clearance and 40 feet vertical clearance above mean high water. The approaches to this structure are on a three per cent grade and are of the low level trestle type construction. The main superstructure spans are supported on a cluster of eight battered 54" prestressed concrete cylinder piles tied together with a poured-in-place oversize cap.

FISHERMAN ISLAND CAUSEWAY

Between the North Channel Bridge and the Fisherman Inlet Bridge the project roadway across Fisherman Island is carried on an earth-fill embankment 15 feet above mean low water. The side slopes of the embankment are protected from wave action and erosion by a blanket of stone riprap.

Modern toll collection facilities are located at both ends of the project. The administration and shop maintenance facilities are located at the north end of the project on the Eastern Shore peninsula near Wise Point, at Cape Charles.

The entire structure is equipped with roadway lights from shore to shore, with illumination provided by four hundred watt, 20,000 lumen mercury vapor lamps mounted on prestressed reinforced concrete standards. They are spaced at 225 feet centers on alternate sides of the roadway. A study of various types of poles subject to hurricane wind velocities indicated that the prestressed reinforced concrete poles would better resist vibration due to wind and thus reduce the replacement of luminaires with subsequent reduction in maintenance cost.

Navigation lights and signals for marine traffic are provided in accordance with U.S. Government regulations.

Emergency telephones at approximately one-half mile intervals are provided along the entire project.

The complete electrical system for the project including operating power for the tunnels, navigation and roadway lighting systems, and telephone cables is carried in especially designed

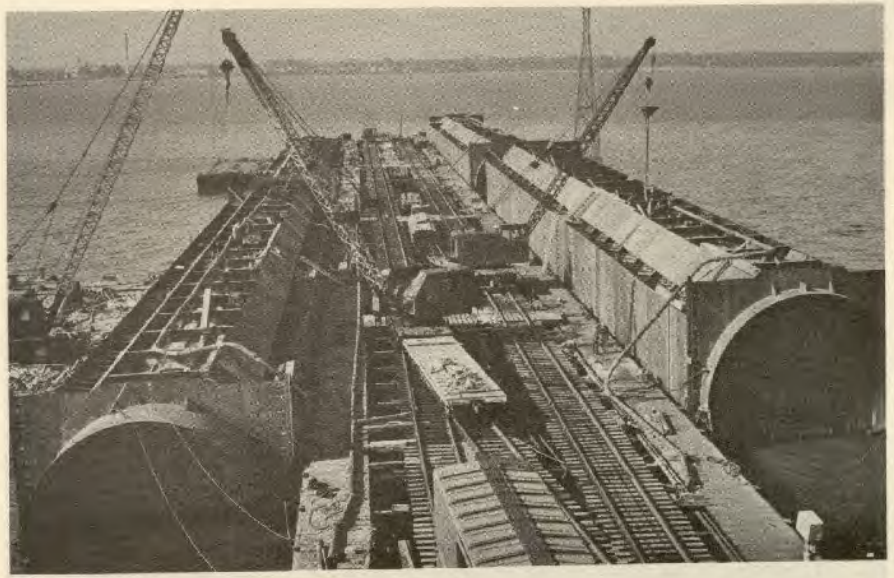
aluminum trays attached to the outside of the precast low level trestle superstructure and bridges. This type of construction provides easy installation and ready access for maintenance.

Sources of Information:

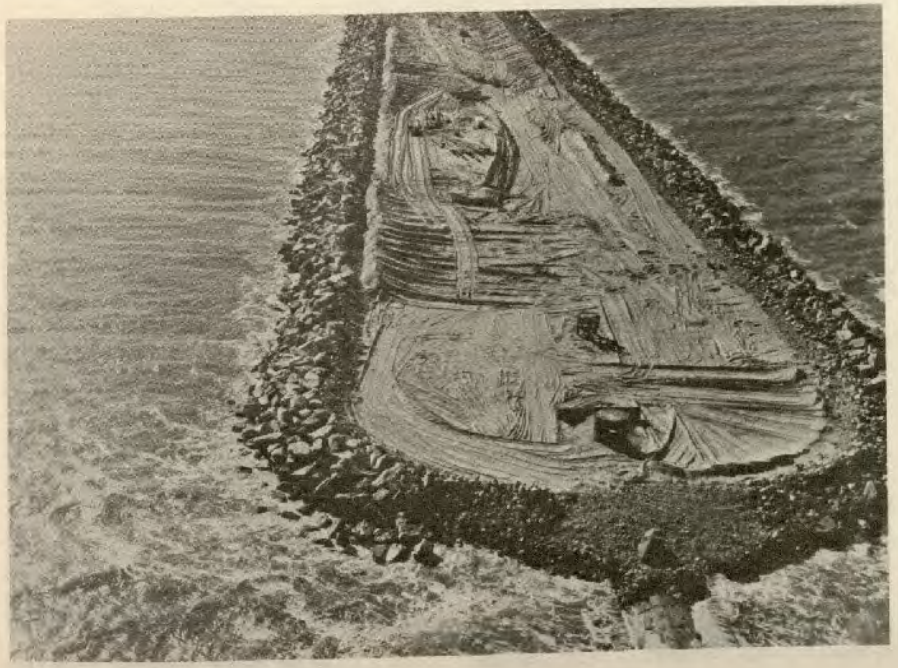
The Chesapeake Bay Bridge-Tunnel Commission, Cape Charles, Va.

Sverdrup & Parcel, Consulting Engineers, St. Louis, Mo.

Man-Made Wonder as Seen from
he Eastern Shore Terminus.



Core of Tunnel



Construction in Progress on a Man-Made Island in the Bay.

Construction of the Entrance and Facilities on One of the Islands.

Trestle Piling in Place Ready for

Barge Being Removed from
Bridge After the Storm of Oct
1972 (Courtesy Virginia Dep

The Big Walker Tunnel (1967-1972)

The tunnel through Big Walker Mountain, on Interstate 77, with the 11.4 miles of roadway itself in approaches and adjacent roads, were, at the time of the letting of contracts involved, the most expensive single project ever taken on the interstate system in Virginia. Contract for the tunnel was let in September 1967 and all of the completed work included was dedicated by ribbon-cutting ceremonies on June 23, 1972. The 23 miles of I-77 between Wytheville and Bland cost almost $50,000,000 and now presents a much shorter route, straighter, wider and safer, and constitutes an important link in the Great Lakes to Florida Highway. It has been characterized by the president of this latter Highway Association as "one of the most important projects of the 20th Century for Southwest Virginia".

Preliminary engineering studies for the project were made by Brokenborough & Watkins, consulting engineers of Richmond, Virginia, and the final design of the roadway and tunnel was by Singstad & Kehart, consulting engineers of New York City.

The tunnel is located some seven miles north of Wytheville near the Wythe-Bland County line. The first grading contract for 3.2 miles of I-77 was awarded in December of 1966 to H. B. Rowe & Company of Mt. Airy, N.C., on a bid of $3,388,849. The second grading, for 2.1 miles, was let on a bid of $2,887,971 to Nello L. Teer Company, of Durham, N.C., which company as a subcontractor under the tunnel contractor, also graded the 2.3 miles of the tunnel and its approaches. The grading, bridgework and paving of 3.8 miles north of the tunnel was done on a bid of $6,537,600 by H. B. Rowe Company and Miller Engineering Company, of Mt. Airy, N.C. Pendleton Construction Company, of Wytheville, built seven bridges south of the tunnel on a $678,062 contract, and the remainder of the paving on a $2,101,646 contract. Rights of way cost $660,000; engineering fees, $1,600,000; legal and closing costs, $180,000; a truck stop, $85,000; and sewerage and wastes treatment plant, $90,000. C. J. Langenfelder & Son, Inc., of Baltimore, Maryland, executed the tunnel contract on a bid of $22,623,793; electrical equipment and wiring, by

Walter Truland Corporation, of Alexandria, Virginia, for $2,288,000; and the transmission, fans, motors, and installation thereof, by the Westinghouse Electric Co., of Boston, Massachusetts.

Studies of methods and use of present day earth moving equipment lead to the decision to cut and fill on the roadway through Little Walker Mountain, a 300-foot cut with slope stakes set some 1,100 feet apart at the deepest portion. About 10,000,000 cubic yards of excavation was required in grading, half being in the Little Walker Mountain crossing, 3,000,000 cubic yards moved to the south entry fill and 2,000,000 cubic yards to the north entry. Estimated on an open cut through Big Walker it would have been 500 feet deep with a movement of 12,000,000 cubic yards of excavation. Actually some 163,000 cubic yards of rock were removed from each of the two tunnel tubes, for a total of 326,000 yards, all in solid rock. Excavation at the portals amounted to a million yards, and was moved into the nearby approach fills.

The major feature of this entire project was the Big Walker Tunnel itself, to provide two 26-foot wide roadways, 27 feet apart or some 64 feet on centers, 4,229 feet long with a vertical clearance of 16.5 feet, and sloping upwards towards the north on a 3.5% grade. The crest of the Mountain is at elevation of 3,650 feet and the greatest depth to paving is 800 feet. The cross section of the tunnel is an inverted horseshoe with a thin slab overhead to provide floor for the air ducts, both exhaust and intake for each tube. Twenty four fans, up to nine feet in diameter, provide ventilation with three blowers and three exhausts at the intakes and exhausts of each tube. Of interest in design, the intake for the upgrade duct may require a maximum of 1,719,200 cubic feet of air per minute while the downgrade, only 956,700 cubic feet, and ducts are sized in relationship. Automatic sensing devices, with manual backups, analyze the carbon monoxide content of the tunnel air and adjust ventilation. The southbound tube can be cleared in one minute but two minutes are required for the northbound tube. Emergency diesel fueled generators provide back-up in the event of power failure.

Traffic lights, five per lane, control the traffic flow in case of

accidents, and fire extinguishers are mounted every 110 feet, while the spacing of the 22 telephones along the tunnel is equalized. Interior lighting is controlled to permit visual transition for the entering driver. The building at the south portal houses offices, controls, garages and maintenance facilities, while that at the north portal is for storage. The National Park Service is providing a major recreational area adjacent and includes a lake, camp site and other conveniences, access to which is through an interchange between I-77 and Virginia Route 717 near the south portal. This is the longest above-ground vehicular tunnel in Virginia.

This interstate facility will provide travelers with one of America's most scenic and exciting rides. That, along with the impetus of the new road will greatly encourage economic development thus repaying many times over the outlay of initial costs.

Sources of Information:

Virginia Department of Highways, A. W. Coates, Information Officer (VDH)

South portal of tunnel—VDH.

Platform and Drills for Rock Excavation in the Tunnel—VDH.

Welding Structural Ribs for the Roof of the Tunnel—VDH.

Reinforcing of tunnel lining—VDH.

oncrete placing equipment—

Completed traffic

The Mixing Bowl Project (1970-1973)

"The most complex, challenging project ever undertaken in the history of the Virginia Department of Highways", is the characterization by Douglas B. Fugate, State Highway Commissioner, when speaking of that portion of the Shirley Highway, or of Interstate-95, beginning just south of the Pentagon then curving around that military installation and then connecting to Columbia Pike, U.S. Route 1, the George Washington Memorial Parkway and serving four of the arteries into the Pentagon. This eighth, of a nine-part Shirley Highway modernization, is proceeding to completion in 1973 and 1974 while maintaining the normal flow in excess of 100,000 vehicles per day, a miracle in traffic service and control, which include some 30,000 vehicles into the Pentagon itself. The three-grade levels beginning at the first of these entrances eliminates the increasing difficulties of the former single-grade mixing of through cross traffic as it seeks to reach Arlington Memorial and the 14th Street Bridges, thus the "Unscrambling of the Mixing Bowl".

The essentials of this design and construction is to provide safer and more rapid transit over the northern seventeen miles of Interstate-95, the Shirley Highway. The four-lane cross State I-95 expands to 10 lanes on approach to the metropolitan area, continuing as far as the Washington Boulevard, the first entry to the Pentagon, where it enlarges to 28 lanes and the three grade-levels stated. Another unique feature of this modernization is the reservation of the central two lanes as busways for rapid bus movement, the first of such vehicular priorities in the nation. Some five and a half miles of a completed section of this road had been used in this experimental way since 1969, and had been found that bus traffic had increased by 20 to 30 per cent the first year. This mode of mass conveyance will be continued through the remainder the Shirley Highway and into the District. It will be reversible in direction to accommodate passenger traffic demand and to speed the flow. Busways are being incorporated in highways elsewhere since this use.

Historically the original Shirley Highway was Virginia Route

350, before the establishment of the interstate system. Upon the construction of I-95 the name of Shirley Highway was transferred to the northern seventeen miles if it, honoring in this way Henry G. Shirley, Virginia State Highway Commissioner for 19 years, prior to his death in 1941. It was during Mr. Shirley's tenure that the main north-south highway, U.S. Route 1, was paved through the State. At the time of construction the Shirley Highway embodied elements of the highest type of road: two concrete ribbons, each 24 feet wide, separated by a grass median varying from 14 to 70 feet of width; gentle horizontal curves limited to slightly more than one degree and located to minimize headlight glare from on-coming vehicles; and maximum ascending grades of 3.5 per cent, and descending, to 4.2 per cent.

The term "Mixing Bowl" was applied shortly after that part of Shirley Highway north of Virginia Route 7 was constructed as part of the Pentagon road network in the Federal Government's program there in 1942. Traffic forecast at that time was 30,000 vehicles per day, and with a Pentagon population of about 30,000. The Federal Government turned over its responsibility for this section of road to the Virginia Department of Highways in 1963, when the latter began reconstruction on the south end of the Virginia portion of the road as a result of studies of traffic problems begun in 1960. Rebuilding from King Street, in Alexandria to just south of the "Mixing Bowl" cost approximately $25,100,000. The "Unscrambling of the Mixing Bowl" was bid in June 22, 1970, at $51,599,791 on offer from combination of five contractors. The only other offer exceeded $53,000,000.

Major elements involved in this construction included the very difficult task of maintaining daily traffic in excess of 100,000 vehicles, holding it within the right of way limitations as no suitable substitute routes were available for detouring; the shifting of busways from place to place in order to maintain this very beneficial service until it could be permanently located in the center of the lanes of travel; the inclusion of four temporary bridges, one of which was one of 570 feet to assist busway construction; and construction of a 200-foot tunnel, 14.5 feet in diameter, to take Long

Branch Creek for drainage under the highway. Temporary paving provided a shift from the original, construction of the new lane, releasing traffic to the new lanes, opening detours further along the way, all was the sequence of construction. Utilities such as telephone, electricity, gas, water and sewerage were continued without interruption as were the cold water and steam lines for the Pentagon services. Estimates of materials and work involved were 583,000 cubic yards of excavation and 577,000 cubic yards of borrow, aggregating some 1,500,000 cubic yards of earth removal; 67,900 cubic yards of concrete; 17,334,000 pounds of structural and reinforcing steel; 13.6 miles of underdrains; 21 miles of curbs; and 56,000 feet of guardrail. Extension of I-95 to U.S. Route 1 include 19 more bridges as well as improvements in the latter road at the connection. Traffic expected through this segment of Shirley Highway is estimated to be about 147,000 vehicles per day.

Local ecology was an important consideration in design and construction. Dredging and filling were studied carefully and a sandy fill material over ramps was used to control silt removal in erosion, and, as a factor of safety, desilting basins have been included to protect surface streams. Smoother paving as well as the grade separations were to eliminate stop-and-start of traffic but to permit uninterruption of movement, save on fuel and to appreciably reduce emissions in exhausts both of passenger and truck as well as bus vehicles.

The appearance and beautification of its highways has been of concern to the Department of Highways and it maintains a section devoted to this in its design division. However, for the projects along the Shirley Highway Messrs. Stanley Abbott and Edward G. Carson and Associates, of Williamsburg and Norfolk respectively, were consultants who designed and directed landscaping from Woodbridge to Duke Street (the Little River Turnpike, or Virginia Route 236), a distance of 13.6 miles on which were planted some 30,000 rose bushes, 1,500 dogwoods, 25,000 pines, ivy, holly and seventy five varieties of trees and shrubs aggregating about 185,000 trees and shrubs, some as tall as ten feet. This was one of the most ambitious beautification projects undertaken by

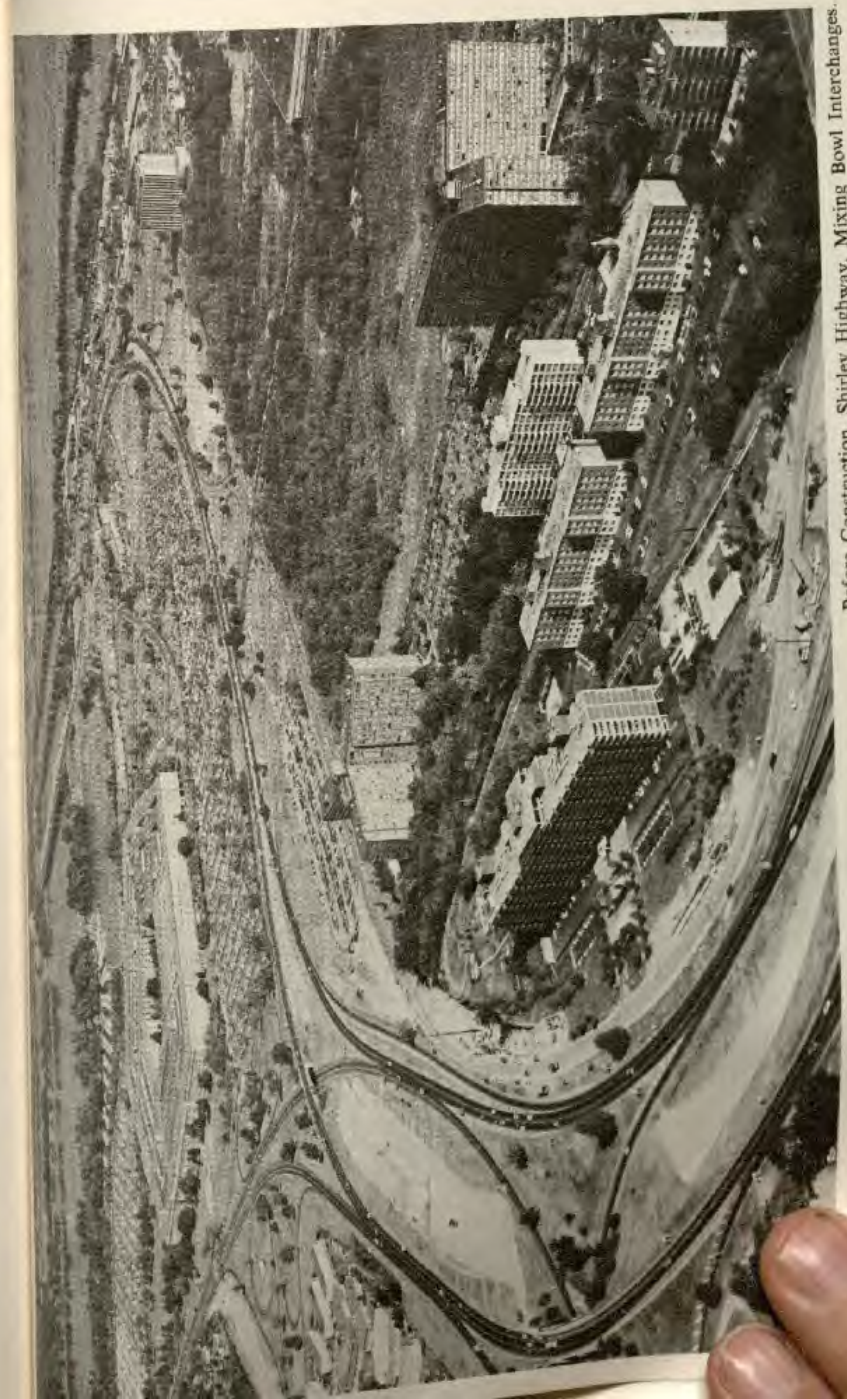
the Department. Landscaping appropriate to the surroundings, available median and side space in right of way exposure will be extended northward to the Potomac as paving and grading is completed.

The location of this modernization of a highway with its improvement in construction, continuity of traffic flow, uniqueness of busways, all involved several governments and their agencies, other than the Virginia Department of Highways: the Federal Highway Administration, the Pentagon, the Army Corps of Engineers, General Services Administration, the National Park Service, the District of Columbia Highway Department, Washington Metropolitan Area Transit Authority, Washington Aqueduct, and Arlington County were interested and contributed to the final result.

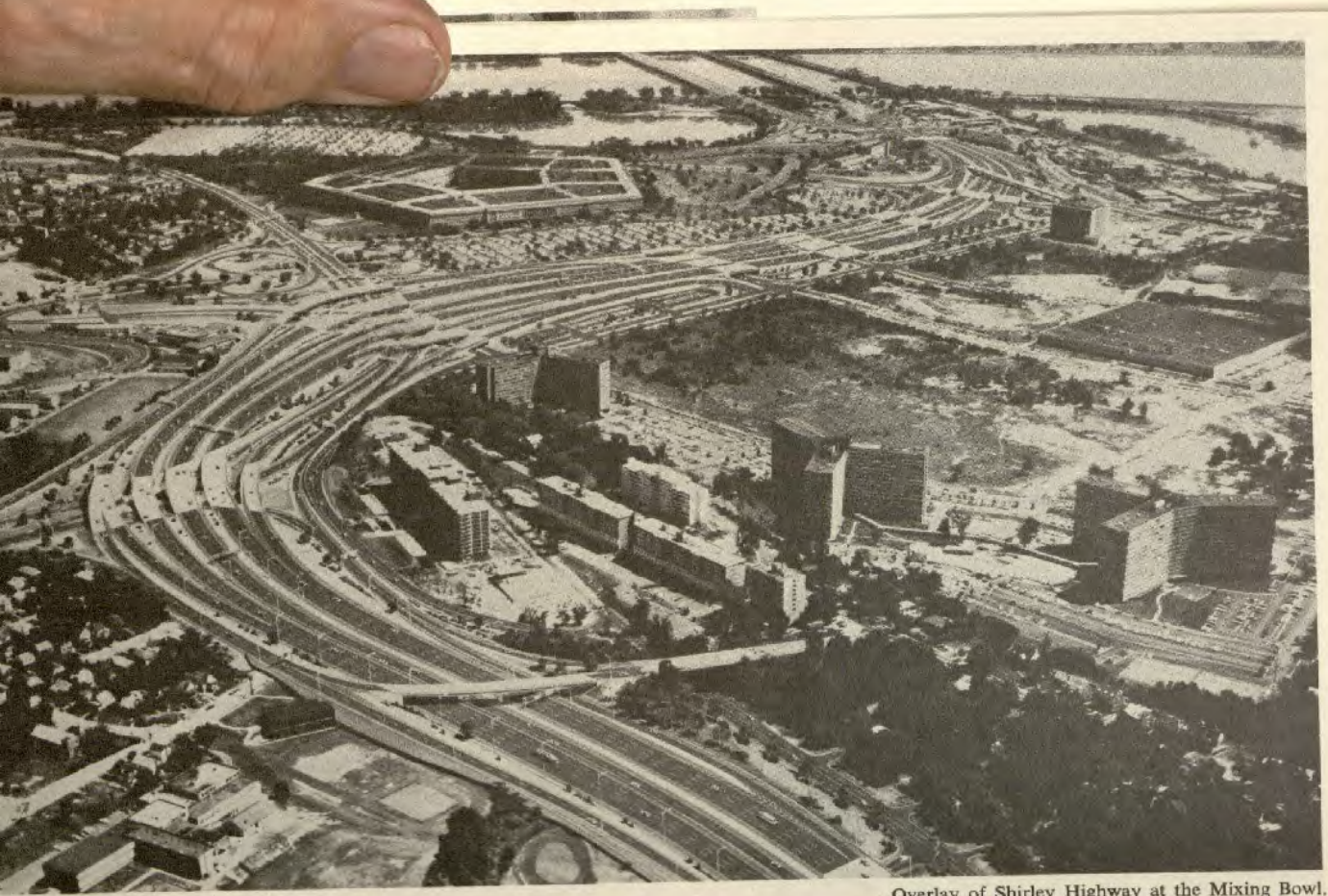
Total cost of rebuilding and modernizing the Shirley Highway is estimated at $164,000,000.

Sources of Information:

Federal Bureau of Public Roads
Virginia Department of Highways
Army Corps of Engineers

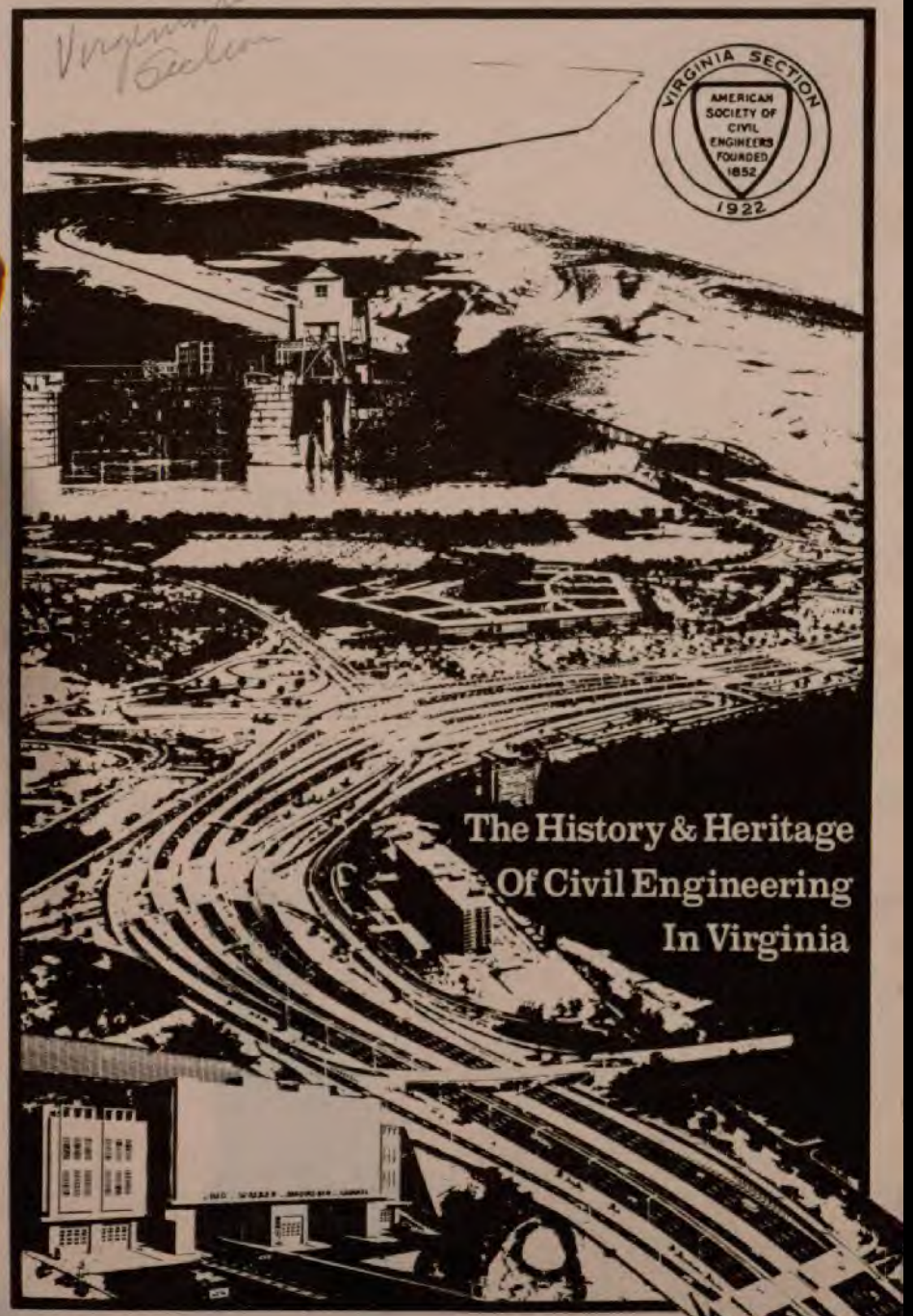


Before Construction, Shirley Highway, Mixing Bowl Interchanges.



Overlay of Shirley Highway at the Mixing Bowl.

Virginia Section



The History & Heritage Of Civil Engineering In Virginia