HISTORIC AMERICAN ENGINEERING RECORD

LAKE CHAMPLAIN BRIDGE

HAER No. NY-541

Location:	Spanning Lake Champlain at NY Route 185 and VT Route 17, Town of Crown Point, Essex County, New York, and Town of Addison, Addison County, Vermont. The Lake Champlain Bridge is located at latitude 44.0149, longitude -73.2524. The coordinate represents the center of the bridge at the New York/Vermont boundary. The coordinate was obtained on 4 May 2010 by plotting its location on the 1:25,000 Port Henry, NY USGS Topographic Quadrangle Map. The accuracy of the coordinate is +/- 12 meters. The coordinate's datum is North American Datum 1983. The Lake Champlain Bridge location has no restriction on its release to the public.
Structural Type:	Steel continuous through and deck truss span
Date of Construction:	1928-29
Designer:	Fay, Spofford and Thorndike, Engineers
Builders:	Substructure - Merritt-Chapman and Scott Corporation, Boston Superstructure - American Bridge Company, New York Deck and Approach Paving - Scott Brothers Construction Company, Rome, New York Electrical Equipment - Alvin E. Bennett, Crown Point, New York Toll House – Charles Malone, Port Henry, New York
Present Owner:	New York State Department of Transportation and Vermont Agency of Transportation
Present Use:	Vehicular bridge, closed October 16, 2009, removed December 28, 2009
Significance:	The bridge was a nationally significant engineering landmark and one of the country's most technologically inventive and aesthetically sophisticated designs for highway bridges of its period. Opened to traffic in 1929, the bridge symbolized a convergence of four separate but related trends in transportation engineering, the origins of which can be traced to the closing decades of the nineteenth century: (1) continuous truss technology; (2) a debate within the engineering community regarding the

aesthetics of bridge design, and especially the aesthetics of truss bridges; (3) the use of cantilevers in truss design to extend span length, reduce construction costs, and address aesthetic concerns; and (4) evolving engineering responses to rapidly increasing travel by automobiles. Those trends intersected at Lake Champlain, and the inventive design that blossomed from that meeting is original in American engineering. Equally important, the crossing served as the country's prototype for a succession of important bridges built or planned for major waterways during the remainder of the twentieth century.

Historians: Mark S. LoRusso, M.A., Cultural Resources Survey Program, New York State Museum, Albany, New York

Robert McCullough, Ph.D., Associate Professor of Historic Preservation, University of Vermont, Burlington, Vermont

Project Information: Recording of the Lake Champlain Bridge was completed in November and December 2009, under the direction of Mark S. LoRusso, Historian, Cultural Resources Survey Program (CRSP), and under the supervision of Dr. Christina Reith, Program Director, CRSP. The photography team consisted of New York State Museum Photographer Thaddeus Beblowski and Mark S. LoRusso. The New York State Department of Transportation provided additional photographs. Measured drawings were prepared from the original plans by CRSP Cartographer Jessie Pellerin. Comprehensive field measurements were not possible due to the emergency closure and removal of the bridge.

The historical report was prepared by Mark S. LoRusso, with assistance from Christopher Marston, HAER Architect, National Park Service. Mark S. LoRusso authored the introductory sections, the site description, the background history, and the descriptive information from 2009-2011. The bridge description, the biography of Fay, Spofford and Thorndike, and the statement of significance are from the draft National Historic Landmark (NHL) Nomination of the Lake Champlain Bridge by Robert McCullough, prepared in October 2009 and revised in 2010. A copy of the NHL Nomination is provided in the field records accompanying this documentation. The documentation was submitted to HAER in 2011.

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CHRONOLOGY

April 1922	Carl F. Peterson, Port Henry manager for the Essex County News, initiates a popular movement to build a bridge across Lake Champlain at Crown Point-Chimney Point.
1923	Vermont appoints a preliminary commission to investigate the possibility of building a bridge across the lake.
February 18, 1925	New York State appoints a Joint Legislative Committee on the bridge. The New York and Vermont commissions subsequently act in unison.
April 9, 1926	New York Commission submits a preliminary report and requests an appropriation of $25,000 for surveys and borings at six proposed bridge locations at the south end of Lake Champlain.
January 26, 1927	Final Report of the Joint Legislative Commission recommends the immediate construction of a bridge at the most favorable site, Fort St. Frederic-Chimney Point. This is based on findings by the Office of the State Engineer and Surveyor, State Geologist C. A. Hartnagel, and Consulting Engineer J. A. L. Waddell. The bridge is to be a high level steel truss span supported on concrete piers footed on bedrock. The channel span is to be 300' in length with a clearance of 90' above the lake high water mark for navigation. The bridge is to be a toll bridge, with tolls used to repay the costs of construction and cover yearly operation and maintenance.
Early 1927	Legislatures of New York and Vermont establish a temporary Joint Commission to negotiate a compact between the two states and to prepare a plan for building the bridge.
May 11, 1927	The compact is signed, creating the Lake Champlain Bridge Commission, with the power to purchase, construct, own, maintain, and operate a highway bridge across Lake Champlain.
August 2, 1927	Fay, Spofford and Thorndike, Engineers, are appointed to make preliminary studies and estimates of various bridge designs.
November 15, 1927	Fay, Spofford and Thorndike submit a “Report on Preliminary Designs and Estimates” to the Lake Champlain Bridge Commission. The report finds that a six span, arched truss design, is preferred over a suspension bridge design. This is based on lower cost, within the $1 million set by the Bridge Commission, a more attractive appearance, and less impact to a residential property on the Vermont side. The continuous truss design is adopted by the Bridge Commission.

February 16, 1928	U.S. Congress ratifies the Lake Champlain Bridge Commission compact.
May 15, 1928	The Lake Champlain Bridge Commission awards contracts for the bridge construction. The substructure contract is awarded to Merritt-Chapman and Scott Corporation, Boston. The superstructure contract is awarded to the American Bridge Company, New York.
June 14, 1928	Merritt-Chapman and Scott begins work on the substructure.
December 1928	Final pier is completed December 21. The American Bridge Company begins work on the superstructure in mid-December.
June 22, 1929	Channel span is closed. Final riveting on the superstructure is completed in early July.
August 26, 1929	Bridge is officially opened by Governors Franklin Roosevelt of New York and John Weeks of Vermont. Total cost of the bridge is $967,800 and total cost of the project is $1,149,032, with funding from a $200,000 legislative appropriation and from $994, 290 in bonds to mature between 1940 and 1958. Initial tolls are $1 for automobiles, $1-2 for trucks or tractors, and 25 cents for pedestrians and bicycles.
1953	Tolls for automobiles are reduced by half.
1956	Bonds used to build the bridge are retired, and debt payment to New York State and Vermont is completed.
1959	Tolls are reduced by half, and commuter rates are established.
1972	Tolls for commercial vehicles are doubled to cover increased cost of maintenance and repair on the bridge. Tolls for all vehicles are increased in 1974.
1987	Under an agreement between New York State and Vermont, the Lake Champlain Bridge Commission is abolished, and tolls are eliminated. The New York State Department of Transportation (NYSDOT) takes over maintenance of the bridge.
1991	A major rehabilitation of the bridge is completed by NYSDOT, including repairs to the steelwork and substructure, replacement of the deck, new railings, and painting.
2007	NYSDOT cites severe deterioration of bridge bearings and piers, considers rehabilitation or replacement of the bridge by 2012.

July 2009	NYSDOT begins bridge repairs to remedy red-flagged structural deficiencies, resulting in one-lane traffic.
October 16, 2009	NYSDOT and the Vermont Agency of Transportation (VTrans) jointly decide to close the bridge due to severe deterioration of the piers. NYSDOT and VTrans begin planning to build a ferry to maintain service at the crossing. Closure of the bridge causes major impacts to traffic circulation around the lake until the ferry opens.
November 9, 2009	Engineers determine that the bridge cannot feasibly be rehabilitated and recommend removing the bridge for safety reasons. NYSDOT and VTrans accept the recommendations.
November 18, 2009	NYSDOT requests the New York State Museum Cultural Resources Survey Program to initiate Historic American Engineering Record documentation of the bridge.
November 25, 2009	A Programmatic Agreement for the Lake Champlain Bridge Removal is signed by the Federal Highway Administration, the New York State Historic Preservation Office, the New York State Department of Environmental Conservation, the Vermont State Preservation Office, the New York State Department of Transportation, the Vermont Agency of Transportation, and the Advisory Council on Historic Preservation. NYSDOT project leaders for the bridge demolition and the construction of a temporary ferry consist of John Grady, Regional Construction Engineer, Dave Richards, Construction Supervisor, and Tim Farrell, Engineer-in-Charge.
December 8, 2009	Design approval to demolish the bridge is granted by the Federal Highway Administration, based on the Final Safety Assessment Report by HNTB New York Engineering and Architecture.
December 10, 2009	NYSDOT contracts with Advanced Explosives Demolition, Inc., of Coeur d'Alene, Idaho, to demolish the bridge.
December 12, 2009	NYSDOT publicizes six possible designs for a replacement bridge. The designs, by HNTB New York Engineering and Architecture, consist of two versions of a cable-stayed bridge, a network tied-arch, and a modified network tied arch.
December 28, 2009	The Lake Champlain Bridge is demolished by controlled explosion.
January 14, 2010	NYSDOT announces the selection of the modified concrete network tied arch design for the replacement bridge. This design, favored by the public

and Public Advisory Council, features an arched main span that recalls the defining feature of the original bridge.

January 29, 2010.	A Programmatic Agreement for the Lake Champlain Bridge Replacement is signed by the Federal Highway Administration, the New York State Historic Preservation Office, the New York State Department of Environmental Conservation, the Vermont State Preservation Office, the New York State Department of Transportation, the Vermont Agency of Transportation, and the Advisory Council on Historic Preservation. NYSDOT project leaders are John Grady, Regional Construction Engineer, Dave Richards, Construction Supervisor, and Jeff Brown, Engineer-in-Charge.
February 1, 2010	Temporary ferry begins service at the Crown Point-Chimney Point crossing.
April 15, 2010	NYSDOT lets the contract for the new bridge. Eight bids are received.
May 27, 2010	Flatiron Construction Company, of Longmont, Colorado, is awarded the $69.9 million construction contract for the new bridge.
June 10, 2010	Groundbreaking ceremony for the new bridge is attended by Governor David A. Paterson, Governor Jim Douglas, and state and local officials. The governors are praised for their quick response and commitment to the Lake Champlain Bridge Replacement, demonstrated by a planned completion date and opening for the new bridge in early fall 2011.

INTRODUCTION

The Lake Champlain Bridge, built from 1928 to 1929, was a landmark continuous through and deck truss span that crossed Lake Champlain between Crown Point, New York, and Chimney Point, Vermont. Placed at an earlier ferry crossing, the bridge ushered in a new era of transportation for the Champlain Valley, providing a highway connection across the lake between the Adirondack Mountains of New York and the Green Mountains of Vermont. The bridge was hailed as a symbol of progress that would cement the bond between the states of New York and Vermont and bring growth to the surrounding towns.

The Crown Point-Chimney Point crossing historically was a strategic narrows held by the French, and later the British, in their efforts to control Lake Champlain in the eighteenth century. Fortifications erected here consisted of an original fort by the French at Chimney Point in 1731, the larger Fort St. Frederic, built by the French at Crown Point in 1734, and Fort Crown Point, built under British General Amherst from 1759 to 1763. Fort Crown Point fell to American forces in 1775 but was retaken in 1776 and held by the British through the Revolution. In the 1920s, the visible ruins of the Crown Point forts stood testament to the importance of the crossing as planning began for the Lake Champlain Bridge.

Investigations for the Lake Champlain Bridge were initiated by Vermont in 1923, with New York State joining in 1925. In 1927, the Lake Champlain Bridge Commission, representing both states, was created to oversee the construction and future operation of the bridge. Six locations at the south end of the lake were tested as suitable sites for the bridge, with geologic and topographic conditions favoring the Crown Point-Chimney Point crossing. Engineers Fay, Spofford and Thorndike of Boston, designed an innovative, continuous truss span that would meet the physical constraints of the site and complement the panoramic lake setting. The bridge pioneered the use of a continuous truss to achieve an arching transition between deck and through truss spans in locations where aesthetics were important. The bridge was built at a vigorous pace by the Merritt-Chapman and Scott Corporation of Boston and the American Bridge Company of New York over a fifteen-month period, opening to a grand celebration on August 26, 1929. The bridge would operate as a toll span, with revenues used to repay the construction costs and cover yearly operation and maintenance.

The Lake Champlain Bridge and its sister Rouses Point Bridge at the north end of the lake were vital links in an improved highway network encircling Lake Champlain by the late 1930s. The Lake Champlain Bridge exceeded original estimates for revenue in its first years, benefiting from summer and fall tourist traffic and from comparatively light local and commercial traffic. Use of the bridge slowed during the Depression, but spiraled upward after World War II, with the Champlain Valley both a stopping point for excursions between New York, Montreal, the Adirondacks, and New England, and a history-steeped destination in itself.

Heavy use of the bridge eventually took its toll, with signs of wear appearing by the 1950s, and significant deterioration occurring in the 1970s and 1980s. Essential repairs at this time included the replacement of bearings, the reinforcement of cracked piers, and a restoration of the deck. Although the construction costs of the bridge had been repaid in the 1950s, the tolls remained in place to cover the increased costs of maintenance and to fund the replacement of the also deteriorating Rouses Point Bridge.

In 1987, the Bridge Commission, under continued pressure to eliminate tolls on the Lake Champlain Bridge, was dissolved, relinquishing operation of the bridge to the New York State Department of Transportation (NYSDOT). In 1991, NYSDOT completed a major rehabilitation, consisting of a deck replacement and repairs to the floor system and substructure. Periodic maintenance kept the bridge operational through the 1990s and early 2000s, but with deterioration accelerating, NYSDOT, in 2007, weighed replacement or rehabilitation options for the bridge within its five-year capital program.

The future of the bridge was decided suddenly in 2009. Following an emergency repair of the floor system and a partial closure in July, the bridge was closed to all traffic on October 16 due to the potential failure of one of the piers. A final structural inspection by NYSDOT determined that due to extensive deterioration of the substructure and the possibility of a catastrophic failure, the bridge was unsafe for rehabilitation and would not reopen. On November 9, 2009, Governor Paterson of New York officially announced that the bridge would be replaced.

The Lake Champlain Bridge was demolished by a controlled explosion on December 28, 2009. Falling heavily into the lake after eighty years of service, the bridge was remembered by the many that passed beneath its arch or viewed its silhouette above the lake. Appreciation for the bridge was expressed in the choice of a replacement span, voiced in public meetings held by NYSDOT. The new bridge, scheduled for completion in fall 2011, will be a modified network tied arch, reminiscent of the high arching truss of the original bridge.

Bridge Documentation and Recognition

The Lake Champlain Bridge was nominated for listing in the National Register of Historic Places by Alexis Godat and Robert McCullough of the University of Vermont Graduate Program in Historic Preservation in 2007, and it was listed in 2009. Robert McCullough prepared a draft National Historic Landmark (NHL) nomination of the bridge in 2009; however, the bridge was removed before the nomination process was completed. Both nominations were largely based on the plans, photographs, annual reports, and other records of the Lake Champlain Bridge Commission, housed in the Vermont State Archives in Montpelier, Vermont, and in the University of Vermont in Burlington.

This Historic American Engineering Record (HAER) report builds on the National Register and NHL nominations with further research of the Bridge Commission records, regional newspapers, local repositories, and informants to provide a wider historical context for the bridge. Scaled drawings for the HAER documentation were based on the 1928 design plans by Fay, Spofford and Thorndike and shop drawings by the American Bridge Company and on photographs taken by the recording team in 2009 and by NYSDOT during the 2001 and 2009 inspections.[1]

With the removal of the bridge, the associated toll house and light standards remain as original components of the historic bridge site. The toll house retains a high level of integrity, with most changes centered on the rear additions to the structure in 1945. A handicap entry ramp was added when the building was reopened as a visitor's information center in the 1990s. The original metal light standards, with extension arms for the lights, remained over the length of the bridge in 2009, while the original concrete light standards with the supporting arms remain on the New York (two standards) and Vermont approaches (three standards). The original pendant globes were replaced with upright, lantern-style lamps, in the 1980s.

DESCRIPTION OF THE BRIDGE

Bridge Site

The Lake Champlain Bridge spanned Lake Champlain between Crown Point, New York, and Chimney Point, Vermont, in a panoramic setting framed by the Adirondack Mountains to the west and the Green Mountains to the east. The bridge stood at the dividing point between the narrow, lower third of the lake, and the expansive, middle and upper portions, providing views of Bulwagga Bay and the Village of Port Henry to the north, and the level to rolling farmland of the lake plain to the south. The name Crown Point, from the French term "Pointe a la Chevelure," refers to the peninsula that juts out from the west shore of the lake, forming a narrows less than one-third mile wide at the bridge site.

The Lake Champlain Bridge was a central link in the highway system around Lake Champlain, connecting New York Route 9N/22 on the west side of the lake and Vermont Route 22A on the east side. These highways, leading north from the lower tip of the lake at Whitehall and Fair Haven, are primary collectors to the Adirondack Northway/I-87 in New York, and US 7 and I-89 in Vermont, which provide access to the northern lake crossing at Rouses Point.

The bridge occupied a 30-degree northeast to southwest orientation, reflecting the physical constraints of the site, both topographic and historic. The bridge crossed between Crown Point State Historic Site (SHS) on its southwest end and Chimney Point SHS on its northeast end. In

[1] The 2009 New York State Department of Transportation Interim Bridge Inspection revealed in six locations inspected for serious section loss that the actual structural members differed in shape from the design drawings but matched the shop drawings. A casual comparison of the design and shop drawings, based on photographs previously collected, showed that the shop drawings were more reliable for shape and size verification than the design drawings. Spot measurements of structural members were taken by NYSDOT just prior to the bridge removal for the lower chord in Spans 6-8, a diagonal in Span 5, and stringers and floor beams in Spans 4, 6, and 9. A consistent difference between the actual member and the shop drawings was observed for the three measured sections of the lower chord on Spans 6-8 (L2-L4R, L12, L17), with the actual beam $^{3}/_{8}$" to $^{1}/_{2}$" smaller, both in width and height, than the shop drawings; however, it was possible that the observed difference reflected section loss in the actual member.

Crown Point SHS, the bridge was built less than 10' from the southeast bastion of Fort St. Frederic, and in Chimney Point SHS, less than 20' from the 1780s Chimney Point Tavern. Both state historic sites are listed in the National Register of Historic Places, and both Fort St. Frederic and Fort Crown Point, in Crown Point SHS, are National Historic Landmarks. The replacement bridge will occupy the same alignment, minimizing impact to these resources.

The Lake Champlain Bridge was 2191' in length, consisting of fourteen spans supported on concrete piers and abutments. The centerpiece of the bridge was the 1014' continuous, cantilevered, through and deck truss channel span, with three additional deck truss spans over open water, and girder viaduct spans on the shores. The center arch of the bridge was off-center to the lake, due to its crossing of the navigational channel at the deepest part of the lake, closer to the Vermont shore.

Superstructure

The principal segments of the bridge consisted of one end-supported Warren deck truss; two continuous Warren trusses, one of which was the three-span channel segment that combined deck and through trusses, and the other a two-span deck truss; eight plate girder viaduct spans; and two filled causeway approaches. Of the bridge's overall length, roughly 1500' was over water. The original plans numbered the structure's fourteen spans from west to east, and the spans were supported by thirteen piers (also numbered from west to east) and two abutments. Spans one, two, and three were plate girder deck viaducts, each 50' or slightly less. The girder for span three was braced by vertical bents at mid-span and a simple truss (easterly half) having a web of cross braces and a short strut extending from mid-point of the bottom chord to the intersection of the laterals. Spans ten, eleven, twelve, thirteen, and fourteen marked the Vermont approach and were structurally identical to their counterparts (one, two and three) on the New York side, with span ten also employing a simple truss similar to that for span three. The girders of viaduct spans one, two, eleven, twelve, thirteen, and fourteen were riveted together after the dead load was in place, making them continuous for live loads.

Spans four and five, respectively 225' and 270' in length, comprised a continuous Warren deck truss. Each span had ten panels, and truss webs contained verticals at each panel juncture. At the mid-points of spans three and four, truss depths were slightly more than 23' and 25', respectively. Span nine was a simple-span, end supported Warren deck truss, 270' in length and with ten panels. Truss depth at mid-span was slightly more than 28'.

Spans six, seven, and eight comprised the continuous channel approaches and measured, respectively 290', 434', and 290' in length. Spans six and eight both utilized ten panels and span seven utilized fourteen panels. Truss depth at the two piers framing the channel (piers six and seven), was less than 1" short of 62', and truss depth at the center vertical of span seven was slightly more than 42'. In addition to its 90' of clearance across a channel width of 186', span seven also accommodated, alternately, 78' of clearance across a channel width of 300', or 50' of clearance across a still greater width of 400'. Spans six and eight provided navigational clearance of 40' at piers six and seven and slightly greater clearance at mid-span.

As originally designed, the deck systems for the viaduct and truss spans differed. For the viaducts, plate girders supported transverse 24" I-beams employed as floor beams but without intermediate stringers. For the truss spans, floor beams carried longitudinal I-beam stringers set slightly more than 6' apart. The deck beams carried a reinforced-concrete slab strengthened with unit trusses to counteract shear stresses in the slab. Initially, a patented, two-course, plain-concrete, wearing surface - 1-$^{1}/_{2}$" in depth - was poured above the reinforced concrete slab.

To allow the wearing surface to be removed without damaging the integrity of the reinforced-concrete floor slab beneath it, burlap was embedded into the floor slab before it had acquired its initial set. This cleavage fabric prevented the large aggregate of the slab from bonding with the wearing surface. That floor system remained in use until 1964, when the wearing surface was replaced with a 2" bituminous concrete surface, separated from the reinforced-concrete floor slab by membrane waterproofing. Expansion joints, located above each abutment and over piers five and eight, were repaired or replaced at the same time. Plans to repair the deck and curbs were developed in 1970 and finally implemented in 1975, 1978, 1979, and 1980. Repairs to piers six and seven also occurred during the 1970s

The bridge's structural width from center to center of trusses was 18' for the two-span continuous deck truss (spans four and five), the end supported truss (span nine), and each of the girder viaduct spans (center to center of girders). Width for the three-span continuous channel truss (spans six, seven and eight) was 30' (center to center of trusses). The truss and girder systems were designed for a live-loading of H-15 as determined by the Standard Specifications for Steel Highway Bridges issued by the U.S. Department of Agriculture, and the floor system was designed to carry 20-ton trucks.

As designed, the roadway width extended 24' between curbs across the entire structure and along most of the approach causeways. At each end of the approaches, however, the roadway was widened to accommodate toll collection. Double-height concrete curbs were originally added to the bridge's floor system as a safety precaution for motorists, but those curbs were modified during the 1970s. Railings were designed with steel wire mesh (similar to modern chain-link fencing) connected top and bottom to wire cables stretched between railing posts of steel. A steel channel rail was installed at the top of the railing, more than 4' above the top curb. Cables and top railings were separated by a space of slightly more than 11", a design judged adequate to afford protection as well as views of the lake and mountains. The original railings were replaced by box beam railings. The bridge's design offered no sidewalk for pedestrians, who were forced to rely on narrow foot walks (slightly more than 2' wide) above the curbs on each side of the bridge within the railings. Curb openings, a foot wide and spaced every 3', provided drainage channels and reduced the bridge's dead load. When the curb design was modified, drainage ducts were installed.

Substructure

Piers three through nine were concrete, and footings for the steel bents used for piers one, two, ten, eleven, twelve, and thirteen were also concrete, as were both abutments. Piers three to eight were built in the water, pier nine was dry-laid, and all except piers six and seven (the channel piers), were originally designed for construction with open coffer dams. Bids for piers six and seven were solicited for both the open coffer-dam process and the pneumatic caisson process, but the former proved substantially less costly and was selected. Site conditions, namely a soft lake bed overlying bed rock at a depth of 100', a fresh water lake without rapid changes in water level, and comparatively little current, made reliance on the unusually deep coffer-dam method possible. In addition, the surfaces of bed-rock had been scored by glacial action and contained potholes, as well, ensuring a good bond between concrete pier and bed-rock. Piling for the coffer dams was driven to bed-rock with a steam hammer, and a system of horizontal bracing was constructed between interior steel sheet piling and exterior wooden piles. Struts in the form of I-beams also extended across the full width of the coffer dam, and segments of that bracing were left in place in those parts of the piers in which concrete was laid beneath water level.

Piers were tapered bottom to top, and constructed in segments that are staggered in dimension as well. For example, channel piers at bed-rock were 48' x 16', a block that rose to an elevation of 72', approximately 20' above the lake bed. The next pier segments ascended to an elevation well above standard low water level, approximately 92' in 1929, and dimensions were roughly 44' x 10', although end elevations are rounded. At its bearing pads, taper reduced the dimensions of these channel piers to approximately 40' x 7'. Slightly protruding pier caps beneath those pads provided the only relief in the otherwise smoothly-faced concrete surfaces, but the piers were reinforced with steel plates and tension rods.

The design of bearing systems varied to accommodate either stresses in the simple and continuous spans or to facilitate the original assembly. The bearing at pier three was fixed; that on pier four, the center span for the two-span continuous truss, was a rocker; two bearings on pier five were rollers, one for the two-span continuous truss, and one for the three-span continuous channel truss; the bearing on pier six was fixed; that on pier seven was a roller, as were the two bearings on pier eight, one for the three-span continuous channel truss and one for the single-span simple truss; and the bearing on pier nine was fixed. All roller and rocker nests were placed in steel boxes filled with grease and installed with sides that could be removed for maintenance. They were exposed during the documentation of the bridge in 2009.

Structural Components and Materials

Steel structural components were designed using a combination of riveted plate girders, riveted box girders, rolled beams, and forged or cast steel. Riveted plate girders used in the approach spans were assembled with paired angle bars at top and bottom and as vertical stiffeners. Box girders used in the fixed span and continuous trusses varied in size and compositional structure. For example, the top and bottom chords for the simple span Warren deck truss (span nine) were both box girders. Bottom chords were assembled with channel section rolled beams as sides joined by lattice bars top and bottom, with large stay plates at panel junctures. Top chord box girders, in contrast, were assembled with riveted plates and angles that formed channel section sides, with lattice bar on the bottom but a full plate along the entire length of the chord top. Verticals and diagonals in the truss web for that span were typically box girders built up from pairs of rolled channel sections joined by lattice bars. Rolled channel beams for the vertical members were slightly smaller than those used for diagonals. Box girders forming the end-panel diagonals were slightly larger than other web members and used riveted angles and plates to form channel sections joined by lattice bars. Trusses were braced laterally at panels, top and bottom, with I-section girders assembled with paired angles joined by lattice bars.

Similar compositional designs were used for the structural members in the continuous trusses, but box girders for the top and bottom chords were larger. In addition, top chords in the deck truss portions of those continuous spans joined floor beams at the same height. The box girders forming truss chords were assembled with riveted plates and very large angles rather than rolled channel beams, and they typically employed double lattice bars on only the bottom side. In addition, a greater number of large stay plates were used. Portal and lateral bracing for the through truss above the channel employed riveted I-section girders with large paired angles and lattice bars, as well as paired-angle struts.

The riveted box-beams used extensively for the continuous and fixed-span trusses, albeit of components that varied in dimension, represented standard design for the period. However, lateral bracing was omitted from the panels over the intermediate piers where the trusses swung from deck to through design. Lateral stiffening in this intermediate area was accomplished with heavy portal braces on panels nine and ten (span six), twelve and thirteen (span seven), twenty-one and twenty-two (span seven), and twenty-four and twenty-five (span eight). Wind forces on the top chords in panels where bracing was omitted were transferred to the bottom chords by sway-bracing installed below the deck. Overhead sway bracing was used at all other panel points for the through truss. The engineers' original calculations for the total quantity of structural steel required, 6,000,000 pounds, exceeded final estimates based on payments by 60 tons.[2]

Structural components in the floor systems were also different. For the approach spans, floor beams were rolled I-section beams supported by the plate girders and stiffened by paired and single angle diagonal bracing. Floor beams, in turn, supported the deck but without stringers, and they also were extended with small lengths of rolled I-section beams attached with gusset plates. For the fixed-span Warren deck truss (span nine), floor beams were large rolled I-section beams, as were the smaller stringers held in place by brackets mounted on the floor beams. For the continuous trusses, floor beams became large riveted plate girders similar to those supporting the approach spans, and stringers were rolled I-section beams.

Vertical bents supporting the approach spans alternated between box girders with rolled pairs of channel section beams joined by lattice bars and stay plates on two sides, or rolled wide-flange beams; those beams at pier three were splayed outward. Bents were joined to the bearing points of approach spans with large pins, presumably cast steel, and concrete footings supported housings for these joints. Footings, in turn, were covered by a steel apron. Truss spans were also connected to bearing houses with similar pins.

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[2] Charles M. Spofford, "Lake Champlain Bridge," Paper No. 1839, presented at Meeting of the Structural Division, Boston, October 10, 1929, in *Transactions of the American Society of Civil Engineers*, vol. 96 (1933): 622-659.

The American Bridge Company fabricated the steel for the superstructure. Following common practice for that period, design specifications mandated use of open hearth furnace steel rather than Bessemer steel. Forged steel parts could be produced through either the open hearth or electric furnace methods, and cast steel could, in addition, be produced through the crucible method.

The bridge was painted a light gray color with the specific goal of establishing harmony with the surrounding landscape and preventing the bridge from becoming too conspicuous. Two field coats of tinted white lead paint covered the shop coat of red lead, and the second field coat was carefully developed from a mixture of raw umber in linseed oil, white lead, and a small quantity of ferrite yellow.

Lighting and Toll Facilities

By the spring of 1929, with construction of the bridge rapidly advancing toward completion, plans for the bridge's lighting systems, a toll booth with islands and gates, and approach roadway alignments were in place. Carroll Farwell oversaw the development of these aspects of the project, including design of the toll booth. He also established a formal and carefully organized entry to the bridge from the New York approach. Contract drawings include a toll collection area on the northwesterly side of the Vermont approach, but those plans were abandoned.[3]

Farwell placed twenty-five street lights, each with 400 candle power, on alternating sides of the bridge, and his plans specified tapered wooden or concrete poles, 18' in height, with arm extensions from which lighting units with bell-shaped lamps and acorn globes were hung.[4] Four concrete lamp posts, two of which survive, were placed on each side of the travel way at the toll collection plaza. A 24" revolving airways beacon, based on designs provided by the U.S. Department of Commerce, Airways Division, was also installed on the bridge. Two sets of navigational lights were also installed, one electric and one oil, the latter for emergency use only; it was later replaced with an electrical system.[5]

The original light standards and extension arms remained on the bridge in 2009, and a few of the original concrete light standards, with the extension arms, remain on the New York (two standards) and Vermont approaches (three standards). Records show that the original acorn globes were replaced with similar globes, G. E. Catalog No. 166, beginning with six new globes

[3] Plan 42, Sheet No. 22, Lake Champlain Bridge Commission Collection, Oversize Folders 1, 2 and 3, Vermont State Archives and Records Administration, Middlesex, VT (hereafter cited as VT State Archives). Original records of the Lake Champlain Bridge Commission (hereafter cited as LCBC).
[4] The bridge used steel channels and plates for the light standards and extension arms, as shown in LCBC, "Supports for Lights," F3132, Sheet No. X1, *Lake Champlain Bridge,* American Bridge Company, June 1928, New York State Department of Transportation (NYSDOT), Region 1, Schenectady, NY, digital copy.
[5] Fay, Spofford and Thorndike, "Contract 4, Lighting Detail of Street Light and Connections," April 1929; U. S. Department of Commerce, Airways Division, "24-inch Revolving Airways Beacon," 21 February 1928, LCBC Collection, Oversize Folders 1, 2 and 3, VT State Archives.

in 1966. The acorn globes remained on the bridge in the late 1970s, but had been replaced by the extant, lantern-style lamps when plans were drawn for the NYSDOT bridge rehabilitation in 1989.[6]

At the New York side, a small tollbooth was erected opposite the toll collector's dwelling, and to the northeast of the booth (toward Vermont), single smaller gate-islands divided each of the two travel lanes into two more lanes, each 20' in width, in the toll-collection area. Rectangular frame "roadway gates" with four panels, each panel web containing cross bracing, extended from posts placed on the roadway shoulder opposite these islands, and cables extended from the tops of those posts to the ends of each gate. The posts were capped by round steel castings. Tolls could thus be collected from cars moving in both easterly and westerly directions and from four possible points: easterly and westerly approaches and from each side of the central island.[7]

The center of the gate-island permitting passage to cars traveling from New York to Vermont was placed approximately 18' from the toll booth (toward Vermont), while that for traffic moving in the opposite direction was placed approximately 32' from the booth (also toward Vermont). Thus, travelers from New York paid the toll and advanced toward the gate, which presumably had begun opening. Vehicles arriving from Vermont at the opposite gate-island, in contrast, waited until the toll operator opened the gate before proceeding to the booth to pay the toll. That unusual design may have been intended to allow the toll collector to control the number of cars arriving at the booth simultaneously, but desire to place all the electronic gate equipment in close proximity also may have been a factor. Electromatic traffic counters were placed in the roadway at each of the four gates, as well. Mushroom lights (also a noteworthy if short-lived roadway feature in use during the 1920s and early 1930s) were imbedded in the roadway surface at the New York entrance to the toll collection area.[8]

Design of the toll collection system, and in particular the staggered arrangement of the gates, followed a careful study of major American bridges and their toll houses in use at the time, including the Peace Bridge in Buffalo, the Bear Mountain Bridge across the Hudson River, and the movable Kennebec Bridge at Bath, Maine. Results of the firm's study were summarized in its Memorandum on Methods of Toll Collection, dated December 28, 1928. That document emphasized that most large bridges relied on toll houses at both ends of the crossing, as well as vouchers, which were received at one end and returned at the other. However, the bridge at Bath had abandoned the second toll booth for sake of economy. In addition, a single toll house that

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[6] Robert McCullough, "Draft National Historic Landmark Nomination, Lake Champlain Bridge," October 2009, 2010, updated by Mark S. LoRusso, 2011. See also, Max D. Serota, Fay, Spofford and Thorndike, to Warren Lee, Lee Brothers, Crown Point, NY, Subject: Replacement Globes and Sockets, 5 April, 1966; Max D. Serota, Fay, Spofford and Thorndike, to Graybar Electric Company, Inc., Albany, NY, Subject: Your Quotation RJY:G 6/14/66, Purchase Order, LCBC, 16 June 1966, all in Records of the LCBC, New York State Archives, Albany, NY (hereafter cited as NYS Archives). "Bridge toll-takers; their lot's not always routine," *Ticonderoga Press Republican*, 9 September 1977; NYSDOT, Record Plans, "Rehabilitation of Crown Point Bridge Over Lake Champlain," Contract D253114, October 1989, NYSDOT, Albany, NY, digital copy.
[7] Various plans, LCBC Collection, Oversize Folder 3, VT State Archives.
[8] Various plans, LCBC Collection, Oversize Folder 3, VT State Archives.

allowed collectors to accept tolls from vehicles moving in two directions simplified procedures during times of limited traffic, in one or both directions. The study indicated that ticket sellers were capable of handling about 220 cars per hour, and the gate design adopted by Carroll Farwell probably sought to maximize both efficiency and accuracy.[9]

The toll-collector's dwelling provided an office for the Bridge Commission, an office for the toll takers, and a residence for the bridge superintendent, who oversaw the daily workings of the bridge.[10] The dwelling faced the collection area, with the front ell serving as an office. A surface paved with granolithic concrete provided an entrance area to both the office ell and to the house. The building's center-bay front door opened from a small stoop, also granolithic concrete, and framed by high-back bench seats. An entrance vestibule and center-hall led to the large commissioner's room (front, left) and living room (front right), which also contained a closet bed as well as separate entry to the office-ell. Dining room, kitchen and bath extended across the rear portion of the house, also accessible via a long flight of steps, open porch sheltered by a shed roof, and small entrance hall. The building's upper story contained a hall, two bedrooms, and attic storage areas in the front and rear eaves. The basement contained a fireproof vault, two-car garage with Lowden stock garage doors mounted on "round-the-corner tracks," and a coal-fired furnace. Plans also called for a black slate roof on the main block and office ell, wooden Elhide shingles laid 8" to the weather, and rock-wool insulation. Designs for the building were developed by architect D. Jackson in association with Fay, Spofford and Thorndike, and plans were signed in April 1929. However, very little is known about Mr. Jackson.[11]

The commission enlarged the dwelling in 1945, adding an ell on the building's back or southeasterly side based on plans prepared by L. C. Heney for the Champlain Valley Construction Company of Westport, New York. The ell added a sunroom to the dwelling's first floor and a storage area below, subsequently converted to a garage. A flight of steps ascended to a small deck at the building's back door.[12]

By November, 1928, landscape architect Elmer Eugene Barker had prepared a site plan for the dwelling house, toll collection area, and roadway approach at the Crown Point Reservation. Barker, born in Crown Point in 1886, attended Cornell University as an undergraduate, followed by study at Harvard University, where he obtained a degree in landscape architecture. He later returned to Cornell for doctoral studies and then taught plant breeding at that institution. His career as a landscape architect included employment for the Westchester Park Commission, the federal government, and the New York State Department of Public Works. However, his

[9] Fay, Spofford and Thorndike, Memorandum of Methods of Toll Collection, 28 December 1928, typewritten, LCBC Collection, Box 3, Folder 15, VT State Archives.
[10] McCullough, "Draft NHL Nomination," updated by Mark S. LoRusso, 2011.
[11] See various plans, LCBC Collection, Oversize Folder 3, VT State Archives. Inquiries about Jackson produced no information from the Boston, New York, Vermont, and Washington offices of the American Institute of Architects. However, continued investigation of the national data base is probably warranted.
[12] L.C. Heney, "Toll-Keeper's Addition," Plan for the Champlain Valley Construction Co., 18 December 1945, LCBC Collection, Oversize Folder 4, VT State Archives.

expansive career activities extended to history, conservation, and regional planning, and he authored several books on topics as diverse as the iron industry in the Crown Point region, the Civil War, and botany.[13]

For the toll-collector's dwelling's relatively simple plan, Barker introduced a grass-covered traffic circle (similar to a modern roundabout) at the entrance to the toll plaza, planted trees (mountain ash and thorn-apple) and shrubbery (barberry, aromatic sumac, and vines) at strategic locations around the house and on the slopes of the bridge approaches, and he also created a border hedge around a garden on the building's southwesterly side. Many of those plantings survive.[14]

The use of a traffic circle on the New York approach reflected a trend toward more efficient, safer highway designs in the late 1920s and early 1930s, first promoted in New Jersey. With vehicular accidents on the rise at this time, traffic circles, grade separations, median strips, and wider shoulders were offered as ways to improve traffic flow on highways while limiting collisions. In New York State, an early traffic circle was built at the west approach to the Bear Mountain Bridge from Storm King Highway in 1924. Other circles were built at the Saw Mill River Parkway connection with the Cross County Parkway in Westchester County and at the intersection of Route 9 and Route 7 in Albany County in the early 1930s. At the Lake Champlain Bridge, the traffic circle eased a potential bottleneck where the bridge road intersected the turn to the Crown Point forts, just beyond the toll plaza. The circle replaced the traditional "Y" intersection used elsewhere on the Crown Point Reservation and on the Vermont approach where VT 17 (from the north) and VT 125 (from the south) joined before making a sharp turn to the bridge.[15]

The toll plaza was modernized in 1959 and 1969, according to designs by Fay, Spofford and Thorndike. In 1959, new counting devices were installed, requiring modification of the toll booth and the traffic lanes. In an effort to maintain the original appearance of the toll booth, the contract plans called for the careful removal and reuse of wooden shingles with new paint to be approved by the Bridge Commission. In 1969, the toll plaza was entirely rebuilt. A two-lane road replaced the traffic circle, a prefabricated metal booth replaced the old toll booth, the toll zone was narrowed to a single lane in each direction, and new barrier gates and new roadway

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[13] "Dr. E. Eugene Barker Dies; Noted as Historian, Author," *Ticonderoga Sentinel*, 2 April 1964. See also archival files, Cornell University.

[14] Elmer Eugene Barker, "Landscape Development at the Superintendent's House, Crown Point Reservation," undated plan (ca. 1928), LCBC Collection, Oversize Folder 2, VT State Archives. In a letter from Frederic H. Fay to Mortimer Y. Ferris dated 15 November 1928, Fay acknowledges receipt of the landscape plan; LCBC Collection, Box 5, Folder 8, VT State Archives.

[15] McCullough, "Draft NHL Nomination," updated by Mark S. LoRusso, 2011; "Safer Motor Roads," *The New York Times*, 1 December 1935; "Cross Hudson Span In Autos This Week," *The New York Times*, 23 November 1924; "New Parkway Link Open," *The New York Times*, 22 October 1933; "To Relieve Congestion," *The New York Times*, 2 September 1934. All *New York Times* articles from NYS Library Subscription Database, ProQuest Historical Newspapers, http://www.nysl.nysed.gov/gate/remotedb.htm#N.

treadles were installed. An updated electrical system, housed in a new transformer building, provided 7620-volt, single phase power for the bridge lighting, toll booth, and toll house.[16]

In 1987, when the Bridge Commission was dissolved and the bridge became toll free, the toll booth and toll collecting equipment were removed. Since 1992, the toll house has been used as a Visitor's Information Center by the Lake Placid/Essex County Visitors Bureau, now the Regional Office of Sustainable Tourism-Lake Placid Convention and Visitors Bureau, under an agreement with the New York State Department of Environmental Conservation.[17] Essex County and the Department of Environmental Conservation sponsored a major restoration of the building in 2008-9.

HISTORY

PLANNING FOR THE BRIDGE

Lake Champlain has long served as a vital link between the Saint Lawrence River and the Hudson River, but at the same time, has acted as a barrier between New York State and Vermont. Numerous ferries crossed the lake in the nineteenth century, but with the advent of automobiles, ferries were viewed as an outmoded system. The idea of a highway bridge over the lake came to light during the Champlain Tercentenary of 1909. The idea blossomed into a popular movement in the early 1920s through the efforts of Carl F. Peterson, Port Henry manager of the Essex County News. In April 1922, Peterson began an editorial campaign for a bridge between Crown Point and Chimney Point, near Port Henry, and as other newspapers spread the story, public demand for a bridge swelled. Peterson enlisted the help of state, county, and community organizations, together convincing the legislatures of New York and Vermont of the importance of the bridge.[18]

In 1923, the Vermont General Assembly appointed a commission to consider the feasibility of building a bridge across Lake Champlain through joint action with New York State. In February 1925, the New York State Assembly appointed a Joint Legislative Commission to study the idea, and subsequently, the two states acted in unison. State Senator Mortimer Y. Ferris of

[16] McCullough, "Draft NHL Nomination," updated by Mark S. LoRusso, 2011; Fay, Spofford and Thorndike, "Proposal for Rebuilding Toll Booth and Plaza Crown Point Bridge," 11 May 1959, LCBC Records, Roll 9, NYS Archives; Fay, Spofford and Thorndike, "Contract for Rebuilding the Toll Plaza and Electrical System at Lake Champlain Bridge," 1968, LCBC Records, Roll 9, NYS Archives.
[17] McCullough, "Draft NHL Nomination," updated by Mark S. LoRusso, 2011; Suzanne Maye, Comments on First Draft, Lake Champlain Bridge HAER documentation, 24 June 2010.
[18] James Sullivan, "Carl Frederick Peterson," in *The History of New York State* (New York: Lewis Historical Publishing Co., 1927), 124-125; "C. F. Peterson's Work Duly Recognized," *The Essex County Republican*, 12 July 1929; "Peterson Awoke Public to Span Idea," *Glens Falls Times*, 26 August 1929. All newspaper articles, 1987 or earlier, other than *The New York Times*, are from Northern New York Historical Newspapers, available at http://news.nnyln.net/, NYS Library, or LCBC Records, Rolls, 13-14, NYS Archives. Later articles are from internet sources.

Ticonderoga chaired the New York commission, while George Z. Thompson of Proctor chaired the Vermont commission, which was reorganized in 1925.[19]

In 1925 and early 1926, public hearings were held in nine communities around the lake to determine the best location for the bridge, with chambers of commerce, motor clubs, and tourism organizations weighing in on the debate. The Village of Ticonderoga made a strong case for the bridge, citing the success of Fort Ticonderoga as a tourist attraction, and the village position at the convergence of five primary highways. The village contended that the nearby Larabee's Point ferry was the busiest on the lake for travelers heading to and from the Adirondacks, and to Burlington, Middlebury, and other parts of Vermont. The City of Plattsburg and State of Vermont favored a bridge at the north end of the lake, with Plattsburg and Clinton County supporting a vehicular bridge between Rouses Point and Allburg, Vermont, and Vermont supporting a combined vehicular and railroad bridge that would continue east to Swanton, Vermont.[20]

On April 9, 1926, the Joint Legislative Commission submitted a preliminary report requesting $25,000 to make surveys and test borings of six proposed sites for the bridge at the south end of the lake. The appropriation was granted under Chapter 275, Laws of 1926, and the investigation of the lake bottom, as part of an interstate waterway, was approved by the federal government on July 15, 1926. State Engineer Roy G. Finch directed the engineering for the survey, including the preparation and supervision of the drilling contract, and the preparation of maps, plans, and estimates. State Geologist C. A. Hartnagel provided a report on the lake geology and test borings. The Vermont Commission, for its part, sought public and railroad funds to test a seventh site, at Rouses Point, on the north end of the lake, but was not successful, leaving the site for future consideration.[21]

Test borings reaching a maximum of 170' below lake level were taken at Fort St. Frederic-Chimney Point (Location 1), Crown Point Village-West Bridport (Location 2), Fort Ticonderoga Station-Larabee's Point and the Old Rutland Railroad Trestle near Larabee's Point (Location 3), Fort Ticonderoga ruins-Mt. Independence (Location 4), and Wright's-Chipman's Point (Location 5). The borings revealed deep clay on the lake bottom at all locations. At Fort St. Frederic-Chimney Point, the presence of continuous bedrock at a workable depth, up to 115' beneath the clay, allowed for the construction of a multi-span bridge on deep water piers. At Fort Ticonderoga-Mt. Independence and Wright's-Chipman's Point, the presence of bedrock on the surface or at a workable depth on the shore allowed for the construction of a suspension bridge using shoreline piers. The other sites were eliminated due to absence of bedrock in test borings except on the Vermont side at Location 2, and the absence of bedrock in test borings except on

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[19] New York State, Final Report of the Joint Legislative Commission, *Bridge Connections Between The States of New York and Vermont Across Lake Champlain*, Legislative Document No.59 (Albany: J. C. Lyon Co., 1927), 3-4.
[20] *Bridge Connections*, 3-4; McCullough, "Draft NHL Nomination," 17; "Larabee's Point Ferry Is Preferred By Tourists," *Ticonderoga Sentinel*, 3 September 1925; "Ticonderoga Makes Strong Bid for Champlain Bridge At Hearing Yesterday," *Ticonderoga Sentinel*, 21 January 1926; "Bridge Commission Members Differ As To A Proper Site," *Plattsburg Sentinel*, 24 July 1925; "Lake Champlain Bridge," Editorial, *Plattsburg Sentinel*, 31 December 1926.
[21] *Bridge Connections*, 3-4.

the New York side at Location 3. The only option for a bridge at these locations was a span supported on deep piles in the soft, untested clay.[22]

The Joint Commission requested the State Engineer to prepare designs and cost estimates for bridges at Locations 1, 4, and 5. Two designs were prepared for each location, consisting of a high level truss/arched bridge and a low level truss/lift bridge at Location 1, and suspension bridges with different length suspended spans at Locations 4 and 5, allowing for a 30' roadway and a sidewalk. Following the selection of the preferred designs at a meeting between the New York State and Vermont bridge commissions, on December 15, 1926, new cost estimates were prepared by the State Engineer for the high level bridge at Location 1 and the shorter-length suspension bridges at Locations 4 and 5 bridges, allowing for a 24' roadway and no sidewalk.

At the request of the Joint Legislative Commission, comparative designs and estimates were prepared by J. A. L. Waddell, one of the nation's most eminent bridge engineers. The commission retained Waddell because of the complicated nature of the engineering and the need to have a sound proposition to present to the New York State and Vermont legislatures, with reliable cost estimates for all interested parties. The commission used the findings of both Waddell and the State Engineer in its final selection of a bridge site, commending the State Engineer and staff for the comparability of its findings to Waddell's.[23]

On December 27, 1926, the Joint Legislative Commission submitted a final report on its findings. The report stressed the urgency for a bridge over the lake, due to the inability of the existing ferries to handle the growing traffic in the Champlain Valley. At the time, there were seventeen ferries operating on the lake, with five principal lines on the north end, and seven on the south end. Long delays sometimes resulted from insufficient accommodations on the ferries in the summer, and shortened hours in the spring and fall, and ferry navigation as a whole was limited by a lack of night service on most lines and a short operating season. The report considered this to be an "intolerable situation" remedied only by bridging the lake at suitable points.[24]

The Joint Commission concluded that a bridge over Lake Champlain was needed to provide quick, safe, all day, year-round service and to improve transportation for the public, commerce, and agriculture between New York and New England. The commission recommended Crown Point-Chimney Point as the most cost effective site, laying at the approximate mid-point of the lake, and enhanced by its proximity to the Crown Point Reservation. The committee recommended the construction of a multi-span truss bridge with a 300'-wide channel span, a 90' navigation clearance, and a weight capacity of 24 tons. The proposed design was the original high level bridge design by the State Engineer, consisting of a cantilevered, tied arch channel span with multiple arched deck girder spans extending to each shore. The bridge was to be built, owned, and maintained jointly by New York State and Vermont, at 60 percent and 40 percent

[22] *Bridge Connections*, 9-14.
[23] *Bridge Connections*, 9-12, 17-22, 29-32.
[24] *Bridge Connections*, 6-8.

respectively. The costs were to be repaid by tolls not to exceed the current ferry rate, and the bridge was to be toll free when the debt was paid.[25]

On May 11, 1927, a compact was approved between New York and Vermont, creating the Lake Champlain Bridge Commission. The commission had full power to purchase, construct, own, maintain, and operate a highway bridge across Lake Champlain, and to borrow money, and secure it by bonds or mortgages on any property held or acquired by the commission. The six-member commission consisted of Mortimer Y. Ferris, Chairman; George Z. Thompson, Vice-Chairman; Albert E. Phelps and Marion L. Thomas, New York State; and Charles E. Schoff and William R. Warner, Vermont.[26]

FAY, SPOFFORD AND THORNDIKE, ENGINEERS

The commission appointed Fay, Spofford and Thorndike, of Boston, as Engineer on August 3, 1927. The firm of Fay, Spofford and Thorndike was established in 1914 by three graduates of civil engineering programs at the Massachusetts Institute of Technology (M.I.T.), Frederic H. Fay, Charles M. Spofford, and Sturgis H. Thorndike. Fay graduated in 1893, Thorndike in 1895, and both began working as engineers for the City of Boston soon after graduation, although Fay worked briefly for Boston Bridge Works before joining the city's engineering department. In Boston, both men became actively involved in bridge projects. Fay eventually was Chief Engineer for the Bridge and Ferry Division in the Department of Public Works, and Thorndike was Engineer-in-Charge of bridge design and, later, a designing engineer in the Bridge and Ferry Division. Both men left the city in 1914 when they formed their consulting partnership with Charles Spofford. However, Fay remained active in city and regional planning and guided the firm on many large-scale planning projects. He also served as the principal figure in securing the contract for the Lake Champlain Bridge.

Spofford, who with Fay graduated from M.I.T. in 1893, worked for the Phoenix Bridge Company during summers for several years and, at the same time, began teaching courses at M.I.T. In 1905, he accepted a full-time appointment to the faculty of Polytechnic Institute of Brooklyn, a position he held until 1909, when he returned to M.I.T. as Hayward Professor of Civil Engineering. He remained in that post until his retirement in 1954. In addition to his teaching and consulting work, Spofford also authored several engineering textbooks, including a 1937 treatise titled *The Theory of Continuous Structures and Arches* and a subsequent edition titled *The Theory of Structures*.[27]

The firm's earliest commissions involved projects in the Boston area, including a very large undertaking for the Boston Army Supply Base during the years 1918 to 1920. In 1921, however, they were selected to supervise the construction of streets, utilities, water systems, and other

[25] *Bridge Connections*, 14-15.
[26] Spofford, "Lake Champlain Bridge," 624.
[27] Charles M. Spofford, *The Theory of Structures* (New York: McGraw Hill Book Company, Inc., 1939).

infrastructure for the new town of Mariemont, Ohio, a project that helped to put the firm in a national spotlight and may have impressed the Lake Champlain Bridge Commission.[28]

However, the commission's annual reports are generally silent on the process by which Fay, Spofford and Thorndike were selected, mentioning only that the group investigated the standing and ability of a number of engineers and engineering partnerships or corporations with the goal of finding the engineer or engineers who could satisfactorily address the engineering problems presented by the project. Minutes of the commission's meetings and records of correspondence are only slightly more informative. The commission first convened on June 20, 1927, and, after electing Ferris as Chairman, Thompson as Vice-Chairman, Schoff as Treasurer, and Phelps as Secretary, apparently assigned the task of soliciting interest among the country's bridge engineers to one or more members, including Marion Thomas. Thomas's inquiries included a letter to the American Institute of Mining and Metallurgical Engineers requesting recommendations, and the names of J. V. W. Reynders, Ralph Modjeski, J. A. L. Waddell, and Gustav Lindenthal were offered in reply.[29]

At its meeting of August 2, 1927, the commission established a separate engineering sub-committee comprised of Ferris, Thompson, and Thomas and authorized this sub-committee to engage engineering services and to close contracts. At that same meeting, too, Ferris introduced Frederic Fay to the commission and later that day, the engineering sub-committee executed a contract with Fay's firm. Attached to the contract were sketches of four designs, including two designs for simple-span trusses, one swinging continuous truss similar to the design eventually selected, and a suspension bridge. Charles Spofford almost certainly prepared those drawings in anticipation of securing the contract, indicating that members of the firm, Fay in all likelihood, had been in communication with commission members, probably Ferris, for some time. Spofford's drawings may have been particularly influential in the selection process, as well, complementing Fay's energetic abilities as a project planner.[30]

Although Spofford ultimately played a principal role in designing the Lake Champlain Bridge, Fay served as the primary contact between the firm and the commission during much of the project, and he also approved designs for the substructure. Letters between Fay and commission members, usually Ferris, reveal Fay to be a capable figure, prompt in his correspondence, who worked diligently for the commission and who addressed a multitude of obstacles in seeing the complex project through to completion. Fay's partner, Carroll A. Farwell, joined him at the site in August of that year as the firm prepared to conduct field surveys, and another partner, George Mirick, began serving as the resident engineer in May 1928. In particular, Fay proved adept at confronting the slow progress of the contractor for the sub-structure, Merritt-Chapman & Scott Corporation, during the fall of 1928, and he relied considerably on Mirick for information about

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[28] Richard Casella, "National Historic Context and Significance of the General Sullivan Bridge," prepared for the Preservation Company, Kensington, New Hampshire, and the New Hampshire Department of Transportation (Concord: New Hampshire Division of Historical Resources, October 2005).
[29] H. Foster Bain, Secretary of the American Institute of Mining and Metallurgical Engineers, to M.L. Thomas, 12 July 1927; M.L. Thomas to J.V.W. Reynders, 14 July 1927, LCBC Collection, Box 3, Folder 1, VT State Archives.
[30] Lake Champlain Bridge Commission, Minutes (2 August 1927 and 13 September 1927), in LCBC Collection, Box 1, Folder 2, VT State Archives.

emerging problems. The rapid completion of the successful project is a tribute to Fay's abilities, and also to Mortimer Ferris's administrative skills as chair of the commission. Thorndike, sadly, died in 1928, at age 60, before seeing the bridge completed.[31]

DESIGN OF THE BRIDGE

On November 15, Fay, Spofford and Thorndike submitted a "Report on Preliminary Designs and Estimates" to the Lake Champlain Bridge Commission. The report considered three designs refined from their four original designs, a multi-span continuous truss bridge (Scheme C-2), and two suspension bridges (Schemes D-2 and D-3). The proposed truss bridge, ultimately chosen, was 2192' in length, consisting of a 434' arched channel span, five deck truss spans, and a viaduct at either end. The use of a cantilevered, continuous truss structure linking the channel span to the two flanking spans, offered two advantages: an economy of materials and an ease of construction. The channel span could be built out from the center piers with limited falsework, which was important due to the depth of supporting bedrock at the center of the lake and to the need to keep the navigation channel open at all times. Deck trusses would provide an unobstructed view of the lake from the bridge. The bridge featured an extra span on the New York side due to the navigation channel being closer to the Vermont shore. Otherwise the bridge was designed to be symmetrical, with deck spans of increasing length leading to the long arched span at center.

Both suspension bridge designs were 2200' in length. The Scheme D-2 suspension bridge consisted of a 1000' suspended span between the supporting piers, 350' anchor spans, and viaducts on each end. The Scheme D-3 suspension bridge consisted of a 700' suspended span between the piers, 350' anchor spans, and a 185' deck truss and viaduct on each end. This design was provided as a less expensive alternative to the truss bridge, which overall was the least costly. Among the shortcomings of the suspension bridges was the use of a stiffening truss along the deck, which would partially obscure the view of the lake from the bridge, and the high supporting towers, which would rise approximately 180' above the lake.[32]

[31] LCBC, Minutes. See also "Agreement, Engineering Services for Proposed New Lake Champlain Bridge between Fort Frederick in the Town of Crown Point, New York, and Chimney Point in the Town of Addison, Vermont," 2 August 1927, LCBC Collection, Box 10, Folder 2, and Frederic H. Fay to Honorable Mortimer Y. Ferris, 13 August 1927; Frederic Fay to Mortimer Ferris, 24 April 1928, and Frederic Fay to H. Hopson, Chief Engineer of Merritt-Chapman & Scott Corporation, 25 September 1928, LCBC Collection, Box 5, Folder 8, both in VT State Archives.

[32] The truss design of Fay, Spofford and Thorndike was similar in appearance to the original high level bridge designed by the Office of State Engineer Roy G. Finch and likely was influenced by it. In both designs, the concept was the same, to provide an attractive center arch over the navigation channel and deck structures elsewhere on the bridge to allow an open view of the lake. The preliminary report indicates that Fay, Spofford and Thorndike specifically weighed their design against the State Engineer design, citing the greater impact of the State Engineer design on the Barnes property on the Vermont side, and the steeper roadway gradient of the State Engineer design. In their continuous truss design for the channel span, Fay, Spofford and Thorndike offered an improvement on the tied arch truss proposed the State Engineer, which, according to the preliminary report, would be too expensive to build due to the depth of bedrock below the arch springing lines.

A key factor in the consideration of a suspension span, as well as a multiple truss span, was the cost of building the supporting piers. Specifically, piers built at the center of the lake, on bedrock more than 100' below the mean water level, would be much more expensive than piers built on shallower bedrock closer to the lake edge. The truss bridge required two deep water piers, while the shorter suspension bridge required only one deep water pier, and the longer suspension bridge required no deep water piers. The engineers specified that the shallow water piers were to be built by the open coffer dam method and the deep water piers by either the open coffer dam method or the pneumatic caisson method. The shallow water piers were to have solid concrete rectangular sections, while the deep water piers were to have cylindrical columns from bedrock to below the extreme water level, with solid concrete rectangular upper shafts. Ultimately, the extra expense of building deep water piers for the truss span was not enough to disqualify it, due to the much higher cost of building the superstructure of the suspension bridges.

Other factors discussed in the engineering report were the channel span vertical and side clearance, the center line of the bridge, and the effect on the property of W. F. Barnes on the Vermont side. The recommended vertical clearance of 90' was based on the height of the smokestack on the steamer *Vermont* at the extreme high water level. The recommended side clearance of 300' was based on the requirement of towage fleets navigating a curving channel. The center line of the bridge was set at 30' north of the Vermont ferry road, both to maintain the operation of the ferry, and to limit impact to the property of W. F. Barnes. The truss design was found to have less impact on the Barnes property than either suspension bridge design, both from a physical and an aesthetic standpoint. The report concluded with a comparison of construction costs for the three designs, with the truss bridge at $835,740, the long suspension bridge at $997,430, and the short suspension bridge at $925,790. With the added cost of engineering, the truss bridge was the only design that was guaranteed to be within the $1 million ceiling set by the Bridge Commission for building the bridge.

A subsequent paper presented by Charles Spofford provided further insight into the design selection for the bridge. The engineers had considered the pros and cons of four different types: the end-supported truss, the cantilever truss, the continuous truss, and the suspension bridge. The end-supported truss was eliminated due to its less pleasing appearance relative to the other designs, and a too-steep gradient over part of its length. The cantilever design was eliminated because it required a suspended span that was proportionately shorter than considered advisable and would be less rigid than a continuous truss due to more expansion joints in the floor. The continuous truss was favored over the cantilever truss because it had a greater economy of construction, a lower degree and rapidity of deflection, and a more pleasing appearance. A potential shortcoming of the continuous truss was the possibility that it could settle and cause serious changes in the truss stresses, however, the footing of the piers on bedrock was thought to eliminate this possibility. A possible unequal settlement of the piers after the truss was erected would only affect the stresses at the truss ends, which were used to jack the truss into place, and not the stresses on the entire truss. The comparison of a continuous truss bridge to a suspension bridge revealed that in addition to its lesser cost, the profile of the continuous truss was more appealing. The shorter suspension bridge, with long flanking spans on either end, appeared too short for the crossing, while the longer suspension bridge, despite extending between the two shores, appeared too long.[33]

The engineering report did not specifically mention the ruins of Fort St. Frederic at Crown Point as a factor in the bridge design, but it is clear that any impact to the ruins were unacceptable to the Bridge Commission. The Crown Point Reservation, including Fort St. Frederic and Fort Crown Point, was an important historic site and tourist attraction on the lake and one of the reasons originally given by the Joint Legislative Commission for building the bridge at Crown Point. In a discussion of the bridge site in the 1929 Annual Report, the Bridge Commission noted the "interesting old ruins of the two historic forts" and the "magnificent memorial lighthouse" commemorating Samuel de Champlain on the Crown Point Reservation. Commission Chairman Mortimer Ferris was a native of Ticonderoga and knew of the historic resources on the lake. In earlier consideration of a bridge site at Ticonderoga, he had cited the floating bridge erected there by General Amherst for a highway to Massachusetts and later used to bring cannon from Fort Ticonderoga to Boston. The bridge ultimately was built very close to the southeast bastion of Fort St. Frederic, separated from the fort by just the width of the access road to the old ferry.[34]

The following passage from *The Lake Placid News* suggests the condition of the fort at the time the bridge was built:

> Fort St. Frederic, built by the French at the extreme end of the point, is practically in the shape in which it was left by General Montcalm upon his retirement from it. A grass covered mound of debris occupies the site of the chapel, flag tower and the powder magazine, blown up when Montcalm evacuated the fort, and it is claimed-the dungeons. Other mounds mark the bastions, but little or no trace of the stone work is visible. One grass grown mound topped by a tree was opened some time ago and below it were found the fort ovens built of stone. [35]

Although the fort was more overgrown than it is today, the preceding passage appears to exaggerate the condition of the fort in 1929. Photographs taken during the bridge construction reveal the clearly exposed stonework of the southeast bastion of the fort, closest to the bridge.[36]

Across the lake, the site of the earlier French fort at Chimney Point was known, but was not acknowledged in the engineering report by Ferris. Lacking any visible ruins, this fort received no special consideration in the planning for the bridge, which was built directly over its site. The

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[33] Spofford, "Lake Champlain Bridge," 631-634.
[34] Lake Champlain Bridge Commission. "Third Annual Report," (1929), in LCBC Records, Roll 7, NYS Archives; "Ferris Hopes to Have New Bridge Soon," *Plattsburg Sentinel*, 10 March 1925; Fay, Spofford and Thorndike, LCBC, "General Plan and Elevation of Superstructure," Plan 29, Sheet 9, "Fay, Spofford and Thorndike, Lake Champlain Bridge," Fay, Spofford and Thorndike, March 1928, NYSDOT, Region 1, Schenectady, NY, digital copy.
[35] "Interest Grows in Crown Point Reservation," *Lake Placid News*, 2 August 1929.
[36] See Appendix III, Figure 15.

Chimney Point Tavern, then the dwelling of Millard Barnes, was given ample distance by the bridge.[37]

The Bridge Commission adopted the continuous truss design at the submission of the engineer's report on November 15, 1927. The plans for the bridge were formally approved by United States District Engineer on February 1, 1928, and by the Chief Engineers and Secretary of War on March 23, 1928. The U.S. Congress approved the Bridge Commission in its purpose of building a bridge across Lake Champlain, on February 16, 1928.

CONTRACTS, FINANCING, AND TRAFFIC ESTIMATES

The contracts for constructing the bridge were advertised in newspapers and trade publications on April 12, 1928. Separate contracts were advertised for the whole bridge (Contract 1), for the substructure using the coffer dam method or the pneumatic caisson method for the channel piers (Contract 2), and for the superstructure (Contract 3). Contract 1 received one bid, by James E. Cashman, Inc. of Burlington for just over $1 million; Contract 2-pneumatic caisson method received four bids with a low bid of $433,490 by The Foundation Company of New York City; Contract 2-open caisson method received four bids with a low bid of $385, 000 by Merritt-Chapman & Scott Corporation of New York City; and Contract 3 received five bids, with the low bid of $535,177.06 by the American Bridge Company of New York City. On May 18, 1928, the contracts were awarded to Merritt-Chapman & Scott and the American Bridge Company as low bidders, following an investigation of the qualifications of each firm.[38]

The contracts for the street lights and electrical facilities (Contract 4) and for a toll collector's dwelling to be built on the New York end of the bridge (Contract 5) were advertised in early 1929 and awarded on May 7, 1929. The lighting contract was awarded to Alvin E. Bennett of Crown Point, for $9,450, the lowest of six bids. The toll collector's dwelling contract was awarded to Charles E. Malone of Port Henry, for $9,593, the lowest of seven bids.[39]

The title for land on the New York end of the bridge was obtained from the New York State Conservation Commission under Chapter 321 of the Laws of New York for 1927. The title for land on the Vermont end was obtained from property owner Millard F. Barnes on March 29, 1928. A preliminary payment of $5000 for damages was given to Mr. Barnes at this time, as the price of his land was being negotiated. A total damage award of $17,500 was assessed on August 28, 1928.[40]

The financing for the bridge consisted of an initial $200,000 appropriation by New York and Vermont in 1927, which was to last until September 1928. Following the letting of the construction contracts, an estimate was made of the total cost of completing the bridge, plus the

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[37] "Interesting History of Chimney Point Home," *Essex County Republican*, 20 July 1928.
[38] Lake Champlain Bridge Commission, "Second Annual Report, (1928)," 4-5.
[39] LCBC, "Third Annual Report," 12.
[40] LCBC,"Second Annual Report," 4-5.

interest accrued prior to the opening of the bridge, when it would become self-supporting from toll revenues. A total amount of $1 million in bonds was sold to finance the bridge. The condition of the bond market in May 1928 dictated that the bonds be sold early to take advantage of more favorable interest rates. The Bridge Commission authorized the bond issue on May 18, 1928, and advertised it on May 23. Six financial institutions bid on the bond issue and offered interest rates ranging from 4 to 5 percent. The bid of the National City Company and Old Colony Corporation, for $994,290 at 4.29 percent, was accepted as the largest amount at the lowest rate. This was considered a very favorable rate which would save the commission a large amount over the 30-year amortization period.[41]

As part of its planning process, in 1928, the Bridge Commission requested that Fay, Spofford and Thorndike complete a detailed study of the amount of traffic that would cross the bridge, especially in its early years of operation. The engineers would need to take into account numerous factors, including the amount of traffic presently carried by ferries and the amount of ferry traffic that would be diverted to the bridge, the conditions of main highways leading to the bridge, the normal rate of increase of traffic paired with the additional traffic attracted by the bridge, and the rate of the bridge tolls. Two sets of estimates were made, for probable traffic, based on figures for other bridges, and for minimum traffic. The estimates generally indicated that after an initial surge, traffic increases would slow to the normal rates on highways in New York and Vermont. The estimates for minimum vehicles were 95,000 for 1930, 190,000 for 1935, and 222,000 for 1940. The estimates for probable vehicles were 142,000 for 1930, 333,000 for 1935, and 402,000 for 1940. Left out of the equation was the economic collapse and slow recovery that would define the 1930s, resulting in actual figures well below the estimates.[42]

BUILDING THE BRIDGE

Merritt-Chapman and Scott commenced work on the substructure of the bridge in mid-June 1928, and progressed rapidly, completing the work in just over six months. The substructure was built under the direction of George Burrows, assistant construction manager, with Fred Logan, superintendent, and W. H. Walder, engineer on-site. Merritt-Chapman and Scott was a large and experienced firm, specializing in marine salvage and a variety of port and harbor development projects. In 1929, the company employed more than 2500 people, including more than forty divers for salvage and underwater construction, with fifty projects then under construction.[43]

Merritt-Chapman and Scott shipped construction materials, floating equipment, and supplies to the bridge site from its headquarters in New York City, using the Hudson River and the Barge Canal to reach Lake Champlain. Aggregate for the concrete used in the abutments and piers was obtained primarily from the Witherbee Sherman Company iron mines at Mineville, 9 miles

[41] LCBC, “Second Annual Report,” 6-7.
[42] LCBC, “Second Annual Report,” 8-9; LCBC, “Eleventh Annual Report, (1937),” Exhibit G.
[43] Robert Mac Millen, *Black Horse of the Sea* (New York: Merritt-Chapman and Scott Corporation, 1929), 7, 15; “Deep Foundations for Lake Champlain Bridge Built With Open Cofferdams,” *Engineering News-Record* (21 November 1929), 799.

northwest of the bridge. Coarse aggregate, consisting of crushed ore containing than 10% of the original iron, and fine aggregate, consisting of iron tailings, was brought down to Port Henry by rail and floated by barge to the bridge site. Supplementary coarse aggregate was obtained from the Chateaugay Ore and Iron Company mine at Lyon Mountain, in August 1928, due to a temporary shortage in supply from Witherbee and Sherman. Nearby farm lots provided the fill materials for the abutments.[44]

The many laborers who worked on the bridge came from the surrounding towns and places further away, including northern Vermont and Canada. Most of the workmen were housed in barracks near the entrance to Fort St. Frederic, with company personnel residing there, in area farmhouses, and at Port Henry. Two workers for Merritt-Chapman and Scott lost their lives at the beginning of construction. On June 12, 1928, George Vanderhof of Port Henry was critically injured while loading timber onto a barge. One of the timbers rolled back and struck him, fracturing his spine, left arm and left leg. Vanderhof was taken to the Mineville hospital and subsequently died. On August 5, 1928, Archie Arseneau, from Canada, died after being struck by a swinging beam, falling from a pier thirty feet into the lake.[45]

Progress reports on the bridge were published in newspapers around Lake Champlain, including *The Ticonderoga Sentinel*, *The Adirondack Record-Elizabethtown Post*, *The Essex County News* (Keeseville and Port Henry), *The Plattsburg Sentinel*, and *The Burlington Free Press*. The frequent news reports fueled interest in the bridge, bringing a steady stream of onlookers to view the work.

In late August 1928, *The Ticonderoga Sentinel* described the bridge site as “one of the busiest places in the Champlain valley.”

> Construction houses, machinery and great numbers of bridge workers have transformed the quiet lakeside spot into a center of activity, and the noise of construction work rivals that of a city. Dredges are engaged in clearing away soft rock on the lake bottom in order that bed rock may be reached for the piers of the bridge. Great concrete mixers pour large quantities of concrete into the pier forms. Many trucks add the noise of their motors to the general din. A large number of spectators congregate daily at the scene of operations.[46]

All of the six piers for the truss spans were built in water by the open coffer dam method. The coffer dams consisted of steel sheet pilings driven to bedrock inside a timber guide frame from a

[44] Spofford, “Lake Champlain Bridge,” 639; George L. Mirick, Resident Engineer, Fay, Spofford and Thorndike, Weekly Report to Lake Champlain Bridge Commission, Lake Champlain Bridge, 17 August 1928, LCBC Records, Roll 8, Box 10, Folder 3, NYS Archives; LCBC, Minutes, 7 August 1929, LCBC Records, Roll 1, Box 2, NYS Archives; “Material for New Bridge to Cross Lake Champlain,” *Adirondack Record-Elizabethtown Post*, 30 August 1928.
[45] “Port Henry Man Hurt At Crown Point,” *Plattsburg Sentinel*, 15 June 1928; “Champlain Bridge Worker Killed in Accident Yester’y,” *Ticonderoga Sentinel*, 15 August 1928; Fay, Spofford and Thorndike, “Lake Champlain Bridge,” Engineers Final Report Preliminary Draft, 3 January 1930, 33, LCBC Records, Roll 8, Box 10, Folder 3, NYS Archives.
[46] “Work on Lake Champlain Bridge Going Ahead,” *Ticonderoga Sentinel*, 30 August 1928.

working floor above the pier site. The pilings were internally braced by tiers of horizontal steel I-beam frames, with heavier bracing used on the lower portion, to be poured under water. A team of divers positioned and wedged the frames into place as clamshell buckets removed the lake sediment, linking the sections together with vertical tie rods, except at Pier 8, where cables were used. The divers worked in shifts of a maximum of one hour due to the cold water and extreme pressure at depth. The excavated lake clay was loaded onto barges and deposited in nearby Bulwagga Bay.[47]

The bedrock exposed at the bottom of the coffer dams was inspected for any remaining sediment or loose rock that required removal. The bedrock surface proved to be especially satisfactory for the piers according to Engineer Thomas Spofford. The surface revealed glacial scouring, which ensured a good bond with the concrete of the pier footings. The piers for the channel span, Piers 6 and 7, required excavation to a depth of 100' below the low water level of the lake to reach bedrock. Spofford considered these to be the deepest piers yet constructed using a single-walled open coffer dam and with a deep concrete seal under water.[48]

The concrete was handled by a derrick boat and mixed on an accompanying barge. The underwater concrete used a mix of 1:1.8:3.6 (cement, sand, aggregate, in cubic yards) with 6.5 gallons of water per sack of cement, and the dry concrete used a mix of 1:2.5:5 with 7.7 gallons of water per sack, with mixing times of two minutes and 1.5 minutes, respectively. The lower portion of each pier was poured under water to an elevation of 72', or approximately 20' below the low water level of the lake. The concrete was poured using a patented bottom-drop bucket with a capacity of one cubic yard, covering a circle of 10' to 12' in diameter. The bucket was kept full to restrict water from entering, and the concrete was maintained at a standard slump of 3" to 4". The concrete was spread out from the center to the sides of the coffer dam, allowing the laitance to flow out from the edges.[49] The pour was continuous, requiring six days for the deep water piers. The upper portion or shaft of each pier, above 72' elevation, was poured in a dry state by pumping the water out of the coffer dam once the underwater seal had hardened. The shaft concrete also was poured by drop buckets using wooden forms.[50]

The concrete was inspected throughout the construction process. The upper surface of the piers was spot checked by divers and shown to have little or no laitance, and only 2" to 3" of accumulated laitance was removed from the surface of the completed piers. The concrete was shown to have a high strength as it was removed from the mixer, though it was not tested for potential reduced strength from the formation of laitance after it was poured. Test cores taken throughout the work were sent to the Cambridge Laboratories of the Massachusetts Institute of Technology, which found the concrete to be "unusually strong," reflecting the use of iron mine tailings, with a high percentage of iron ore, for the aggregate. One concern was the potential effect of hydrostatic pressure on the setting time and strength of the concrete poured under water

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[47] Spofford, "Lake Champlain Bridge," 641-3; "Deep Foundations," 797-8.
[48] Spofford, "Lake Champlain Bridge," 641-3.
[49] "Laitance" is defined as the accumulation of fine particles on the surface of fresh concrete due to the upward movement of water.
[50] "Deep Foundations," 797-8; Spofford, "Lake Champlain Bridge," 643-4.

at considerable depth. In a report on the Lake Champlain Bridge, presented October 1929, Thomas Spofford stated that a previous investigation, in 1928 and 1929, showed that concrete of similar composition and poured under a pressure of 50 lbs per square inch, was actually stronger than concrete poured under atmospheric conditions when allowed to cure over a period of three to twenty-eight days.[51]

By early October 1928, most components of the substructure were either complete or underway. The Vermont abutment, the viaduct piers on each end, and pier four on the New York end were complete. The New York abutment was nearly complete, and piers five, six, seven, and nine were in progress. Only pier eight had not been started. By early November, most of the piers had been completed and pier eight was ready for underwater concrete. Pier six, one of the deep-water piers, proved to be troublesome due to problems in placing the walings and bracing at the bottom of the caisson. Seven divers worked in relay teams to expedite the work, with three divers leaving work due to the bends. As a result, Merritt-Chapman and Scott was forced to set up a decompression lock and sweat room at the insistence of their insurance company. The pier was completed December 21 and an American flag was floated over it to signify the practical completion of the substructure contract.[52]

In the meantime, the American Bridge Company had commenced work on the superstructure, under the direction of J. E. Wadsworth, division engineer; H. W. Troelsch, assistant engineer; and J. B. Gemberling, construction manager. Formed by J. P. Morgan and Company from twenty-four small companies in 1900, the American Bridge Company was the major bridge builder in the United States in the early twentieth century. By 1929, the versatile company had erected spans ranging from simple truss bridges over the New York State Barge Canal to the steel-arched Hell Gate Bridge in New York City (1916), the Benjamin Franklin suspension bridge in Philadelphia (1926), and the Carquinez Strait Bridge near San Francisco Bay (1927), a cantilever truss span that required a complicated assembly procedure perfected with scale models.[53]

In August 1928, American Bridge began to fabricate steelwork for the Lake Champlain Bridge at its plant in Elmira, New York, using steel from its Pencoyd mill, near Philadelphia, Pennsylvania. All parts of the bridge were fabricated at Elmira, except for some of the large cast-steel truss bearings, which were made at Pencoyd. Beginning in mid-November, the completed steelwork was brought in on the Delaware and Hudson Railroad to Burdick's Crossing, on the New York side, and trucked 3 miles to the bridge site.[54]

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[51] Spofford, "Lake Champlain Bridge," 638-9; "Deep Foundations," 798; Frank Lanagan, "Ore Tailings in Sidewalk Top Course," *Concrete* 11 (July-December 1917): 45.
[52] "Champlain Bridge Work Progresses," *Adirondack Record-Elizabethtown Post*, 4 October 1928; "Deep Foundations," 800; Fay, Spofford and Thorndike, Mirck, Weekly Reports, 17 November 1928, 1, 15, 22 December 1928..
[53] "Timeline," American Bridge, available at http://www.americanbridge.net/AboutUs/timeline.php, accessed 10 January 2011.
[54] Fay, Spofford and Thorndike, "Lake Champlain Bridge - Engineers Final Report," 34; Fay, Spofford and Thorndike, Mirick, Weekly Report, 17 November 1928.

Work on the superstructure began in mid-December, and with the help of good weather, the company completed the New York viaduct and began the first truss, span four, by the end of the year. *The Adirondack Record* reported that the Crown Point forts were "literally packed" with automobiles bringing in sightseers to view the work. Construction progressed almost on schedule through January, with only a day and a half lost due to bad weather, and by the beginning of February, span four and half of span five had been erected. With February came severe cold and snow, resulting in several serious accidents and three days of lost work. George Mirick, resident engineer for Fay, Spofford and Thorndike, surmised that more days would have been lost except that most of the workers were from northern Vermont. By the end of the month, span five had been completed and span six was underway.[55]

On the Vermont side of the bridge, the original plan was to carry the steel to the end of a completed span five and skid the beams across the lake ice to the opposite shore. Unfortunately, the relatively mild weather in January resulted in thin ice which would not bear the weight of the steel. The solution was to ship the steel to Vergennes, Vermont, by rail and transport it 15 miles over unimproved roads to the bridge. This procedure continued until the ice went out of the lake, after which the steel was carried across the lake by barge.[56]

Preparations for work in Vermont began in early March 1929, with the first steelwork arriving from Vergennes, a field office built near the bridge, and a team of sixty workmen organized to do the construction. By the end of the month, the Vermont viaduct had been completed and span nine was underway. On the New York side, span six was in place and was awaiting the final riveting. Additionally, the Scott Brothers Construction Company had completed hauling material for the bridge deck and approaches, which had been ongoing since December. Work was slowed throughout the month due to poor road conditions caused by the spring thaw. The access road from Burdick's Crossing was described as impassable for automobiles ("even Fords") with companies forced to grade the road to allow their trucks to pass. The state road to the bridge on the New York side had commenced construction in July 1928 but would not be concreted until July 1929, while the newly approved state road connector on the Vermont side would not begin construction until April 1929. Additional delays came at the end of March due to continued rain and snow, forcing crews to work long hours to regain time and to hasten the removal of falsework under span six, which was threatened by melting ice.[57]

Work progressed steadily in April and May, with spans six and eight completed, and span seven, the channel span, underway by the beginning of June. Other work underway by early May included the construction of the toll house by Charles A. Malone and the installation of electric utilities by Alvin E. Bennett, and by late May, the beginning of concrete work on the deck. Additionally, Merritt-Chapman and Scott removed the sheet piling used to build piers six and

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[55] "Champlain Bridge Piers Completed," *Adirondack Record-Elizabethtown Post*, 20 December 1928; Fay, Spofford and Thorndike, Mirick, Weekly Reports, 15, 22 December 1928; 5, 19 January 1929; 2, 9, 23 February 1929.
[56] "Champlain Bridge Now 22 Per Cent Done, Ferris Says," *Ticonderoga Sentinel*, 7 February, 1929; "Ceremonies to Mark Opening of Lake Champlain Bridge," *Ticonderoga Sentinel*, 14 February, 1929; "Deep Foundations," 798.
[57] Fay, Spofford and Thorndike, Mirick, Weekly Reports, 2, 9, 15, 25, 30 March 1929; 6 April 1929; 13 July 1929.

seven and finished the surface of all the piers, as part of moving toward the completion of its contract.[58]

Most aspects of the bridge construction are illustrated in photographs included in the Appendix of this report. On the New York side, the steel was placed by a light-corner derrick traveler that received material from a track on the deck. On the Vermont side, the steel was placed by a traveling A-frame or jinnywink traveler, which received material from a barge below. Except for span seven, all of the bridge was built on timber falsework consisting of towers supported on pilings driven through the lake sediment to bedrock. Most of the falsework was erected during the winter months using the ice as a working surface, with slots cut out for the pilings. For spans four, six, eight, and nine, the towers were built at alternate panel points to support the span as it progressed to the next pier. For span five, the builders chose to cantilever the truss six panels out from span four, place falsework at the end panel to relieve stress at the top chord connection between the spans, and then complete the span by cantilever. This method necessitated an increase in the original size of several of the main members of span four.[59]

Span seven was built out by cantilever from piers six and seven and joined using a technique devised by Fay, Spofford and Thorndike. The technique consisted of levering the two halves of the span into position by lowering and then raising the far ends of continuous spans six and eight. The ends of spans six and eight first were lowered 20" by temporarily removing the roller nests, wedges, and shims under the expansion shoes on piers five and eight. This allowed gaps of 13" in the top chord and 7" in the lower chord of span seven, which were gradually closed to allow insertion of the final members in an unstressed condition. The bottom chord first was closed by jacking up and sliding span eight approximately 3.25" southward, using a sliding rocker shoe on pier seven. The top chord was closed by jacking up the ends of spans six and eight.[60]

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[58] Fay, Spofford and Thorndike, Mirick, Weekly Reports, 6 April 1929; 4, 18, 25 May 1929.

[59] Spofford, “Lake Champlain Bridge,” 650; Henry W. Troelsch, Designing Engineer, American Bridge Company, “Discussion,” in Spofford, “Lake Champlain Bridge,” 655; “Deep Foundations,” 798.

[60] Deep Foundations,” 799. In the following passage from the draft NHL Nomination, Robert McCullough discusses the superstructure stress computations and assembly. “In his address to the American Society of Civil Engineers, Charles Spofford noted that preliminary stress computations for the continuous spans were based on values provided in the 2nd edition of “Kontinuierliche Trager Tabellen,” by German engineer Gustav Griot ‘containing influence data for shear and moment for continuous beams of constant moment of inertia.’ Spofford’s method of erection eliminated the statistical indeterminateness of the dead stresses by establishing the dead reactions at both ends of the three-span approach and channel continuous truss (spans six, seven, and eight). For these spans, the ‘values of the dead reactions, as obtained at piers five and eight from the preliminary design, were used as final values,” and once the trusses were in place, the ends were raised by hydraulic jacks fitted with gauges to secure these predetermined reactions before the concrete deck was installed. Presumably a similar method was used for the two-span continuous truss on the New York side. Before final determination of reactions after jacking, ‘the Method of Least Work’ was used to determine the dead-load reactions. That same method, more precise than the preliminary calculations, also was used to calculate live-load stresses accounting for the elasticity of the members and the irregular depths of the trusses.”

[61] Spofford, “Lake Champlain Bridge,” 644-6.

[62] Spofford, “Lake Champlain Bridge,” 647.

A final step in completing the bridge was the construction of the deck and approaches by the Scott Brothers Construction Company. The deck was built one-half at a time, the southwesterly half first, with concrete delivered in hopper cars pulled by gas-powered dinkeys. The deck featured a reinforced-concrete slab with a special patented concrete wearing surface. A cleavage fabric, burlap, embedded at the base of the wearing surface, facilitated its eventual replacement without disturbing the integrity of the floor slab. Heavy wear on the deck was expected due to the steep incline of the bridge and the use of vehicular chains in winter.[62]

In early June 1929, the Lake Champlain Bridge Commission reported that the bridge approaches were substantially complete and that the channel span would be closed by July 1. Commission Chairman Mortimer Ferris stated that "Splendid progress has been made with the work from the start. Work on the bridge has aroused the keenest interest from the public, and it had to be a very cold and stormy day that did not find many spectators gathered at each end of the bridge, and fairly pleasant Sundays brings a crowd."[63]

By July 15, 1929, the final riveting had been finished on the channel span, completing the steel work except for the railings. The New York approach was complete, and one lane of the connecting road had been concreted. Work continued on the deck and roadways over July and August, with the bridge deck and the Vermont approach completed by August 10, a rebuilt New York approach completed by August 20, and the state roads on both ends completed by August 24. The toll collector's dwelling, toll booth, and temporary lighting for the bridge also were in service by this time, leaving the final painting, installing of toll counters, and landscaping to be finished after opening day.[64]

SIGNIFICANCE OF THE BRIDGE

The Lake Champlain Bridge was a nationally significant engineering landmark and one of the country's most technologically inventive and aesthetically sophisticated designs for highway bridges of its period. Opened to traffic in 1929, the bridge symbolized a convergence of four separate but related trends in transportation engineering, the origins of which can be traced to the closing decades of the nineteenth century: (1) continuous truss technology; (2) a debate within the engineering community regarding the aesthetics of bridge design, and especially the aesthetics of truss bridges; (3) the use of cantilevers in truss design to extend span length, reduce construction costs, and address aesthetic concerns; and (4) evolving engineering responses to rapidly increasing travel by automobiles. Those trends intersected at Lake Champlain, and the inventive design that blossomed from that meeting was original in American engineering. Equally important, the crossing served as the country's prototype for a succession of important bridges built or planned for major waterways during the remainder of the twentieth century.

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[63] "Bridge To Be Opened Ahead of Schedule," *Adirondack Record-Elizabethtown Post*, 6 June 1929.
[64] Fay, Spofford and Thorndike, Mirick, Weekly Reports, 13, 20, 17 July 1929; 3, 19, 17, 24, 31 August 1929; 7 September 1929.

The Lake Champlain Bridge was the third American bridge to adapt continuous-truss technology to highways during an era of rapidly increasing automobile travel. The other two examples, both designed by Austrian engineer Gustav Lindenthal, were completed in 1925 and 1926 across the Willamette River in Portland, Oregon, preceding the Lake Champlain Bridge by several years. However, the distance separating the three bridges, nearly an entire continent, draws them more closely together temporally in the context of assessing regional and national contribution.

More significantly, the Lake Champlain Bridge was the most advanced of this important trilogy and was the country's first example of a continuous-truss highway bridge that employed constructional cantilever anchor spans to achieve a graceful, ascending transition between deck truss approach spans and through truss channel span with curving upper and lower chords. The genesis of that creative design, which offered engineers a structural and aesthetically-comparable alternative to arch bridges for both short and long-span highway crossings, becomes strikingly clear in the sequence of these three bridges.

Continuous trusses, first developed for railroads during the late nineteenth and early twentieth century, represent an important advance over simple span bridges because the latter, in order to achieve multiple spans, are designed as individual structures supported at each end by piers or abutments. In contrast, continuous truss bridges extend over two or more spans as a single structure. The result is a bridge that distributes stresses more efficiently throughout the entire structure, increases overall rigidity, economizes the use of materials, and reduces costs proportionally. As automobile travel increased, producing a corresponding need for increasing numbers of crossings and ever-longer spans above large rivers, bays, and other water bodies, the advantages of continuous truss technology provided important, cost-effective engineering solutions for the design of highway bridges, both moderate and long-span structures, and the bridge type became ubiquitous on the country's network of roads.

The significance of the design introduced by the Lake Champlain Bridge rested in part on the application of continuous truss technology, but especially on a design that offered an aesthetic engineering alternative to arch bridges for highway crossings that must establish adequate channel clearance while responding visually to the many different scenic locales made accessible to automobiles. It is fitting that the first American continuous truss bridge to demonstrate the aesthetic merits of this solution stood at a site as scenic as the crossing of Lake Champlain between Crown Point and Chimney Point. Fay, Spofford and Thorndike specifically selected a continuous truss with cantilever anchors to achieve this swinging channel transition, rather than cantilevers with a suspended truss span or a series of simple trusses, because it offered a more pleasing, curving aesthetic profile for the relatively short channel. Their very successful design was quickly copied at other important crossings where, as at Chimney Point, arch and suspension bridges were either structurally impractical, or too costly.

When the bridge opened in the summer of 1929, the first vehicular bridge to cross Lake Champlain and connect Vermont with New York, Fay, Spofford and Thorndike immediately joined the ranks of America's most innovative bridge engineers. Carl Condit, whose seminal, two-volume work, *American Building Art* chronicles the inventiveness of American engineering, confirms the bridge's original contribution to this country's engineering history, describing it as a "swinging truss" and proclaiming Fay, Spofford and Thorndike to be among the leading pioneers in improving the appearance of truss bridges.[65]

Between 1929 and 1977, more than twenty-five major American bridges located throughout the country borrowed the design introduced by the Lake Champlain Bridge, three of them by Fay, Spofford and Thorndike; others will undoubtedly be added to that list, which also includes an international representative, the Bridge of the Americas across the Pacific Ocean entrance to the Panama Canal. The importance of this select group of bridges immediately becomes apparent when one considers the bodies of water crossed: the Cape Cod Canal; the Niagara, Potomac, Delaware, Piscataqua, Susquehanna, Schuylkill, Columbia, and Hudson rivers; Newark Bay; Chesapeake Bay; Corpus Christi Harbor; the Chesapeake and Delaware Canal; the Port of Long Beach; the Outer Baltimore Harbor, among others. Each of these bridges represents a significant engineering accomplishment in the context of American automobile transportation; each bridge stands at sites that are very visible to multitudes of travelers or urban populations every day; each bridge spans heavily-used waterways that require substantial clearance above navigation channels; each bridge employs an engineering solution—the swinging, cantilever-anchor transition between approach and channel spans—that attempts to reconcile the aesthetic impact of large, engineered structures on scenic environmental contexts and, at the same time, to meet demands for structural and functional efficiency through continuous design; and each bridge is a direct progeny of the Lake Champlain Bridge.

Moreover, the Lake Champlain Bridge design continues to influence American structural engineering, as plans are currently being developed for yet another bridge, this one to be erected between Bristol Township in Pennsylvania and Burlington Township, New Jersey, an identical twin to the Delaware River Turnpike Toll Bridge erected in 1956.

Secondarily, the Lake Champlain Bridge also demonstrated inventive engineering in the design and construction of its channel piers, erected using the open, single-wall coffer-dam process to a depth of nearly 100' below extreme low water. Pier construction is especially important in the design of continuous trusses, necessitating the founding of piers on bedrock of stabile bearing quality. When completed, piers for the Lake Champlain Bridge were among the country's deepest examples built using that design, selected as a more cost efficient system than the pneumatic caisson method at that site. In their 1941 treatise, *Foundations of Bridges and Buildings*, Henry S. Jacoby and Roland P. Davis credited the designers of the Lake Champlain Bridge with significant progress in the construction of deep coffer dams, solving the difficult problem of placing a bracing frame in position inside the coffer dam in such a way that work through water can take place within the dam.[66]

Secondarily, as well, the bridge is significant for its important record of travel scrupulously maintained by the Lake Champlain Bridge Commission throughout the period when tolls were in

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[65] Carl Condit, *American Building Art. The Twentieth Century* (New York: Oxford University Press, 1961), 109-110.
[66] Henry S. Jacoby and Roland P. Davis, *Foundations of Bridges and Buildings* (New York: McGraw-Hill, 1941), 249-250.

place, 1929 to 1987. The commission was established in 1927 by a compact and treaty between Vermont and New York, authorized by legislative resolutions in each state and ratified by an act of Congress. The project provided a new traffic route between the Adirondack, Green and White mountains, and linked up-state New York with northern New England's major cities and coastal resorts. The commission retained Fay, Spofford and Thorndike to conduct traffic predictions, principally to calculate financing requirements and to anticipate repayment of bonds. However, when the bridge officially opened on August 26, 1929, few could have predicted that the country's financial markets would crumble two months later, almost to the day – October 29. Although the firm's traffic estimates exceeded actual use during the ensuing decade, bridge traffic steadily increased from year to year, offering a valuable glimpse of Depression era automobile travel related to commerce, agriculture, industry, and tourism in the country's northeastern region.

The collaborative venture by these two states, for public benefit and at no direct cost to taxpayers, also adds a measure of significance to the bridge, as does the superb documentation of the project in all its details. These materials include site studies, preliminary design sketches and cost estimates, contract plans, bidding proposals, construction and maintenance records, design of the superintendent's dwelling and its landscape plan, design of the toll-booth and its islands and gates, electrical systems, and extensive correspondence among commission members, its engineers, and the public. These records have been carefully preserved and are housed in the Vermont State Archives in Montpelier where they provide opportunity for an exhaustive study of a major bridge project during this important era.

A Context for Continuous-Truss Technology Adapted to Highway Bridges

By 1927, when the Lake Champlain Commission and its engineers had completed the process of selecting a design for the Lake Champlain Bridge, the long era of structural advances made possible (and necessary), by railroads was drawing to a close. Continuous truss bridges had gained modest attention during the last quarter of the nineteenth century, offering in theory a substantial improvement in the distribution of stresses throughout the entire structure, thereby reducing the quantity of materials required (as well as weight and cost). In addition, continuous trusses offered greater stiffness and lateral resistance to wind loads. However, engineers were cautious about several problems associated with the design of continuous trusses and were thus slow to exploit the full potential of the design's benefits for long-span bridges.[67]

For one reason, continuous trusses are statically indeterminate, requiring extensive and difficult calculations to account for stress distributions. In addition, pier settlement creates extreme and unpredictable secondary stresses, although those stresses actually decrease as the length of the span increases; in any case, sinking piers to bedrock is essential. Addressing rapid shifts in bending moment also proved to be vexing. For continuous trusses, bending moment changes from positive at mid-span to negative at intermediate supports, and the fluctuation in bending

[67] Condit, *American Building Art*, 92-98. See also Casella, "National Historic Context and Significance of the General Sullivan Bridge."

moment from a minimum at end points to a maximum at intermediate supports occurs rapidly. To solve this problem, engineers deepened the truss at intermediate supports – either by adding haunches below the bottom chords or by elevating the top chord. However, these circumstances also influenced placement of the expansion joints that must absorb the effects of thermal expansion, which can be considerable in continuous trusses, but which also must be capable of transmitting heavy loads to the structure. To address these concerns, the expansion joints must be located at points where the bending moment is zero, specifically the point between mid-span and intermediate support where the bending moment changes from positive to negative.[68]

Complexities notwithstanding, the Chesapeake and Ohio Railway elected to exploit continuous-truss technology for a colossal bridge across the Ohio River at Sciotoville, Ohio, built between 1914 and 1917. A crossing at that location had become necessary to secure a direct route for the transportation of coal from Allegheny coal fields to ports on the Great Lakes, particularly Toledo and Detroit, and the considerable investment in the bridge revealed the economic importance of the mounting volumes of coal being shipped by that railroad. Carl Condit credits the bridge as marking a turning point in the development of long-span continuous truss designs because of its great size and clear span, and because of the crucial economic role of the route it served. Austrian engineer Gustav Lindenthal, who had been retained as a consultant to assist the railroad's engineering staff, designed the structure and successfully addressed the many problems associated with continuous trusses, aided by the fact that bedrock and riverbed were practically the same, and lay in nearly a horizontal plane from shore to shore, as well, thus solving any concerns about pier settlement and attendant stresses.[69]

Engineers and bridge fabricators subsequently focused considerable attention on the technical aspects of the design and construction methods used for the Sciotoville Bridge. In particular, its two continuous spans, each 775' in length and totaling 1550'—made it the longest continuous truss in the world, a distinction it held for two decades and one that helped the bridge garner acclaim. The McClintic-Marshall Company fabricated and erected the Sciotoville Bridge, and in 1918 that firm's principal competitor, the American Bridge Company, responded by collaborating with engineers from the Bessemer & Lake Erie Railroad (B&LE) to design another major continuous truss bridge across the Allegheny River at Oakmont, Pennsylvania, near Pittsburgh, accomplished with two, three-span continuous deck trusses. Both the American Bridge Company and the B&LE Railroad were subsidiaries of U.S. Steel Corporation, and the bridge became a showpiece for the parent company's products. More importantly, though, both the Sciotoville and the Oakmont bridges elevated interest in continuous truss bridges among the country's engineers and demonstrated the potential for this structural technology.[70]

Lindenthal became a chief proponent of the type and, of special importance, urged engineers to consider it as an economic alternative for short span bridges, as well. Nevertheless, debate among engineers persisted concerning the merits of continuous trusses and focused on analysis

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68 Condit, *American Building Art*, 92-98.
69 Condit, *American Building Art*, 92-98
70 Condit, *American Building Art*, 92-98. See also, Justin Spivey, "Bessemer & Lake Erie Railroad, Allegheny River Bridge," HAER No. PA-508, 2000.

of indeterminate structures in addition to the overall economy of the design, relative to simple spans. Disagreement continued to swirl around the question of assessing stresses, particularly secondary stresses, but by the early 1930s these issues had been put to rest by Hardy Cross, whose analysis of the distribution of fixed-end bending moments reduced computations to a manageable process.[71]

By 1927, Lindenthal had designed two, continuous-truss highway bridges of moderate span in Portland, Oregon: the Sellwood Bridge (1925) and the Ross Island Bridge (1926), each crossing the Willamette River. Both bridges are deck trusses and the older of the two, the Sellwood Bridge, is continuous over four spans with straight top and bottom chords; the two middle spans are each 300' in length. Channel clearance is 75', 15' lower than the Lake Champlain Bridge.

The Ross Island Bridge also employs deck-trusses with straight chords for the approach spans, but then progresses to steeply-curving, constructional-cantilevers anchoring the channel span. Those cantilevers were joined by hinges during construction but were then riveted into place after the deck was installed, becoming continuous at the point. The result is a five-span continuous truss with the channel span achieving a length of 535' and clearance of 100'. The curving chords of the channel anchor spans give the bridge a graceful profile and improve the appearance of the ordinary deck-truss approach spans. In many ways, the Lake Champlain Bridge, completed three years after the Ross Island Bridge, takes the design innovations begun by Lindenthal in Portland to their logical and visually sophisticated conclusion. In many ways, too, the evolution of the design that finally emerged at Lake Champlain can be observed in clear sequence by considering the three bridges together. In this context, Fay, Spofford and Thorndike's contribution is clearly in the forefront of adapting continuous truss technology to highway bridges in America.

As does Lindenthal's Ross Island Bridge, Fay, Spofford and Thorndike's design also borrows elements derived from advances in the design of cantilever truss bridges, inventive developments that occurred during the late nineteenth and early twentieth century, as well. During this period, engineers began employing cantilever systems as expedients in both the construction and span length of truss bridges. Engineer Charles Shaler Smith, who early in his career had formed a partnership with Benjamin H. Latrobe that eventually became the Baltimore Bridge Company, subsequently made important contributions to the development of cantilever designs. Two of his cantilever railroad bridges are among the country's earliest examples, including the Kentucky River Bridge at Dixville, Kentucky, for the Cincinnati & Southern Railroad (1876), and a smaller bridge across the Mississippi River at St. Paul (1880). However, Smith's most accomplished continuous truss to use cantilevers was built between 1885 and 1887 to carry the Canadian Pacific Railway across the St. Lawrence River at the Lachine Rapids near Montreal. The four principal channel spans of his Lachine Bridge, continuous over five piers, were erected with

[71] Hardy Cross, "Analysis of Continuous Frames by Distributing Fixed-End Moments," *Transactions of the American Society of Civil Engineers* 96 (1932): 1-10, discussion 11-156.

cantilever anchors to carry dead load during construction but were then riveted together to form the continuous spans.[72]

Equally important, Smith devised an ingenious method for establishing the transition from deck truss approach spans to through truss channel spans. Generally, through-truss bridges offered a practical solution to the problem of attaining vertical clearance over channels, allowing less-costly deck trusses to be employed on approach spans. Although this method addressed the principal objective of clearance, the two truss types, very different in appearance, produced a visually awkward progression of simple span structures. At the Lachine Bridge, Smith used the cantilever anchors for the two channel spans as transitional forms, curving the bottom and top chords appropriately to provide an arching rise from deck to through truss. By this process, the transition could be disguised easily and the bridge could become a single, visually and structurally integrated continuous span from end to end.[73]

Shaler's Lachine Bridge was the first North American structure to employ that inventive combination of constructional cantilever anchors designed to achieve a swinging transition between deck and through trusses for continuous spans, and Fay, Spofford and Thorndike's Lake Champlain Bridge was the first to use it on any bridge in America, establishing a prototype that would be employed on an impressive number of major highway bridges across some of the country's most important waterways. In addition, Charles Spofford, the bridge's principal designer, improved Shaler's innovation by giving the cantilever anchors a more graceful, less abrupt swing from deck to through truss, achieving resolution of the design in the process.

The complete success of Spofford's design becomes apparent when one compares efforts by both American and European engineers to explore various structural designs that achieve transition from deck-truss approach spans to through-truss channel spans, for both continuous and cantilever trusses. For example, J.A.L. Waddell's Red Rock Bridge (1890) carried a single-line railroad across the Colorado River between Arizona and California, and the cantilever anchors extend both above and below the chords of the channel through truss, providing a segmental transition from half-through truss to through truss.[74]

A number of such designs are considered in Henry Grattan Tyrrell's 1911 treatise, *History of Bridge Engineering*, and Tyrrell acknowledges that some of the bridges have awkward profiles, including the Winona Bridge across the Mississippi River at Winona, Minnesota (1894), where the cantilever anchors have curved upper chords above the channel piers but gradually descend to a half-through trusses at the approaches; a highway bridge across the Mississippi River at Clinton, Iowa (1892) is especially curious in profile, and Tyrrell may have intentionally omitted the names of the engineers for both bridges.[75]

[72] Condit, *American Building Art*, 104-110. See also Henry Tyrrell, *History of Bridge Engineering* (Chicago: Published by the author, 1911), 265; and J.A.L. Waddell, *Bridge Engineering*, 2 vols. (New York: John Wiley & Sons, 1916), 62 and 1072.
[73] Condit, *American Building Art*, 104-110. See also Tyrrell, *History of Bridge Engineering*, 265.
[74] Henry Tyrrell, *Artistic Bridge Design* (Chicago: The Myron C. Clark Publishing Co., 1911), 279.
[75] Tyrrell, *History of Bridge Engineering*, 272, 281.

Other designs employed through-truss approaches with straight upper and lower chords that ascend to curving chords above the channel span, where the roadway is suspended. The Ludendorff Bridge, a railroad crossing erected in 1918 above the Rhine River at Ramagen, Germany, is a notable example of this type, more famous for its role in the Allied invasion of Germany than for its advanced design.

Several important European bridges also utilize truss-reinforced arches for channel spans, again developing various means of transition from the flanking approach spans, typically using a combination of deck arch, half-through arch, and through arch to achieve that transition. Although structurally these bridges are very different from the line of North American bridges begun by Shaler's Lachine Bridge, the methods for achieving a transition between approach spans and through or half-through arch channel spans often suggest a visual exercise similar to that undertaken successfully by Shaler and perfected by Spofford. Thus, these developments may be part of a very broad context, particularly considering the contributions of European engineer Gustav Lindenthal. The Rhine Bridge in Bonn, designed by engineer Reinhold Krohn and architect Bruno Moehring and built between 1895 and 1898, is an early example, distinguished by large masonry towers that create portals for the two-hinged-arch channel span and, in the process, establish a distinctive means of transition from the single-span, hinged deck-arch approaches at each end. Another particularly good example is the Passerelle Debilly across the Seine River, a footbridge designed by French engineer Jean Resal for the 1900 Paris Exposition. The walkway proceeds smoothly from short, partial deck arches to the truss-reinforced through-arch channel span, where the walkway is suspended.[76]

The principal value in expanding this context to include these very different structural types, both American and European, is to demonstrate: (1) that for many years engineers had been seeking a visually satisfactory solution to the problem of transition between approach and channel spans for both truss and arch structures; and (2) that no clear direction had been established with respect to continuous truss bridges until Fay, Spofford and Thorndike achieved a breakthrough at the Chimney Point/Crown Point crossing. That so many other bridges, structurally comparable to the Lake Champlain Bridge, borrowed the same design during the ensuing years is further confirmation of the bridge's contribution to American engineering history.

Among the many reasons for the engineering community's acceptance of this design, its facile applicability to highway bridges proved to be especially important. This was partly because the rising grade of the highway could be more easily concealed as it moved from span to span, cresting above the channel. By increasing highway grade, but doing so in a visually unobtrusive manner, the design thus offered opportunity to maximize clearance at the channel span and, at the same time, reduce the required length of approaches, thus minimizing costs and visual or physical intrusion of the approaches on surrounding contexts. The full value of that advantage gradually became apparent as the need for increasing numbers of highway bridges in very visible locations challenged engineers to be more cognizant of the impact of large structures. For example, the Lake Champlain Commission specifically cautioned its engineers that the historic

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[76] Tyrrell, *Artistic Bridge Design*, 258-59; and Tyrrell, *History of Bridge Engineering*, 346-47.

importance of the site and the fact that the bridge would be conspicuous for many miles made its appearance especially important. In response, Charles Spofford specifically rejected an end-supported truss design for a number of reasons, remarking that he "found it impossible to sketch any simple span design that was at all satisfactory in appearance."[77]

At the time that Fay, Spofford and Thorndike developed their design, plans for another truss bridge with a transitional swinging deck/through truss design were being developed for an elevated expressway between Newark and Jersey City, New Jersey. Designed by Danish engineer Sigvald Johannesson, but not completed until 1932, the Pulaski Skyway represented one of the country's first true superhighways. Carl Condit credits the design as advancing the development of cantilever anchors used as swinging transitions between approach and channel spans, and the profiles of two identical bridges across the Passaic and Hackensack rivers are exceptionally graceful. Part of the explanation is that for these much larger bridges, the entire approach spans (350') for each bridge are used to achieve the transition between the approach spans and the through truss channel spans, and the steadily ascending upper chords of these approach trusses rise to a crest centered above the cantilevers. Johannesson was able to achieve such a very gradual transition because the elevated roadway had already attained much of its required height well before the actual river crossing. For more modest highway crossings, a similar design would have added expense by increasing materials unnecessarily.

Although Johannesson began work on the New Jersey expressway as early as 1923, the project developed in several stages before adoption of the final bridge design. In addition, the Lake Champlain Bridge was completed three years before the Pulaski Skyway opened. When Charles Spofford presented a paper to the American Society of Civil Engineers in October 1929, discussing the history of the Lake Champlain Bridge and its design, members of the audience referred to plans for the Pulaski Skyway, but the extent to which Fay, Spofford and Thorndike considered that project is not known. Presumably, though, Spofford was aware of the project during the period that designs for the Lake Champlain Bridge were being developed.[78]

Regardless, the decade of the 1920s represents an important period in the evolution of bridge design when engineers specifically sought aesthetic solutions to accompany rapidly advancing structural technology. In part, emphasis on aesthetic contributions had been sharpened by competition between the rapidly growing concrete industry and steel manufacturers. This competition led to a national awards program adopted by the American Institute of Steel Construction (AISC) in 1929, providing annual recognition for aesthetic solutions to problems in steel bridge design. The American Institute of Architects and the American Society of Civil Engineers joined the AISC in appointing jury members for those awards.[79]

However, some engineers had been calling for greater emphasis on bridge aesthetics for many years. For example, Henry Tyrell's 1912 treatise, *Artistic Bridge Design*, enters a strong plea for the important relationships between bridges and their settings. Arrival of the automobile added

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[77] Condit, *American Building Art*, 104-110. See also Spofford, "Lake Champlain Bridge," 622-659.
[78] Spofford, "Lake Champlain Bridge," 622-659.
[79] Casella, "Significance of the General Sullivan Bridge."

accent to this dialogue, particularly where new locations for crossings had become necessary to accommodate motorists. Both the annual reports prepared by the Lake Champlain Bridge Commission and the subsequent presentations by Charles Spofford to the American Society of Engineers and, separately, to the Vermont Society of Engineers in 1928, underscore their shared concern for an aesthetically satisfactory design.[80]

J. A. L. Waddell, in his two-volume treatise, *Bridge Engineering*, published in 1916, also proclaimed that the engineering profession, "in order to keep pace with advancing demands upon it," should give more attention to the aesthetic qualities of bridges. Waddell and contributing author, architect Henry Van Brunt, took pains to single out steel truss bridges as "inherently ugly," but Waddell also predicted that with further perfecting of bridge design, aesthetic forms would evolve. Indeed, much of the subsequent discussion was aimed at improving the aesthetic qualities of truss bridges, principally by using curving lines since those were deeemed more compatible with natural forms. Waddell's essay included the author's own conception of a bridge across the entrance channel to the harbor at Havana, Cuba, designed with deck-truss cantilevers rising gradually to support a suspended through truss span, vaguely suggestive of the design that blossomed to maturity at Lake Champlain. Waddell called the lines of his bridge graceful, but the design is visibly unresolved when compared to the profile of the Lake Champlain Bridge. Waddell probably deserves credit, though, for predicting that engineering skills would evolve in response to public demands, and in the case of Fay, Spofford and Thorndike's design, the demands were those of automobile travel through scenic locales.[81]

In any consideration of a topic as subjective as the aesthetic qualities of bridge design, differences of opinion and changing attitudes are inevitable. Attitudes toward engineered structures as starkly utilitarian – designed for strength, durability, rigidity, and utmost economy but without regard to beauty – rests at the core of debate about aesthetic bridge design during the early twentieth century. However, more recent outlook considers pure engineering to have its own redeeming aesthetic qualities. Nevertheless, two important points are indisputable. The first is that the engineering community had confronted the issues surrounding the aesthetic qualities of truss bridges during the early years of the twentieth century, and Charles Spofford's design was a direct and original response to that challenge. The second point is that the best evidence of the success of Spofford's solution can be found in the testimony of those engineers who subsequently borrowed his design. That testimony takes the form of more than twenty-five major bridges in locations throughout the country. The most recent example is the 1977 Francis Scott Key Bridge for the Outer Harbor Crossing at Baltimore, and thus the period of significance for the Lake Champlain Bridge continues through much of the twentieth century, possibly later depending on current plans to use the design for the Delaware River Toll Bridge on the Pennsylvania Turnpike. A partial list of the bridges with designs directly traceable to the Lake Champlain Bridge follows, placed in chronological order. These include examples that partially

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[80] LCBC, "First Annual Report," and "Third Annual Report." See also Spofford, "Lake Champlain Bridge," 622-659.
[81] Waddell, *Bridge Engineering*, 1150-1160; see especially 1158.

suspend deck systems from the curving, through-truss channel spans, as well as those that tie the floor systems to bottom truss chords.[82]

1. Pulaski Skyway, Passaic and Hackensack rivers, between Newark and Jersey City, New Jersey. Sigvald Johannesson (1932).

2. General John Sullivan Memorial Bridge (Little Bay Bridge), Piscataqua River, between Dover and Newington, New Hampshire. Fay, Spofford and Thorndike (1934).

3. Bourne Bridge, Cape Cod Canal, Bourne, Massachusetts. Fay, Spofford and Thorndike (1934).

4. Sagamore Bridge, Cape Cod Canal, Sagamore, Massachusetts. Fay, Spofford and Thorndike (1935).

5 & 6. South Grand Island Twin Bridges, Niagara River, between Grand Island and Tonawanda, New York. Waddell and Hardesty (1935).

7. Cordell Hull Memorial Bridge, Cumberland River, Carthage, Tennessee (1936). Tennessee Department of Highways, L. W. Erickson, Bridge Engineer.

8. Governor Harry Nice Bridge (formerly the Potomac River Bridge), Potomac River between Newburg, Maryland and Dahlgren, Virginia. J. E. Greiner Co. (1940).

9. Susquehanna River Bridge (later the Thomas J. Hatem Memorial Bridge), U.S. Route 40, between Havre de Grace and Perryville, Maryland. J. E. Greiner Co. (1940).

10. George Sellar Memorial Bridge (Columbia River Bridge), WA-285 over the Columbia River, Wenatchee, Washington. Washington State Department of Highways (1950).

11. George C. Platt Memorial Bridge, (Penrose Avenue Bridge), PA-291 over the Schuylkill River, Philadelphia. Modjeski and Masters (1951).

12. John Greenleaf Whittier Bridge, Interstate 95 over the Merrimack River between Amesbury and Newburyport, Massachusetts. Massachusetts Highway Department (1951).

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[82] This inventory of bridges is far from complete, and examples will continue to surface as future studies are completed. A twenty-fifth example depicted on a postcard that is part of Eric DeLony's collection has yet to be identified. Unfortunately, various sources erroneously describe some of these as arch bridges. Rather, they are best described as arching, continuous truss bridges with constructional cantilevers that provide a swinging transition between deck truss approach spans and through truss channel spans. Decks of the through spans are sometimes suspended from the arching trusses. As of September 2011, all of the bridges are still extant. The Gerald Desmond Memorial Bridge is currently under contract for replacement. The General John Sullivan Memorial Bridge, the Governor Harry Nice Bridge, and the Corpus Christi Bridge, are all being considered for replacement. The Cordell Hull Memorial Bridge is closed to traffic.

13. Chesapeake Bay Bridge (Bay Bridge, William Preston Lane, Jr. Memorial Bridge (eastern channel span), U.S. Routes 50 and 301 across Chesapeake Bay, Maryland. J. E. Greiner Co. (1952).

14. Vincent R. Casciano Memorial Bridge (Newark Bay Bridge), Interstate 78 and the New Jersey Turnpike across Newark Bay between Newark and Bayonne, New Jersey (1956).

15. Delaware River Turnpike Toll Bridge, Delaware River between Bristol Township, Pennsylvania and Burlington Township, New Jersey (1956). An identical, parallel span is being planned to accommodate the widening of the I-276 approach in Pennsylvania. Construction of the bridge is scheduled to begin in 2012.

16. Corpus Christi Harbor Bridge, Corpus Christi, Texas. Texas Department of Transportation with the firm of Howard, Needles, Tammen and Bergendoff (1959).

17. Summit Bridge, US 301 across the Chesapeake and Delaware Canal, between Newark and Dover, Delaware (1960).

18. Vantage Bridge, I90 over the Columbia River near Vantage and George, Washington. Washington State Department of Highways (1962).

19. Bridge of the America's, Pacific Ocean entrance to the Panama Canal. John F. Beasly and Company (1962).

20. & 21. Hamilton Fish Newburgh-Beacon Bridges, Interstate 84 over the Hudson River, New York. Modjeski & Masters (1963 – North Span and 1980 (South Span).

22. Gerald Desmond Memorial Bridge, Long Beach Freeway, Port of Long Beach, California. Moffat & Nichol (1968).

23. Piscataqua River Bridge, Interstate 95 over the Piscataqua River between Portsmouth, New Hampshire and Kittery, Maine. Hardesty & Hanover (1972).

24. Francis Scott Key Bridge, Outer Harbor Crossing, Interstate I-695, Baltimore Beltway across Baltimore Harbor, Maryland. J. E. Greiner Co. (1977).

Excluded from this list, however, are the large number of arching, continuous deck or through truss bridges designed without cantilever anchors to provide an ascending transition between deck and through-truss spans, as well as those examples where the transition is between through-truss approach spans with straight or polygonal chords and an arched through-truss channel span (for example, the Julien Dubuque Bridge, Mississippi River, Dubuque, Iowa). Both categories of bridges are probably part of the context relating to aesthetic qualities of truss bridges, but they are more distantly related to the Lake Champlain Bridge.

OPENING DAY CELEBRATION

Governor Franklin Roosevelt made his first visit to the Lake Champlain Bridge on a trip through the Adirondacks on July 29, 1929. Arriving by yacht from Westport, Roosevelt delivered a speech to a receptive crowd in Port Henry before heading to the bridge in the state boat *Inspector*. Governor Weeks of Vermont was expected to meet Roosevelt in a prelude to the bridge opening. The official opening on August 26, 1929, had been announced several days earlier in newspapers. Anticipation of the opening escalated over the next month as towns and villages around the lake and beyond planned their part in the celebration.[83]

The opening day celebration was the culmination of the five years of planning and fifteen months of labor. From its conception, the Lake Champlain Bridge had represented a high-arching symbol of unity and progress for New York and Vermont, promising substantial growth to the surrounding communities. The celebration offered a stage where communities presented their best face to a national audience. The long awaited event became an outpouring of joy and civic pride that was not to be forgotten.

News articles at the end of July 1929 provided early details of the opening day celebration, which was aptly described as an event of international importance. Governors Roosevelt and Weeks would attend, and, possibly, the governors from the other New England states. Invitations were sent to the high dignitaries of the United States as well as noted personages of Canada. The Lake Champlain Bridge Commission, in cooperation with chambers of commerce on both sides of the lake, planned a program that included a marine parade, an aviation display, water sports, and fireworks.[84]

The centerpiece of the celebration would be a grand parade featuring historic and descriptive floats and decorated cars. Vermont planned six floats from Rutland and Burlington, and two or more floats from Montpelier, Vergennes, Middlebury, Brandon, St. Albans, and Bristol. New York expected at least three floats from Ticonderoga and Port Henry, and one or more floats from Crown Point, Westport, Camp Dudley, Lake Placid, Plattsburgh, Lake George, Silver Bay, Glens Falls, Keeseville, Ausable Forks, and Elizabethtown, with additional floats provided by Essex County and the Adirondack Resorts Association. The Lake Champlain Bridge Commission offered $150 for the best floats and decorated cars, and the Vermont State Chamber of Commerce offered $75 for the best from Vermont. [85]

In mid-August 1929, LCBC Chairman Mortimer Ferris called on local committees for a large representation in the parade. Middlebury asked its residents for the best possible showing and

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[83] "Governor Roosevelt Will Greet Residents of Port Henry Mon;" *Glens Falls Times*, 25 July 1929; "L. Champlain Span to Open Aug. 26," *Albany Times Union*, 26 July 1929; "New Bridge Is Inspected by Governor," *Glens Falls Times*, 29 July 1929.
[84] "To Open Champlain Bridge Aug. 26th," *Ticonderoga Sentinel*, 1 August 1929; "L. Champlain Span to Open Aug. 26," *Albany Times Union*, 27 July 1929.
[85] "Completing Plans For Bridge Opening," *Ticonderoga Sentinel*, 1 August 1929; "Thousands to Attend Bridge Opening," *Schuylerville Standard*, 15 August 1929.

invited the smaller surrounding villages to join its contingent. In Fort Edward, a local automobile club pledged its support. In Burlington, the *Free Press* promoted participation as a direct competition with other communities, noting "the City of Burlington would look like a punched spurious three cent piece if it were to appear at the dedication and opening of the new Champlain Bridge with a representation surpassed by that of the progressive village of Bristol." While Rutland was out to top Burlington with its exhibit, the biggest concern of all was that Port Henry and other New York communities might outdo Vermont and threaten the very prestige of the Green Mountain State."[86]

The final plans for the celebration were announced on August 15. The festivities would begin with a ribbon-cutting by Elizabeth Ferris, the daughter of LCBC Chairman Ferris. Governors Roosevelt and Weeks would shake hands at the center of the bridge and then proceed to the reviewing stand on the New York side. The New York parade would cross the bridge and join the Vermont parade, the combined parade returning over the bridge in front of the reviewing stand, with an expected completion at 3:15 p.m. The final ceremony would follow, with a presentation of dignitaries and addresses by Governors Roosevelt and Weeks. Water and air displays would conclude the celebration. The official slogan for the bridge was "Now that we got the bridge, Let's have miles and miles of smiles."[87]

Opening day dawned clear and breezy, near perfect for the celebration.

> Clip went a diminutive pair of scissors in the hands of a pretty maiden and a white ribbon was severed yesterday afternoon at four minutes before two o'clock, Eastern Standard Time, which opened the Champlain bridge to traffic, bringing to fruition the dream of a century and setting in motion long lines of vehicular traffic which promise to go on for centuries to come…Seventeen year old Betty Ferris was the lucky girl who clipped the ribbon. She was the central figure in a notable group which occupied the center of the bridge at this unique ceremony, which group included Governor Franklin D. Roosevelt of New York and Governor and Mrs. John E. Weeks of Vermont, with their respective official escorts.[88]

Following a seventeen gun salute and a bugle call, Governors Roosevelt and Weeks shook hands and then proceeded to the parade reviewing stand on the New York side. They were joined by Gen. Hanson Ely, Commander of the Second Corps Area, Col. John Madden, Commander of the Plattsburg Barracks and the 26th Infantry of Plattsburg, members of the Lake Champlain Bridge Commission, and others, including representatives of the legislatures of the two states.[89]

The parade was marshaled by Maj. Leonard Wing of the Vermont National Guard and the Vermont Guardsmen, followed by Company G of the 26th Infantry and its band, Company K of

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[86] "Middlebury Plans Participation in Champlain Bridge Dedication," *Middlebury Register*, 15 August 1929; "Club to Attend Bridge Opening," *Fort Edward Post-Star*, 15 August 1929; "Burlington at the Bridge," *Burlington Free Press*, 15 August 1929; "Communities Asked to Join Bridge Parade," *Keeseville News*, 16 August 1929.
[87] "Final Plans Are Now Complete For Bridge Opening," *Ticonderoga Sentinel*, 15 August 1929.
[88] "Thousands of Automobiles Carry 40,000 People to Witness the Opening of Champlain Bridge," *Burlington Free Press*, 27 August 1929.
[89] "Thousands of Automobiles"; LCBC, "Third Annual Report," 15.

the 105th Infantry, the 105the ambulance company, the Howitzer Company of the 105th Infantry, and the official cars from both states. At either end of the bridge were the New York and Vermont processions that would combine into one long parade on the Vermont side and return. Extending 10 to 12 miles with an estimated 4000 cars, the parade was much larger than was expected, creating what was called the worst traffic jam in the history of Vermont. As a result, the leading part of the parade crossed from the New York side and returned before the Vermont parade began, and only the floats and decorated cars from New York were permitted to cross to Vermont. New York contingents who joined the rear of the parade at 5:30 pm were not able to return across the bridge until well into the evening. Some of the Vermont floats had to travel 5 miles just to get back in line to return to Vermont.[90]

The parade was temporarily halted at 4:25 pm to allow the dedication ceremony to proceed. The ceremony began with an invocation by Reverend G. Ashton Oldham, followed by introductions of the Lake Champlain Bridge Commission and representatives of the engineering and construction companies. An address by Maj. Gen. Hanson D. Ely was followed by the addresses of Governors Roosevelt and Weeks. The Green Mountain Chorus, scheduled to open and close the ceremony, was unable to reach the bridge in time due to the traffic jam caused by the parade.[91]

Air and sea displays complemented the parade. A squadron of planes circled above, and one pilot, possibly L.C. Churchill from Burlington, wowed onlookers by unexpectedly flying under the main span. A flotilla headed by Commodore Wack of the Westport Yacht club passed beneath the bridge, including yachts and motor boats from clubs in Albany, Westport, Burlington, and St. Albans. Fireworks were set off from the ferry *Henry Proctor*, but windy conditions canceled the planned burning of the specially constructed ferry, to have symbolized the end of an era at the Champlain crossing.[92]

In the end, an estimated 40,000 to 50,000 people participated in or watched the celebration. People observed from the Crown Point reservation and the Champlain Memorial Monument, from a bluff south of Chimney Point, and from boats on Bulwagga Bay. Ten-year old Nelson Hyatt and his two brothers walked 8 miles along the South Moriah Road and Bay Road, cutting through fields, and ending up a mile away on the bridge road. A lucky few crowded close to the reviewing stand, including 9-year-old Martin Bezon of Port Henry, whose thoughts drifted to fishing as his parents watched the parade.[93]

The overriding theme of the celebration was the idea of a restored unity between New York and Vermont. Governor Roosevelt called the opening a happy occasion for two reasons: "The first is

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[90] "Thousands of Automobiles"; "Bridge Marks Progress For Otter Valley;" *The Brandon Union*, 30 August 1929.
[91] "Thousands of Automobiles"; "Champlain Bridge Opened With Fete," *The New York Times*, 27 August 1929.
[92] "Lake Champlain Bridge Dedication Ceremonies Monday," *Essex County News*, 23 August 1929; "Thousands of Automobiles;" *Burlington Free Press*.
[93] Freeman Beebe, Martin Bezon, Archie Rosenquist, Thomas Scozzafava, Moriah Town Supervisor, and Joan Daby, President Moriah Historical Society, interview by Mark S. LoRusso, 23 April 2010, tape recording, Moriah Historical Society, Port Henry, New York; Nelson Hyatt, telephone interview by Mark S. LoRusso, 5 October 2010, transcript, Moriah, New York.

that one of the greatest strategic points in American history finds itself again on a main artery of travel after a lapse of 150 years…The other and most significant reason for the celebration this day is that it marks the reuniting of two states, which in the old days were one." Governor Weeks stated that the bridge "will bind more closely the people and interests of the two states." By bringing development to the Champlain valley, and shortening the distance between the Adirondacks, the Green Mountains, the White Mountains, and the Maine coast, he called the bridge an asset for all the localities of "this beautiful northeastern vacationland."[94]

Newspapers throughout New York and New England published accounts of the celebration, recalling the efforts to build the bridge and the expected benefits. A number of stories cited the work of Carl F. Peterson for awakening people to the possibility of the bridge. Governor Roosevelt had complimented Peterson personally at the celebration:

> Peterson, you have done a great work. I am proud of what you did and you have every reason to be happy. This is your bridge because, without your zeal, it is very doubtful whether it would be here. You 'sold' the bridge to New York state and Vermont state, both of which should, and do, feel grateful.[95]

An editorial in *The Troy Times* hailed the contribution of women in the celebration.

> Almost every float in the passing show, either on lake or land, was designed by woman to interpret some era or event in Lake Champlain's history, that part of it localized at Chimney Point on the east shore and Crown Point on the west shore. The delicate touch of woman's fingers and the more tender thought of woman's mind were, as a matter of fact, in evidence during the entire panorama.[96]

The Brandon Union expressed great pride in contributing to the parade, a sentiment echoed in many communities. The Brandon Inn float, a stagecoach mounted on a truck, with a sign reading "Brandon, Vermont's Beauty Spot" had won the first Vermont prize. Second prize had gone to Montpelier for its replica of the state capitol. On the New York side, first prize had been awarded to Fort Ticonderoga, for a float depicting Champlain's battle with the Iroquois, while Witherbee, Sherman, and Company won second prize for a float illustrating the iron mining industry.[97]

The Burlington Free Press published a less complimentary opinion of the bridge by W. F. Barnes, the Vermont farmer whose property lay in its path.

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[94] "New Bridge From Crown Point to Chimney Point," Unknown newspaper, 26 August 1929.
[95] "Peterson Awoke Public to Span Idea," *Glens Falls Times*, 26 August 1929; "Champlain Bridge Opened With Fete," *The New York Times*, 27 August 1929; "The Bridge Opening," *Ticonderoga Sentinel*, 22 August 1929; "New Bridge Will Cement Union of Sister States," *The Troy Times*, 27 August 1929.
[96] "New Bridge," *The Troy Times*.
[97] "Bridge Marks Progress For Otter Valley," *The Brandon Union*, 30 August 1929; "Prize Winning Floats in Parade," *Essex County Republican*, 6 September 1929.

> His house, full of Indian and colonial relics, collected in the vicinity, stands on the tip of Chimney point with a splendid view of the lake in either direction…Yet, Mr. Barnes, pacing his veranda, a fortnight since, seemed disturbed in the mind, for he does not relish the invasion of modern "progress" which is now established in the locality he had considered sacred to the associations and traditions of remote former times and an era far more romantic than which he deems to be signified by the pounding rivets and snorting of automobiles. It is a wonderful bridge, but he wishes it could have been erected elsewhere.[98]

EARLY YEARS OF THE BRIDGE

The Lake Champlain Bridge began collecting tolls on August 27, 1929, the day after the opening. The tolls were scheduled to be fair to the traveling public, while covering the costs of operation and maintenance of the bridge, and repaying the costs of construction. The rates were set at $1 for an automobile, $1 to $2 for a truck or tractor, $2 to $3 dollars for a motor bus, 50 cents for a horse drawn carriage or motorcycle, and 25 cents for a pedestrian. Within a week, the bridge had raised $7286.10, with 2300 automobiles crossing on the first day.[99]

The opening of the bridge brought an immediate end to the ferry *G. R. Sherman* which had run for thirty-nine-years between Port Henry, Fort St. Frederic, and Chimney Point. The *Essex County Republican* reported that "many will miss seeing it churning its way across the lake," with C. B. Olds and family of Port Henry among the last to use it. The ferry between Westport and Basin Harbor also discontinued service at this time.[100]

The bridge exceeded the engineers' estimates for use during its first year and a half of operation. For the remainder of 1929, receipts totaled $74,000, and in 1930, totaled $107,747, which were 27.1 percent and 47.8 percent, respectively, above the original estimates. At this pace, the Bridge Commission anticipated that the construction bonds would be retired well ahead of their maturity. Approximately 75 percent of the total expense of the bridge went toward paying the interest on the bonds. The remainder paid the salaries of the bridge commissioner, a superintendent, two full-time toll takers, and a seasonal helper, and maintenance costs.[101]
Use of the bridge was overwhelmingly by automobiles. In 1930, traffic on the bridge consisted of 93.2 percent passenger cars, 3.9 percent trucks, 2.1 percent pedestrians, and .8 percent motorcycles, horse teams, buses, horses, and bicycles. Approximately three quarters of the traffic occurred during the peak tourist season of June through October, with just over 2 percent in January and February primarily representing local use.[102]

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98 "The New Bridge Over Lake Champlain," *Burlington Free Press*, published in *Potsdam Freeman*, 1 September 1929.
99 LCBC, "Third Annual Report (1929)," 15-16; "All the World a Wheel…," *Burlington Free Press*, 11 September 1929; "Champlain Bridge Tolls Reach $7286.10," *Essex County Republican*, 6 September 1929.
100 "Champlain Bridge Tolls."
101 LCBC, "Fourth Annual Report (1930)," 1-2.
102 LCBC, "Fourth Annual Report," 3-4.

Automobiles from all forty-eight states, eight provinces of Canada, and four foreign countries, crossed the bridge in 1931. Automobiles originated two-thirds from New York and Vermont and one-quarter from Massachusetts, New Jersey, Connecticut, and Pennsylvania, totaling 2904, 1493, 619, 452, 252, 264, respectively. The Bridge Commission was pleased that winter traffic had increased substantially in 1931. Local residents, sometimes traveling long distances, increasingly used the bridge instead of crossing the lake on the ice. Improved efforts to keep connecting roads clear of snow contributed to increased use in winter. [103]

As the Depression took hold and people traveled less, use of the bridge declined. Total receipts decreased 18 percent in 1932, largely reflecting a decrease in tourism. Looking for bright spots in the 1932 Annual Report, the Bridge Commission stated that the bridge was becoming better known and appreciated, citing a doubling of winter traffic, with overall earnings proportionately far better than the competing ferries. Responding to calls for a reduction in tolls, the commission defended the set rates, which it said were needed both to pay the operating costs as well as to build a surplus prior to 1940, when principal payments on the bonds began coming due. As the national economy bottomed out in 1933, revenues declined another 19 percent, with fewer vehicles year-round.

Gradual economic improvement spurred a rise in traffic from 1934 to 1937, with bridge revenues returning near original levels. Automobiles continued to represent 93 percent of the traffic with over half occurring during the peak tourism months. Numbers of trucks over 2.5 tons increased, while trucks under 2.5 tons decreased, reflecting a trend toward larger trucks. Horse-drawn vehicles largely disappeared, with only twenty crossing the bridge in 1937 compared to 315 in 1932. Pedestrian use remained about the same, having declined from a high of 1600 in 1930 to an average of between 800 and 900 annually. With its narrow sidewalks, the bridge was not safe for pedestrians. In January 1938, Anna Burlingame and her sister were walking over the bridge at night, using the road because of the poor condition of the sidewalk, when Anna was hit and killed by a car. A lawsuit in her behalf claimed that that the bridge commission was negligent in maintaining the sidewalk and in not providing adequate lighting on the bridge. [104]

In July 1937, the Bridge Commission completed the construction of a second bridge across the north end of Lake Champlain, connecting Rouses Point, New York, and Allburg, Vermont. Initially planned in the late 1920s, the Rouses Point Bridge was delayed by the onset of the Depression but was eventually built using funds from the Public Works Administration. Vermont Governor George D. Aiken and New York State Conservation Commissioner Lithgow Osborne hailed the Rouses Point Bridge as a step that further cemented the bond between New York and Vermont. With the completion of the Rouses Point Bridge, the Bridge Commission instituted a $1.50 round-trip toll for travel with forty-eight-hours over either of the bridges.[105]

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[103] LCBC, "Fifth Annual Report (1931)," 2-3.

[104] LCBC, "Eighth Annual Report (1934)," 1-4; LCBC, "Eleventh Annual Report (1937)," Exhibit G; "Bridge Commission Is Sued as Outgrowth of Fatality in January," *Glens Falls Times*, 26 July 1938.

[105] "Rouses Point Bridge Opens Friday," *The North Countryman*, 15 July 1937; "Editorial – The Bridge," *The North Countryman*, 15 July 1937; "$800,000 Span Dedicated in Ceremonies Yesterday At Rouses Point Village," *Plattsburg Republican*, 17 July 1937; "$1.50 Round Trip for 2 Champlain Bridges To Be Effective July First," *Ticonderoga Sentinel*, 10 June 1937.

The Lake Champlain Bridge saw a decrease in traffic in 1938 partly due to diversion to the Rouses Point Bridge. This included commercial traffic between Plattsburg and Burlington, which especially in winter, had previously crossed at Crown Point. Traffic volume remained stable in the years leading up to World War II, with toll revenues of $64,809 on the Lake Champlain Bridge and $55,307 on the Rouses Point Bridge in 1941. With travel restrictions largely eliminating the summer tourist season during the war, bridge revenues fell below half of previous levels. The Lake Champlain Bridge carried only a few military vehicles during the war, with 113 units of a total 28,217 vehicles in 1943, and twenty-one units of a total 33,677 vehicles in 1944.

LAKE TOURISM AND TRANSPORTATION

Newspapers from around New England and New York had proclaimed the benefits of the Lake Champlain Bridge as it had neared completion in 1929. *The New London Day* wrote, "It is particularly significant to lovers of American History that the bridge should be stretched across the lake at the point chosen. It was the only point that appeared so advantageous not only for the commercial business which makes its way from state to state, but for the tremendous flow of tourist travel up and down New York and Vermont." *The Boston Transcript* suggested, "No prettier trip could be imagined for motorists having a few days at their disposal than that which embraces a tour across Massachusetts to Williamstown and up the (New) York side to the bridge, thence returning through Vermont and the White Mountains." [106]

The Lake Champlain Bridge Commission actively promoted the bridge in its annual brochure, in tourism publications, and in newspapers. The brochure highlighted the connection of the bridge between the Adirondack Mountains and New England, the unsurpassed lake and mountain views at the Crown Point crossing, and nearby attractions, including Fort St. Frederic, Fort Crown Point, the Samuel de Champlain Memorial Lighthouse, and the New York State Campground. Visitors from Canada were informed that they "may conveniently vary their trip, see both sides of the lake, and travel entirely on hard surfaced State Highways. Noted features of the bridge were, "Midway on the Lake," "Paved Highway Connections," "No Delays," "Safe," and "Always Open."[107]

In the late 1930s, the Lake Champlain Bridge and the Rouses Point Bridge were promoted together as "The Champlain Tour." The tour circled the lake on Route 22 and Route 9 in New York State, and on VT 17, US 7, and US 2 in Vermont, crossing the two bridges at either end. An advertisement for the tour in the 1939 edition of Canadian Holiday Magazine, a publication of the Automobile Club of America, showed highway connections from Montreal and suggested the tour as the scenic route to the New York World's Fair. The Bridge Commission also

[106] "Vermont-N.Y. Bridge, Built by Merritt-Chapman & Scott, Valuable Link in Highways," *New London Day*, 22 August 1929; "Lake Champlain Bridge Great Boon to Hotels," *Boston Transcript*, 24 August 1929.
[107] LCBC, *Lake Champlain Bridge, Popular Motor Route Between Adirondacks Green Mountains Canada* (Crown Point, NY: LCBC, early 1930s), LCBC Records, Rolls 13-14, NYS Archives.

promoted the bridges in "Great Trails to the Adirondacks," a publication of the Albany Auto Club; in "Fort Ticonderoga on the Warpath of the Nations," a brochure featuring historical attractions of the Champlain Valley; and on a tourism map by the Adirondack Resorts Association. Route 22, following the west side of the lake from Ticonderoga to Plattsburg, was alternatively called the Champlain Trail and the Warpath of the Nations. [108]

Intrinsic to tourism and increased use of the bridge were improved roads. On the New York side, a flurry of improvements accompanied the construction of the bridge in 1928 and 1929. The state highways from Ticonderoga to Westport and from Ticonderoga to Whitehall were widened and resurfaced, completing the Lake Champlain portion of an improved route leading all the way from Florida to Quebec. Also improved at this time were the state highway from Ticonderoga to Paradox and the state highway leading along the west side of Lake George to Ticonderoga. [109]

Across the lake, Vermont was recovering from the floods that devastated New England in November 1927. The floods caused $3 million in damages to roadways and damaged or destroyed more than 1400 bridges in Vermont. The state legislature appropriated an emergency bond of $8.5 million to restore highways, with an additional $2.65 million in federal aid funds approved in May 1928. By summer 1928, the reconstruction of flood-damaged highways was well underway, and with the upcoming tourist season at stake, the state Chamber of Commerce, the Highway Board, and Governor John Weeks assured visitors that the roads were in good condition. Vermont and New York newspapers provided conflicting assessments of conditions, but most people agreed that the flood had resulted in roads that were much better than before.[110]

In December 1928, the Champlain Valley Council of Federated Chambers of Commerce called on the Vermont Highway Commissioners to build as many miles of paved roads as possible to connect with the bridge, echoing pleas by the Lake Champlain Bridge Commission. In March 1929, with trucks plying rutted roads to bring steel to the bridge, Vermont state authorities assured the Bridge Commission that the roads would be greatly improved before the span was opened. In August 1929, an ambitious highway program proposed by Governor Weeks was approved, despite opposition in the state legislature, that provided for 60 miles of improvements, including the 2.3 mile access road to the bridge. In 1931, the highway between Addison and

[108] LCBC, *Lake Champlain Bridges, Linking the State Highways of New York and Vermont* (Crown Point, NY: LCBC, late 1930s); Earnest Bearnarth, Director, Travel Bureau of the Automobile Club of New York, Inc., to Mortimer Ferris, Chairman, LCBC, 1 February 1940; LCBC, *Fort Ticonderoga on the Warpath of the Nations*, (Crown Point, NY: LCBC, n.d.); M. K. Nolan, Advertising Department, Albany and Adirondack Auto Motor Clubs Inc., to Mortimer Ferris, Chairman, LCBC, 15 April 1940; *Map of the Adirondacks* (Port Kent, NY: The Adirondack Resorts Association, n.d.); "Lake Champlain Bridges," *Burlington Free Press*, n.d. All in LCBC Records, Rolls 13-14, Box 18, Folders 1-23, NYS Archives.
[109] "Rushing Work On Nearby Roads," *Ticonderoga Sentinel*, 6 September 1928; "Work on Roads Progressing," *Ticonderoga Sentinel*, 22 November 1928; "Rosy Future Visioned For Bridge Area," *Keeseville News*, 15 August 1929.
[110] Deborah Pickman Clifford and Nicholas R. Clifford, *The Troubled Roar of the Waters* (Durham, NH: University of New Hampshire Press, c.2007), 127-28; Arthur Stone, *The Vermont of Today* (New York: Lewis Historical Publishing Company, Inc., 1929), 190-191.

New Haven Junction was improved, completing a continuous paved highway over the bridge between Route 22 in New York and US 7 Vermont.[111]

The Bridge Commission continued to advocate for improved roads to benefit the bridge. In 1934, the commission called on Vermont to extend the Bellows Falls-Rutland highway to bring tourists to the bridge from Boston and the eastern seaboard. The commission commended the paving of the Addison-Vergennes highway as improving access from the north and requested that the three main approaches on the Vermont side be taken over by the state and maintained to state standards. On the New York side, the commission expressed support for a proposed causeway across Bulwagga Bay that would improve access from the north, and called for the reconstruction of Route 22 along Lake Champlain as part of the three-lane "super-highway" proposed between New York and Montreal.[112]

Tourism on Lake Champlain had commenced a century before the bridge with the advent of steam transportation. The first steamboat on the lake, the *Vermont*, operated from 1808 to 1815, providing service between Whitehall and St. John's. Five steamboat companies came into operation over the next two decades. The Lake Champlain Transportation Company, organized in 1826, emerged as the leader by 1835, profiting from trade on the Champlain Canal-Lake Champlain route, and increasingly from passenger fares, as pleasure excursions grew in popularity. In the late 1830s, the company built two luxurious ships, the *Burlington* and the *Whitehall,* for excursions up and down the lake, as well as a smaller boat, *The Saranac,* for ferry service between Burlington and Plattsburg. In the late 1840s, the company added the large and powerful *United States*, which squashed competition from Peter Comstock, giving the Lake Champlain Transportation Company full reign over the lake's waters.

Early tourists found lodging at the spacious Hotel Champlain near Plattsburg, built in the 1850s, and at smaller hostelries around the lake, including Pell's Hotel at Fort Ticonderoga, one of the early attractions. Travelers by this time could reach the southern tip of Lake Champlain over the Saratoga and Whitehall Railroad, continuing north by steamboat, or over a connection to the Rutland and Burlington Railroad.[113]

In the late nineteenth century, tourists streamed into the Adirondacks via the Adirondack Railroad from Saratoga Springs to North Creek and via the Delaware and Hudson Railroad (D & H), which followed the west shore of Lake Champlain to Plattsburg. With the D & H soon capturing the lion's share of through traffic along the lake, the Lake Champlain Transportation Company began to shift its business to pleasure excursions. The *Vermont II,* launched in 1871, became a favorite of the company's fleet among passengers and crew, featuring rich décor and superior power and handling. The *Vermont III* replaced the *Vermont II* in 1902 and had the distinction of being the largest steamer ever to sail the lake. The Lake Champlain Transportation

[111] "Plea for New Hard Roads In Vermont to Connect Bridge," *Adirondack Record-Elizabethtown Post*, 27 December 1928; "Vermont Legislature Passes Bill Providing Two-Mile Concrete Road To Approach of Champlain Bridge," *Ticonderoga Sentinel*, 21 March 1929; "Champlain Bridge and Vermont Road Progress," *Burlington Free Press*, 7 August 1929; LCBC, "Fourth Annual Report (1930)," 6; LCBC, "Fifth Annual Report (1931)," 6.
[112] LCBC, "Eighth Annual Report (1934)," 3-4.
[113] Jim Shaughnessy, *Delaware & Hudson* (San Diego: Howell-North, 1982), 105-106, 235-250.

Company provided round-trip service from the south end of the lake to Plattsburg and Burlington on the *Vermont* steamers, and shorter excursions on these and two smaller steamers, the *Ticonderoga*, and the *Chateaugay*. Local service was provided to Ticonderoga, Crown Point, Port Henry, Westport, Basin Harbor, Essex, Burlington, Port Kent, and Plattsburg.[114]

The forts and beach at Crown Point had become a popular attraction on Lake Champlain by the beginning of the twentieth century. Visitors to the site, often coming for picnics, included church and social groups from the surrounding communities and regional groups such as the Railroad YMCA, which came by train from Saratoga Springs, boarding the *Vermont* at Port Henry for dinner at Crown Point and an evening at Burlington. At this time, Witherbee, Sherman, and Company owned the forts, having purchased the encompassing property years earlier to obtain limestone for its Mineville iron operations. In 1910, in recognition of the historic importance of the forts, the company offered a 25-acre parcel, including the ruins of Fort St. Frederic and Fort Crown Point (then known as Fort Amherst), to New York State for preservation. The state immediately accepted the parcel, and it became the Crown Point Reservation and the core of the modern Crown Point State Historic Site. During the selection of a site for the Lake Champlain Bridge, the already popular Crown Point Reservation was considered a potential "mecca for tourists." This became a reality, with improvements during construction of the bridge consisting of new bath houses, a boat landing and recreational pier, and campsites soon after, bringing a record attendance in the early 1930s.[115]

At Chimney Point, Ashahel Barnes Sr. had continued the 1780s inn as a lakeside landmark, operating a tavern, store, and post office there after his purchase of the property in 1821. In 1897, grandson Millard Barnes converted the property to a summer resort known as the St. Frederick Inn, with a new piazza offering grand views of the lake designed by Port Henry architect J. H. Bruffee. Barnes wished to promote Chimney Point both as the terminus of the supply road between Fort Crown Point and New England and shipyard of Benedict Arnold, and as the location of the historic tavern, thought to be built with bricks from the destroyed Crown Point fort. The resort would offer bathing, boating, shooting, and fishing, and in the starry eyes of one reporter, was destined to become "the first vacationists retreat in the land."[116] Millard Barnes was dedicated to preserving Chimney Point and would oppose the Lake Champlain Bridge as a modern affront to the property. Mary Barnes retained Chimney Point after her husband's death in 1943, and in 1966, the State of Vermont purchased the property to protect it from private development. The Vermont Division of Historic Preservation ultimately restored the tavern and reopened it as a museum in 1991.[117]

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[114] Shaughnessy, 255-265.
[115] "Local and Miscellaneous," *Essex County Republican*, 16 July 1896; "Paragrams," *Essex County Republican*, 30 April 1896; "A Notable Good Deed," *Essex County Republican*, 8 April 1910; "Interest Grows in Crown Point Reservation," *Lake Placid News*, 2 August 1929; "State Campsites to Open May 30," *Essex County Republican*, 19 May 1933.
[116] "Chimney Point on Lake Champlain," *Essex County Republican*, 10 June 1897; "Obituary for Millard F. Barnes," *Essex County Republican*, 3 December 1943.
[117] "The Chimney Point Tavern," Chimney Point State Historic Site, available at http://www.historicvermont.org/chimneypoint/chimneypoint.html, accessed May 5, 2011.

By the mid-1920s, significant numbers of tourists were coming to Lake Champlain by automobile. The Lake Champlain Transportation Company, having converted the *Ticonderoga* to a car ferry in 1925, saw gains of 20 percent in business each year from 1925 to 1928. In 1928, company boats carried 20,000 cars, mostly between Burlington and Port Kent, as well as motor coaches from as far away as Chicago and Washington. With the completion of the Lake Champlain Bridge, however, the profits of the Lake Champlain Transportation Company were short lived. The loss of ferry traffic to the bridge and competing ferry operators, paired with the waning interest in steamboat excursions, caused the company to cease business in January 1933. The *Vermont III*, which had served as a benchmark for designing the bridge, was converted to a diesel ship and later used in New York City.[118]

Summer holidays brought record crowds to the lake as automobiles took to the roads. On Labor Day 1929, the *Ticonderoga Sentinel* reported the heaviest volume of traffic ever on main highways in the Adirondack region, including many of the 25,000 cars that crossed the Lake Champlain Bridge in its first week. On July 4, 1931, record traffic again was reported in northern New York, with filled hotels on Lake Champlain having to turn away visitors. Summer holidays on the lake continued to be popular during the 1930s and revived after World War II. Celebrating crowds in Ticonderoga, over July 4, 1946, even caused a food shortage, forcing people into the "bread lines" of years past.[119]

With people resuming summer vacations after the war, travel writers recommended visits to the Champlain Valley to witness the scenic beauty, experience the history, and partake in sporting activities, often as part of a longer trip to the Adirondack region. Motorists were encouraged to take less-congested routes along Lake Champlain, including Route 9N from Lake George to Ticonderoga and Route 22 from Ticonderoga to Port Henry and points north, which were further improved in the 1950s. Recommended stops along the way were Fort Ticonderoga, Ausable Chasm, and the beaches at Port Henry and Plattsburg. A popular travel theme was the rich military history of the lake, with the renovated Fort Ticonderoga atop the must-see list. At Crown Point were Fort St. Frederic, Fort Crown Point, and the Champlain Memorial Lighthouse, and at the north end of the lake were Fort Izard, Fort Montgomery, and Valcour Island. Those willing to explore further could trace the route of the Crown Point Highway in Vermont, the British supply road that ended at Chimney Point. Lakeside activities included swimming, sailing, steamboat excursions, and fishing.[120]

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[118] "Champlain Boats Carried 20,000 Cars," *Ticonderoga Sentinel*, 14 February 1929; "Transportation Co. to Cease Operations," *Keeseville Republican*, 20 January 1933; Shaughnessy, 265.

[119] "Traffic Crush Over Week-End Broke Records," *Ticonderoga Sentinel*, 5 September 1929; "Week End Traffic Shattered Records," *Ticonderoga Sentinel*, 9 July 1931; "Weekend Traffic Breaks Records, Few Accidents," *Ticonderoga Sentinel*, 10 September 1936; "Resorts In N.N.Y. Had Busy Week," *Ticonderoga Sentinel*, 3 June 1937; "Record Crowds in Ticonderoga Over Holiday," *Ticonderoga Sentinel*, 11 July 1946.

[120] "Trek to North Woods," *The New York Times*, 9 June 1946; "Back Roads of the Adirondacks," *The New York Times*, 24 August 1952; "Scouting New York State's Early Americana," *The New York Times*, 6 May 1956; "Vacations in New York State," *The New York Times*, 4 May 1947; "A Chain of Forts," *The New York Times*, 12 April 1953; "Champlain Valley Listed Among Vacationlands In State Booklet," *Ticonderoga Sentinel*, 18 May 1950; "Two Vermont Roads," *The New York Times*, 4 May 1947; "Sailing Through Lake Champlain," *The New York Times*, 20 June 1948.

Fishing was also popular in winter, with perch, pike, pickerel, and smelt among the most prolific species. Port Henry was a popular location for smelt fishing, with shanty towns erected as soon as the ice permitted. More than a recreational pursuit, tons of fish caught from the lake were sold to markets locally as well as New York and other cities.[121]

The Vermont side of the lake was often promoted as part of a fall foliage tour. Here too, motorists were encouraged to take the back roads to see the "varied, rich, and tranquil blend of shore, wide water, island, and mountain" of the western edge of Vermont. Attractions included Burlington, a city of mansions reflecting the fortunes of lakeside merchants, and the Islands, with many undisturbed coves, rocky points, and beaches, and a backdrop of orchards and pastures. Near the Lake Champlain Bridge were a golf course at Basin Harbor, a yacht basin at Button Bay, and the village of Vergennes, "with an inn, an extraordinary library and a history distinguished by shipbuilding."[122]

The bridges at Crown Point and Rouses Point and the five ferries still operating on the lake after the war were integral to the lake experience. The crossings offered a variety of options for through travelers and tourists. At the south end were the "Three-Minute" ferry at Chipman's Point, Larabee's ferry at Ticonderoga, and the Lake Champlain Bridge, with fares in 1952 of $1, $1.25, and $1, respectively. In the middle of the lake were the twenty-minute ferry from Essex to Charlotte and the one-hour ferry from Port Kent to Burlington, considered one of the most beautiful ferry trips in the country, with fares of $1.75 and $2.90, respectively. At the north end were the fifteen-minute Cumberland Head-Grand Island ferry, costing $1.75, and the Rouses Point Bridge, costing $1. The factors of time, cost, connecting routes, scenery, and historic attractions favored one crossing over another, with the two bridges and the ferries at Ticonderoga and Burlington seeing the heaviest use.[123]

The Lake Champlain Bridge thus was part of an improved transportation network that encouraged people to vacation on the lake, and cross through, en route to the Adirondacks, Vermont, and Montreal. The many tourists who used the bridge supported the area economy by staying at hotels, motels, and camps, and purchasing goods and services in the surrounding communities. The villages of Ticonderoga, Port Henry, Crown Point, and Vergennes, advertised accommodations for travelers, and village stores and restaurants welcomed the business brought by summer tourists.

Residents of these communities, of course, also used the bridge for work and recreation. Farmers accounted for much of the local traffic, managing fields across the lake, transporting produce, taking business trips, and attending cattle sales or Dairymen's League meetings. The

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[121] "Ice Fishing Gets Early Start on Lake Champlain," *Essex County Republican*, 27 December 1929; "Survey of Smelt Fishing Shows Lake Champlain Catches High First 3 Months of Year," *Essex County Republican*, 28 April 1944; "Report of Fish Survey on Lake Champlain Made," *Essex County Republican*, 19 November 1943.
[122] "Visiting Vermont," *The New York Times*, 28 August 1955; "Looking at the Leaves in Vermont," *The New York Times*, 21 September 1952.
[123] "Crossing Points on Lake Champlain," *The New York Times*, 10 July 1949; "Champlain Ferries," *The New York Times*, 29 June 1952.

eight or nine trucks crossing the bridge daily in the mid-1930s included tractors pulling combines or hay wagons that required opposing traffic to wait.

Logging trucks also crossed over, carrying pulp wood from Vermont to the paper mill in Ticonderoga. Occasionally, higher vehicles struck and damaged the overhead portal bracing of the bridge. Commuters, including iron miners Raymond Russell of Vergennes, and Louis Bouchard of Ferrisburg, who probably worked in Moriah, also used the bridge. New Yorkers increasingly crossed over to work in the hospital in Middlebury and to obtain medical services in Burlington.[124]

On weekends, residents of Port Henry, Crown Point, and Ticonderoga might cross the bridge to shop or attend events in Burlington, while families from these communities exchanged visits with family in Barre, Brandon, Shoreham, and Vergennes, using the bridge or one of the Ticonderoga ferries. During World War II, Nelson Hyatt of Moriah hitchhiked to and from the U. S. Army base near Burlington, often walking across the bridge. The bridge also provided direct access to the popular Crown Point Reservation and to Chimney Point.[125]

A survey of vehicles crossing the bridge in October 16-22, 1935, showed that 142 vehicles originated from nearby communities in Essex County, New York, and 215 vehicles came from communities between Burlington and Rutland, Vermont. A total of thirty-nine of the Vermont vehicles made round-trips during the week, with most taking longer trips or returning a different way. A survey taken on October 26, 1935, showed that ten vehicles from New York made round-trips the same day, largely Port Henry residents attending a football game with rivals in Middlebury.[126]

LATER YEARS OF THE BRIDGE

In 1956, the Bridge Commission completed payment for the Lake Champlain Bridge and the Rouses Point Bridge, having retired the construction bonds and paid the debt to New York and Vermont. The commission considered reducing or eliminating the tolls at this time but decided to keep the current tolls to build a reserve for repairs and maintenance and to pay for a feasibility study for a new bridge over the lake at Cumberland Head. In 1958, the commission changed course and reduced tolls, citing the remote chance of building a new bridge in the near future. The lower tolls, expected to bring more traffic over the bridges, would cover projected repairs over the next ten years, including deck resurfacing, new pilings and fenders, and painting. A 50 percent reduction in toll rates was made effective in May 1959. The toll for automobiles,

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[124] Freeman Beebe et al., 2010 interview; Dan Lee, telephone interview by Mark S. LoRusso, 28 July 2010, transcript, Ironville, NY; Frank Wojewodcik, telephone interview by Mark S. LoRusso, 5 October 2010, transcript, Port Henry, NY; Bureau of the Census, *1930 Census Population Schedules*, Vermont, Addison County.

[125] "News of Crown Point," *Ticonderoga Sentinel*, 13 May 1944; "Port Henry News," *Ticonderoga Sentinel*, 15 June 1950; "Crown Point (news)," *Ticonderoga Sentinel*, 10 August, 1950; "North Ticonderoga (news)," *Ticonderoga Sentinel*, 26 October 1950; Nelson Hyatt, 2010 interview.

[126] LCBC, "Census of New York and Vermont Traffic, Lake Champlain Bridge," 16-22 October 1935, LCBC Records, Roll 8, Box 9, Folder 5, NYS Archives.

previously lowered to 50 cents in 1953, was halved to 25 cents and further discounted by commuter books and annual passes. As for the complete elimination of tolls, the Bridge Commission asserted that the tolls allowed for primary users, largely tourists and out-of-state travelers, to pay for the bridge instead of the average taxpayers of New York and Vermont.[127]

Use of the two bridges rebounded dramatically after World War II and spiraled upward through the 1950s and mid-1960s with the expansion of commerce and tourism. The number of vehicles on the Lake Champlain Bridge increased 75 percent from 1945 to 1946, 20 percent from 1946 to 1947, and 4 to 13 percent annually in all but two years from 1948 to 1966. In 1955, the increase was 25 percent, and in 1960, less than 1 percent. In total, 416,848 vehicles crossed the bridge in 1966 compared to 50,903 in 1945. The Rouses Point Bridge, carrying the large majority of commercial traffic over the lake, eclipsed the Lake Champlain Bridge in 1947 and saw greater gains over the next two decades, with 643,582 vehicles crossing in 1966 compared to 48,410 in 1945. Vehicle registrations in New York State increased 150 percent over this period, with each vehicle traveling an estimated 10 percent more miles by 1966.[128]

Annual fluctuations in traffic on the Lake Champlain Bridge reflected the impact of weather and economics on regional tourism. In the 1950s and 1960s, there were numerous festivals and events that brought tourists to the Champlain region, including Ethan Allen Day at Fort Ticonderoga, Old Home Days in Vermont, horse shows at Willsboro and Keeseville, and county fairs around the lake. The Crown Point Reservation remained popular for camping, picnics, and history tours, attracting many thousands of visitors each year. Fort St. Frederic was named a National Historic Landmark in 1941, and the entire site was given expanded facilities in 1945. In addition to the two bridges, ferries remained active for transportation across the lake. The Port Kent-Burlington ferry set a record for business in 1954, providing service to Ausable Chasm and the Shelburne Museum south of Burlington, and the ferry between Cumberland Head near Plattsburg and Grand Isle Vermont, extended its season to December 31 beginning in 1954, marking its latest ever advertised service.[129]

In 1955, a strong economy and a banner year in automobile sales, paired with favorable weather, spurred a surge in tourism in the Champlain region, reflecting a statewide and national trend. Special attractions around the lake included the Fort Ticonderoga Bicentennial, the Town of Essex Sesquicentennial, the arrival of the retired *Ticonderoga* at the Shelburne Museum, and the opening of the St. Lawrence Seaway. The Lake Champlain Bridge carried 25 percent more

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[127] LCBC, "Annual Report for Year 1956," 31 December 1956, 1-4, LCBC Records, Roll 7, NYS Archives; LCBC, "Annual Report for Year 1958," 31 December 1958, 1-3; LCBC, "Annual Report for Year 1959," 31 December 1959, 1-2.

[128] LCBC, "Monthly Report to Commissioners," 1945-1966, LCBC Records, Roll 8, Box 9, Folder 5, NYS Archives; "Traffic on 2 bridges spanning Lake Champlain is on the rise," *Plattsburg Press-Republican*, 26 May 1976; "Lake Champlain bridges' traffic up by 2 percent," *Plattsburg Press-Republican*, 24 January 1977; New York State Department of Motor Vehicles, *Accident Facts* (Albany: Department of Motor Vehicles, 1967, 1974).

[129] "Crown Point Reservation Included Post War Project," *Essex County Republican*, 25 May 1945; "Cumberland Head Ferry Will Run Through Dec.31," *Essex County Republican*, 5 November 1954.

traffic in 1955 than 1954, including 70 percent more in September and October, and 90 percent more in November and December.[130]

In July and August 1959, the Champlain Sesquicentennial, highlighted by a "Canoecade" reenacting Champlain's 1609 voyage down the lake, brought another spike in tourism. Campsites, hostels, restaurants, and gas stations reported 15 to 20 percent increases in patronage during the celebration in July and August, with comparable increases in traffic on the Lake Champlain Bridge. These gains counterbalanced a sluggish June, due to poor weather and the lasting effects of a recession, with bridge traffic ahead 6 percent for the year.[131]

Use of the Lake Champlain Bridge would remain relatively static from the late 1960s to the mid-1970s, with 434,293 vehicles in 1976 compared to 416,848 in 1966. Primary reasons for this were the unsteady national economy from 1968 to 1971 and the much higher cost of transportation, beginning with the oil embargo of 1973. These events overshadowed the early years of the Adirondack Northway which eased travel to the Adirondack region. The Rouses Point Bridge was less affected over this period, with 880,730 vehicles crossing in 1976 compared to 643,582 in 1966.[132]

By the early 1970s, the overall heavy use, the increasing size of vehicles, and the advanced age of the bridges resulted in increased repairs that in turn brought higher tolls. In 1972, the rate for commercial vehicles was doubled, and in 1974, the passenger rate was raised back to 25 cents from 20 cents, and the commercial rate was increased another 25 percent. An audit by New York State found the Bridge Commission to be in strong financial condition at this time with existing toll revenue expected to cover repairs and maintenance costs for the foreseeable future. In 1974, a total of $275,608 in tolls was collected versus a total of $126,835 in repairs.[133]

At the same time, the Bridge Commission came under fire for some of its financial practices, stemming from the fact that commission costs were paid with public funds. High salaries, extravagant spending for conferences, and health insurance payments to resigned employees, were questioned. The policy of investing surplus toll funds equally among banks in Vermont and New York, with no consideration of the higher rates in Vermont, was questioned, and the choice of banks was thought to be a potential conflict of interest due to commission members serving on the respective bank boards. Further, the continued use of Fay, Spofford and Thorndike, of Boston, as consulting engineers, was considered non-competitive due to the availability of less expensive local contractors.

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[130] "Shelburne Museum Gains Wide Interest," *Essex County Republican*, 2 December 1955; LCBC, "Monthly Report," 1954-55.
[131] "Festival's Aftermath," *The New York Times*, 20 September 1959.
[132] LCBC "Monthly Report," 1965-70; "Northway Stretching Further North," *The New York Times*, 7 May 1967; "Lake Champlain bridges' traffic up by 2 percent."
[133] "Bridge Rates Doubled," *Burlington Free Press*, 23 June, 1972; "Bridge toll goes up on NY-Vt span," *Ticonderoga Sentinel*, 3 December 1974; "Age of lake bridges blamed for repairs," *Plattsburg Press-Republican*, 11 December 1975.

The Bridge Commission also faced renewed pressure to eliminate tolls on the bridges in the mid-1970s. Leading the charge was Representative Ray Poquette, of Allburg, Vermont, who sponsored a bill for a financial and performance audit of the commission in 1975. Poquette continued his attack, in 1978, sponsoring a bill for replacing the commission with a supervisory board under the governor of Vermont. The rejection of this bill spurred a compromise bill, in which Poquette called for the Vermont State Transportation Board to study the need for the commission and continued tolls. The Vermont legislature, in 1978, ultimately called for the elimination of the commission, with bridge costs to fall to the state highway departments, pending agreement by New York State. The New York legislature, in January 1979, disagreed, recommending that the commission be retained and that the tolls be increased to cover costs and planning for the new bridge at Rouses Point. The Lake Champlain Bridge alone needed $600,000 in repairs, and the new bridge was expected to cost $12 to $16 million.[134]

In the early 1980s, the Bridge Commission scrambled to secure final funding for the Rouses Point Bridge, while the commission's own future remained in question. In December 1984, under continued pressure from Vermont, the commission agreed that the bridge should be toll free and that the commission should be disbanded. New York and Vermont passed the agreement in February 1985, and on September 21, 1987, the new Rouses Point Bridge was opened toll free. At the same time, the Bridge Commission was dissolved and tolls were removed from the Lake Champlain Bridge. The operation of the Lake Champlain Bridge was relinquished to the New York State Department of Transportation, and the Vermont Agency of Transportation took over operation of Rouses Point Bridge.[135]

BRIDGE TOLL TAKERS

Over its fifty-eight year history as a toll span, the Lake Champlain Bridge was manned 24-hours-a-day, 365-days-a-year, by a dedicated crew of toll takers and maintenance workers. In the early years, the bridge was operated by a three-man crew, consisting of a superintendent, who worked a six-hour shift, and two aides, who worked nine-hour shifts. The original crew, hired in 1929, consisted of Superintendent Wallace C. Foote, and aides Harry Norton and Fred Fiske. Foote, 61-years old, was a dry goods merchant from Vergennes, and Norton, 56-years old, was a farmer who also lived in Vergennes. Fiske, 31-years old, appears to have worked concurrently on the bridge and as manager of the state fish hatchery in Crown Point. A fourth employee, Warren Lee of Ironsville, was hired to maintain the electrical system. Lee had performed some of the

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[134] "Toll-Free Bridges May Be Recommened (sic) by Auditor in Report on Lake Commission," *Barre-Montpelier Times Argus*, 8 July 1976; "Committee Rejects Bill to Abolish Bridge Commission," *Burlington Free Press*, 2 February, 1978; "Rep Poquette Revives Bridge Commission Bill," *Burlington Free Press*, 15 February 1978; "Tolls Block Repair Funds For Bridges," *Burlington Free Press*, 27 February 1978; "Move afoot in Vt. to end bridge unit," *Plattsburg Press-Republican*, 21 February 1978; "Bridge Toll Increase Predicted," *Burlington Free Press*, 27 October 1978; "Bridge Report Submitted," *Plattsburg Press-Republican*, 10 January 1979.
[135] "States takeover of bridges suggested," *Plattsburg Press Republican*, 28 February 1983; "Bridge Commission Expected to Approve Own Dissolution," *Burlington Free Press*, 3 December 1984; "Toll-free bridge now official," *Burlington Free Press*, 11 February 1985; "New York and Vermont Get New Toll-Free Bridge," *The New York Times*, 21 September 1987.

original electrical work on the bridge, including wiring the field office for the bridge engineers.[136]

The bridge crew expanded over time to handle peak traffic periods and increased maintenance. Six regular employees were on the payroll in July and August 1944, including new workers replacing departing staff. Fred Norton, the last original toll keeper, died in June 1944, having worked on the bridge for almost sixteen years. Superintendent Donald Van Brakle, having replaced Wallace C. Foote in July 1939, resigned in July 1944 to move to Saranac Lake. His successor was Joseph T. Carroll, who would serve as superintendent until 1967.[137]

A six-man crew staffed the bridge in the late 1950s. The crew of mostly older workers hailed from the surrounding villages of Crown Point, Port Henry, Moriah, Vergennes and Bridport. John Pepper was the veteran, having worked on the bridge since the early 1940s. Robert Hicks, the youngster at 41-years old, would work for another twenty years or so, completing his tenure in the early 1980s.[138]

The salaries of the toll takers in 1943 averaged $150 per month for the superintendent and $124 per month for the aides. By 1959, the salaries had increased to $400 per month for the supervisor and an average of $345 per month for a full-time aide, and by 1970, had increased to $630 per month and $550 per month, respectively. The superintendent gained the additional benefit of living accommodations at the bridge with no commuting costs. Overall, while providing steady employment, a toll-taker's job did not afford a high standard of living, with many workers adding second jobs to make ends meet.[139]

The life of a toll keeper was not always routine, with incidents on the bridge ranging from the dangerous to the absurd. In July 1933, the officer on duty witnessed the arrest of a bootlegger's convoy transporting $20,000 worth of liquor from Burlington, thought to be richest haul ever confiscated in northern New York. In May 1944, three teenagers robbed John Pepper of $150 during his Sunday night shift and escaped in his car. They were later arrested in Ticonderoga. This was considered "one of the most flagrant cases of juvenile crime on record in the area." In December 1945, a car driven by Charles Wilkinson accidentally destroyed the toll house, landing toll keeper Richard Watson in the road. Watson was not seriously injured, but the damage to the toll house and toll counter was estimated at $2500 to $3000.[140]

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[136] "Decrease in Receipts of Lake Bridge," *Glens Falls Times*, 6 December 1932; Bureau of the Census, *1920 and 1930 Census Population Schedules*, Vermont, Addison County; Dan Lee, 2010 interview.

[137] LCBC, "Employee's Monthly Withholding Tax Forms" and "Special Charge Vouchers," LCBC Records, Roll 14, Box 20, NYS Archives; "Lake Champlain Bridge Superintendent Resigns," *Ticonderoga Sentinel*, 27 July 1939; "Carroll Named To Post At Champlain Bridge," *Ticonderoga Sentinel*, 3 August 1944.

[138] LCBC, "Income Tax Withholding Forms" LCBC Records, Roll 14, Box 20, NYS Archives; "Bridge Toll-takers."

[139] LCBC, "Income Tax Withholding Forms"; Dan Lee, 2010 interview.

[140] "$20,000 Cargo of Liquors Seized," *Ticonderoga Sentinel*, 20 July 1933; "Three Boys Apprehended After Hold-up of Official At Lake Champlain Bridge," *Ticonderoga Sentinel*, 4 May 1944; "Tollhouse and Machine Toll In Span Crash," *Ticonderoga Sentinel*, 6 December 1945.

Other incidents involved deliberate attempts to avoid the toll. In September 1938, William Wells from Watervliet attempted to cross after his round-trip ticket had expired. He drove off, paying only half of the $1 toll, and ultimately was arrested and fined $10. In March 1950, Gerney Beran of New Hampshire ran the gate and later was arrested and fined $26 after causing an accident in Port Henry. Moriah farmer Freeman Beebe recounted the instance of an out-of-town traveler who asked John Pepper what he would do if the traveler did not pay. "All I got to do is push a button, Pepper says, that opens right up in the middle and you'll drop right in." John Pepper was an affable fellow with a reputation for storytelling. In response to a naïve traveler's question, "How far did Samuel de Champlain's boat sail down the lake?" Pepper quipped that Champlain had broken his mast trying to sail under the Lake Champlain bridge.[141]

By the late 1970s, a staff of seven full-time employees and five part-time employees collected tolls and maintained the bridge and grounds. In September 1977, the four-man staff on duty, consisting of Superintendent Robert Clarke, aides Frank Wojewodcik and Robert Hicks, and Warren Lee, were interviewed about their experiences on the bridge. Their daily routine included giving directions, trying to understand French-speaking drivers, and hearing complaints about the tolls. Robert Hicks described having seen two "streakers" cross the bridge, and Frank Wojewodcik recounted a case where a woman passenger had asked him to arrest the driver for kidnapping. With criminals occasionally crossing the bridge, Robert Clark had been hired partly because he was a deputy sheriff with arresting powers. Clarke replaced George Hanby as superintendent in 1974 and would serve until 1981, when he was succeeded by the sixth and final superintendent, Jerome Downs. [142]

Warren Lee ultimately was the longest serving worker on the bridge, having maintained the electrical system for fifty-one years, retiring in 1981. Warren Lee's son, Dan, assisted his father during four-year maintenance cycles in 1954, 1958, and 1962. In addition to electrical work and painting, Dan helped change bulbs in the street lamps and the navigation lights under the bridge. Mary Lou Scozzafava assisted Warren Lee for a few months in the 1970s and also remarked on the job of changing bulbs on the street lamps. With Lee steadying the ladder against the light pole, in often windy conditions, she climbed up to the top trying not to look down to the lake far below.[143]

In 1987, when the Lake Champlain Bridge Commission was abolished and the bridge was made toll free, the New York State Department of Transportation and the Vermont Agency of Transportation absorbed all of the toll and maintenance workers.[144]

DETERIORATION AND REPAIR OF THE BRIDGE

[141] "Refuses to Pay Bridge Toll, Fines $10," *Lake Placid News*, 2 September, 1938; "Evasive Action at Toll Bridge Costs Man $26," *Ticonderoga Sentinel*, 30 March, 1950; Freeman Beebe et al., 2010 interview; Dan Lee, 2010 interview.
[142] "Bridge Toll-takers;" LCBC, Minutes, LCBC Records, Roll 1, Box 2, NYS Archives.
[143] "A man, a bridge," *Ticonderoga Press-Republican*, 8 June 1981; Freeman Beebe, et al., 2010 interview; Dan Lee, 2010 interview.
[144] "Newly repaired Crown Point Bridge reopens," *Ticonderoga Press-Republican*, (ca.1991).

Deterioration of the Lake Champlain Bridge became apparent within fifteen years of its opening. Surface deterioration on the piers was identified in 1945, and in 1956, hairline cracks were identified in the lower parts of the pier shafts and around the bearing seats. Spalling had occurred on the tops of piers five, six, and seven. Also in the 1950s, the abutments were rebuilt and both approaches were repaved. In 1960 to 1961, the deck revealed deterioration over 10 percent of its length, with 50 percent deterioration on the underside of the curbs. The superstructure remained in generally good condition, with aluminum painting in 1950, 1957, and 1964, and spot painting in the interim. A main deficiency of the bridge, cited in the 1956 inspection, was the sharp approaches on either end, which became problematic due to increasing traffic volume and speed. The New York approach was improved as part of the reconstruction of the toll building and toll plaza in 1959 and 1968.[145]

More significant repairs were required in the 1970s. In 1970, the deck was restored on spans one to five and spans nine to fourteen, and the pier caps and abutments were restored and sealed. In 1974, the tops of piers six and seven were reinforced with a post tensioned containment assembly to arrest vertical cracking. An underwater inspection in 1974 revealed hairline to $^{1}/_{16}$" cracks in piers three to seven, with more severe cracks in pier seven recommended for repair. The expansion bearings on pier eight and on the east side of pier five were replaced in 1972 and 1973, with the build-up of pack rust observed at other bearings. The remainder of the deck, on spans six to eight, was restored in 1976.[146]

In the 1980s, further deterioration affected the piers, bearings, and deck. In 1980, repairs were completed on the outer stringers at piers three and nine, which had rusted due to leaks in the expansion joints. The scuppers were replaced, and the deck armoring assembly at both abutments was replaced or restored. In 1983, containment assemblies were installed on piers five and eight, the pier tops were pressure grouted, and the bearings were replaced on pier five span five and pier eight span eight. The final inspections by the Bridge Commission in 1985 and 1986 called for the replacement of the entire deck, the installation of a containment assembly on piers three and four, and the continued repair of cracks and spalls on the piers.[147]

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[145] Fay, Spofford and Thorndike, "Report on Inspection of Crown Point Bridge And Rouses Point Bridge," October 1956; Fay, Spofford and Thorndike, "Report on Restoration of Roadway Surfaces Crown Point Bridge And Rouses Point Bridge," May 1960; Fay, Spofford and Thorndike, "Report On Inspection of Crown Point Bridge And Rouses Point Bridge," May 1961; Fay, Spofford and Thorndike, Memorandum of 1968 Annual Inspection Rouses Point And Lake Champlain Bridges, 5 June 1968. All in LCBC Records, Roll 8, Folder 6, NYS Archives.

[146] Fay, Spofford and Thorndike, "Report on Diver Inspection Of Piers At The Lake Champlain Bridge And Rouses Point Bridge," November 1974; Max D. Serota, Fay, Spofford and Thorndike, to Lawrence M. House, Chairman LCBC, 1976 Diver Inspection of Piers Lake Champlain Bridge, 21 October 1976; Max D. Serota, Fay, Spofford and Thorndike, to Leo C. Kelly, Chairman LCBC, 1978 Annual Inspection Lake Champlain Bridge, 12 May 1978; New York State Department of Transportation, "Bridge Needs in New York State," September 1979. All in LCBC Records, Roll 8, Folder 6, NYS Archives.

[147] Max D. Serota, Fay, Spofford and Thorndike, to Leo C. Kelly, Chairman LCBC, 1980, 1982, 1983, Annual Inspections Lake Champlain Bridges,and James G. Rourke, Fay, Spofford and Thorndike, to Leo C. Kelly, Chairman LCBC, 1985, 1986 Annual Inspections Lake Champlain Bridges; Fay, Spofford and Thorndike, Memorandum of 1983 Annual Inspection Lake Champlain And Rouses Point Bridges, 13 May 1983; Fay, Spofford

The New York State Department of Transportation estimated that the bridge required $5 to $6 million in repairs when it took over operations in 1987. In 1991, the upper portion of the deck was replaced with a hard polymer surface, and repairs were made to the steelwork and the substructure at a total cost of $6.4 million. The 36-ton weight restriction placed on the bridge was removed at this time. In 1995 the Vermont abutment was rebuilt, and in 1996, the rubber deck fenders at piers six and seven were replaced.[148]

In October 2001, the biennial inspection by NYSDOT rated the overall condition of the bridge at 4.2 on a scale of 1 to 7. A rating of less than '5' indicates a status of structurally deficient, characterized by severe deterioration. The superstructure was rated '4' for the primary members of spans six to nine, and '3' to '4' for the secondary members of spans seven and eight, and otherwise '5' or above. The piers were rated '3' to '4' for the bearings/bolts/pads of spans five, seven, and eight, '3' to '4' for the pedestals and cap of span eight, '3' to '4' for the stem solid pier of spans three to eight, and otherwise '5' or above.[149]

A five-year diving inspection in 2005 identified widespread map cracking and scaling on piers four, five, six, seven, and eight, with deterioration at water level up to 4" deep. The inspection recommended the repair of cracks on piers six and seven, and abrasion damage on all of the piers at waterline. By the 2007 inspection, the overall condition of the bridge had dropped to 3.7, with extensive deterioration identified at the pier cams and stems at the water line. The compressive strength of the concrete in thirteen cores taken from the piers ranged from 3500 PSI to almost 10,000 PSI.[150]

In 2006, NYSDOT considered rehabilitation or replacement in its five-year planning for the bridge. In June 2007, a Citizens' Advisory Committee was appointed to assist in the planning, with preservationists favoring rehabilitation and others desiring a new span built to modern standards and requiring limited maintenance. Local residents feared that closure of the bridge would cause a major disruption in their daily routines.[151]

In May 2009, the biennial inspection of the bridge identified four red flags for corrosion section loss in the bottom chord and gusset plates of spans four and six, and for cracks in floor beams of spans five and nine. Twenty yellow flags were identified, mostly for section loss in the bottom chord and gusset plates of spans four, five, and nine. The pier sections above water level revealed cracked or hollow-sounding concrete on 100 percent of pier eight, on 80 percent of pier five, and on 75 percent of pier four, with cracked, hollow, or crumbled concrete on the tops of

and Thorndike, "Report On Diver Inspection of Piers At The Lake Champlain Bridge," July 1984. All in LCBC Records, Roll 8, Folder 6, NYS Archives.
[148] "Crown Point Bridge Needs Repairs," *Ticonderoga Press-Republican*, 8 June 1987; HNTB New York Engineering and Architecture, Lake Champlain Bridge-Safety Assessment Report (Draft), prepared for NYSDOT (New York, NY: HNTB Engineering and Architecture, 11 November 2009), 4-5.
[149] NYSDOT, "Biennial Inspection of Lake Champlain Bridge," 29 October 2001, NYSDOT, Region 1.
[150] HNTB, 3-4.
[151] "Citizens call for repair of bridge," *Ticonderoga Press-Republican*, 16 December 2007.

piers five, six, seven, eight, and nine, and around the bearings of piers five, six, eight, and nine. The bearings on piers three to nine were either frozen or inhibited by pack rust.[152]

In July 2009, the bridge was closed to one-way traffic to allow repairs to the flagged areas on the lower chords, floor, gusset plates, and hanging straps. In mid-September, with repairs ongoing, NYSDOT announced that the bridge was in worse structural condition than previously thought.[153]

Further inspections revealed extreme deterioration of the piers, especially pier five, and on October 16, 2009, NYSDOT closed the bridge for safety reasons. The bridge closure forced people to find alternate ways across the lake, using detours over bridges in Whitehall and Plattsburg or by ferry in Ticonderoga. The closure brought hardship to service and retail businesses along the bridge route, with steady traffic giving way to a disturbing silence in the Village of Crown Point.[154]

On November 6, 2009, a Draft Safety Assessment Report for the Lake Champlain Bridge was completed by HNTB New York Engineering and Architecture, for NYSDOT. The report provided the results of a series of in-depth inspections that confirmed the fragility of the substructure. A comprehensive underwater inspection revealed severe deterioration at and below water level in all of the piers, with cracking below water especially severe at piers five and seven. Core samples from above the water level at pier five revealed the compressive strength had dropped significantly since 2007, resulting from water saturation deep inside the pier. Major factors causing the deterioration were frozen bearings, which had caused increased bending and shear forces at the piers, and ice freeze/thaw cycles and abrasion, which had degraded the axial and bending capacity of the piers. The opening of large cracks below water in the shoreline piers, caused by ice pressure, had been exacerbated by the lack of steel reinforcement in the piers.[155]

The HNTB report analyzed the original design of the piers and the methods used to build the piers. The underwater piers were built on non-reinforced-concrete caissons footed on bedrock. The cofferdams used to build the caissons were braced on the outside, but some of the bracing extended through to the inside and was left embedded in the concrete. The caissons were built with a drop bottom bucket, an unusual technique that when used underwater could result in the formation of laitance when the concrete came in contact with the surrounding water. A thin layer of laitance potentially developed each time the bucket was dropped and may have been buried within the completed structure. If this was the case, the ultimate strength and durability of the piers, incorporating potential planes of weakness, would have been compromised. Engineer Thomas Spofford had originally downplayed the possibility of excessive laitance in his response

[152] NYSDOT, "Biennial Inspection of Lake Champlain Bridge," 1 May 2009, NYSDOT, Region 1.
[153] "Champlain Bridge future discussed," *Ticonderoga Press-Republican*, 17 September 2009.
[154] HNTB, 5, 27-28.
[155] HNTB, Executive Summary, 27-28.

to concerns by Jacob Feld, C.E., with diver inspections during construction showing little or no build up of laitance.[156]

The HNTB report indicated that the continuous truss design of the bridge was susceptible to damage that could cause the entire superstructure to fail, with the frozen bearings and deteriorated piers potentially contributing to a failure. The report considered the piers to be too slender to withstand live and dead load when the bearings are frozen, given the use of non-reinforced concrete. The use of non-reinforced concrete was considered unusual for a major truss bridge in the late 1920s, reducing the flexural capacity of the piers, and making the piers more susceptible to deterioration over time. The piers also were not protected from abrasion at the water line. Protection of the piers originally was considered unnecessary by Thomas Spofford. Again responding to concerns by Jacob Feld, C.E., Spofford had cited the location of the bridge in a freshwater lake, with little current and virtually no danger of abrasion from ice and floating objects, as reasons for not protecting the piers. The HNTB report noted that the piers had begun to deteriorate already in the 1940s, and that the repair of visible surface defects in the ensuing years may have disguised more significant structural problems.[157] The report concluded that the bridge could collapse suddenly due to the potential failure of pier five. The report recommended that the bridge be demolished, rather than rehabilitated, due to the safety risks involved in working close to the bridge during rehabilitation, and called for a new bridge to be built immediately in the same location.[158]

In a public announcement on November 9, 2009, New York Governor David A. Paterson reported that the New York State Department of Transportation and the Vermont Agency of Transportation would accept the engineers' recommendations to remove the bridge based on the reported overwhelming safety issues and would begin planning for a new bridge. On December 8, 2009, the Federal Highway Administration concurred with the recommendations based on the Final Safety Assessment Report by HNTB.[159]

The decision to remove the bridge was received with controversy and dismay by the historic preservation community. Robert McCullough, Associate Professor of Historic Preservation at the University of Vermont, who had prepared the National Register of Historic Places and National Historic Landmark nominations for the bridge, suggested that poor maintenance over the past two decades contributed to the demise of the bridge. Steven Engelhart, director of Adirondack Architectural Heritage and a member of the Project Advisory Committee, called the bridge "the most important work of American civil engineering in northern New York and Vermont" and questioned the speed of HNTB in calling for its demolition.[160]

The New York State Department of Transportation, under programmatic agreements with the Federal Highway Administration, the New York State Historic Preservation Office, the New

[156] HNTB, 10-11; Spofford, "Lake Champlain Bridge," 658.
[157] HNTB, 2-3, 11-16; Spofford, "Lake Champlain Bridge," 658.
[158] HNTB, Executive Summary, 27-28.
[159] NYSDOT, Lake Champlain Bridge Project, History, available at https://www.nysdot.gov/lakechamplainbridge/history, accessed 16 July 2010.
[160] "A bridge too far gone," *Burlington Free Press*, 15 November 2009.

York State Department of Environmental Conservation, the Vermont State Preservation Office, the Vermont Agency of Transportation, and the Advisory Council on Historic Preservation, became the lead agency for the Lake Champlain Bridge Removal and Replacement, which included the demolition of the bridge and the construction of a new bridge. In the interim, a project to establish a temporary ferry crossing was advanced as an emergency undertaking under Section 106. The NYSDOT project leaders consisted of John Grady, Regional Construction Engineer, with Dave Richards, Construction Supervisor, Tim Farrell, Engineer-in-Charge for the demolition and ferry construction, and Jeff Brown, Engineer-in-Charge for the new bridge construction.[161]

On December 10, 2009, NYSDOT announced that an expert demolition firm, Advanced Explosives Demolition, Inc. (AED) of Coeur d'Alene, Idaho, had been hired to demolish the bridge under a subcontract with NYSDOT general contractor, Harrison, & Burrowes, Bridge Constructors, Inc. Over the next two weeks, AED made selective cuts in the steelwork to weaken the bridge and placed more than 800 pounds of explosive at these and other critical locations on the superstructure. The use of RDX explosive in shaped charges, with a focused impact of 2 million pounds per square inch, was designed to easily cut through the steel and drop the bridge straight down into the lake.[162]

Public safety was the primary concern in preparations for the demolition. The United States Coast Guard established a 1000' safety zone around the bridge, restricting unauthorized access to vehicles, vessels, or persons, and the Federal Aviation Administration established a 2,000' no-fly zone over the bridge. NYSDOT discouraged the public from viewing the demolition and advised spectators not to stand on the lake ice near the bridge or on the railroad tracks on the New York side. Official public viewing areas were designated at Port Henry in New York and along Route 125 in Vermont, and a viewing area for the press was designated at the Crown Point State Historic Site. Also of concern was the potential impact of the demolition on the stone forts of Crown Point State Historic Site and the brick tavern of the Chimney Point State Historic Site. To measure any possible impacts, NYSDOT conducted vibration monitoring at three locations on both sides of the lake during the demolition and during subsequent pile driving for the new bridge, and completed inspection reports of both historic sites before and after the demolition.[163]

The bridge was demolished on December 28, 2009, after a five-day delay resulting from severe cold and ice on the lake. Governor Jim Douglas of Vermont triggered the charge, and following multiple explosions marked by light, smoke, and a 130-decibel boom, the truss portion of the bridge dropped into the lake, leaving the viaducts and piers standing. The demolition was partially obscured to onlookers by the overcast snowy conditions, however, many people witnessed the event on local news and in a video circulated on the internet. Over the ensuing months, cranes operating from barges removed the remains of the bridge, with crews working

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[161] Richard Ambuske, NYSDOT, Region 1, e-mail message to Mark S. LoRusso, 16 May 2011.
[162] "AED Selected for Lake Champlain Bridge Demolition," Advanced Explosives Demolition, Latest News, available at http://www.biggerblast.com; accessed 16 May 2011; "Champlain Bridge demolished this morning," *Vermont Business Magazine*, 28 December 2009, available at http://www.vermontbiz.com, accessed 16 May 2011.
[163] "Champlain Bridge demolished"; Ambuske, e-mail message, 16 May 2011.

hard to clear the navigation channel by April 15, and to remove all of the debris from the lake by June 15, as required by the U.S. Coast Guard. The debris was floated to Port Henry, dismantled, and sold for scrap. Salvaged girders were provided for interpretation and display to the Essex County Visitor's Information Center in the old toll house, to the Vermont Agency of Transportation for use at the Chimney Point State Historic Site, and to the Iron Center Museum in Port Henry. The Federal Highway Administration was provided numerous samples of the steelwork for forensic testing. The bridge builder's plaque and state line markers were removed prior to the demolition and stored by NYSDOT. The New York State Office of Parks, Recreation and Historic Preservation will restore the plaques, which will be exhibited at the Visitor's Information Center.[164]

BUILDING A NEW BRIDGE

Planning for a new bridge commenced as soon as the Lake Champlain Bridge was slated for demolition. The first order of business was to restore ferry service to open the crossing. The ferry was to be built on the south side of the bridge, with landings south of the old toll house within the Crown Point Public Campground on the New York side, and south of the Chimney Point Tavern, within the Chimney Point State Historic Site, on the Vermont side. The ferry construction included dredging the lake at the landing sites, and building docks and access roads to the docks on both sides. The ferry began operation on February 1, 2010, with two ferry boats providing free, continuous service across the lake.[165]

Cultural resources investigations were required prior to the removal of the Lake Champlain Bridge and the construction of the ferry under Section 106 of the National Historic Preservation Act, consisting of the HAER documentation, and archaeological surveys in areas of potential effect. On the Vermont side, staff of the University of Vermont Consulting Archaeology Program identified evidence of the original 1731 French fort adjacent to one of the existing piers, consisting of a stone foundation, possibly a bastion of the fort or an associated homestead, where French ceramics and window glass had been identified previously. Further investigation was planned at the foundation site in conjunction with the new bridge construction. On the New York side, Phase I investigations along the ferry approach by staff of the Cultural Resources Program of the New York State Museum identified a non-intact feature of fieldstones and mortar, with associated pearlware and wrought nails suggesting an eighteenth-century association. Phase II investigations identified a section of a cobblestone roadway probably associated with the construction of Fort Crown Point in 1759. The fieldstone feature was avoided, and the cobblestone road section was removed by the approach road construction.[166]

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[164] "Champlain Bridge demolished"; "Eroding Lake Champlain Bridge is felled; will be rebuilt," *The Boston Globe*, 29 December 2009; "Champlain Bridge cleanup effort on schedule," WCAX.com, available at http://www.wcax.com/story/12230179/champlain-bridge-cleanup-effort-on-schedule, accessed 17 May 2011; Ambuske, e-mail message, 16 May 2011.

[165] NYSDOT, "December 12, 2009 Temporary Ferry Presentation," Lake Champlain Bridge Project, Community Outreach, available at https://www.nysdot.gov/lakechamplainbridge/community-outreach, accessed 17 May 2011.

[166] Aaron Gore, summary of Phase 1 Archeological Survey and Archeological Monitoring for Temporary Access Road, NYSDOT PIN AX16.13.701, Lake Champlain Bridge, e-mail message to Mark S. LoRusso, 16 May 2011;

On December 12, 2009, NYSDOT publicized six possible designs for the new bridge by HNTB, seeking comment in public meetings held in Ticonderoga and Vergennes. The designs also were posted for comment on the NYSDOT website. The designs consisted of two versions of a cable-stayed bridge, a network tied-arch, and a modified network tied arch. The steel girder bridge was the most economical to build and maintain, while the arch designs were more expensive, but aesthetically similar to the original bridge.[167]

On January 14, 2010, NYSDOT announced the selection of the modified network tied arch design, which was the favorite of area residents who attended the public meetings, people responding to an online survey, and the Public Advisory Committee. Preliminary plans of the new bridge were released on February 1, 2010, and letting for the bridge contract was held on April 15, 2010. Bids were received from eight construction companies from the Northeast, Chicago, and Colorado, including the American Bridge Company, of Quincy, Massachusetts, the same firm that built the 1929 bridge.[168]

On May 27, 2010, the construction contract was awarded to Flatiron Construction Company of Longmont, Colorado, the low bidder at $69.6 million. Flatiron achieved recognition in the late 1980s with the construction of a series of award winning segmental concrete bridges on Interstate 70 in Colorado. The company has built noteworthy bridges across the United States in recent years, including the segmental concrete I-35 replacement bridge in Minneapolis, the cable stayed Arthur Ravenel Bridge in Charleston, South Carolina, and the Carquenez Suspension Bridge in San Francisco.[169]

Designed with a minimum lifespan of seventy-five years, the new Lake Champlain bridge will be 2200' long, incorporating a 402' long and 80' tall arched main span, supported on delta fixed frames. The arch will have a network cable arrangement with internally redundant box tie girders supporting a composite precast concrete deck. The main span will be built off-site and floated in on barges. The bridge will feature zinc metalized corrosion protection, one of the largest bridges in North America to receive this treatment.[170]

Governors Paterson and Douglas presided over the ground breaking ceremony for the new bridge on June 10, 2010. Governor Paterson called the event "an important step in reconnecting our two states and restoring this critical link for commerce, tourism, employment, education and medical services." Governor Douglas emphasized the critical importance of the bridge to the daily life and economy of area residents, and commended everyone involved for expediting the work. Other state and local officials lauded the governors for their quick response and

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"French fort unearthed at Chimney Point," *Addison County Independent*, 22 March 2010, available at http://www.addisonindependent.com/201003french-fort-unearthed-chimney-point, accessed 16 May 2011.

[167] NYSDOT, "January 4, 2010 Bridge Concepts Presentation," Lake Champlain Bridge Project, Community Outreach, Public Meetings.

[168] NYSDOT, Lake Champlain Bridge Project, History.

[169] "Lake Champlain Bridge," Flatiron Construction Company, http://www.flatironcorp.com/, accessed 10 June 2010.

[170] "Lake Champlain Bridge," Flatiron.

commitment to the project, demonstrated by a goal to complete and open the new bridge in early autumn 2011.[171]

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