ROUTE 1 NOTTOWAY RIVER BRIDGE
U.S. Route 1 spanning Nottoway River
McKenney Vicinity
Dinwiddie County
Virginia

HAER No. VA-120

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Philadelphia Support Office
U.S. Custom House
200 Chestnut Street
Philadelphia, PA 19106

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HISTORIC AMERICAN ENGINEERING RECORD
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HAER NO. VA-120

LOCATION: U.S. Route 1 spanning Nottoway River, McKenney vicinity, Dinwiddie county, Virginia.
USGS McKenney, VA Quadrangle
UTM Coordinates: 18.256550.4092120

DATE OF CONSTRUCTION: 1927

BUILDER: Virginia State Highway Department, William P. Glidden, bridge engineer; Hagedorn Construction Company, contractor.

PRESENT OWNER: Virginia Department of Transportation

PRESENT USE: Highway bridge

SIGNIFICANCE: The Route 1 Nottoway River Bridge is an example of a short-span concrete through-arch highway bridge of the extremely rare tied-arch type. The bridge was part of the final construction project completing the realignment and concrete paving of Route 1 from Washington, D.C., through Virginia to Raleigh, North Carolina, an important event in national and state transportation history.

PROJECT INFORMATION: The Route 1 Nottoway River Bridge was recorded in October 1996 by the Cultural Resource Group of Louis Berger & Associates, Inc., Richmond, Virginia, for the Virginia Department of Transportation. The recordation was undertaken pursuant to a Memorandum of Agreement between the Virginia State Historic Preservation Officer and the Virginia Department of Transportation. Project personnel included Richard M. Casella, Senior Architectural Historian; Philip E. Pendleton, Architectural Historian; and Rob Tucher, Senior Photographer.

DESCRIPTION

The Route 1 Nottoway River Bridge, built in 1927, is a two-lane seven-span reinforced concrete bridge that carries U.S. Route 1 over the Nottoway River, connecting Dinwiddie and Brunswick counties in Virginia.

The bridge consists of a concrete through tied-arch center span, 90' long, and six concrete T-beam deck spans. The two deck spans immediately flanking the center span measure 38'-5" in length; the remaining four deck spans measure 37'-6". The total length of the bridge is 316'-10". The bridge spans the river at a maximum height of approximately 25' above the water, which averages three to four feet in depth.

The center span over the channel consists of the two arch rings measuring 3' wide by 1'-6" deep, spaced 24' apart center-to-center. The deck beams are suspended from the arches by eight 12" square spandrel columns. The columns are chamfered and meet the ring with a plain square capital. The arch is tied by a continuous reinforced concrete slab measuring approximately 3'-6" wide by 9" thick, which joins the bases of the columns and the tops of the floor beams, and serves as a curb for the roadway. The two arch rings are laterally braced with two segmentally arched concrete beams located 30' in from each end. The arch rings terminate with flared ends formed by turning the extrados upward until parallel with the deck. The result is a rectangular concrete block, massive and strong in appearance, which originally carried lampposts.

The concrete T-beam deck spans are of a standard design consisting of four longitudinal T-beams carrying five transverse floor beams. The arch span is carried by battered open-pedestal type reinforced concrete piers measuring 4' by 3'-6" by 25' high. The piers are topped with 12"-thick caps that overhang the columns by 12". The joint between the cap and the column is filleted, and all edges of the piers are chamfered. The concrete abutments are of the open type with battered columns. The open column piers supporting the deck spans consist of 24" square columns on plain built-up bases with filleted caps. The bridge does not have sidewalks. Railings are of the standard concrete "cork type," with two horizonal rails supported by square posts.

The area immediately around the bridge is undeveloped and thickly wooded, but within a short distance becomes exurban, combining remnants of agricultural activity with roadside commercial enterprise and scattered residences.

HISTORICAL INFORMATION

Background

The Route 1 Nottoway River bridge is situated on the boundary between the counties of Dinwiddie, to the northeast, and Brunswick, to the southwest. Brunswick County was established in 1720, originally encompassing a much larger region than at present. At its birth, Brunswick consisted of territory newly organized for government, as opposed to being created from the subdivision of an older county. After Brunswick had repeatedly undergone subdivision itself, the county's present boundaries were delineated in 1781. Dinwiddie County was formed in 1752. Prior to that date, the Dinwiddie area was within the boundaries of Prince George County (1703-1752). Dinwiddie's boundaries remain as they were at the county's founding.

The land in the vicinity of the bridge began to receive European-American settlers in significant numbers in the 1720s (Bell and Heartwell 1957:25-27). These migrants were largely American-born Anglo-Virginians participating in the expansion of the Chesapeake settlement area, accompanied by African-American slaves. As regards cultural heritage, the composition of the local population has remained substantially the same until recent decades. Also enduring has been the preeminence of agriculture, particularly tobacco cultivation, in the area's economic life. There has been noticeable diversification in local farming in the twentieth century, with dairying and the raising of beef cattle emerging as important aspects. Manufacturing industry has historically been a limited presence in the Dinwiddie-Brunswick border area (Bell and Heartwell 1957:66-70; Work Projects Administration [WPA] 1942:149, 163-75).

The site of the Route 1 Nottoway River Bridge has been in use as a bridge location for an important regional transportation artery since at least 1820. In that year, four bridges spanned the Nottoway River along the Dinwiddie-Brunswick boundary. The one at the Route 1 location was known as Birch's (or Burche's or Birchett's) Bridge. The county maps drafted by surveyor John Wood in 1820 indicated the bridge in place on the stage route running south from Petersburg that would ultimately evolve into Route 1 (Neale 1975:119; WPA 1942:161). Birch's Bridge became the conveyor of a chartered toll highway in 1853, when the Boydton-Petersburg Plank Road was constructed. Present-day Route 1 runs essentially on the alignment of the 1853 road, which traversed a bed of eight-foot wooden planks. The road and bridge are depicted on Keily's 1854 map of Dinwiddie County (Keily 1854). The plank road operation is said to have proved a fiscal failure within a few years due to the cost of maintaining the wooden highway (Bell and Heartwell 1957:back cover; Neale 1975:119-20; WPA 1942:159).

The type of bridge which was located at Birch's crossing prior to 1891 was not determined. In 1891 it was rebuilt, with the county's specifications directing that it be "12 feet wide one rock abutment to the other," and constructed of heart white oak cut as twelve-by-twelve timbers for the trestles, and eight-by-ten timbers for the braces. Planks for the floor were to be two-and-one-half inches thick and at least six inches wide (Neale 1975:121). Maps dating to 1917 and

1921 referred to this bridge as Long Bridge (*Sketch Map of Brunswick, County, Va.* 1917; U.S. Geological Survey 1921).

History of Route 1 Nottoway Bridge

The building of the present Route 1 Nottoway Bridge was one part of a larger state and federal funded highway project to improve Virginia Route 31, a north-south highway through the state, and to incorporate it into the Federal Highway System as U.S. Route No. 1. The project had its roots in the establishment of the first state highway system, approved in 1918 by Virginia's General Assembly. Included in the plan to create a 4,000 mile state road network, was the reconstruction of the old Washington to Richmond highway and roads running south from Richmond through Petersburg to the North Carolina border. When completed, the new road, designated Route 31, would constitute 215 miles of the 2,321-mile-long U.S. Route 1, stretching from Fort Kent, Maine, to Miami, Florida (*South Hill Enterprise* 1927a:1; Virginia Department of Highways 1973:14).

In the Virginia portion of the Route 1 project, the first concrete was laid on the Washington to Richmond section in 1919 by the State of Virginia. Small allocations each year allowed construction to continue. The greatest period of construction occurred in 1926 when $1 million was allocated, comprising the entire amount of the "gap closing fund" (*Richmond News Leader* 1927a:1).

Drawings for the Nottoway River Bridge were prepared in September 1926 by State Bridge Engineer William P. Glidden and approved by Chief Engineer C.S. Mullen. The drawings were revised on February 26, 1927, and construction was begun shortly thereafter by Hagedorn Construction Company. Work on the bridge continued through the summer and was completed in August. Final "as built" drawings were prepared by the highway department on September 1, 1927 (Virginia State Highway Department 1927).

Along with the construction of the Nottoway River Bridge, a second bridge of nearly identical design was built over Stony Creek, approximately 12 miles north of the Nottoway River Bridge. A photograph of the Stony Creek bridge appears in the 1927 *Annual Report of the Virginia State Highway Commission*. The caption identifies the contractor as Hankins and Collins of Richmond and states that the bridge was begun June 28, 1926, and completed February 4, 1927 (Virginia State Highway Commission 1927:19).

On May 28, 1927, the 109-mile Washington to Richmond portion of Route 1 was opened with a celebration in Fredericksburg. It was reported by the *Richmond News Leader* as the greatest highway celebration ever held in Virginia, and probably the greatest held in any state. Governor Harry F. Byrd presided over the festivities, which included a parade, luncheon, and speeches. Speakers included Governor Byrd; former Governor E. Lee Trinkle; Henry G. Shirley, chairman

of the State Highway Commission; St. J. Wilson, chief engineer of the United States Bureau of Public Roads; Eppa Hunton, Jr., president of the Richmond, Fredericksburg and Potomac Railroad; and Claude A. Swanson, United States Senator (*Richmond News Leader* 1927a:1).

Meanwhile, as construction continued through the summer on the final stretches between Petersburg and South Hill, citizens in each of those cities began planning to host the grand celebration that would mark the route's completion. South Hill moved quickly to secure the honor by electing a committee, setting aside funds, and holding organizational meetings to plan the event. In early August, Petersburg yielded to South Hill and agreed to participate in the celebration and help in any way (*South Hill Enterprise* 1927b:1) .

The state convict force paved the 10-mile stretch of Route 31 north and south of Nottoway Bridge. To help meet the demand for roads, the State Highway Commission and prison authorities agreed to put more convicts to work on road gangs, particularly on secondary roads that would otherwise have received little attention. Thirty-two convict-labor projects and fifty-eight contract projects were underway in 1927, totaling $12.5 million in new construction and $3.3 million for maintenance. The bulk of these monies were raised through the gasoline tax (*Richmond News-Leader* 1927b:1; Virginia State Highway Commission 1927:12)

With the opening of the 1927 construction period, it was determined that just over fifty miles of road would have to be constructed to complete the highway from Richmond to North Carolina. The entire fifty miles lay south of the village of Dinwiddie, the sections north of that point having been completed in previous years. Weather conditions were favorable through the year resulting in the 1927 construction program being completed on October 23, well ahead of schedule. The concrete pavement was sufficiently hard for traffic on November 14, and for all practical purposes the entire highway from the District of Columbia to North Carolina was opened to traffic on that date (*Richmond News Leader* 1927c:4).

The official celebration marking the opening of the road was held in South Hill on November 26, 1927. The event eclipsed the Fredericksburg celebration with well over ten thousand in attendance. A gate which had been erected across the road at the border between Virginia and North Carolina was ceremoniously opened by Governor Harry Flood Byrd and Governor Angus W. McLean, who shook hands across the border while bands played and the crowds cheered. Festivities then moved to South Hill where a parade, speeches, concerts, a luncheon, and other events consumed the day. At the close of the celebration, Governor Byrd and his wife returned to Richmond aboard an army blimp, brought from Langley Field for the occasion (*Richmond News Leader* 1927c:4).

Technology and History of Concrete Through-Arch Bridges

The concrete through-arch bridge type is defined as those bridges which are supported by arch rings which extend above the plane of the roadway and carry the roadway structure by either steel or steel and concrete suspenders. The type encompasses two subtypes depending on the method in which the thrust of the arch is restrained, either by gravity abutments or by a tension member which ties the ends of the arch rings together (Taylor et al. 1928:446).

In the former type, the arch ring usually intersects the floor at some distance out from the abutments, usually at the first floor beam, and is fixed to the abutment below the plane of the roadway. The arch is hingeless or fixed and the type is best referred to as a fixed through arch, but has been variously referred to in literature as a half-through arch, a Rainbow arch, a Marsh arch, and even quite incorrectly as a bowstring arch (*Engineering News* 1917:272; LaLonde 1961:1667; Marsh 1912; Rings 1913:91).

The second type of concrete through arch was commonly called a bowstring arch during the first half of the twentieth century, but now is almost universally referred to as a tied arch. Since the arch rings terminate at the floor and are tied by horizonal members located in, or nearly in, the plane of the floor, the design is nearly always a through arch. Modeled after the nineteenth-century steel bowstring truss design, the tied arch has also been called a concrete arch truss and a Rainbow arch. The tied arch is essentially an inverted arch from which the floor system is suspended by hangers, and the thrust of the arch is restrained by a bottom chord. The bottom chord or "tie," can be designed either as functionally continuous steel reinforcement in the deck slab, as steel tension members independent of the floor system and located in the curb or sidewalk, or a combination of the two. The hangers are commonly either steel rods or reinforced concrete columns (Lindau 1924:131; McCullough 1931:337).

The first concrete through-arch bridge appears from the literature to have been of the fixed-arch type, built in France by M.A. Considere in 1904. Considere was one of the leading engineers in reinforced concrete and the inventor of the hoop-reinforced column. The application of the design grew from the need to provide greater cross-sectional area under the bridge to accommodate flooding, for example in cases where elevating the deck was not a practical solution (*Engineering News* 1911:199).

The development of the first concrete tied-arch design also occurred at the beginning of this century. In 1900, Daniel B. Luten, a designer and builder of thousands of concrete highway bridges in the U.S. during the early twentieth century, patented a design for a concrete deck tied-arch bridge. The purpose of the tie, which took the form of concrete beams or a slab located beneath the streambed, was to reduce the thrust on the abutments, which in turn could be less massive, allowing a substantial savings in concrete costs (Luten 1900).

The combination of the concrete through arch and the tied arch resulted in the through tied arch or the concrete bowstring bridge, the first of which were built in France prior to 1909 (*Engineering News* 1909:440). Various forms of concrete deck trusses were also developed in Europe during this time, but did not see use in this country. Concrete bridge building was a Roman invention, but the technique was lost following the empire's fall. Since the re-introduction of concrete bridges to the world by the French in the 1860s, American concrete bridge technology had for the most part lagged behind that of the Europeans by more than a decade . That gap began to close in 1909 when the first concrete bridge truss was designed and used on the Sparkman Street Bridge in Nashville, Tennessee. The unusual design consisted of a concrete bowstring truss with spandrel columns extending from the bottom chord up through the arch rings, to carry a deck above. Since the bridge was to be constructed over a railroad yard, conditions dictated a corrosion resistant structure of relatively long span. The design was severely criticized by the editors of *Engineering News* as structurally unsound and "a bid for notoriety through the world-old craze for the 'new thing'" (*Engineering News* 1909:440).

Two years later, the first concrete tied arch of the through type, similar in all essential ways to the Nottoway Bridge, was built in the U.S. The 73' span was designed by E.A. Gast, a virtually unknown engineer working as an assistant county surveyor in Hamilton County, Ohio. Gast described the bridge in detail in an article that appeared in the February 1911 issue of *Engineering News* and in the May 1911 issue of *Good Roads*. Once again, *Engineering News* criticized the design in an editorial, this time pointing to the inefficiency of reinforced concrete tension members. This publication argued that "it is only the steel that does any work and the concrete covering, demanded by artistic considerations, is far too voluminous to satisfy mere protective requirements, while adding considerably to the dead load of the bridge" (*Engineering News* 1911:199; Gast 1911:196-197).

A significant figure in the history of concrete through-arch bridges was James B. Marsh of Des Moines, Iowa. Marsh designed and patented a concrete fixed half-through arch in 1912, which was built in moderate numbers, primarily in the Midwest, up until about 1930. The key element of Marsh's design was a roadway system which rested on friction bearings at each point of support, allowing longitudinal expansion of the deck independent of the structural elements of the bridge. The ubiquitous term "Rainbow arch" is believed to have been introduced by Marsh, or by one of his sales agents, as a romantic sounding layman's term to be used in describing and promoting his patented design (*Engineering News* 1917:272; Marsh 1912).

The high price of steel during World War I stimulated the concrete bridge business, resulting in increased competition and lower prices. By the 1920s, most of the municipal and county highway departments in the country were specifying concrete highway bridges to replace aging steel and iron trusses dating from the late nineteenth century. The concrete through arch remained a seldom used form, substantially more expensive than a deck arch due to the extensive form work required. Between 1910 and 1920 dozens of patent infringement suits were waged by the owners of concrete bridge patents, with the vast majority being found invalid. The Marsh

bridge was copied and used by simply eliminating the independent deck system, a feature found to be not necessary for shorter span bridges (Epps 1919:994).

In 1921, the Ohio Department of Highways adopted a concrete through-tied arch as a standard design for short-span highway bridges, a move that received national attention. The design is essentially identical to the 1909 Gast bridge, and its satisfactory performance may have served as an example for the highway department. The number of other states that adopted standard plans for tied-arch bridges was not determined; however, by 1926 Virginia had a standard design very similar to Ohio's. The Virginia design, reflected in both the Nottoway and Stony Creek bridges, was given two bits of architectural styling which aesthetically resulted in a vastly superior design. The primary detail takes the form of a reverse curve at the terminus of the arch ring so that the extrados of the arch meets the top of the railing in a gentle sweeping curve. The second feature was to segmentally arch the two concrete girders which laterally brace the arch rings. Viewed from the side or end-on, these details are a commendable touch and reflect a nod by their designers to the trend at the time to designing architecturally pleasing concrete bridges rather than simple blocky masses (Ohio Department of Transportation 1994:82; Virginia State Highway Department 1927).

Part of the reason that tied-arch bridges remained an obscure form in the U.S. was due to the difficulty in structurally analyzing the design. In 1931, Conde B. McCullough, bridge engineer with the Oregon State Highway Department, designed a 120' tied-arch bridge and developed an extensive analysis of the mathematical theory governing the stresses in the bridge. McCullough found the design to be especially suited to the corrosive conditions over coastal streams in the northwest where the high maintenance cost of painting put steel truss construction at a disadvantage, and where foundation conditions made it imperative that pier reactions be determinate and vertical. Although undoubtedly the longest tied-arch bridge in the U.S. at the time, the success of McCullough's Wilson River Bridge did little to increase the popularity of the type in the U.S., although they remained widely used in Europe (Hool and Kinne 1928:633; McCullough 1931:337-333; 1932:550; van Bergen 1933:37).

The maturation of the tied-arch bridge type in America did not arrive until 1941 with the design and construction of the 540'-span St. Georges Bridge that carries DuPont Highway over the Chesapeake and Delaware Canal at St. Georges, Delaware. The designer, J.M. Garrelts, Associate Professor of Civil Engineering at Columbia University and designing engineer with the prestigious bridge engineering firm of Waddell and Hardesty of New York, presented an in-depth analysis of the theory behind the design in a paper published in the 1943 *Transactions of the American Society of Civil Engineers*. In his synopsis, Garrelts stated that although the type had been used in Europe, he believed that the design introduced a new type in American practice. It is curious that none of the eight engineers who responded with discussion of the paper took objection to that claim, particularly in light of the similarity of the bridge to McCullough's design ten years earlier. What was objected to by some, were the assumptions required in Garrelts' theoretical analysis. Most agreed that the form was extremely rare in the

U.S., that little to nothing could be found on the subject in the technical literature, and that the analysis of the stresses in an arch rib tied with a stiffening girder was an extremely complicated problem. These conclusions offer some explanation as to why the tied arch has remained a rare bridge form in the U.S. (Garrelts 1943:543-576).

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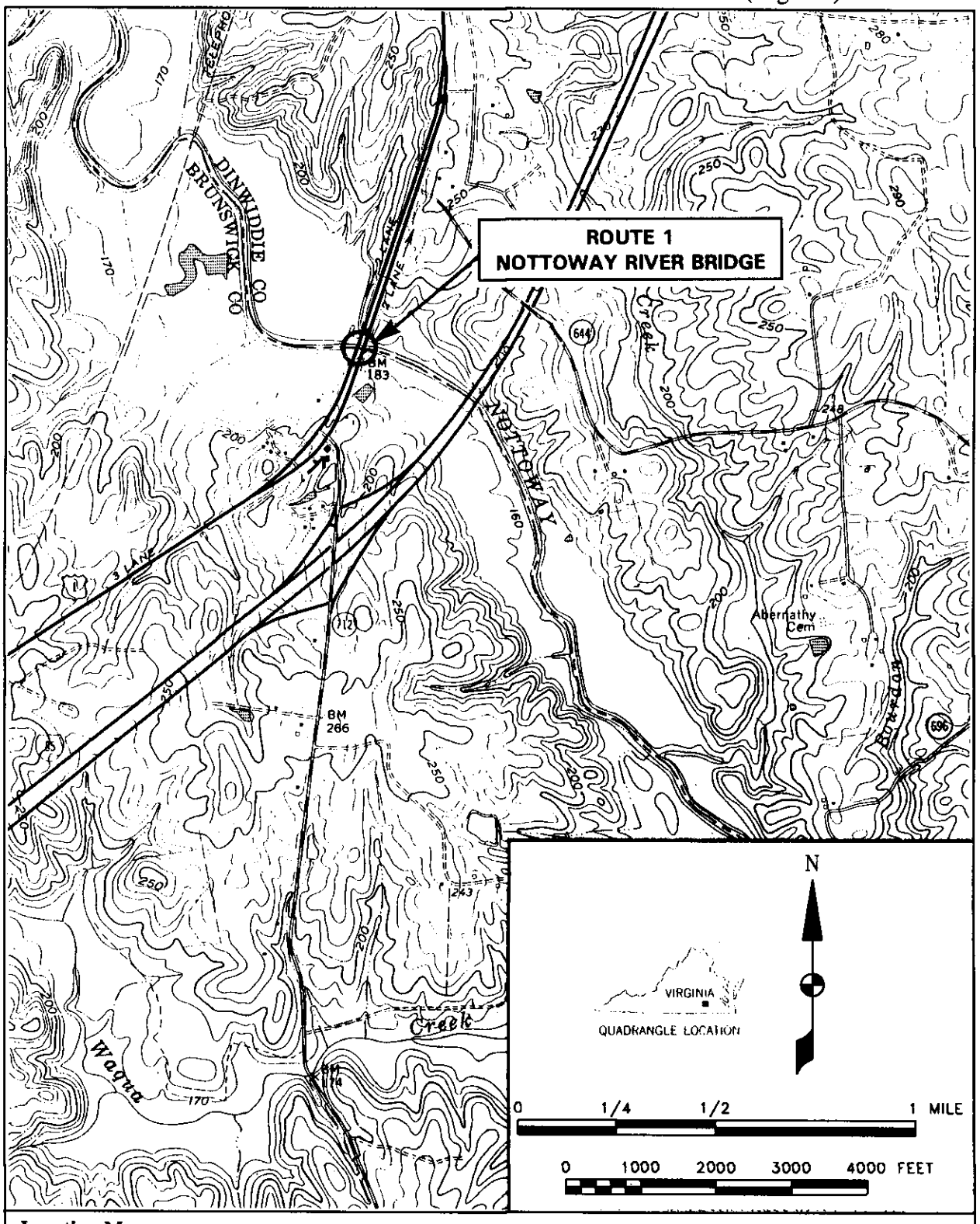
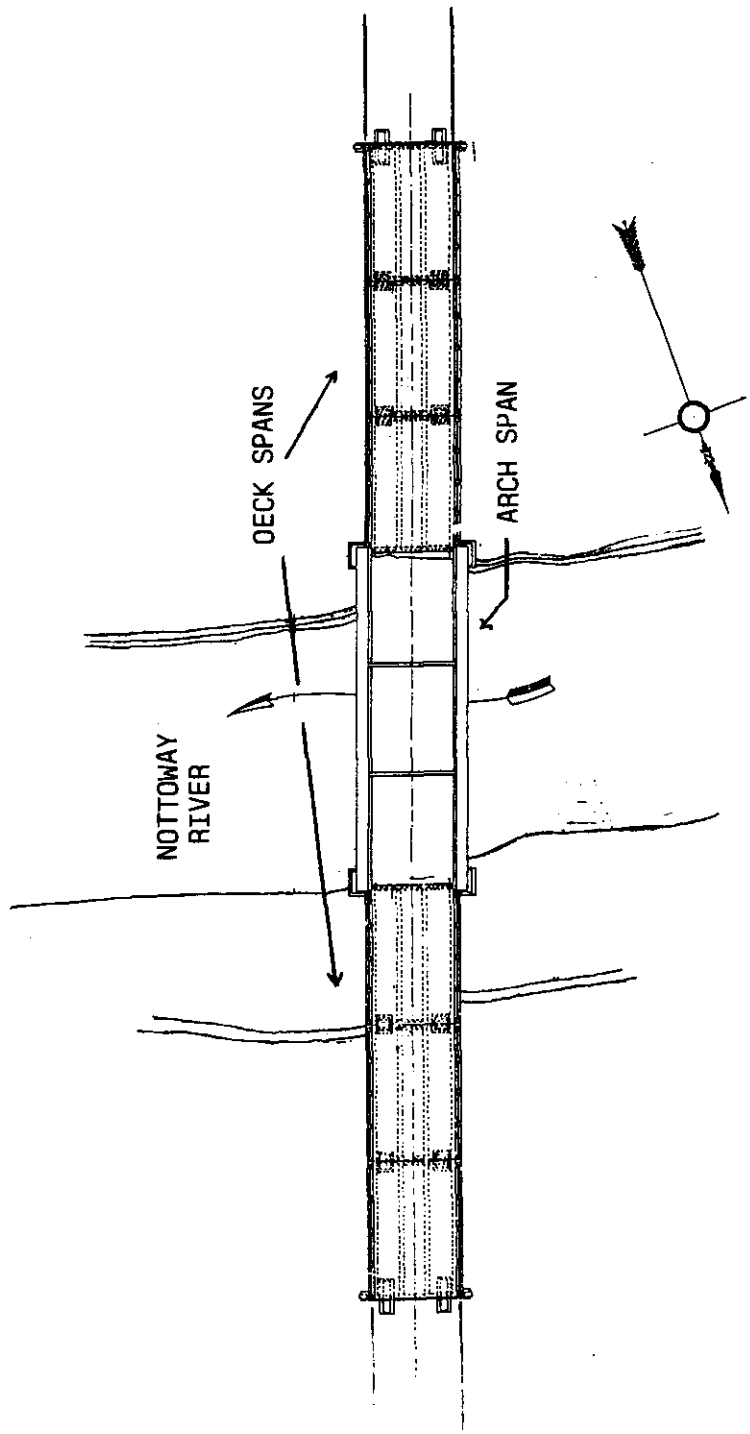


Location Map

SOURCE: USGS 7.5 Minute Quadrangle, McKenney, VA, 1963 (Photorevised 1972)



Site Sketch