RA-2009-1H

MINNESOTA HISTORIC PROPERTY RECORD

PART I. PROPERTY IDENTIFICATION AND GENERAL INFORMATION

Common Name (if applicable):
Bridge 9800, Lafayette Bridge

Bridge Number:
009800

Identification Number:
RA-SPC-7891

Location:
Bridge 9800 carries Minnesota Trunk Highway/United States Highway (TH/US) 52 over the Mississippi River in the city of St. Paul, Ramsey County, Minnesota.

Township: 29	Range: 22W	Section: 32	
Township: 28	Range: 22W	Section: 5	Ramsey County

UTM:
Zone 15: 493499E, 4977660N (north end)
Zone 15: 493830E, 4976804N (south end)

Quad:
St. Paul East; 7.5 Minute Series; NAD83

Present Owner:
Minnesota Department of Transportation (Mn/DOT)

Present Use:
Vehicular bridge

Significance Statement:

Introduction
The Lafayette Bridge (Bridge 9800) is a continuous steel deck girder span that carries Trunk Highway/United States Highway 52 (TH/US 52) over the Mississippi River in the city of St. Paul. It connects downtown St. Paul with West St. Paul and South St. Paul on the south, and links TH/US 52 with Interstate 94 (I-94) on the north. The Lafayette Bridge is situated east and downstream of the Robert Street Bridge (Bridge 9036, built in 1926) and the Wabasha Street Bridge (Bridge 62555A and 62555B, built in 2001). When completed in 1968, the Lafayette Bridge was the first new river crossing in St. Paul in nearly 80 years.

Planned and designed during the Interstate Highway era of the 1950s and 1960s, the Lafayette Bridge was intended to both relieve downtown traffic congestion and connect TH 52 with I-94 and I-35E.[1] The alignment of the Lafayette Bridge allowed northbound traffic to easily bypass downtown St. Paul and connect directly with I-94 leading into Minneapolis or Wisconsin. Southbound traffic on TH 52 could easily access West St. Paul and South St. Paul via Concord Street or Plato Boulevard on the south side of the river. Alternatively, southbound traffic could continue southward to I-494, Cannon Falls, Rochester, and I-90.

The Lafayette Bridge's planning history is marked by design compromises made as a result of topographical and navigational requirements that created multiple constraints on the bridge design. The bridge's design negotiated concerns from river navigation, aviation, and railroad interests throughout the planning and construction process. At the time of construction, the Lafayette Bridge was reportedly the second longest bridge structure in Minnesota and incorporated the state's largest plate girders.[2]

In 1975 the bridge was closed to traffic for more than a month after developing a large fracture in a girder in the southbound roadway of the main river span, which was potentially catastrophic for the bridge. The state consulted with national bridge experts to study the fracture's cause, and the conclusions drawn resulted in a repair plan that allowed the bridge to reopen to traffic and manage continuing fractures. The published fracture-related study further resulted in changes to local and national bridge design and inspection standards, as well as increased awareness and vigilance towards existing bridges prone to similar problems.

Early Planning and Need (1922-1961)

To Bypass or Not to Bypass

Early vehicular traffic in St. Paul crossed the Mississippi River via the original Robert Street Bridge or Wabasha Street Bridge, both of which were established in the mid- to late nineteenth century, before the emergence of automobile traffic. As automobile usage increased during the early twentieth century, the City of St. Paul identified and promoted the need for a third Mississippi River crossing in downtown St. Paul. In particular, increased automobile traffic caused congestion on the Robert Street Bridge, prompting city officials to recommend greater bridge capacity at or east of Robert Street in their 1922 comprehensive plan.[3] If located east of Robert Street, the proposed span would bypass the city's central business district, and this possibility resulted in debates that hindered progress on the new bridge for more than thirty years. As a result, a new Mississippi River bridge was not constructed in the 1920s to

[1] At the time of the Lafayette Bridge's construction, TH/US 52 in this location was known as TH 56. In this document, the historical text will refer to the trunk highway route over the Lafayette Bridge as TH 52 because of its current designation as TH/US 52.

[2] "$10-1/2 Million Lafayette Bridge Dedication, Opening Set Nov. 13," *St. Paul Dispatch*, 24 October 1968, 27.

[3] City Planning Board of Saint Paul, *The Proposed Freeways for Saint Paul*, vol. 104 (St. Paul, Minn.: City Planning Board of Saint Paul, June 1957), 29.

alleviate traffic concerns; rather, the 1880s wrought iron span at the Robert Street crossing was replaced and upgraded for increased traffic in 1926.[4]

In 1928 the City of St. Paul created the United Improvement Council (UIC) to further address street and highway improvements within the city. The UIC's primary objectives were to ensure that the designated state trunk highways led into the heart of the city by as direct a route as topographically and geographically possible, and to facilitate the relief of traffic congestion in the city by selective street widening. These recommendations were greatly influenced by the city's merchants and business owners, as well as the increasing numbers of motor vehicle drivers.[5] In particular, the UIC enumerated thirteen specific street improvement recommendations based on previous City Planning Board suggestions, including the improvement and widening of Lafayette Road.[6] At this time, the UIC opposed any plan that would route traffic around the central business district, be it through or local traffic, The UIC believed that bypasses would adversely affect merchants and local businesses. Thus, traffic congestion continued to be a problem in downtown St. Paul.[7]

Despite the replacement of the Robert Street Bridge in 1926, another river span was again introduced in the 1940s as part of the City of St. Paul's program for postwar improvements. In response to mayoral instructions, the St. Paul Department of Public Works issued a list of possible trunk highway, street, and parkway improvement projects to be included in the postwar improvement program. A new bridge over the Mississippi River at either Broadway Street or Pine Street, both located downstream from Robert Street, with connections to South Concord Street and Mississippi Street, was included in the list. A bridge at either of these locations would help to alleviate traffic on the Wabasha and Robert Street Bridges. By 1956 the location of the proposed bridge and its connections would shift east to Lafayette Road. Located further downstream from the Robert Street Bridge, the Department of Public Works believed this new Mississippi River crossing would alleviate congestion on Robert Street that stemmed from stock trucks hauling livestock through the city core, an action the City asserted hurt retail operations on Robert Street. The St. Paul Union Stockyards, located in South St. Paul, was one of the largest stockyards in the nation, and stock trucks traveling from the north and west would travel through downtown St. Paul and across the Wabasha Street or Robert Street Bridges in order to reach the stockyards. Heavy stock truck traffic contributed to the City's desire for a new Mississippi River bridge that would bypass downtown St. Paul retail areas.[8]

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[4] Minnesota Historical Society, "Minnesota's Historic Bridges, Robert Street Bridge, Historic Significance," Minnesota Historical Society, <http://www.mnhs.org/places/nationalregister/bridges/nrrarsb/sign.html> (accessed 8 April 2009).

[5] George H. Herrold, "The Story of Planning St. Paul from the Beginnings to 1953," St. Paul, Minn., 1958, 117.

[6] Herrold, "The Story of Planning St. Paul from the Beginnings to 1953," 117-118. Although Lafayette Road was mentioned in the 1928 recommendation, it was not identified as a potential route for a new bridge span.

[7] Herrold, "The Story of Planning St. Paul from the Beginnings to 1953," 118-119.

[8] St. Paul Department of Public Works, *Program of Post War Improvements for the City of St. Paul and Ramsey County* (St. Paul, Minn.: 1944), n.p.; Herrold, "The Story of Planning St. Paul from the Beginnings to 1953," 133; Roy Grieder, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc., Transcript, Minnesota Department of Transportation Bridge Office, Oakdale, Minnesota, January 8, 2009.

Providing a second impetus for establishing a new Mississippi River span was the United Civic Council (UCC) of 1941-1944, a citizen committee established by the mayor to promote the effective utilization of the trunk highway system within the city, region, and state. Between 1919, when the trunk highway system was first authorized, and 1933, the Minnesota State legislature designated numerous trunk highway routes, including proposed routes extending from Kenyon north into St. Paul and extending southerly from St. Paul to Rochester, via Zumbrota.[9] Although designated, the legislature did not fix the exact locations of these routes; therefore, the City of St. Paul had leeway to determine which streets or routes would be identified as trunk highways. The highways and streets advisory committee of the UCC believed that the legislative highway routings and the fixed locations of railroad right-of-way would determine the pattern of the city for many years to come, and that a thoroughfare plan that effectively connected the city routes with other trunk highways in nearby communities and beyond would be a good basic pattern to which to conform. In 1944 the Executive Committee of the UCC, known as the House of Delegates, also approved prioritizing the construction of thoroughfares that were connected with state and regional routes.[10]

By the 1950s the City of St. Paul made the planning, design, and construction of a new bridge downstream from Robert Street a high priority. At this time, the previous civic decisions to not bypass the city, in an effort to preserve local businesses, were questioned. In 1952 the U.S. Chamber of Commerce widely circulated a brochure entitled "Do By-passes Hurt Business." The Chamber of Commerce surveyed retail districts in 30 cities and concluded that bypasses did not, in fact, negatively affect retail businesses.[11] Additionally, with the passage of the Federal Aid Highway Act of 1956 and a 1956 state constitutional amendment funding municipal, county, and state trunk highway road projects, the Minnesota Department of Highways (MHD)[12] rapidly began efforts to plan and construct networks of efficient trunk highways, freeways, and Interstates.[13] These efforts, coupled with a shift in thinking about the economic effects of bypasses, led to increased support for a third bridge in St. Paul that would connect the trunk highway and Interstate system, and ultimately bypass the city's central business district.

Establishing a "New Kind of Road:" The Lafayette Freeway

In a June 1957 publication, the City Planning Board of St. Paul carefully and thoroughly considered the implications of the newly authorized Interstate Highway System for the city's comprehensive planning efforts. On the whole, the City Planning Board looked forward to the implementation of a freeway system in the metropolitan area, which it suggested would provide "the only real basis for a solution to the traffic problem. This new Interstate Highway System...provides an unprecedented opportunity to reorganize

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[9] TH 56 was proposed to extend north from Kenyon into St. Paul, while TH 52 would connect St. Paul with Rochester, via Zumbrota. At the time of the Lafayette Bridge's construction, TH/US 52 was known as TH 56. Currently TH 52 and TH 56 join south of St. Paul in Inver Grove Heights and separate further south in Hampton.

[10] Herrold, "The Story of Planning St. Paul from the Beginnings to 1953," 127-130.

[11] Herrold, "The Story of Planning St. Paul from the Beginnings to 1953," 119.

[12] Although officially named the Minnesota Department of Highways, the acronym MHD, which corresponds to Minnesota Highway Department, a casual reference to the department of highways, was used historically prior to the department being renamed Mn/DOT.

[13] Mead & Hunt, Inc., *Minnesota Bridges, 1956-1970: Politics, Policies, Technology, and Design* (May 2008), 12-17.

our City's basic circulation system to meet today's and tomorrow's needs, thus assuring St. Paul's continued growth and development as a pleasant and prosperous place in which to live."[14] In addition to the authorized north-south (I-35), east-west (I-94), and circumferential (I-494) Interstate crossings in the Twin Cities area, the City Planning Board also considered other major routes in their 1957 assessment.

Although not formally proposed by the MHD until 1959, the Lafayette Freeway would adhere, in many ways, to the definitions provided in the 1957 report. First and foremost, the City Planning Board defined a freeway as:

> A new kind of road – it is a product of the automobile age. It is a major highway built to the highest standards of traffic efficiency and safety known to our technology. It is characterized by: (1) access limited to designated points, (2) all crossings separated by bridges, (3) four or more traffic lanes, (4) opposing lanes separated by a dividing strip, (5) design for speeds of 50 to 70 miles per hour, (6) ability to carry safely and smoothly, far more traffic than any other type of road or street.[15]

This definition of a freeway was recently echoed by Clement P. Kachelmyer, a former MHD geometric design engineer who was involved with the design of the Lafayette Freeway. Kachelmyer succinctly stated that, during the late 1950s and early 1960s, a freeway was considered "a highway with interchanges between major roadways, and with no at-grade intersections, built with approved alignment curvature and with full width driving lanes and shoulders, all of which would meet Federal standards to provide for the projected traffic volumes."[16]

In its report, the City Planning Board also envisioned the St. Paul freeway system as the backbone of the city's street network. In classifying the city's street system, the board identified freeways and expressways as:

> Major high-speed routes with controlled access and generally grade separations at intersections. A freeway is of a higher standard than an expressway in that by definition it never has any crossings at grade whereas an expressway may. All of the Interstate System in the City falls into the freeway category. A few additional proposed routes may not be of freeway standards but would be expressways. An example is the proposed Lafayette Street [B]ridge across the Mississippi River, and highway to the South St. Paul area.[17]

The Lafayette Freeway was formally introduced by the MHD in 1959 to accommodate the forecasted traffic volumes and meet the needs for a "controlled access north-south radial extending from the St. Paul business district through northern Dakota County."[18] Moreover, the proposed route addressed the ineffectiveness of Robert Street and Concord Street as "facilities for the expeditious movement of large

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[14] City Planning Board of Saint Paul, *The Proposed Freeways for Saint Paul*, n.p.

[15] City Planning Board of Saint Paul, *The Proposed Freeways for Saint Paul*, 1.

[16] Clement Kachelmyer, Mead & Hunt, Inc., Letter, Minneapolis, Minn., March 31, 2009.

[17] City Planning Board of Saint Paul, *The Proposed Freeways for Saint Paul*, 8.

[18] Community Planning & Design Associates Inc., *Lafayette Freeway Study* (St. Paul, Minn.: Community Planning & Design Associates Inc., 1961), 1.

volumes of traffic."[19] In its preliminary study, the freeway would generally follow the "corporate limits between South St. Paul and West St. Paul" and provide residents with "excellent access to the entire metropolitan area." The freeway would "join the Interstate Freeway system north of the Mississippi River in St. Paul and also in Inver Grove Township near present Highway 100."[20] As Kachelmyer recalls, the original plan for the Lafayette Freeway actually included extending the highway north of East 7th Street, its current northern terminus, but the extension proposal did not receive public support. Additionally, it was not until the preliminary design for I-94 and I-35E was determined that an interchange between the Lafayette Freeway and the Interstate routes became a necessity due to projected traffic volumes. At its southern terminus, the Lafayette Freeway joined TH 52 and TH 55 in Inver Grove to provide for an interchange with both trunk highways and to allow for a future extension further south.[21] Thus, the Lafayette Freeway and the Lafayette Bridge would effectively link major thoroughfares within the city to destinations beyond the metropolitan area.

Planning for the Lafayette Bridge

During the late 1950s, surveys conducted by the MHD and the City's Department of Public Works concluded that the proper location for a third Mississippi River crossing would be along "a center line extending southeasterly from the intersection of Sixth Street and Lafayette Road, where it will connect with I-94, crossing the railroad tracks and Union Depot Company property and the Mississippi River to a point on the west bank near Minnetonka and Alabama Streets, with a southerly approach crossing Concord Street just northeasterly from Andrew Street."[22] Occurring contemporaneously with the proposal of the Lafayette Freeway, the preliminary bridge location was recommended both on a location plan dated April 1959 and a profile dated April 13, 1960, as prepared by the MHD and on file in the City's Department of Public Works.[23] Figure 1 identifies the location of the Lafayette Bridge on the 1968-1969 Official Highway Map of Minnesota.

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[19] Community Planning & Design Associates Inc., *Lafayette Freeway Study*, 1.

[20] Community Planning & Design Associates Inc., *Lafayette Freeway Study*, 2.

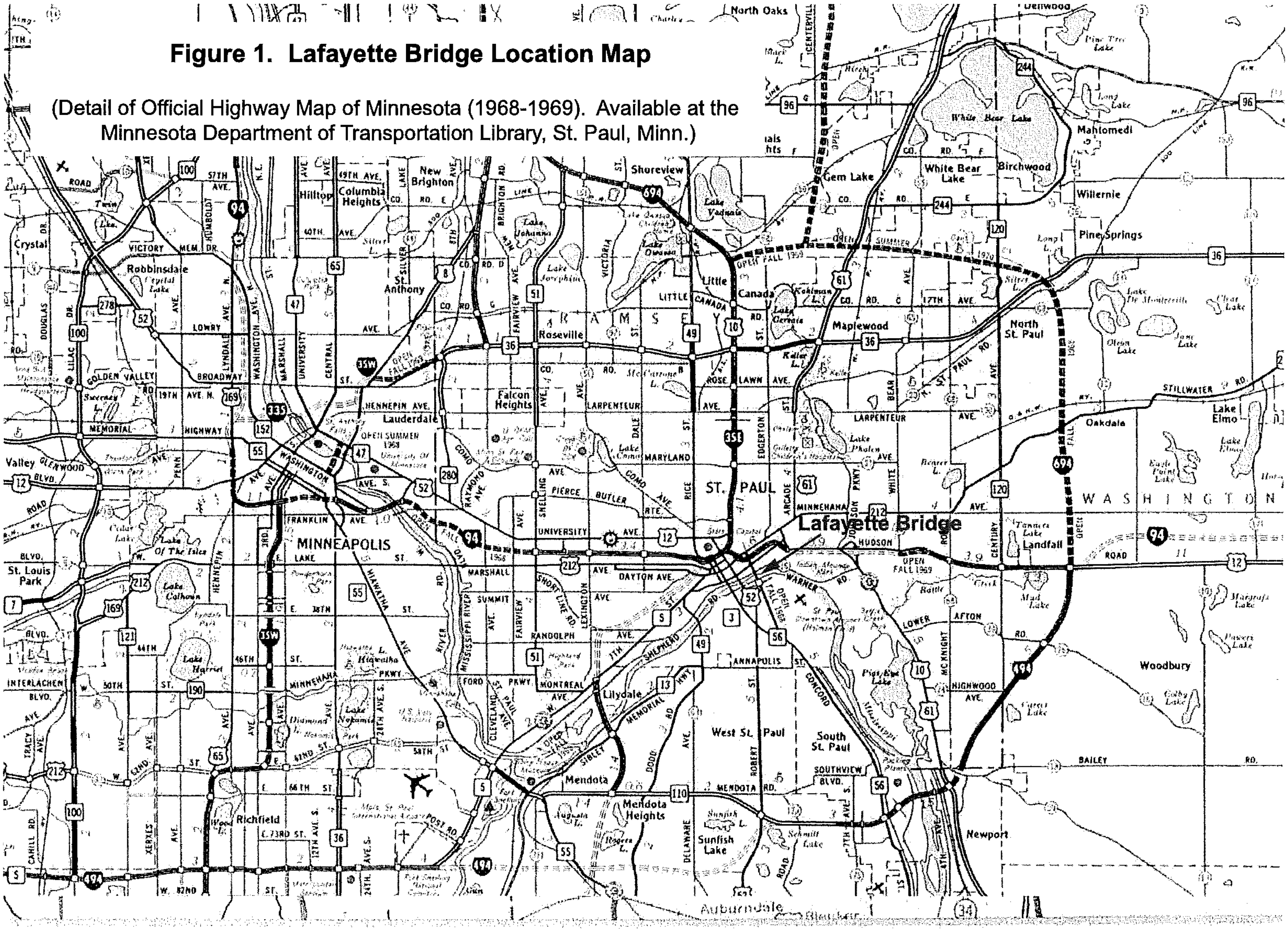
[21] Kachelmyer, Mead & Hunt, Inc.

[22] Milton Rosen, "Letter to Hon. L. P. Zimmerman, Commissioner of Highways, State of Minnesota," 13 July 1960, n.p.

[23] Rosen, "Letter to Hon. L. P. Zimmerman, Commissioner of Highways, State of Minnesota," n.p.

Figure 1. Lafayette Bridge Location Map

(Detail of Official Highway Map of Minnesota (1968-1969). Available at the Minnesota Department of Transportation Library, St. Paul, Minn.)

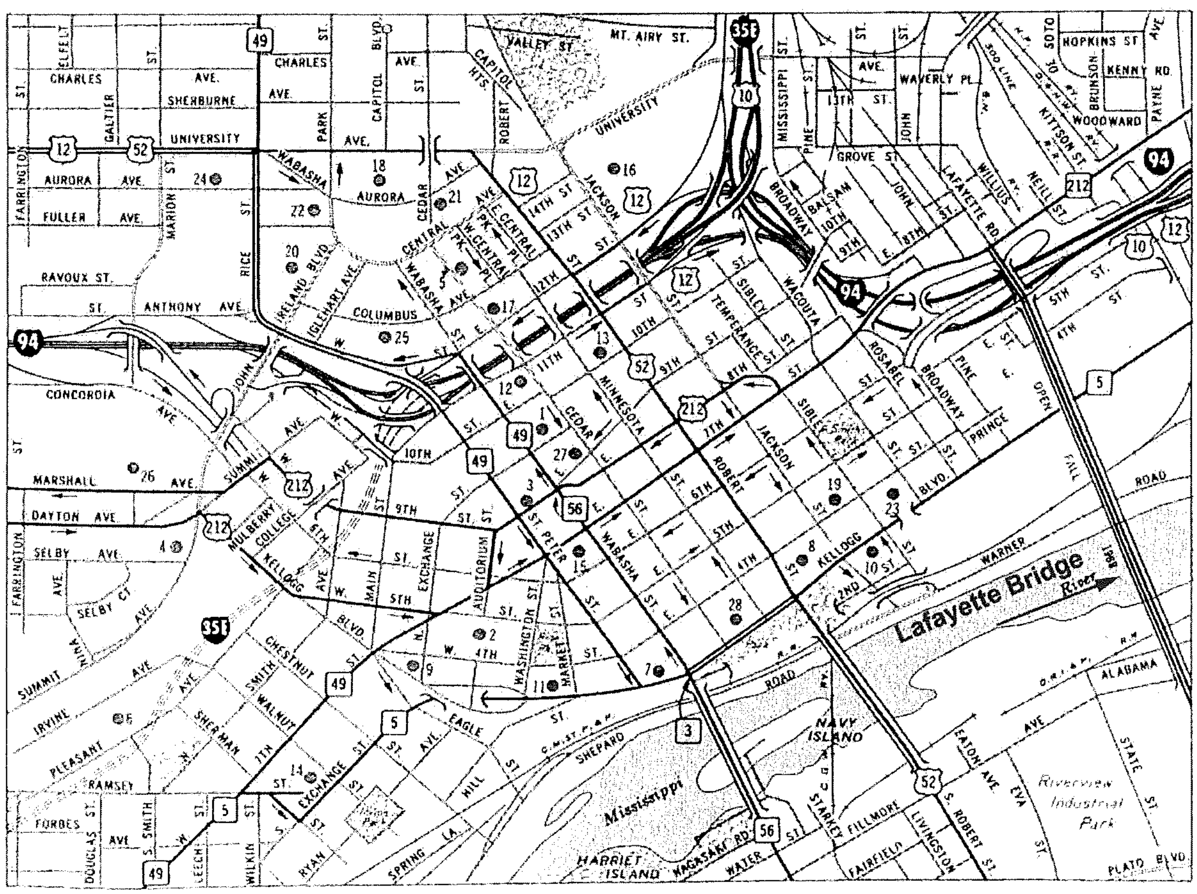


DOWNTOWN ST. PAUL

SCALE ONE INCH EQUALS 0.45 MILES APPROX.
One-way streets indicated by arrows

Places of Interest

1. Arts and Science Center
2. Auditorium (municipal)
3. Bus Depot
4. Cathedral of St. Paul
5. Centennial Building
6. Children's Hospital
7. City Hall and Court House
8. Federal Courts Building
9. International Institute
10. Post Office and Federal Building
11. Public and Hill Reference Library
12. Public Health Center
13. Public Safety Building
14. Ramsey House
15. St. Paul C. of C.— Convention and Visitors Bureau
16. St. Paul—Ramsey County Hospital
17. State Armory
18. State Capitol
19. State Employment Office
20. State Highway Department
21. State Historical Department
22. State Office Building
23. Union Station
24. U.S. Social Security Office
25. Veterans Service Building
26. Vocation Trade School
27. Y.M.C.A.
28. Y.W.C.A.



The City of St. Paul deemed the construction of the Lafayette Bridge so significant that they pursued state legislation, which was passed on April 25, 1959, to enable them to advance funds to the MHD for construction of the project. According to Chapter 538 of the Laws of Minnesota for 1959, the City of St. Paul could advance cash or engineering services, or both, to the Commissioner of Highways in order to accelerate trunk highway construction and improvement within the city. The State of Minnesota was required to repay the principal amount of the advance, without interest, over a period of 30 years, with the City paying interest on the funds in the meantime.[24] Ultimately, the City of St. Paul raised most of the $10.5 million cost for the Lafayette Bridge through the sale of bonds between 1961 and 1968. Eager to have the Lafayette Bridge constructed, the St. Paul City Council also adopted a resolution urging the MHD to seek approval of plans as soon as possible so that work could start on the bridge.[25] The MHD proved responsive, and on June 7, 1960, it distributed a preliminary layout of the bridge to interested and involved parties for approval.[26]

While the City and MHD collaborated on financing and early planning efforts for the Lafayette Bridge project, additional studies confirmed the need for the bridge. In September 1959 the City of St. Paul Department of Public Works published a traffic analysis, which suggested that if the then-proposed Lafayette Bridge was in place, it would significantly relieve capacity problems at both the Wabasha Street and Robert Street Bridges. Moreover, the analysis concluded that the relief of traffic on the Wabasha and Robert Street Bridges by the Lafayette Bridge was “nearly imperative.” With regards to planning efforts, the City advised that connections at the south and north ends of the bridge be given high priority in order to effectively divert and distribute traffic between Robert, Wabasha, and Lafayette Streets.[27]

Although the City aggressively pushed forward the Lafayette Bridge project, and their collective sense of urgency was evidenced by state legislation and city resolutions, the MHD controlled the majority of planning and design decisions for the bridge, with consideration given to some private, local, and regional interests. Construction of the Lafayette Bridge was required to fit within a complex network of municipal roads, state trunk highways, and Interstate thoroughfares, as noted in the previous section. Its construction would bypass the city's central business district and connect TH 52 to the Interstate system and residential and commercial districts south of the city in West St. Paul, South St. Paul, Dakota County, and beyond.

By late 1960, the planning and design of the bridge were well underway. Beginning in December 1960 and in accordance with Title 23, U.S. Code, Section 128, which requires public hearings for Federal Aid Highway projects that go through or bypass communities, the MHD held public hearings to address concerns, including those of representatives from the City of St. Paul, St. Paul Port Authority, local

[24] Rosen, "Letter to Hon. L. P. Zimmerman, Commissioner of Highways, State of Minnesota," n.p.; "Transcript of Public Hearing Held in the City Council Chambers," 8 December 1960, 3; Minnesota Office of the Revisor of Statutes, "Session Laws of Minnesota for 1959, Chapter 538-H.F. No. 1274," Minnesota Legislature, <www.revisor.leg.state.mn.us/data/revisor/law/1959/0/1959-538.pdf> (accessed 8 April 2009).

[25] "Lafayette Span Plans Progress," *St. Paul Dispatch*, 20 July 1960, n.p.

[26] A. E. LaBonte, "Chronological Report of Progress on This Bridge Project," 23 July 1962, n.p.

[27] Department of Public Works, *Downtown Traffic: 1959 Analysis and Inventory* (St. Paul, Minn.: September 1959), 36-37, 83; Herrold, "The Story of Planning St. Paul from the Beginnings to 1953," 170.

railroad companies, and surrounding cities and counties. Throughout the public hearings, the City of St. Paul and the St. Paul Port Authority were among the project's most vocal supporters. In particular, the Port Authority favored the project because of the access it would provide to the proposed Riverview Industrial Park on the city's west side, at the south end of the bridge. In reference to Riverview Industrial Park, P. W. Fitzpatrick, President of the St. Paul Port Authority, said, "It is anticipated that a large number of industries will be located there, access to which trunk highways will be required, as this proposed improvement provides. Furthermore, it would provide better access to the park for employees from surrounding areas and counties, who, we hope, will find work there."[28]

Designing the Lafayette Bridge: Negotiating Constraints

The final design chosen for the Lafayette Bridge reflected a number of competing interests, addressed topographical constraints and geographic location, and resulted in significant design compromises. The MHD quickly involved the United States Army Corps of Engineers (Corps), the St. Paul Port Authority, and the Metropolitan Airport Commission in the design of the bridge, particularly with regard to vertical and horizontal clearance. Provisions for substructure design were coordinated with six railroad companies and the St. Paul Union Depot Company, whose established tracks and facilities ran beneath the bridge.

Because of the established transportation infrastructure for water, air, and rail navigation, the design for the main span type of the Lafayette Bridge was limited to a plate girder design. The short vertical clearance between the river navigation level and the bridge, and the existing glide path for aircraft landing at and departing from Holman Field, limited the type of feasible construction.[29] Additionally, the plan and design of the Lafayette Bridge, as part of the Lafayette Freeway, was required to integrate the tenets of freeway design. As a result, the bridge, a critical component in this new freeway, featured four traffic lanes with opposing lanes divided by a three-foot median.

United States Army Corps of Engineers

Before the design plans could be approved by the Bureau of Public Roads (BPR), the predecessor to the Federal Highways Administration (FHWA), approval for vertical and horizontal navigational clearance from the Corps was required. Generally, it was in a highway department's interest to build bridges with low vertical clearance, if possible, in order to save material costs. During the 1960s highway departments in states adjacent to the Mississippi River encouraged the Corps to reduce their vertical clearance requirements along main river channels. Ultimately, the decision regarding minimum vertical clearance standards went to the U.S. Congress.

The MHD submitted their first set of plans for the Lafayette Bridge to the Corps in September 1960, which included a vertical clearance of 51.3 feet above a river stage equal to all but the worst flood stages (the two percent line) and a horizontal clearance of 318 feet between the faces of the main river piers. The Corps objected to the proposed vertical and horizontal clearances and included correspondence from navigation interests, particularly steamboat companies, whose vessels required a 61.6-foot clearance

[28] "Transcript of Public Hearing Held in the City Council Chambers," 6.

[29] Ellerbe and Company, "Lafayette Street Bridge Over the Mississippi River Preliminary Design," St. Paul, Minn., Ellerbe and Company, 29.

above the normal river level. At this time, the national vertical clearance standard for bridges on the Upper Mississippi River was 55 feet above the two percent line, and thus the proposed Lafayette Bridge did not meet the national standards.[30]

The MHD continued to negotiate and adjust their plans through 1961 in order to gain the Corps approval for both vertical and horizontal clearance. While the MHD sought approval for the Lafayette Bridge clearances, the U.S. Congress was considering minimum vertical clearances for bridges over the Mississippi River and possible modification of the General Bridge Act of 1946. The Congressional inquiry occurred as the result of the Corps and BPR proposing a lower criterion for vertical clearances across the Upper Mississippi River, including a clearance of 45 feet above the two percent line, or 50 feet above the normal river level, whichever was greater. The Congressional debate, which would continue into the spring of 1962, threatened to delay the Lafayette Bridge project by preventing the Corps from processing the MHD's application. MHD aggressively urged the BPR and Corps to approve the Lafayette Bridge's vertical clearance, which at 51.3 feet was equal to that of the Robert Street Bridge, recounting the importance of the project to St. Paul and the City's issuance of bond sales and absorption of related interest beginning in April 1961. As a result, the Corps considered and approved a vertical clearance equal to the Robert Street Bridge upstream and a horizontal clearance of 350 feet on May 12, 1961.[31]

Metropolitan Airports Commission and Holman Field

In addition to coordination with the Corps, the MHD entered into conversations with the Metropolitan Airports Commission (MAC) with regard to the bridge's effect on Holman Field (currently the St. Paul Downtown Airport), located near the bridge's south end. The MHD submitted preliminary plans to MAC in late 1960, and MAC reviewed the project with respect to the approach zone profiles for the Holman Field runways. Although the local newspapers touted the possibility that the bridge would interfere with the approach glide angle for aircraft landing at Holman Field, and the St. Paul Chamber of Commerce expressed concerns that the bridge might hinder future plans to develop the airport for large planes owned and operated by businesses in or near the new Riverview Industrial Park, MAC did not object to the layout and profiles of the bridge grades as submitted. MAC did, however, recommend a clearance of 15 feet over the highway center line to achieve a 40:1 and 30:1 approach glide angle for the two runways. Moreover, MAC requested that further planning for the bridge and lighting of the bridge be coordinated with their office to ensure that tall projections would not interfere with air transportation.[32]

[30] LaBonte, "Chronological Report of Progress on This Bridge Project," n.p.; L. P. Zimmerman, "Letter to Mr. W. W. Fryhofer, Division Engineer, Bureau of Public Roads," 26 July 1960, n.p.; W. B. Strandberg, "Letter to Mr. A. E. LaBonte, Bridge Engineer, Minnesota Department of Highways," 8 November 1960, n.p.

[31] LaBonte, "Chronological Report of Progress on This Bridge Project," n.p.; L. P. Zimmerman, "Letter to W. W. Fryhofer, U.S. Bureau of Public Roads," 5 April 1961, n.p.; James H. Carroll, "Letter to Mr. A. E. LaBonte, Bridge Engineer, Minnesota Department of Highways," 28 March 1961, n.p.; Leonard Inskip, Richard Saunders, and Bob Ylvisaker, "Height Standards for Bridges Changed," *Minneapolis Tribune*, 7 February 1961, n.p.

[32] H. G. Kuitu, "Letter to Mr. L. P. Zimmerman, Commissioner of Highways, State of Minnesota," 17 January 1961, n.p.; "St. Paul C. of C. Hits Plans for Bridge," *Minneapolis Star*, 14 January 1960, n.p.

Railroad Interests

At the bridge's north approach, design accommodations were required for the placement of piers among the tracks belonging to six railroad companies and the St. Paul Union Depot Company[33] that maintained tracks and facilities beneath the proposed bridge location. In June 1960 the MHD sent preliminary layout plans to the six affected railroad companies (Chicago, Rock Island & Pacific Railroad Company; Chicago & Northwestern Railway Company; Chicago, Milwaukee, St. Paul & Pacific Railroad Company; Great Northern Railway Company; Northern Pacific Railway Company; and Chicago Great Western Railway Company) and the St. Paul Union Depot Company, requesting approval of alignment and pier locations. While each of the companies approved of the proposed bridge's alignment, the majority of the companies expressed concern with pier locations and their proximity to railroad right-of-way. The Chicago & Northwestern Railway Company, in particular, summed up general concerns by writing, "pier locations are of the utmost importance to our continued operation below this proposed structure."[34]

Negotiations with the railroad companies continued through 1963 and included correspondence, public meetings, a detailed study of the costs involved for various pier locations, and appraisals for pier locations. In August 1962, based on the cost and appraisal studies, the MHD recommended the final pier locations for the northerly portion of the Lafayette Bridge to the railroad companies. Additional correspondence urged the companies to quickly act on approving the plans. By February 27, 1963, all railroad companies had submitted their approval, and the various skew angles of the bridge piers in the vicinity of the railroad tracks are evidence of the complexity of the design and the required negotiations. The MHD continued to coordinate planning and construction efforts with the railroad companies as efforts to erect the land piers required dealing with existing railroad infrastructure to eliminate interference with continued railroad traffic.[35]

Ellerbe and Company

In February 1961 the MHD contacted Ellerbe and Company, a noted Minnesota architecture and engineering firm, to provide engineering services and prepare plans for the Lafayette Bridge. Despite their national reputation as architects, Ellerbe and Company seemed a surprising choice as designer for the Lafayette Bridge, a complicated engineering structure. Although the company designed the state's

[33] The St. Paul Union Depot Company managed the St. Paul Union Depot, the city's primary train station for passenger rail service. The St. Paul Union Depot Company was comprised of eight proprietary companies, including the Chicago, Milwaukee, St. Paul, and Pacific Railroad; Chicago and Northwestern Railway System; Great Northern Railway Company; Minneapolis, St. Paul, and Sault Ste. Marie Railroad Company; Northern Pacific Railway Company; Chicago and Great Western Railway Company; Chicago, Burlington, and Quincy Railroad Company; and Chicago, Rock Island, and Pacific Railroad Company.

[34] W. H. Huffman, "Letter to Mr. B. C. Galpin, Engineer of Railway Negotiations, State of Minnesota, Department of Highways," 18 May 1961, n.p.; W. B. Throckmorton, "Letter to Mr. B. C. Galpin, Engineer of Railway Negotiations, State of Minnesota," 27 June 1961, n.p.; John L. Jensen, "Letter to Mr. B. C. Galpin, Engineer of Railway Negotiations, State of Minnesota, Department of Highways," 9 May 1961, n.p.; H. R. Peterson, "Letter to Mr. B. C. Galpin, Engineer of Railway Negotiations, State of Minnesota, Department of Highways," 27 May 1961, n.p.; B. J. Ornburn, "Letter to Mr. B. C. Galpin, Engineer of Railway Negotiations, Minnesota Department of Highways," 31 May 1961, n.p.; "Progress Report: S.P. 6244 (T.H. 56), Lafayette Street from T.H. 94 to Concord Street," 28 February 1963, n.p.

[35] "Lafayette Span Ordered Rushed," *St. Paul Dispatch*, 11 September 1962, n.p.

first prestressed concrete bridge in 1957, its overall experience with bridges, as compared to architectural structures, is nearly undocumented. It is likely that Ellerbe and Company's involvement reflected an effort to capitalize on the greatly increasing design and construction efforts associated with the Minnesota's highway and freeway construction boom in the 1950s and 1960s. Moreover, it is possible that the company responded to the general shortage of engineers to provide road and bridge engineering services in Minnesota in the period.[36]

The agreement for Ellerbe and Company's engineering services was reviewed by the BPR in late April 1961. While the BPR did not object to the MHD's selection of Ellerbe and Company, it did express concerns over the company's "somewhat limited experience in the design of projects of this magnitude and complexity." As a result, the BPR suggested that "close liaison between the Bridge section and the Consultant be maintained to assure that both adequate and economical designs are being accomplished." [37] In July 1961 Ellerbe and Company was authorized to proceed with the preparation of plans, and the MHD furnished the company with the bridge alignment, subsurface investigations, grade profile, geometrics, and field surveys.[38] Ellerbe and Company submitted an advanced preliminary design study in January 1962.[39] Elza Loyd (E. L.) Gardner, Chief Structural Engineer for Ellerbe and Company, signed the plans for the Lafayette Bridge and corresponded with MHD officials.[40]

Company History

Ellerbe and Company began as Ellerbe Architects in 1909, when it was founded by Franklin Ellerbe. The company quickly became known for their early work in designing buildings for the Mayo Clinic in Rochester, Minnesota, and the Minnesota Mining and Manufacturing Company (3M) in St. Paul. Upon Franklin Ellerbe's death in 1921, his son, Thomas Ellerbe, took control of the company and led a company expansion that resulted in the largest architectural practice in Minnesota. The firm specialized in the design of medical facilities, educational, industrial, and commercial structures. Among them are the Plummer Building of the Mayo Clinic (1922-1928); St. Paul City Hall and Ramsey County Court House (1931-1932); Cardozo Building (St. Paul) (1931); College of St. Thomas (St. Paul) (1928-1946); the Northwest Airlines hanger at Holman Field (St. Paul) (1942-1943); Cleveland (OH) Clinic and Hospital

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[36] Mead & Hunt, Inc., *Minnesota Bridges, 1956-1970: Politics, Policies, Technology, and Design*, 40; Donald Flemming, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc., Transcript, Minnesota Department of Transportation Bridge Office, Oakdale, Minnesota, January 8, 2009.

[37] LaBonte, "Chronological Report of Progress on This Bridge Project," n.p.; W. W. Fryhofer, "Letter to Mr. James C. Marshall, Commissioner of Highways, Department of Highways," 16 May 1961, n.p.

[38] LaBonte, "Chronological Report of Progress on This Bridge Project," n.p.; Ellerbe and Company, "Lafayette Street Bridge Over the Mississippi River Preliminary Design," 4-5. During his interview, Don Fleming questioned whether Ellerbe and Company would have had the engineering capability to complete the computations for the bridge's main spans. While there is no proof that Ellerbe and Company did not complete the computations, it is possible that MHD or other engineers supplied Ellerbe and Company with additional design assistance.

[39] LaBonte, "Chronological Report of Progress on This Bridge Project," n.p.; E. L. Gardner, "Letter to Mr. J. H. Swanberg, Chief Engineer, State of Minnesota, Department of Highways," 20 February 1961, n.p.

[40] Little is known about E. L. Gardner other than he became a member of the American Society of Civil Engineers (ASCE) in 1951 and a fellow of ASCE in 1959. American Society of Civil Engineers, *Directory* (New York, N. Y.: American Society of Civil Engineers, July 1968), 288.

(1922); Mayo Clinic Diagnostic Building (1953-1969); and Sacred Heart Church (St. Paul) (1949). The company continued to excel as a design firm in the latter half of the twentieth century and merged with the larger firm of Welton Beckett in the 1980s. The firm is still active in architectural projects worldwide and is headquartered in Minneapolis.[41]

Construction of the Lafayette Bridge (1961-1968)

Despite heavy pressure from city interests, the construction timeline for the bridge consistently lagged behind initial estimates of three to five years total construction time. While funding was often mentioned as a reason for delays, the complexity of the project likely contributed, as well.[42] The first contract for the Lafayette Bridge was let in June 1961 for Mississippi River borings. Drilling in the river began in September 1961, and the borings were completed on October 21, 1961.[43] The MHD awarded the contract for the river piers to the Industrial Construction Company of Minneapolis in September 1962. By September 1963 the river piers and the main pier on the south bank were complete, and construction of more than 20 land piers and abutments began. At this time, the construction schedule anticipated completion of the remaining piers by 1965 and erection of the superstructure units and concrete deck by 1966, enabling a fall 1966 bridge opening.[44]

The projected schedule quickly derailed as the project lagged nearly a year behind initial estimates. Rather than the erection of the superstructure during 1966, the project had only progressed to engineering measurements being taken for the prefabricated steel work for the superstructure. In January 1966 the MHD awarded the contract for the superstructure and drainage system to the St. Paul Foundry & Manufacturing Company of St. Paul and the Pittsburgh-Des Moines Steel Company of Des Moines, Iowa, in a joint bid. The St. Paul Foundry would provide steel for the north approach of the bridge, while the Pittsburgh-Des Moines Steel Company would provide steel for the bridge's south approach and river spans. However, in March 1967 the construction timeline was further delayed three weeks by a fire at the St. Paul Foundry. The prefabricated steel units began arriving at the bridge site in April 1967, and the Beasley Construction Company of Dallas, Texas, erected the 4,313 tons of steel by lifting the girders into position with cranes anchored on barges in the river. By January 1968 the steel girders were in place and subcontractors Giertsen Construction Company of Minneapolis began pouring the bridge's concrete deck.

The Lafayette Bridge opened to the public after a dedication ceremony on November 13, 1968, at a cost of $5.5 million. The structure, which joined St. Paul with South St. Paul and West St. Paul, was publically

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[41]Northwest Architectural Archives Manuscripts Division, "Thomas Ellerbe Papers," University of Minnesota, <http://special.lib.umn.edu/findaid/xml/naa004A.xml> (accessed 16 March 2009); "Ellerbe Becket," Funding Universe, <http://www.fundinguniverse.com/company-histories/Ellerbe-Becket-Company-History.html> (accessed 16 March 2009).

[42] W. C. Nitardy, "Letter to District Engineer, U.S. Army Corps of Engineers," 4 April 1966, n.p.

[43] LaBonte, "Chronological Report of Progress on This Bridge Project," n.p.

[44] "Contracts Awarded for Lafayette Bridge Piers, Marshall Letter Says," *St. Paul Dispatch*, 7 November 1962, n.p.; James C. Marshall, "Letter to Industrial Construction Company," 20 September 1962, n.p.; "Work Advances on River Bridges," *St. Paul Dispatch*, 27 September 1963, n.p.; LaBonte, "Chronological Report of Progress on This Bridge Project," n.p.

touted as an important state and regional motor link, providing access to I-94, I-35, and I-494. Additionally, the Lafayette Bridge measured as the second longest bridge in Minnesota at 3,366 feet, and contained the largest single plate girders in the state, measuring 200 tons each.[45]

Just as the design of the Lafayette Bridge had been marked by years of negotiations and compromises between various transportation facets, the construction of the bridge required deftly navigating the existing transportation infrastructure. For instance, the construction of land piers between existing railroad infrastructure required that material delivery and construction activities be carefully timed in order to eliminate interference with railroad traffic. Additionally, the Corps mediated construction efforts by notifying river navigation interests of superstructure construction and narrowed horizontal clearances at the site of the bridge and urging that river vessels use extreme caution during the construction period.[46]

While the Lafayette Bridge was being planned and constructed, a second smaller associated structure (Bridge 62850) was also designed by Ellerbe and Company to carry TH 52 (Lafayette Road) over I-94. Built in 1967 according to 1963 plans, Bridge 62850 abutted the north end of the Lafayette Bridge and was erected by the Sheehy Bridge Construction Company of St. Paul with steel girder spans furnished by the St. Paul Structural Steel Company.[47]

Bridge 9800 Girder Fracture (1975)

In 1975, only seven years after completion, the Lafayette Bridge suffered a serious fracture in a main-span girder. The fracture, which nearly resulted in a catastrophe, was so unexpected and substantial that its occurrence, repair, and subsequent analysis influenced steel testing, steel toughness considerations, and welding details, nationwide.

A Bridge Emergency

On Wednesday May 7, 1975, MHD bridge inspection engineer Ron Olds noticed what appeared to be a deflection or sag of several inches in the roadway of southbound span 10, the 362-foot west main river span. He drove to Warner Road beneath the north end of the bridge and, using a pair of field glasses, spotted a crack in a girder. Unable to reach the maintenance engineer on the phone, Olds called the

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[45] John R. Jamieson, "Letter to St. Paul Foundry & Manufacturing Co. & Pittsburgh-Des Moines Steel Co.," 25 January 1966, n.p.; "Bids Received," *St. Paul Dispatch*, 14 January 1966, n.p.; "Bridge Steel Being Measured," *St. Paul Dispatch*, 21 July 1966, n.p.; "New Lafayette Bridge Platform Work to Begin," *St. Paul Pioneer Press*, 27 January 1967, n.p.; "Fire Delays Work on Lafayette Bridge But Steel Erecting Will Start April 10," *St. Paul Dispatch*, 29 March 1967, n.p.; "Lafayette Bridge Work Begins Monday," *St. Paul Dispatch*, 7 April 1967, 4; Bill Farmer, "Steel Work Starts on Lafayette Span," *St. Paul Dispatch*, 9 May 1967, 34; "$10-1/2 Million Lafayette Bridge Dedication, Opening Set Nov. 13," 27; Lewis Patterson, "Lafayette Bridge Opened," *St. Paul Pioneer Press*, 14 November 1968, 21.

[46] "$10-1/2 Million Lafayette Bridge Dedication, Opening Set Nov. 13," 27; Department of the Army, "Local Notice to Navigation Interests," 23 March 1967, n.p.

[47] Ellerbe and Company, *Construction Plan for Bridge 62850 and Misc. Grading (in St. Paul), Trunk Highway No. 94-397* (1963), n.p.; Minnesota Department of Transportation, "Construction Project Log," Minnesota Department of Transportation, <http://www.dot.state.mn.us/roadway/data/html/roadwaydata.html> (accessed 4 February 2009).

Bridge Office for the State Bridge Engineer, who was out. Don Flemming, a future state bridge engineer, happened to be in the office and took the call.[48]

Olds reported the bridge should be closed immediately. MHD engineer Ray Cekalla recalled: "I remember the response he got was, this is what I heard, 'can't we wait until rush hour traffic gets across?' And he immediately said, 'no, either get somebody over here to close it down or I'm putting my car right across there to stop,' so they did stop it right away." The southbound lanes were then closed. The northbound (east) lanes were closed two days later—May 9—after engineers became concerned that, should it fail, the west bridge would bring the east bridge down with it.[49]

Celkalla, who viewed the fracture soon after it was reported by Olds, recalled his reaction upon seeing it the first time:

> Al Holmboe (MHD bridge design engineer), he and I went out to take an actual look at it. We got on the cherry picker out on the south end, walked along the catwalk and I remember my first recollection. When you see something like that it's just unbelievable. You look at the size of the member [the girder], that flange was something like three feet wide by three inches thick, just a tremendous hunk of steel, and to see it cracked and to see the big web like that cracked, it just kind of, sort of, boggles your mind, you know, because you think anything like that, that's so large, you'd never see it—you know—crack like that, that heinous.[50]

Cekalla remembered the immediate attitude in the MHD was, "We've got ourselves a major problem on our hands here, now let's look at it and let's figure out what to do about it." Don Flemming began to assemble a team within the MHD to address the emergency, including Goodwin "Goody" Kolstad, who was in charge of the bridge maintenance crew, Holmboe, and Cekalla. Cekalla said that several senior staff were attending a national bridge conference in Minneapolis, so the Lafayette issue was left to the engineers remaining at the office.[51]

According to Flemming, "The first night we worked late in the office trying to figure out how to support the bridge and we talked about putting a bent [temporary pier] in the river. We talked about all different things..."[52] Cekalla, Holmboe, and Kolstad decided to meet the next morning and present their best ideas. Cekalla continues the story:

> So the next morning we got together in Al's office and Goody and I both had a very similar idea, which is the one we used. Al had a little different one but he kind of liked

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[48] Ray Cekalla, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc., Transcript, Phone conversation, January 23, 2009; Flemming, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.; S. S. Yuzna, "Lafayette Bridge Girder Failure," [June 1975], n.p.

[49] Cekalla, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.; Yuzna, "Lafayette Bridge Girder Failure," n.p.

[50] Cekalla, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

[51] Cekalla, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

[52] Flemming, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

ours better. At that time, you know, it was just a concept, all we're talking about it, you know, we've got the northbound bridge there with two good girders, this is in between so let's just kind of use that to kind of hold the bad girder up and put some beams across and put a sling down and then jack it up. And at that time it was just a rough, you might say, rough concept. We did it on scratch paper, you know, this is how we could do it and then we broke for lunch. I remember getting back from lunch and Al said Goody found some beams--they're on their way. And I remember it kind of shook me up quite a bit because at that time, you know, it wasn't anything that was, anybody had given a whole lot of thought to it was just kind of, like I said, a concept, and here they were going to go through and build it.[53]

On May 8 the MHD Assistant Commissioner of Engineering Services notified R. L. Brubacher, Commissioner of Administration, that Emergency Order No. 81 had been issued covering repair work for the bridge. The purpose, as announced to the Highway Division, "is to allow you to start work immediately without the necessity of advertising or calling for bids to rent additional equipment, purchase supplies or services."[54]

By the time the stabilization was underway, the bridge was completely closed, including both northbound and southbound lanes.[55] The press had no reports of public concern. Without additional comment, the *Minneapolis Tribune* matter-of-factly quoted an unnamed official that the crack was "large enough to put your arm into."[56] If anything, the public's concern focused on traffic congestion because of the closed lanes and waste of electricity because the "bridge has been illuminated every night since May 9." The MHD responded that they were concerned about vandalism, stating that vandals stole or damaged $800 worth of equipment in the first two days the bridge was closed.[57] "I don't think the public realized, you know, quite how serious this was," Cekalla said. "And within the department, yeah, there was a lot of concern about it...it definitely left a lasting impression on anybody who saw it." Flemming recalled, "I think we all felt a lot more relieved once we had . . . the thing cabled."[58]

The Fracture and the Repair

The fracture, occasionally termed the "rupture," was located in the east (interior) girder (Girder C) of span 10 of the west (southbound) bridge.[59] The fracture was 118 feet and 8 inches south of the Pier 10

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[53] Cekalla, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

[54] E. J. Heinen, "Memo to R. L. Brubacher, Commissioner of Administration: Emergency Order No. 81," 8 May 1975, n.p.

[55] "Lafayette Bridge Closed to Traffic," *St. Paul Pioneer Press*, 10 May 1975, n.p.

[56] "Lafayette Bridge is Closed Because of Cracked Beam," *Minneapolis Tribune*, 10 May 1975, 5B.

[57] "Faulty Bridge Beam Section to be Tested," *St. Paul Dispatch*, 20 May 1975, 22; "Photo and Caption," *St. Paul Pioneer Press*, 28 May 1975, 20.

[58] Cekalla, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.; Flemming, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

[59] In some drawings or sketches found in the MHD files, this is identified as Girder "C," with the girders lettered from "A" (east) to "D" (west) across both bridges. This lettering scheme is used where appropriate in this narrative.

centerline, at approximately the one-third point in the girder's 320-foot length. Span 10 is the center of three main river spans and the longest span in the bridge.[60]

An internal MHD report described the fracture:

> At its uppermost extremity the fracture starts 7 1/2" from the bottom of the top flange, 3'-4" horizontally south of the stiffener and cross frame. It angles downward diagonally at about 30° from the vertical to a longitudinal stiffener, a distance of 2 feet. Then continues downward at about 15° from the vertical to a gusset plate which connects the lower cross frame strut and lateral bracing to a stiffener to the web...The fracture then proceeds vertically the remaining 6" below the gusset and through the 36" x 1 ½" flange. A horizontal extension of the crack goes through a transverse weld joining the gusset to the stiffener at right angle to the web...Loss of section at the crack caused the longer south portion of the girder to sag, opening the crack to a 1" gap and causing a buckle to develop in the web at the upper extremity of the fracture. Additionally a slight buckling of ¼" developed in the top flange.[61]

To immediately halt the progression of the fracture upward into the top flange, a large hole was drilled at the extremity of the crack "to distribute stresses." At that point, the remaining portion of the girder "consisted of only 7 ½" of web, the top flange and the deck, which was not designed to be composite with the girder."[62]

The emergency team of Cekalla, Holmboe, and Kolstad then worked to stabilize the girder itself. They needed to remove the load from the fractured girder to prevent the collapse of the west span and possibly the adjacent east span if the west bridge rolled into it, as Flemming feared. The solution included placing a series of five beams above the deck, extending across the roadways from Girder B (the east interior girder), over fractured Girder C, to Girder D (the west exterior or fascia girder). Jacks were placed beneath the beam ends, directly above Girders B and D. One beam was placed north of the fracture and four beams were placed south of the fracture, above the long portion of the fractured girder. Holes were cut in the deck below the beams to provide access to fractured Girder C. Then cables were extended down from the beams and pulled around the sections of the fractured girder, creating a series of slings. The jacks over Girder D served as leveling jacks. The jacks at the other end, above Girder B, were used to lift the beams and their cable slings, hoisting the fractured ends of Girder C up into their original position to be spliced together in a repair.[63] Records in the project file indicate that a great deal of effort went into the jacking design and technique. MHD computers, with the then-available punch-card system, were used to calculate the effects of the jacking. The jacking was completed on May 21.[64]

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[60] John W. Fisher, Alan W. Pense, and Richard Roberts, "Evaluation of Fracture of Lafayette Street Bridge," *Journal of the Structural Division Proceedings of the American Society of Civil Engineers* (July 1977): 1339-1340.

[61] Yuzna, "Lafayette Bridge Girder Failure," 4.

[62] Yuzna, "Lafayette Bridge Girder Failure," 6.

[63] Minnesota Department of Highways, "Girder Deflections During Jacking at Rupture Station," 23 May 1975, n.p. This pencil drawing signed by JAZ has plan & elevation drawings identifying locations of beams, girders, and jacks.

[64] Flemming, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.; Yuzna, "Lafayette Bridge Girder Failure," 4-5.

After the ends of the girder were in position, the team could begin the repair process. During the jacking, other team members prepared the repair plans. First, they measured and plotted out the fracture itself. According to Cekalla, "...I remember it was a brand new person that was doing his first drafting. I remember that. His first day and I said, boy I sure hope he does this right because everything is based on that crack being plotted right." Cekalla himself then designed the repair, incorporating two immense splice plates, one for each side of the fractured web. Each plate was to be 11 feet, 2 inches by 5 feet, 5 inches and 3/8 of an inch thick, weighing an estimated 1,851 pounds, or almost a ton. The plans specified several additional smaller plates and a large quantity of high-strength bolts.[65] Flemming later recalled that "Al Holmboe thought of Ray as his best designer, so I think Ray and Al were kind of some of the masterminds behind what you do next."[66]

Cekalla took his drawings to local steel fabricators "to see who's interested" and the St. Paul firm of Paper Calmenson took the job.[67] The huge plates were trucked out to the bridge and lowered through a hole cut in the deck to the fracture location. Flemming described the installation of the splice plates:

> We over-jacked it, we brought out the big splice cleats, and we put the plates on and we drilled. It was a magnetic drill, locked on, and drilled all those holes in the thing and bolted it up and then we let it go and it came down and she still sagged a little bit. Then I went out there and we put strain gauges on. We were trying to figure what kind of load we really had in the thing. So we put strain gauges on, and then at four in the morning we ran loaded trucks, and Dobie Gillis and I sat on the bottom down there [on the catwalk] near the bottom flange and watched the strain gauges. We got a fairly good load distribution, good enough that we felt that we were okay. So then that gave us some confidence that we had really spliced it, so it was quite a feat.[68]

Crews released all of the jacking loads about June 2 and the northbound roadway was reopened to traffic on June 5.[69] By June 17, the repair area was cleared and the access opening in the deck was repaired. Then on June 20, as the MHD prepared to reopen the southbound lanes, a team of FHWA bridge engineers inspecting the fracture site found a second and much smaller crack in the same girder. The new discovery, located one floor-beam north of the original fracture, delayed the opening of the southbound lanes. Following the additional repair, the southbound lanes were reopened on June 30.[70]

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[65] Minnesota Department of Highways, "[Repair Drawings]," 15 May 1975, n.p.

[66] Cekalla, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.; Flemming, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

[67] Cekalla, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

[68] Flemming, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

[69] "Photo and Caption," *St. Paul Dispatch*, 6 June 1975, 17.

[70] Yuzna, "Lafayette Bridge Girder Failure," 8; "Lafayette Bridge Open," *Minneapolis Tribune*, 4 July 1975, 5C; R. E. Lundstrom, "Memo to K. V. Benthin, Bridge Engineer," 23 May 1975, n.p.; A. E. Holmboe, "Memo to K. V. Benthin, Bridge Engineer," 14 May 1976, n.p.; Fisher, John W., Alan W. Pense, and Richard Roberts, "Investigation and Analysis of the Fractured Girder in Bridge No. 9800, T.H. No. 56 Over Mississippi River in St. Paul, Minnesota," October 1975, 2.

The splice repair designed by Cekalla and implemented by the MHD crew was designed to reconnect the severely fractured girder, preventing a catastrophic collapse, and keep the bridge in service. Additional investigations and evaluations were required to understand the cause of the fracture and the techniques necessary to stop small cracks in steel from propagating into substantial fractures that threatened entire girders and structures. The investigation into the fracture would have serious ramifications in bridge engineering and steel testing.

Inspection and Analysis

From the time of first discovery, the bridge and particularly the fracture location were the subject of intense investigation and analysis.[71] Many engineering specialists participated, along with representatives of the MHD, FHWA, and the steel industry. Every professional understood immediately that the fracture was extremely serious, the situation potentially catastrophic, and that a thorough understanding of the cause was needed to detect and prevent similar events.

Within the first month or two of the fracture discovery, the following individuals or agencies visited the bridge and investigated the fracture: MHD Structural Metals Section (ultrasonic testing); Charles F. Galambos, FHWA Structures and Applied Mechanics Division, Washington, D.C. office; the FHWA Office of Research and Materials and Methods Group; the American Institute of Steel Construction (AISC); Pittsburgh-Des Moines Steel Company; Maxson Corporation; U.S. Steel Corporation; and Professor John Fisher of Lehigh University, a noted authority on steel fatigue issues.[72]

The ramifications of the Lafayette Bridge fracture reverberated throughout the engineering and steel industries, beginning with the intense interest shown by these visitors to the site. As early as June 20, 1975, J.A. Gilligan, manager of Special Technical Service–Metallurgy at US Steel, wrote to Keith Benthin, State Bridge Engineer, with "comments and suggestions" regarding an investigation that the MHD was commissioning. Benthin engaged Fisher to conduct the investigation (discussed below), which was ongoing while others weighed in on the incident. At about the same time, S.S. Yuzna, FHWA Division Bridge Engineer in St. Paul, prepared a narrative account of the incident through June and offered his own list of "contributing factors to the failure of the girder and to the cracks in the welds....' In December 1975, C.J. Champion, FHWA engineer, placed a memo in the MHD Project File for the Lafayette Bridge, stating that "We have had a great deal of discussion of the Lafayette Bridge failure...." Focusing on "a disturbing stress level in the gusset plate," Champion urged that the MHD review similar details that exist in "a great many of our existing structures" and that revisions be made. He further urged "the detailing of this connection for future structures...."[73]

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[71] Two additional areas of research emerged from the interviews. Don Flemming, in his oral history interview, said that "there was some discussion about suing the contractor." Ray Cekalla, in his oral history interview, said that there was a legislative hearing on the incident, perhaps two months after it happened. No additional information was discovered about either situation.

[72] Yuzna, "Lafayette Bridge Girder Failure," 7.

[73] J. A. Gilligan, "Letter to Mr. K. V. Benthin, Bridge Engineer, Department of Highways, State of Minnesota," 20 June 1975, n.p.; Yuzna, "Lafayette Bridge Girder Failure," 9; C. J. Champion, "Commentary: Lafayette Bridge Diagonal," 30 December 1975, n.p.

The Lafayette incident was on the minds of those attending a January 1976 "combined meeting" of the American Association of State Highway and Transportation Officials (AASHTO), FHWA, AISC, and American Iron and Steel Institute (AISI) in Washington, D.C., to discuss "Fracture and Welding of Bridge Steels." Carl E. Hartbower of the FHWA Bridge Division, who would subsequently submit a written critique of the Fisher investigation, prepared a detailed meeting "commentary on what was and what was not accomplished" in terms of specifications for non-redundant bridge members, noting that "the recent failure of the Lafayette Street Bridge in St. Paul points up the urgency of the problem." "Recently," he wrote, "Lehigh researchers (Fisher and colleagues) investigated the cause of the Lafayette Street bridge failure. . . . Unfortunately, little was said at the meeting about this bridge failure because the Chairman felt the subject inappropriate for discussion." Hartbower included several Fisher report items in his comments on the meeting.[74]

The Fisher Investigation and Report

Dr. John W. Fisher at Lehigh University in Bethlehem, Pennsylvania, the most prominent of the investigators, produced the major report on the incident. Fisher received his Ph.D. in civil engineering from Lehigh in 1964 and by 1975 he was Professor of Civil Engineering and Director of the Fritz Engineering Laboratory at Lehigh. In December 1974, about six months prior to the fracture, Fisher co-authored "Improving Fatigue Strength and Repairing Fatigue Damage," a Fritz Engineering Laboratory Report.[75] He also authored the AISC's "Guide to 1974 AASHTO Fatigue Specifications."[76] In later years Fisher was widely recognized and honored for his professional achievements by major national and international engineering organizations.[77]

Fisher first visited the bridge and inspected the fracture on May 18, soon after the fracture's discovery. On May 23, as a principal of Fisher, Fang, and Associates, Engineering Consultants, Bethlehem, Pennsylvania, he submitted a proposal for tests, studies, and a report to Keith Benthin, MHD Bridge Engineer. Fisher proposed a partnership with Dr. Alan W. Pense, a Professor of Metallurgy and Materials Science at Lehigh and one of Fisher's co-authors in the 1974 Fritz Lab report. For $5,000, Fisher and Pense would conduct material tests of the girder web, flange, and gusset, including many Charpy V-Notch tests for steel toughness[78], and the utilization of an electron microscope. Fisher's proposal stated

[74] L. A. Herr, "Memo to Members of AASHTO Operating Subcommittee on Bridges and Structures and FHWA Bridge Engineers," 15 April 1976, n.p. See Hartbower's "Report of Joint Meeting," p. 2, 4, & 10, as attachment to memo.

[75] A. P. Fisher, "Letter to Clayton Anderson (St. Paul Foundry and Manufacturing Co.)," 21 March 1967, n.p.; John W. Fisher, Michael D. Sullivan, and Alan W. Pense, *Improving Fatigue Strength and Repairing Fatigue Damage* (Bethlehem, Pa.: Fritz Engineering Laboratory, Lehigh University, December 1974), n.p. A copy of the 1974 report with the names of C. Galambos and Sy Yuzna penciled on the cover was found in the Bridge 9800 Project Records. C. Galambos was Charles F. Galambos and Sy Yuzna was Sylvester S. Yuzna. Both were engineers for FHWA.

[76] J. W. Fisher, *Guide to 1974 AASHTO Fatigue Specifications* (Detroit, Mich.: American Institute for Steel Construction, 1974), n.p.

[77] "Lehigh University - CEE: John W. Fisher," Lehigh University, <http://www3.lehigh.edu/engineering/cee/contacts/fisher.asp> (accessed 1 April 2009).

[78] The Charpy V-Notch test, or Charpy impact test, was named for its developer, the French scientist Georges Charpy. The test measures the toughness of steel, particularly in relationship to temperature.

"Our report will provide an interpretation of the test results, an analysis of the cause of the fractured girder, an extrapolation of the results and analysis to other comparable details in the structure, and recommendations for corrective action if any is needed for these other details."[79]

Before the fracture repair began, and following Fisher's recommendations, MHD personnel removed sections of the girder for testing, including parts of the web, part of the gusset and stiffener at the fractured weld point, and a section of the web at the extremity of the crack. The Twin Cities Testing Company conducted Charpy V-Notch tests, and close-up laboratory photographs were taken of the fracture faces, which had been removed. All the materials were shipped to Lehigh University for Fisher's investigation.[80]

A 22-page report, co-authored by Fisher, Pense, and Prof. Richard Roberts (also at Lehigh), was submitted in October 1975 to the MHD Office of Bridges and Structures as "Investigation and Analysis of the Fractured Girder in Bridge 9800, T.H. No. 56 over Mississippi River in St. Paul, Minnesota." In the report the authors summarized the findings of their investigation:

> The fracture of a main girder of the Lafayette Street Bridge was due to the formation of a fatigue crack in the lateral bracing gusset to transverse stiffener weld. This fatigue crack originated from a large lack of fusion region which existed near the back-up bars. At the failure gusset, this groove weld intersected the transverse stiffener-web weld and hence provided a direct path for the fatigue crack to follow into the girder web.
>
> After the fatigue crack had nearly propagated through the girder web, it precipitated a brittle fracture of part of the web and all of the tension flange. Complete fracture was arrested by the tie plate which bridged the crack. Subsequent cyclic load permitted further fatigue crack growth over a limited time interval which eventually resulted in substantial extension of the web crack.[81]

The report presented two methods—a preferred method and an alternate method—for treating the situation and preventing crack propagation, should it be found in other gusset-transverse stiffener welds in the bridge. The methods involved either removing or isolating areas of fatigue cracking by drilling and cutting the steel. The report concluded: "When the corrective action outlined above is completed, there should be no cause for concern with the bridge structure."[82]

The Fisher report, also known as the "Lehigh University Report," was provided to the FHWA Washington Office Bridge Division and, on April 6, 1976, the FHWA St. Paul office returned a review by Carl E. Hartbower, FHWA Bridge Division. Hartbower's 28-page highly technical critique focused on "several unanswered questions that may be important from the standpoint of understanding why the failure

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[79] Yuzna, "Lafayette Bridge Girder Failure," 7; John W. Fisher, "Letter to Mr. Keith V. Benthin, Bridge Engineer," 23 May 1975, n.p.

[80] Yuzna, "Lafayette Bridge Girder Failure," 7-8.

[81] Fisher, Pense, and Roberts, "Investigation and Analysis of the Fractured Girder in Bridge No. 9800, T.H. No. 56 Over Mississippi River in St. Paul, Minnesota," 20. The report also included 40 figures.

[82] Fisher, Pense, and Roberts, "Investigation and Analysis of the Fractured Girder in Bridge No. 9800, T.H. No. 56 Over Mississippi River in St. Paul, Minnesota," 22.

occurred and how to avoid similar occurrences in existing and future bridges." An unsigned and undated two-page response, raising issues with Hartbower's own analysis, was found in the Bridge 9800 Project Records. Nothing was heard from Fisher for several months.[83]

On August 30, 1976, Fisher wrote Benthin at the MHD that he had prepared a draft of his team's report for publication in the ASCE *Journal of the Structural Division*. Fisher said the new draft responded, in part, to Hartbower's comments and that publication would provide a forum and "permit Mr. Hartbower to prepare a discussion, if he desires," taking advantage of the *Journal*'s published discussion format. In the same letter Fisher added a point-by-point response to Hartbower, concluding that "We would certainly have no objection to doing further studies, however, we do not believe that they will change any of the conclusions that were reached."[84] This appears to be the end of the exchange between Fisher and Hartbower. Fisher's article was published in the July 1977 issue of the *Journal*, where it was expanded and heavily illustrated. He acknowledged the assistance of Benthin and his staff, but did not mention Hartbower.

In 1984 Fisher again addressed the Lafayette Bridge fracture as a chapter in his volume *Fatigue and Fracture in Steel Bridges: Case Studies* (John Wiley & Sons). He placed the Lafayette situation in a North American context:

> Since 1967 a number of highway and railroad bridge structures in the United States and Canada have experienced fatigue cracking which sometimes resulted in brittle fracture as a result of service loading. This book provides a detailed review and summary of 22 case studies of bridges that have experienced crack growth.
>
> ...All of the causes of cracking discussed in this book can be prevented with the engineering knowledge and other tools available today. The lessons learned from the past should assist with an understanding of the behavior of structures and the importance of detail and execution.[85]

Fisher included Lafayette as an example of cracking in the web at lateral connection plates because of intersecting welds: "One of the first bridge structures to exhibit this cracking was the Lafayette Street Bridge over the Mississippi River in St. Paul, Minnesota."[86] He presented a conclusion similar to the one provided in the original 1975 report to MHD:

> The fracture of the 'east' main girder of the southbound lane of the Lafayette Street Bridge was due to the formation of a fatigue crack in the lateral bracing gusset plate to the transverse stiffener weld and web plate. This fatigue crack originated from a

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[83] Carl E. Hartbower, "Review of the Lehigh University Report: "Investigation and Analysis of the Fractured Girder in Bridge 9800 T.H. No. 56 Over the Mississippi River in St. Paul, Minnesota"," [1976], 1, 26; "Hartbower Critique on Lafayette Bridge Report," n.d., n.p.

[84] John W. Fisher, "Letter to Mr. Keith V. Benthin, Bridge Engineer, Office of Bridges and Structures," 30 August 1976, n.p.

[85] John W. Fisher, *Fatigue and Fracture in Steel Bridges: Case Studies* (New York, N.Y.: John Wiley & Sons, 1984), vii.

[86] Fisher, *Fatigue and Fracture in Steel Bridges: Case Studies*, 61.

> significant lack of fusion defect. At the failure cross section the partial penetration groove weld intersected the transverse stiffener-web weld and thus provided a direct path for the fatigue crack to penetrate into the web. Eventually, the fatigue crack precipitated a brittle fracture in part of the web and fractured the tension flange.[87]

Fisher added the same information about treating other discontinuities due to lack of fusion. He described the "scheme used to retrofit the structure," using liquid penetrant to observe any crack indication, followed by the cutting of slotted holes into the web to remove the crack and rechecking with the penetrant "to ensure that a web crack did not extend beyond the hole." This retrofit technique represents one of the two treatments identified in the 1975 report.[88]

Fisher's analysis and illustrations appeared in abbreviated form in 1986 in *Metals Handbook*, 9th edition, vol. 11, *Failure Analysis and Prevention*, indicating the extent that the Lafayette Bridge fracture had become part of the permanent literature on the subject. Published by the American Society for Metals, the *Metals Handbook*, or *ASM Handbook*, is a standard reference work for engineers, particularly metallurgical engineers.[89]

The Long-Term Effect of the Lafayette Fracture Event

In a recent interview, Flemming commented on the immediate and long-term effects of Fisher's involvement. The 1975 Fisher report recommended two treatment methods, including the use of holes carefully drilled at a fracture location to deal with fatigue cracking. Following the report, Flemming recalled, "we started drilling all these holes out there [on the Lafayette Bridge]. We drilled hundreds of holes, and we bored . . . on a 45-degree angle through there, took that weld out. And used up many, many hole saws out there trying to get those weld connection points cleaned out."[90]

Then, Flemming and others looked at other bridges on the MHD system: "[The report] opened our eyes to the whole problem of fatigue cracking really fast," he said. "We went on a major witch hunt then and we found a crack running in the Dresbach Bridge then within a short time." The crack was two feet long, Flemming recalled, and was large enough to require a splice repair like Cekalla had designed for the Lafayette bridge, rather than a Fisher-recommended hole-drilling treatment to stop its propagation. The Dresbach Bridge is a large Interstate bridge across the Mississippi that connects Minnesota with Wisconsin, thus involving engineers from both states. Flemming said that he and Holmboe "met with the Wisconsin guys and they hadn't experienced anything like this yet and their thought was they could take a welder and weld that crack shut." Flemming and Holmboe convinced them to use a bolted splice instead, using Cekalla's Lafayette repair method. Flemming noted that the MHD continued to employ Fisher to examine other large bridges—the Dresbach Bridge, the Lexington Avenue Bridge in St. Paul, and the Hudson Bridge, another Interstate bridge connecting Minnesota and Wisconsin.[91]

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[87] Fisher, *Fatigue and Fracture in Steel Bridges: Case Studies*, 74.

[88] Fisher, *Fatigue and Fracture in Steel Bridges: Case Studies*, 75-76.

[89] American Society for Metals, *Metals Handbook*, 9th ed., vol. 11, *Failure Analysis and Prevention* (Metals Park, Ohio: American Society for Metals, 1986), n.p.

[90] Flemming, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

[91] Flemming, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

According to Flemming, the Lafayette fracture incident had additional repercussions in the bridge engineering profession, notably in areas of steel testing (the Charpy V-Notch test), steel toughness, and welding details. Flemming recalled:

- Steel specifications: "Suddenly, you know, AASHTO is really excited about changing steel specs…."

- The Charpy V-Notch: "The whole thing on Charpy V-notch came about with this kind of thing, so before that we didn't even know hardly what Charpy V-notch was.'

- Welding: "The welding specifications changed quite dramatically and you started paying an awful lot of attention to your, you know, you didn't weld things into corners, you left gaps. . . . the whole deal about how you fasten all of this together, that all changed."

Flemming concluded, "So all those details changed, really. I think this was a major, major milestone."[92]

Flemming said the MHD originally selected Fisher for the Lafayette investigation and analysis because of his "stature in the whole metallurgy area." In the end, Fisher's analysis and publications about Lafayette amounted to a turning point in Fisher's professional career, as well as being a boost for Lehigh University. "I think it really boosted them to national reputation," Flemming said. "I think this really made John's career."[93]

Cekalla's original splice repair to the 1975 fracture, together with the extensive use of Fisher's recommended treatment for preventing fatigue-crack propagation, allowed the Lafayette Bridge to continue in vehicular service for an additional 30-plus years.

Recent History (1976-present)

In 1981 the Lafayette Bridge underwent a $3.4 million rehabilitation, which included repair and installation of deck overlay, deck widening, and replacement of median guardrails and bridge railings with maintenance-free, Jersey-style concrete barriers.[94] The MHD completed additional deck maintenance and repairs in 1992 and 2005.[95] Bridge 62850, which abutted the Lafayette Bridge's north end, was replaced in 1992 with a new structure (Bridge 62881).

On August 1, 2007, the bridge carrying Interstate 35W (I-35W) over the Mississippi River in Minneapolis collapsed, killing 13 people and injuring more than 100. While investigations into the collapse concluded that thin gusset plates were largely to blame for the collapse, the event called attention to design weaknesses in many of Minnesota's bridges, including the Lafayette Bridge. In 2007 it was estimated

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[92] Flemming, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

[93] Flemming, Interview by Bob Frame and John Rathke of Mead & Hunt, Inc.

[94] Sean T. Kelly, "City Bridge Block Snags A.M. Traffic," *St. Paul Dispatch,* 19 May 1980, 3B; Minnesota Department of Transportation, "Construction Project Log," Minnesota Department of Transportation.

[95] Minnesota Department of Transportation, "Construction Project Log," Minnesota Department of Transportation.

that over 200 bridges in Minnesota lacked structural redundancy. The I-35W Bridge, Lafayette Bridge, and many others in the state were considered "fracture critical," which meant they have at least one steel component under tension whose failure could mean collapse. A 2006 inspection of the Lafayette Bridge had also found numerous areas of concern, including loose or broken lateral bracing hanger bars and loose concrete pieces that had been, and were in danger of, falling.[96] While plans were already underway to replace the Lafayette Bridge by 2014 because of these reasons, the I-35W collapse hastened the process for the bridge, which, since the I-35W collapse, has been the most traveled bridge in the state with 81,000 vehicles per day.[97]

PART II. HISTORICAL INFORMATION

A: Physical History

Date of Construction:
September 1961 – November 1968

Designer (if known):
Ellerbe and Company, St. Paul, Minnesota
E. L. Gardner, Engineer

Builder, contractor, suppliers:

- Builder: John F. Beasley Construction Co. (superstructure steel erection), Walter D. Giertsen Construction Co. (concrete deck)

- Fabricators: Industrial Construction Co. (river piers), St. Paul Foundry and Manufacturing Co. (superstructure steel for north spans) and Pittsburgh-Des Moines Steel Co. (superstructure steel for south and river spans)

Original Owner:
Minnesota Department of Highways (MHD)

Original plans and construction:
Selected original hard-copy plan sheets prepared by Ellerbe and Company are in the Minnesota Historical Society State Archives. Digitally scanned copies of microfilmed original plans and plans for repairs and alterations are available from Mn/DOT by special permission. Original repair plans for the 1975 fracture are in Bridge 9800 Project Records, Minnesota Department of Transportation, St. Paul, Minnesota.

Alterations:

- Open railings and median barrier were replaced in 1980
- Original light standards were replaced in 1980

[96] Pam Louwagie and James Walsh, "I-35W Bridge Collapse: The Aftermath," *Star Tribune*, 8 August 2007, A6.

[97] Louwagie and Walsh, "I-35W Bridge Collapse: The Aftermath," A6.

- Spans 18 through 29 were widened and piers extended to the west in 1981 and to the east in 1991
- A new off-ramp was added adjacent to Piers 23 through 28 in 1991

B: Historic Context
Minnesota Bridges 1956-1970

C: National Register Criterion
Criterion C: Engineering

PART III. DESCRIPTIVE INFORMATION

Bridge 9800
Bridge 9800, also known as the Lafayette Bridge, is aligned on a northwest-southeast axis (nominally north-south for descriptive purposes in this MHPR) to carry four lanes of TH 52 across the Mississippi River, city streets, a barge terminal, parking lots, and railroad tracks, connecting downtown St. Paul and the city's west side. The bridge consists of two structurally independent superstructures separated by a split median barrier and resting on common piers and abutments. The superstructure type is a continuous steel deck girder with 29 spans, numbered 1 through 29 from south to north, including three main river girder-with-floor beam system spans, eight south steel multibeam approach spans, and 18 north steel multibeam approach spans. The continuous structure has nine hinges, located in spans 1, 5, 8, 12, 13, 17, 20, 24, and 29 to connect the spans. The hinges in spans 8 and 12 connect the large river girders with the multibeam approach spans.

The overall structure length is 3,366 feet and the combined typical out-to-out width of the bridge deck is 67.4 feet with a 30.7-foot-wide roadway with two traffic lanes. A three-foot median separates the northbound and southbound lanes. The vertical clearance between the bottom of the girders of span 10 for the navigation channel between piers 9 and 10 is 51.3 feet.[98] Additional detailed information regarding span length, depth, and type is included in the table at the end of this section.

Spans 9, 10, and 11, the main river spans, consist of two adjacent, non-redundant, girder-with-floor-system structures, one northbound (east) and one southbound (west). River navigation traffic passes beneath span 10. The variable-depth, welded steel plate girders are continuous over the four river piers and have 40-foot cantilever arms at each end where they connect with the approach spans. The girders have a maximum depth of 14 feet, 4 inches over piers 9 and 10, with a depth of 5 feet, 8 inches at the hinge connections. The two-girder system of each structure has cross-bracing panels bolted to the bottom flange below the deck stringers. Welded vertical and horizontal stiffeners add additional strength to the girders. Located on the inner girder of the southbound (west) structure in span 10, about 120 feet south of pier 10, is the 1975 fracture repair with two large, bolted steel plates.[99] A catwalk with open

[98] The vertical clearance measurement is indicated to the two-percent navigation level on plan sheet 1, State Project No. 6244-9800E.

[99] Further information regarding the fracture and its repair can be found in the Significance Statement section of Part 1. Property Identification and General Information of this Minnesota Historic Property Record.

metal floor grating was constructed in the eight-foot-wide area down the center of the two structures between piers 8 and 11 to provide access for inspections. A 24-inch water main is carried on the catwalk support between piers 8 and 11. Temporary plywood and timber bracing has been placed under the deck in span 11 to capture spalling concrete.

Spans 1 through 8 and 12 through 23 include two adjacent continuous multi-girder structures utilizing welded steel plate girders. Spans 24 through 29 include two adjacent continuous multi-girder spans utilizing rolled steel beams with welded cover plates for the original configuration, and welded steel plate girders added during the subsequent bridge widening.

Three types of steel are used in the superstructure: Steel Grade A441 for the river spans, Steel Grade A36 for the approach spans, and Steel Grade A242 for areas in the approach spans where the top flanges of the beams are in tension. All structural steel was originally painted with a shop coat, followed by two field coats of aluminum. In 1987 the superstructure was repainted.

The substructure consists of north and south abutments, river piers (piers 8, 9, 10, and 11), and land piers (piers 1-7 and 12-28). Each pier and abutment supports both the northbound (east) and southbound (west) structures. The river piers are solid reinforced-concrete, single-shaft hammerhead piers with reinforced concrete footings and steel piles. The reinforced concrete land piers have two square columns with cantilevered pier caps, constructed on reinforced concrete footings and steel piles. Design constraints at the north end of the bridge caused many of the piers to be skewed at various angles to accommodate the city street grid and railroad track alignments below. To accommodate later bridge deck widening, piers 18 through 28 were extended with cantilevered pier caps or additional pier columns.

In 1981 spans 18 through 29 were widened to the west to accommodate a new southbound on-ramp for the bridge, and in 1991 they were widened to the east to accommodate a new northbound off-ramp. A new northbound off-ramp structure of 34" welded steel plate girders was added in 1991 near the center of span 26.

In 1992 Bridge 62881, a two-span prestressed beam replacement bridge, was built near the north end of Lafayette Bridge to carry TH 52 over I-94. It is 219 feet long with span lengths of 115.5 feet and 103.5 feet and an out-to-out width of 73.5 feet. It replaced a three-span steel beam bridge (Bridge 62850) that was built in 1963.

The original open concrete railing design was replaced in 1980 with a 2-foot, 8-inch-high solid concrete Type J railing. The outside of the railing is scribed with two horizontal lines. The structure's center median with an open metal railing was replaced in 1980 with a 2-foot, 8-inch-high solid concrete split median barrier, also Type J.

Originally the bridge was equipped with single cobra-head light fixtures mounted along the railing of each of the structures. In 1980 the railing light standards were replaced with 48 single poles mounted in the concrete median with back-to-back double cobra-head fixtures. River navigation lights are mounted to the bottom of metal shafts on the structure at piers 9 and 10. Overhead metal highway directional signs are mounted on vertical columns on the outside of the deck.

Table of individual span details			
Span	**Span length**	**Girder depth**	**Type**
1 (Over E. Fillmore Ave.)	43'-1"	46-3/8"	Multibeam
2	75'-1 15/16"	46-3/8"	Multibeam
3	93'-9"	46-3/8"	Multibeam
4	90'-1/4"	46-3/8"	Multibeam
5	100'-1/4"	46-3/8"	Multibeam
6 (Over Alabama St.)	107'-5/16"	46-3/8"	Multibeam
7	107'	46-3/8"	Multibeam
8	81'	46-3/8" to 11'-6"	Multibeam
9	270'	11'-6" to 14'-4" at pier 9	Girder with floor beam system
10	362'	11'-6" to 14'-4" at pier 10	Girder with floor beam system
11 (Over recreational trail)	250'-6"	11'6" to 14'-4" (at pier 10)	Girder with floor beam system
12	90'-11 5/8"	46-3/8" to 11-6"	Multibeam
13 (Over Warner Road)	99'-3/8"	46-3/8"	Multibeam
14 (Over RR tracks)	113'-6 11/16"	46-3/8"	Multibeam
15	131'-11 5/16"	46-3/8"	Multibeam
16	104'-6"	46-3/8"	Multibeam
17	90'-2"	46-3/8"	Multibeam
18 (Over Kellogg Blvd.)	100'	46-3/8"	Multibeam
19 (Over Kellogg Blvd.)	86'	46-3/8"	Multibeam
20	86'	46-3/8"	Multibeam
21	113'-4"	46-3/8"	Multibeam
22	113'-4"	46-3/8"	Multibeam
23	113'-4"	46-3/8"	Multibeam
24 (over 4th Street E.)	80'	36"	Multibeam
25	80'	36"	Multibeam
26	80'	36"	Multibeam
27	84'2"	36"	Multibeam
28	70'1-1/2"	36"	Multibeam

Table of individual span details			
Span	**Span length**	**Girder depth**	**Type**
29 (Over 5th Street E)	61'3-7/8"	36"	Multibeam
NB off-ramp structure		36"	Multibeam

PART IV. SOURCES OF INFORMATION

References:

A. Research Strategy

The research strategy was designed to locate primary and secondary sources related to the design and construction of Bridge 9800, as well as the discovery, evaluation, and repair of the girder fracture in 1975. The research effort was to include oral history interviews and site visits.

B. Research Process as Implemented

Primary and secondary sources were reviewed to develop a history of the design and construction history of Bridge 9800. This included a review of collections in the Minnesota Historical Society, Mn/DOT Bridge Office, Mn/DOT library, St. Paul Public Library, and St. Paul Public Works Department, Bridge Division. Historians searched collections for original plans, correspondence, reports, newspapers and periodicals, and historic images. To supplement documentary research, oral-history interviews were conducted with former Mn/DOT engineers and consultants having knowledge of the bridge planning, design, and fracture repair. Four interview subjects were identified and interviews were conducted in January 2009. Site visits were completed to evaluate the current condition and integrity of the structure.

C. Archives and Repositories Used

Repositories visited or consulted:

- St. Paul Public Works Department, Bridge Division, St. Paul, Minnesota
- St. Paul Public Library, St. Paul, Minnesota
- Bridge Office, Minnesota Department of Transportation, St. Paul, Minnesota
- Mn/DOT Library, Minnesota Department of Transportation, St. Paul, Minnesota
- Minnesota State Archives, Minnesota Historical Society, St. Paul, Minnesota

Primary and secondary sources and collections reviewed:

- *St. Paul Pioneer Press, St. Paul Dispatch, Minneapolis Star, Minneapolis Tribune, Star Tribune* (on microfilm at St. Paul Public Library)
- Sanborn Fire Insurance Maps
- MHD and Mn/DOT plans and drawings, available through Mn/DOT website
- [Minnesota] Highway Department Records, Minnesota State Archives
- Bridge 9800 Project Records, Mn/DOT

D. Historians

Research and form preparation by Robert M. Frame, Christine Long, and Shannon Malzahn, Mead & Hunt, Inc.

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