



Open the Gates!

Flood Control at the Willow Grove Mill

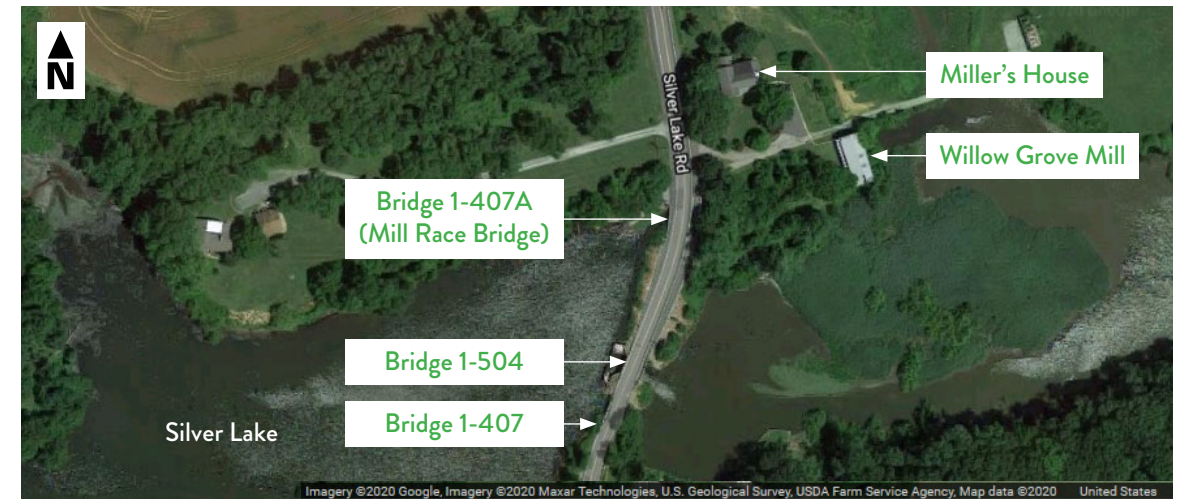


Introduction

Bridge 1-407 and Bridge 1-504 carry Silver Lake Road over the Silver Lake Spillway in Middletown, New Castle County, Delaware. Bridge 1-407 (constructed in 1935) and Bridge 1-504 (constructed in 1939) were built to help control the level and flow of water impounded (i.e., enclosed) by the earthen dam used by the former Willow Grove Mill, which operated from the 1720s until 1929. In 2020, repairs to the bridges' integral sluice gates, which control the water flow from Silver Lake, were required to fix damage caused by heavy rain from two storms in 2017 and 2018.



This informational booklet was prepared as part of the mitigation for the Silver Lake Dam Repair Project undertaken by the United States Army Corps of Engineers and the Delaware Department of Transportation.



Map Source: Google Earth 2020.



View of Bridges 1-407 (foreground) and 1-504 (background), which carry Silver Lake Road over the Silver Lake Dam and Spillway.

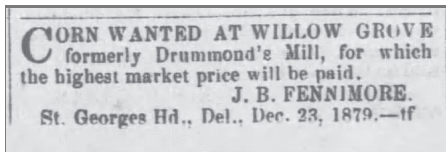


View of the north and west elevations of the Willow Grove Mill. The mill was converted to apartments in the 1940s.

Site History

The Willow Grove Mill, also known as Drummond’s Mill, was one of four grist mills (i.e., mills that grind grain into flour) established in the Middletown area before ca. 1740. Documentation suggests that the Willow Grove Mill was the first grist mill built by Thomas Noxon ca. 1720, preceding his better-known mill at Noxontown located approximately 1 mile southeast of the Willow Grove Mill. Thomas Noxon’s son, Benjamin, sold the Willow Grove Mill in 1767, and it passed through numerous owners before ceasing operations as a grist mill in 1929. The Willow Grove Mill Historic District was determined eligible for the National Register of Historic Places (National Register) in 1999 for its significance related to the 18th- and 19th-century milling industry within the Middletown area and the State of Delaware, as well as for its architecture. The period of significance spans from the 18th century to the mid-20th century, and the elements that contribute to its significance include the miller’s house (constructed ca. 1860-1880), mill building (constructed ca. 1720, enlarged ca. 1830), mill dam/impoundment (originally constructed ca. 1720), Bridge 1-407A (replaced in 2001), Bridge 1-407, Bridge 1-504, and the mill’s head race (originally constructed ca. 1720).

Grist mills utilized the flow of water to provide the power needed to grind grain into a finished product. This was often achieved by constructing a dam across a river or creek to create a lake or pond. Water would be released from the lake or pond through a mill race, which is a channel dug into the ground, and it flowed into the mill’s water wheel or turbine to power the mill.



February 7, 1880, *Middletown Transcript*.



Courtesy of Delaware Public Archives.

This ad placed by J.B. Fenimore was run in the *Middletown Transcript*, the oldest existing newspaper in Delaware.

This postcard from 1901 shows boaters enjoying Silver Lake. Mill owners maintained their dams and sluice gates to ensure the safety and profitability of their mills. As rural mills in Delaware went out of business during the early 20th century, the roads and bridges over earthen dams were left unattended. The state assumed control over these roads and bridges to protect downstream residents and businesses, as well as provide water for irrigation and recreation.



Samuel Rea & Jacob Price, *Map of New Castle County*, 1849.

This 1849 map shows the Willow Grove Mill (circled) under the ownership of Murphy and Vail, who operated the grist mill and a sawmill on the property.

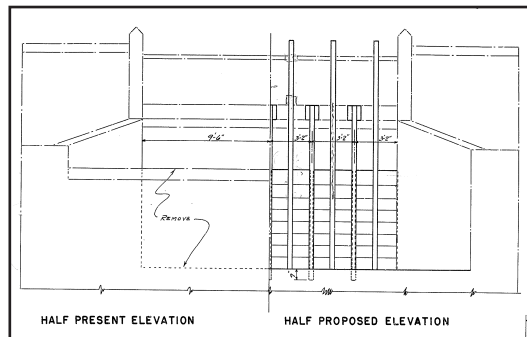


Bridge 1-407A carries Silver Lake Road over the Willow Grove Mill race.

Heavy rains and floods were constant threats to grist mills, as high water and strong currents had the potential to flood mill ponds, overtop mill dams, damage mill races, and destroy milling equipment. Water control structures, such as weirs (i.e., a low dam located under the bridge) and sluice gates, were critical to the success and operation of any water-powered mill, as they could be used to release water from the mill pond in an effort to prevent flooding. Historically, sluice gates took many forms, but typically consist of wooden boards that can be lowered to stop water from flowing through a dam in order to fill the mill pond. Sluice gates can also be raised to allow water to flow through the dam to lower the level of a mill pond prior to, or during, heavy rains or a flood in order to prevent the mill dam from being destroyed or damaged. A newspaper article published in the *Middletown Transcript* on March 14, 1908, noted that Mr. D.R. Rees, who owned the Willow Grove Mill, was planning to partially drain Silver Lake to make needed repairs to the gates in the dam.

Throughout the late 19th and early 20th centuries, several factors, such as the rise in popularity of Midwestern wheat, which was favored for bread making, and the Great Depression leading up to World War II, led to the decline of the milling industry in Delaware and other neighboring states; four out of five mills ceased operations in the first half of the 20th century. The Willow Grove Mill ceased operating in 1929. Its milling equipment was removed, and the mill was converted into residential apartments in the 1940s. With the closure of the mill, New Castle County assumed control over Silver Lake Road.

A flood ca. 1930 overtopped the Willow Grove Mill dam and washed portions away. In response, New Castle County constructed a bridge in 1931 on the south end of the dam to help control water from floods and prevent the dam from washing out again. This bridge utilized a concrete weir built on the upstream side to allow excess water to flow out of Silver Lake. A few years later, another heavy rain storm partially destroyed the bridge and overtopped the dam. New Castle County constructed Bridge 1-407 in 1935 to replace the 1931 structure, reusing the original concrete abutments and weir.



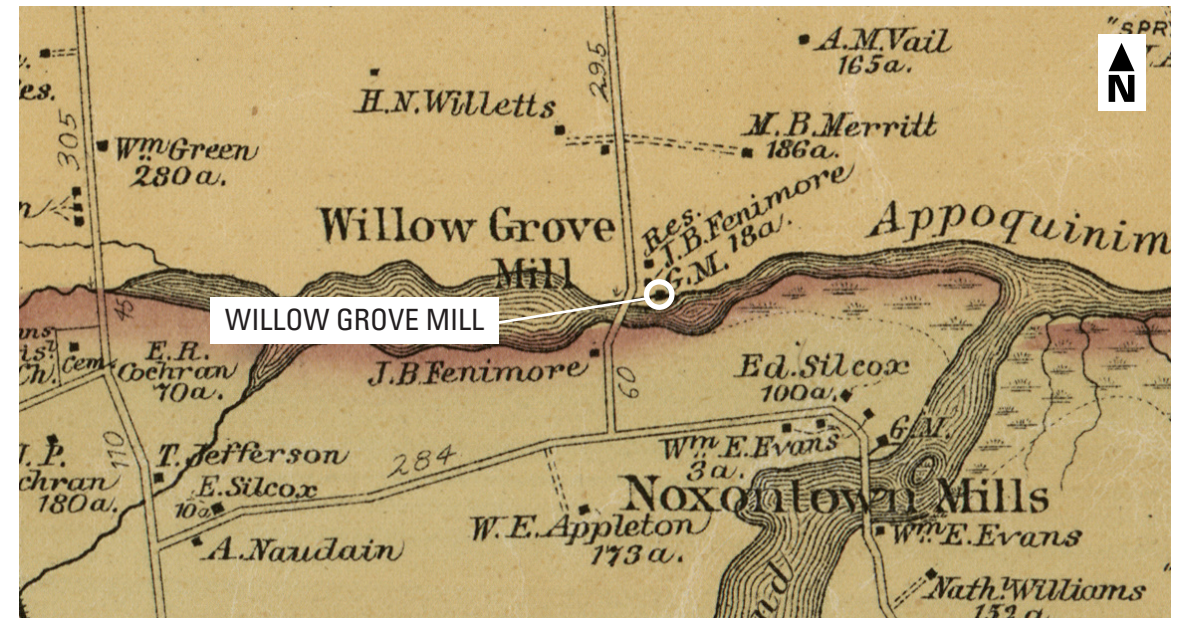
Courtesy of DelDOT.

This plan shows Bridge 1-407 with the concrete weir it reused from the earlier structure, and the proposed repair which would replace the weir with movable sluice gates.



D.G. Beers, *Atlas of the State of Delaware*, 1868.

This 1868 map shows the mill (circled) under the ownership of J. Drummond.



G.M. Hopkins, *Map of New Castle County*, 1881.

This 1881 map shows the Willow Grove Mill (circled) under the ownership of J.B. Fenimore, who was leasing the property by 1883.

Bridge 1-407 is a single-span, 22-foot long, 22-foot wide, concrete-encased, steel multi-girder bridge. The concrete abutments and wingwalls direct water from the downstream (east) side of the concrete spillway, located directly under the bridge. The bridge features decorative concrete parapets with incised diamond shapes. The upstream (west) side features two concrete pylons that support decorative concrete planters, one on each end of the bridge.

Bridge 1-407 was put to the test shortly after construction was completed, when more storms caused high water in Delaware in 1935 and 1938. While the bridge was not destroyed, it proved incapable of allowing enough water to flow out of Silver Lake. The 1938 storm overtopped the earthen dam in two locations: it washed out the area south of Bridge 1-407 on the southern end of the dam; and just south of Bridge 1-407A, which carries the Willow Grove Mill race through the north end of the dam. By 1939, Delaware's State Highway Department (now known as the Delaware Department of Transportation, or DelDOT) had taken ownership of the road and bridges, and began designing a solution to remedy the overtopping and washing out of the Silver Lake Dam. The solution was to redesign Bridge 1-407 to use metal-framed wood sluice gates and to build another, larger combination bridge and flood control structure just north of Bridge 1-407, also with operable sluice gates, to allow even more excess water to flow from Silver Lake during storm events.



Detail of the concrete pylons and decorative planters featured on Bridge 1-407. Note the remnants of the metal stems and wood sluice gate boards, two of which are on top of a concrete planter.



Detail of the original sluice gates and screw mechanism for Bridge 1-504 after having been removed and prior to repairs.



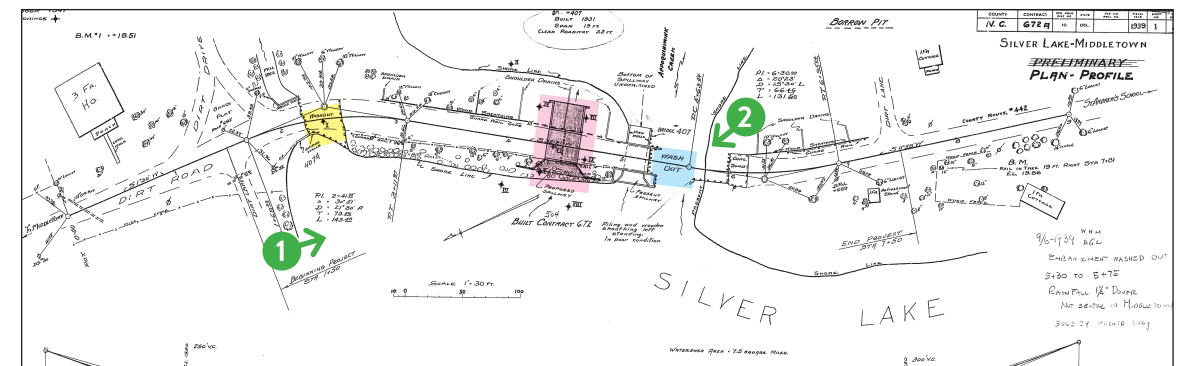
Courtesy of Delaware Public Archives.

This photograph, taken May 2, 1938, shows the washout and damage sustained to the Silver Lake Dam and Bridge 1-407. Note that the original concrete weir of Bridge 1-407 is visible in this photograph before it was redesigned with movable sluice gates to allow more water to flow out of Silver Lake during storms. The view shown in the photograph is indicated on the plan below.



Courtesy of Delaware Public Archives.

This photograph, taken May 2, 1938, shows the washout and damage sustained to the Silver Lake Dam and Bridge 1-407. Note that Bridge 1-504 would later be constructed to the right of Bridge 1-407 in this photograph, as shown on the plan below. The view shown in the photograph is indicated on the plan below.



Courtesy of DelDOT.

This plan shows the damage from the storm that washed out the Silver Lake Dam in 1938. Note the location of the washout south of the mill race bridge (Bridge 1-407A), washout south of Bridge 1-407, and the proposed Bridge 1-504.

- Washout south of the mill race bridge (Bridge 1-407A)
- Washout south of Bridge 1-407
- Proposed Bridge 1-504

The new bridge, Bridge 1-504, was designed in 1939 and constructed shortly thereafter by the Delaware State Highway Department's Bridge Division and their bridge engineer, Arthur G. Livingston. Bridge 1-504 is a two-span, 26-foot long, 20-foot wide, reinforced concrete slab bridge supported on concrete abutments, a concrete pier, and concrete wingwalls. The bridge features concrete parapets with rectangular concrete panels, which are the bridge's only decorative feature. Each span contained a metal frame with wood board sluice gates on the west (upstream) side of the structure. A metal screw mechanism attached to the top of the gates was used to raise and lower the wood boards, regulating the flow of water draining from Silver Lake.

Bridge 1-407 and Bridge 1-504 were determined contributing elements to the Willow Grove Mill Historic District in 1999, and were also determined individually eligible for the National Register during Delaware's Statewide Historic Bridge Survey in 1999. Bridge 1-407 is significant as a representative example of the steel multi-girder bridge type that was prevalent in Delaware during the first half of the 20th century. Bridge 1-504 is significant as a representative example of a common bridge type built during a period of rapid highway expansion in Delaware (1935-1942). In addition, both bridges are also significant for their engineering, which provided a creative solution to the flood and water control issues on Silver Lake. Combination bridge and water control structures were built by the State Highway Department throughout Delaware in an effort to maintain roadways and mill dams against the threat of flood damage.



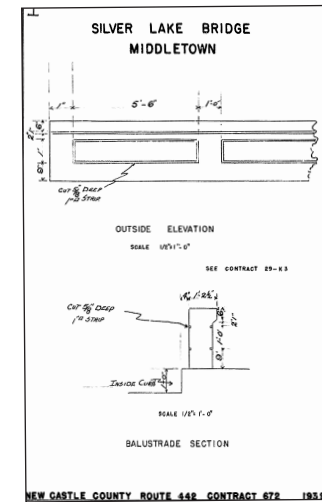
View of the temporary steel pilings installed to prevent Silver Lake from draining through the damaged sluice gates prior to repair.



Detail of the west (upstream) parapet of Bridge 1-407, which features an incised diamond pattern and the original bridge plaque.

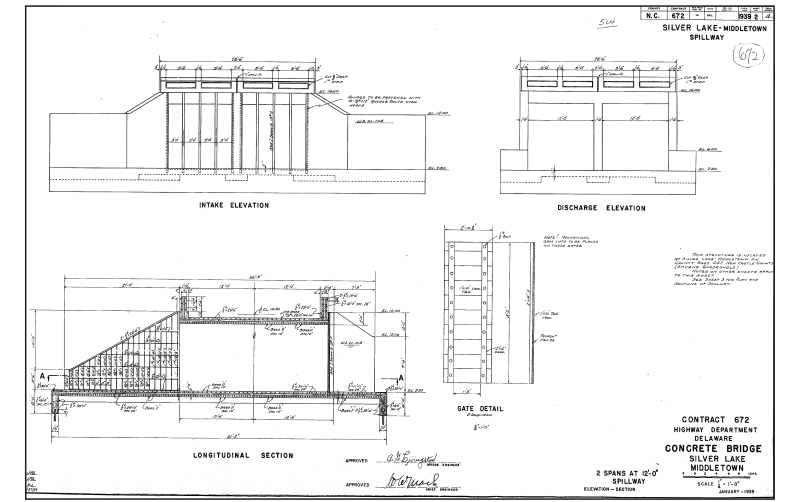
In 2020, DelDOT was preparing to upgrade the flood control features of Bridges 1-407 and 1-504, as the original metal frames and wood sluice gates have become damaged

and deteriorated over the years, rendering portions inoperable. Heavy rainfall and high water events have increased in number and intensity during the 21st century. While the Willow Grove Mill stopped operation nearly 100 years ago, controlling high flood waters is even more critical today than it was in the 1930s when Bridges 1-407 and 1-504 were constructed, due to increased residential and commercial development.



Courtesy of DelDOT.

This plan detail shows the decorative concrete parapet of Bridge 1-504 with its incised concrete rectangular panels.



Courtesy of DelDOT.

Plan from 1939 showing the proposed Bridge 1-504.

MAIN SOURCES CITED

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Lichtenstein Consulting Engineers, Inc.

2000 Delaware's Historic Bridges: Survey and Evaluation of Historic Bridges with Historic Contexts for Highways and Railroads. Paramus, New Jersey.



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