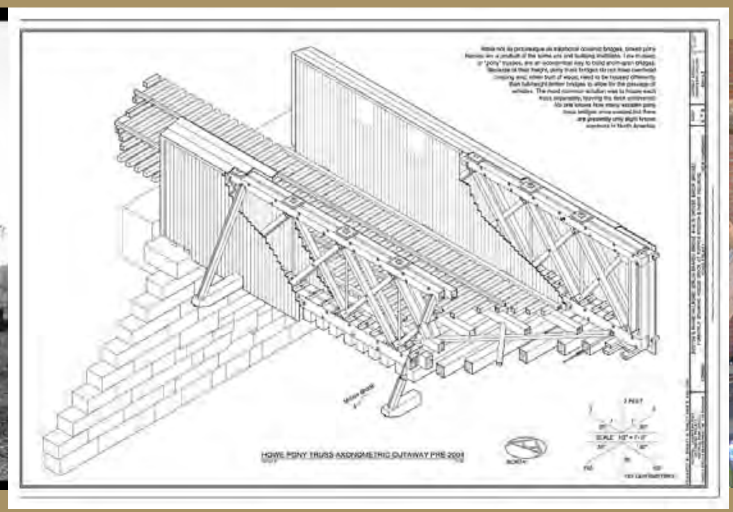
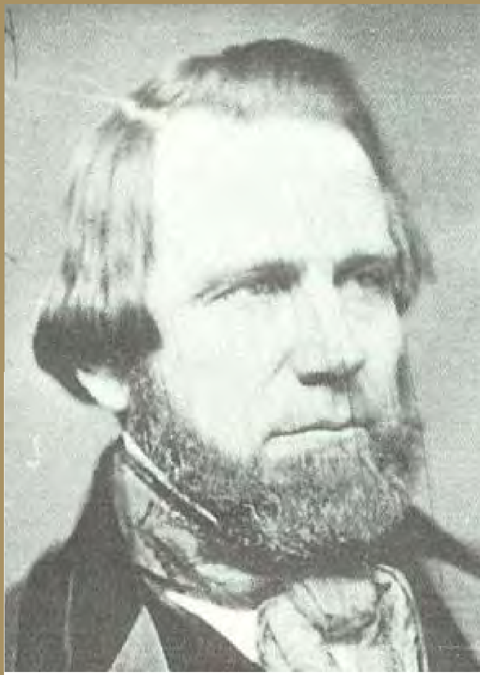
The Salvage, Documentation, and Reconstruction of the Moose Brook Bridge



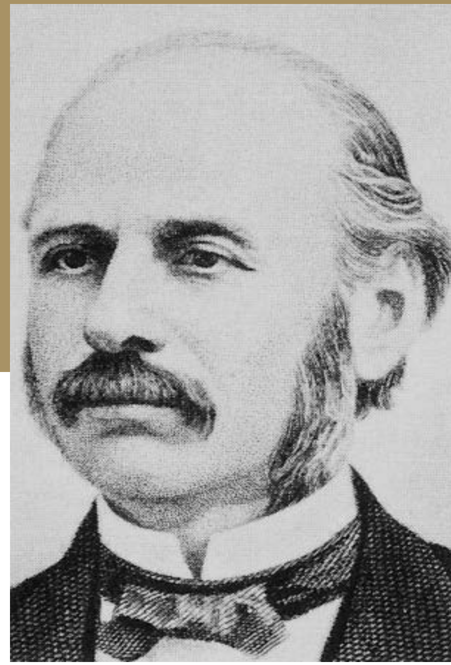
Christopher Marston, Tim Andrews, Vern Mesler

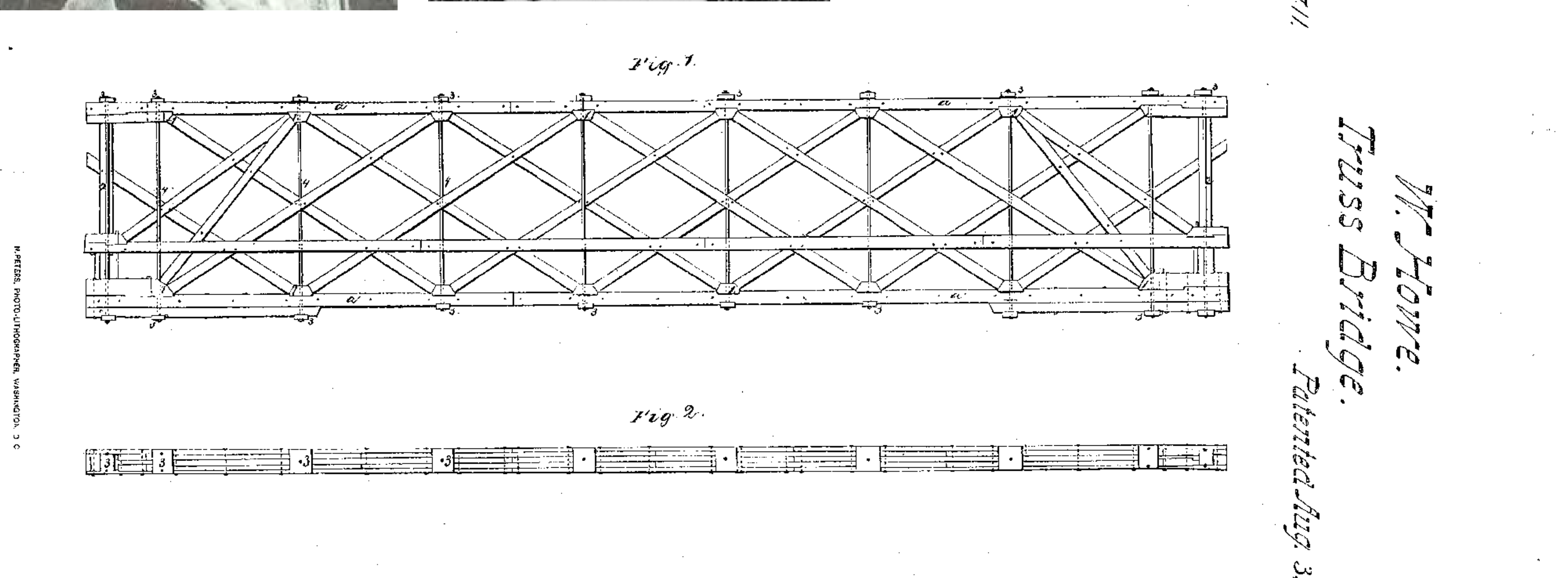
National Covered Bridge Conference
Dayton, June 7, 2013

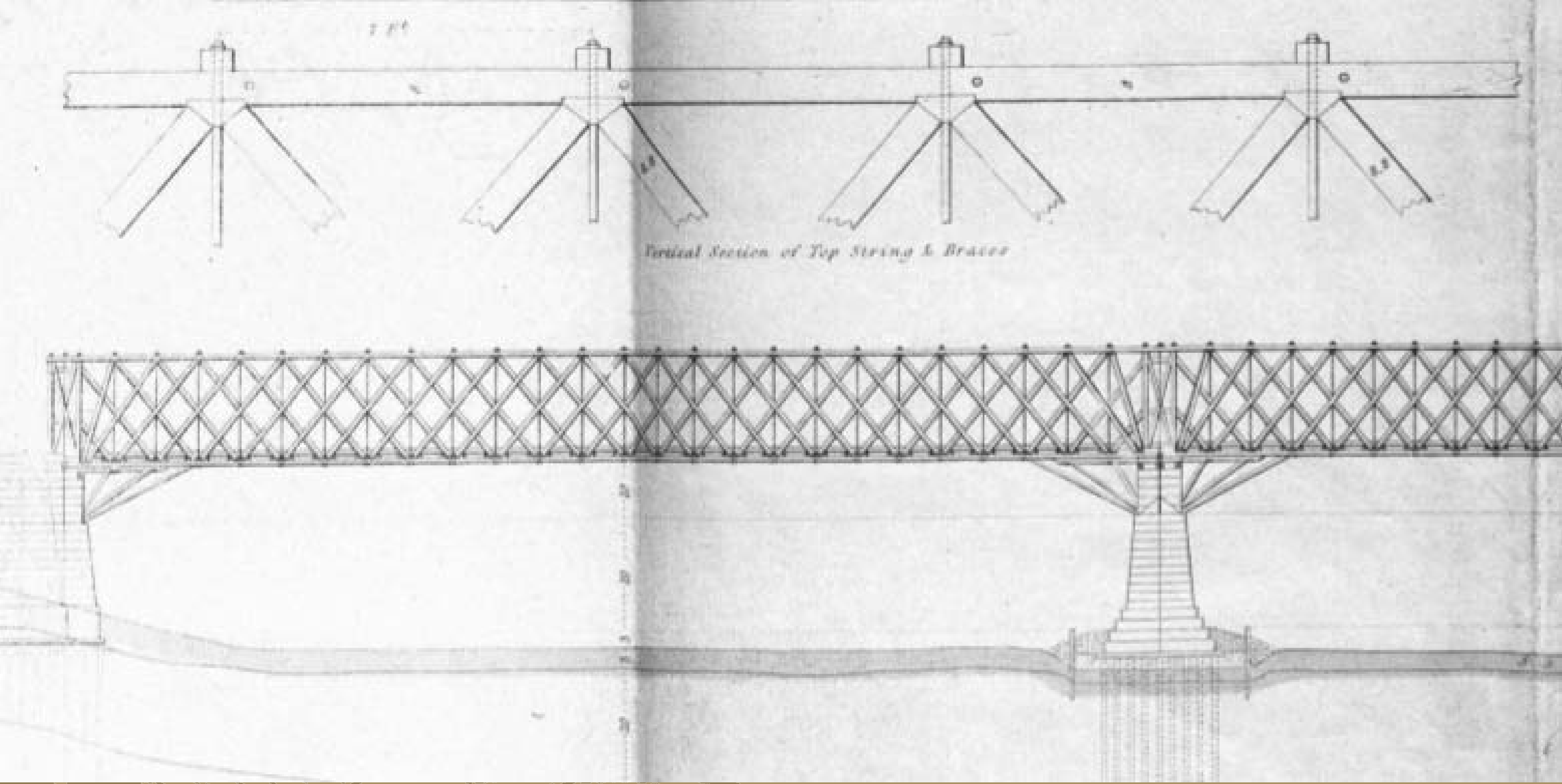
William Howe



Amasa Stone







Connecticut River Bridge at Springfield, 1840

First application of Howe truss

1,264 ft long, 7 spans, 180 ft each

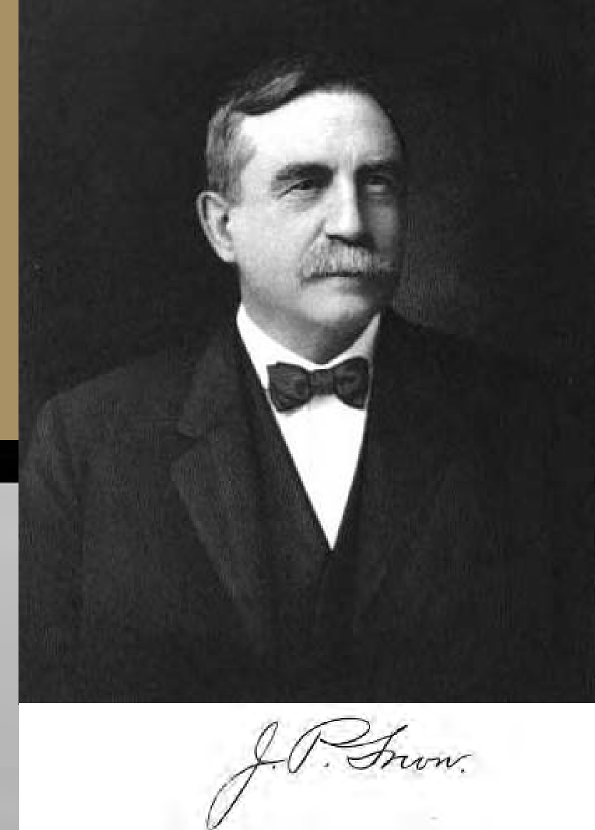
Deck truss: Troy & Greenfield RR

Through truss: Dover Point, NH

Pony truss: Portland & Ogden RR, White Mtns, NH

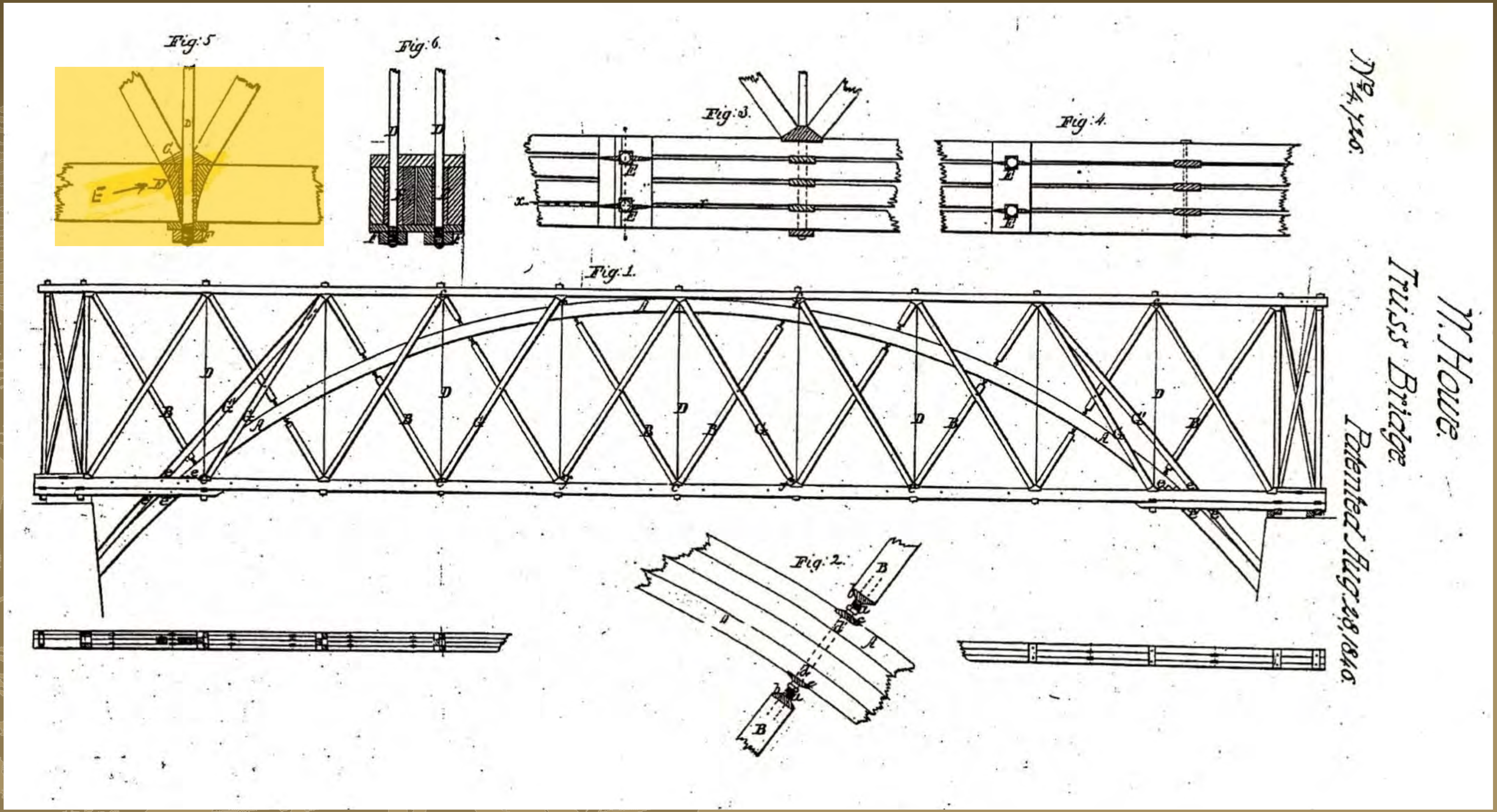
Howe roof truss used in Elysium,1907, approx 120' span

B&O RR Transfer Bridges, 26th St pier on Hudson River, New York City

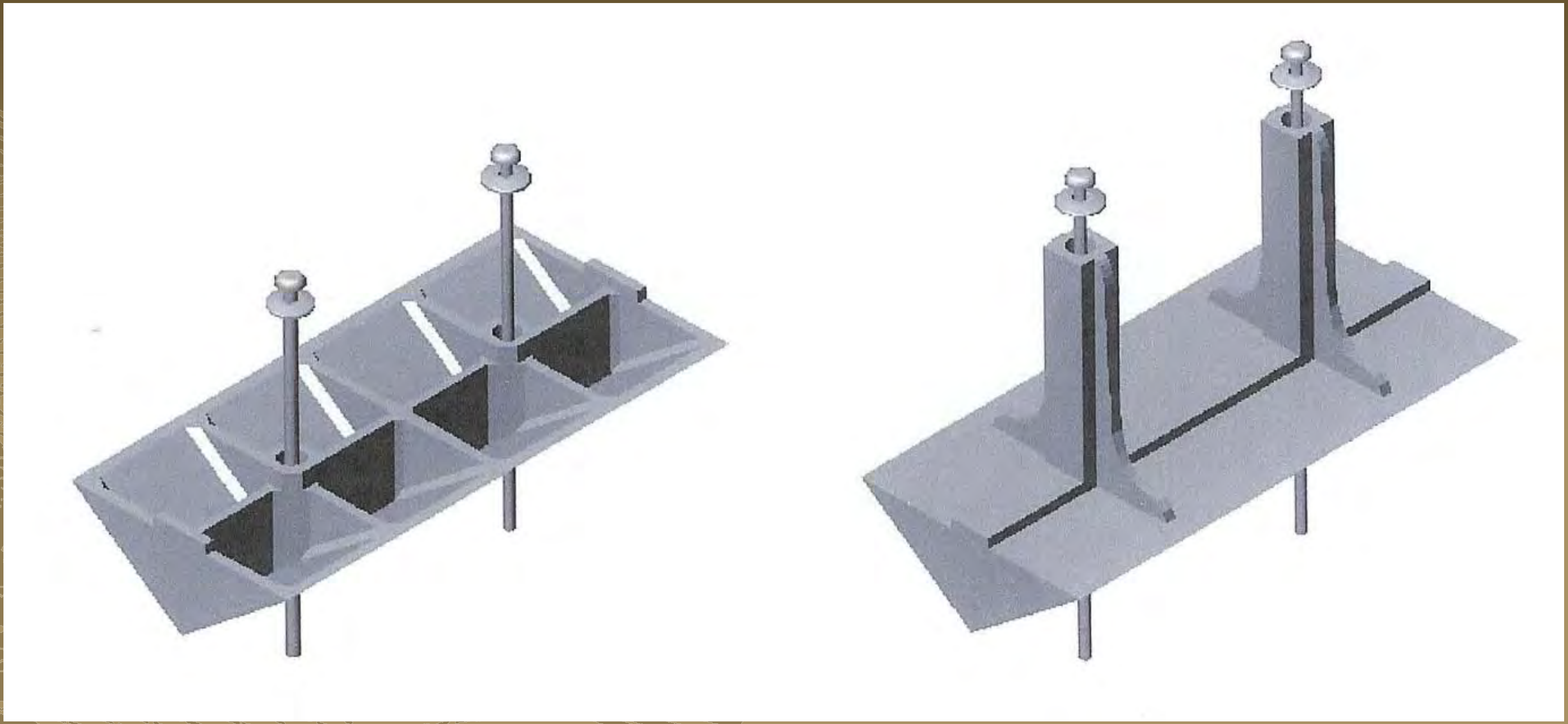


Shoreham Railroad Bridge, 1897
HAER VT-32

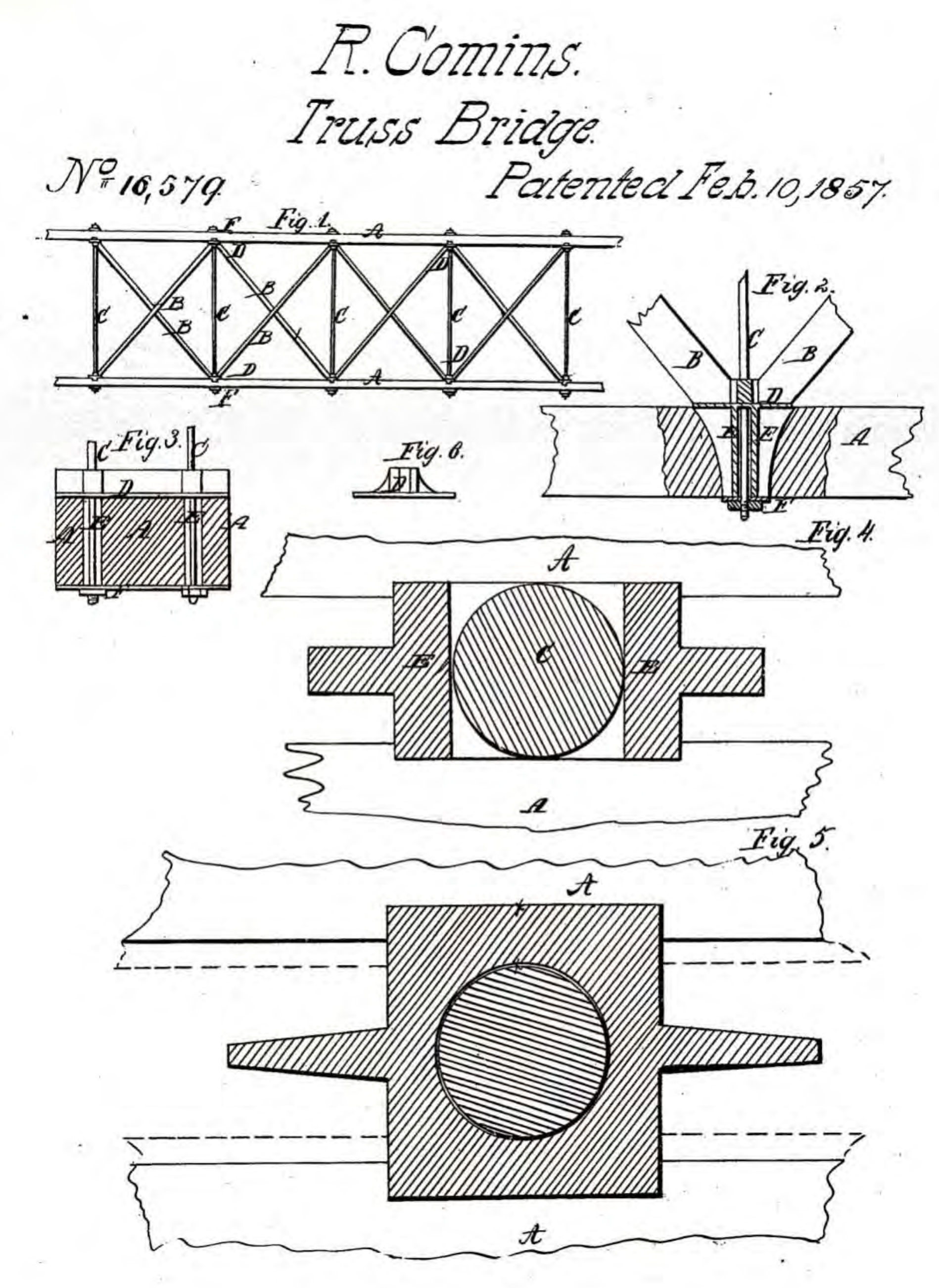
Moose Brook Bridge pre-2004 fire, built 1918



William Howe patent for cast iron node, 1846



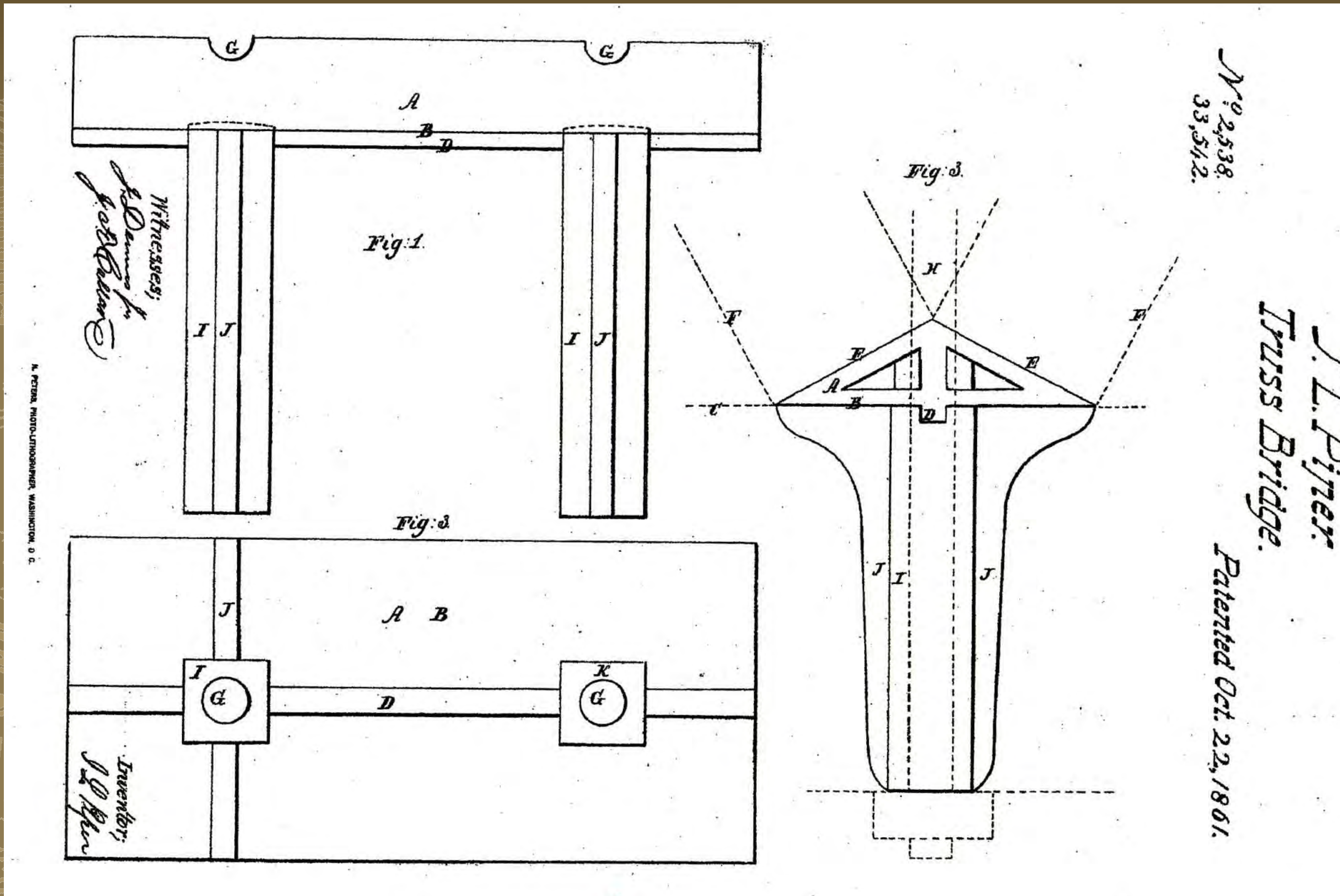
Nodal castings with “sleeves”



Comins node casting patent

Nodal Castings from Rexleigh Covered Bridge, New York

Nodal Castings from Ceylon Covered Bridge in Indiana



Piper patent for nodal casting 1861

HAER-Case Western Reserve University Agreement, 2008: Howe Truss Bridges Design and Performance

A classic Howe truss in good condition, with cast iron nodes, could be selected and then shored, the verticals loosened, instrumentation installed, the nuts tightened to change the stress levels in the members, the shoring removed, and live loads applied. Data could be gathered throughout this process and a time history of member forces and displacements compiled. The database would be useful in calibrating analytical models for the Howe truss. The final report would provide understandable, practical information on the behavior, modeling, and design of Howe truss bridges.

Year 1: Identify bridge, complete agreement with owner; assess condition, design shoring, define experimentation methodology; select contractor to shore bridge; begin installation of instruments; begin to acquire data; produce prelim analysis

Year 2: Monitor periodic data; develop elastic models; acquire data during prestressing and removal of shoring; perform live load testing; develop viscoelastic models; produce intermediate analysis

Year 3: Write final report analyzing test results and providing recommendations for rehabilitation and design of Howe trusses.

Moose Brook Bridge, ca. 2008

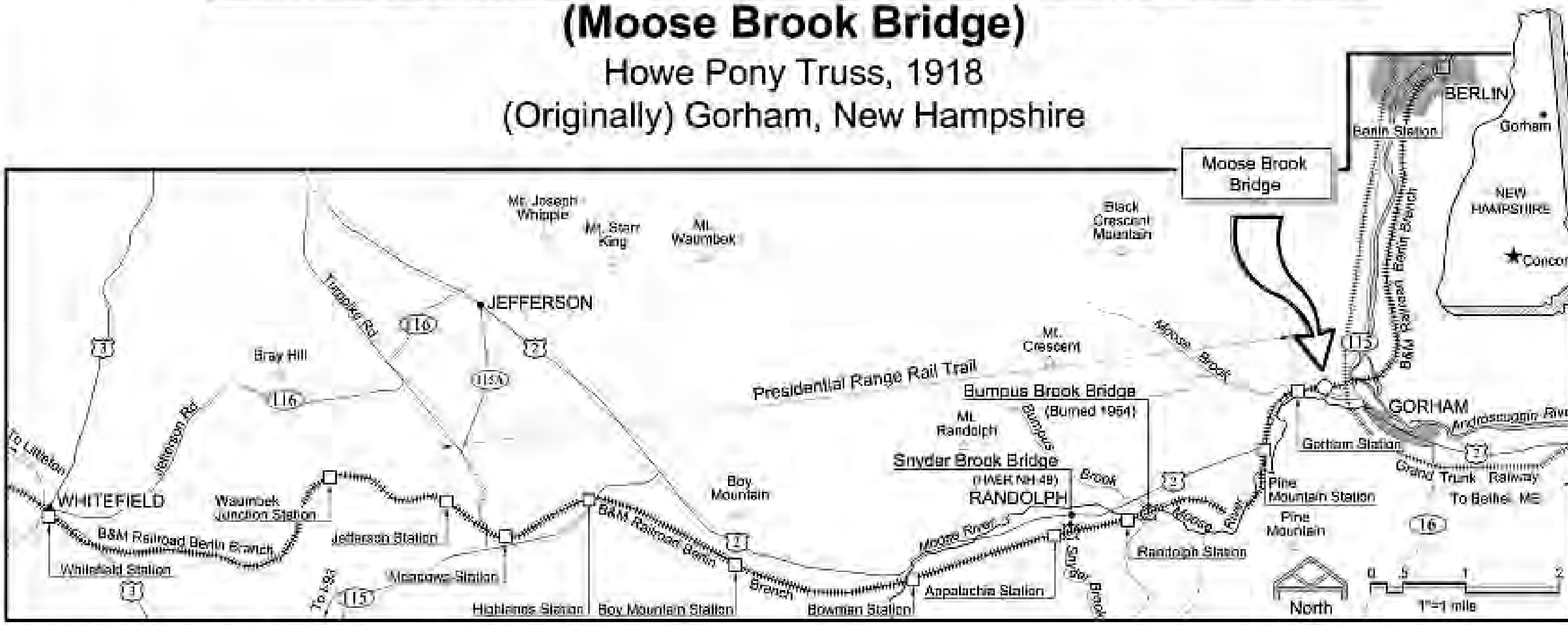
HAER Field Team, 2009

Jet Lowe HAER Large Format Photograph, 2009

Jet Lowe HAER Large Format Photographs of castings, 2009

Dario Gasparini at Snyder Brook Bridge, 2009

Boston & Maine Railroad, Berlin Branch Bridge #148.81
(Moose Brook Bridge)
Howe Pony Truss, 1918
(Originally) Gorham, New Hampshire



Boston & Maine Railroad, Berlin Branch, showing locations of known Howe pony truss bridges built in 1918.

Latitude/Longitude coordinates of original location: 44.40049N, -71.20755W

In 1891-93, the Concord & Montreal Railroad built a 30-mile, single-track branch line from its main line at Whitefield, New Hampshire to the Town of Berlin, where lumber and paper industries were booming. The line passed through the towns of Jefferson, Randolph and Gorham, along the northern edge of the Presidential Range. Shortly after the line's completion, the Boston & Maine Railroad leased the branch for 91 years.

No information has been found concerning the first bridge at this location, but presumably it was a wood structure. The years of World War I brought the need for longer, heavier, and faster freight loads on this division and much of the line was upgraded to accommodate heavier rolling stock. This bridge is one of three known Howe pony truss bridges that were built on the line in 1918 and one of only two that survive. While it was accepted that wood bridges might have a shorter service life than steel bridges, they were economical to build, could be easily repaired, and gave evidence of distress long before failure. The Howe pony truss was the truss of choice for shorter spans on Boston & Maine lines. Patented in 1840 by Massachusetts millwright William Howe (1803-1852), the Howe truss addressed the inherent difficulty of constructing tension connections in wood by using adjustable wrought iron rods instead of wood posts for vertical tension members. The Howe truss was favored by railroads for its rigidity and simple framing connections, and was used extensively on railroad lines in the United States and Europe in the nineteenth century.

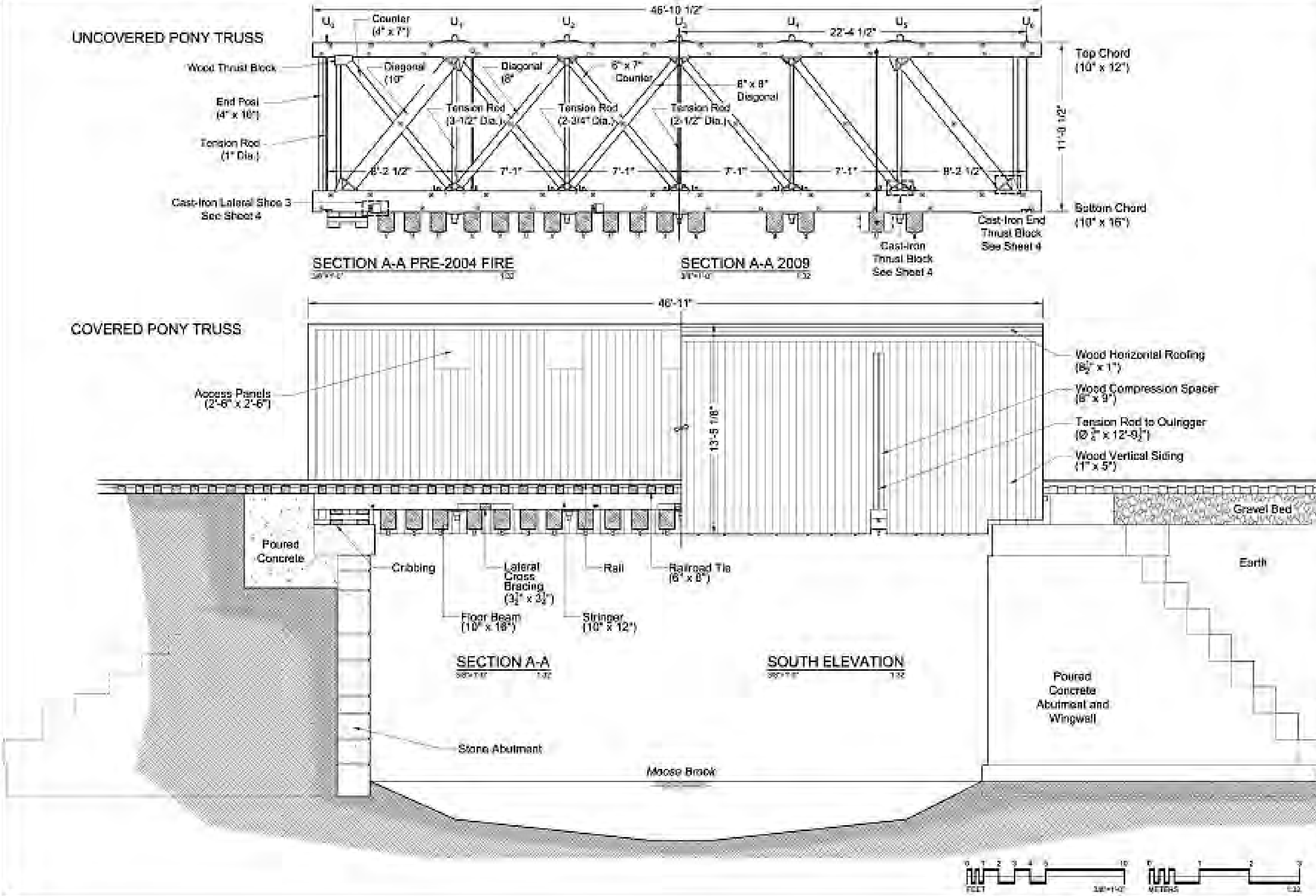
The Boston & Maine's Berlin Branch saw regular use for both passenger and freight trains until the 1980s. The line was leased to Guilford Transportation in 1983 and to New Hampshire & Vermont Railroad in 1989. In 1996, the corridor from Waumbek Junction to Berlin was abandoned and the New Hampshire Division of Parks and Recreation (Department of Resources and Economic Development) purchased and converted the section from Jefferson to Gorham into multiple-use recreational trail called the Presidential Range Rail Trail. On May 20, 2004, the Moose Brook Bridge burned under suspicious circumstances. The New Hampshire State Historic Preservation Office, in collaboration with the National Society for the Preservation of Covered Bridges (NSPCB), salvaged the charred trusses for possible future rebuilding. The New Hampshire Bureau of Trails erected a replacement bridge on the old abutments in the summer of 2004.

The National Covered Bridges Recording Project was undertaken by the Historic American Engineering Record (HAER), a long-range program to document historically significant engineering and industrial works in the United States. HAER is administered by the Heritage Documentation Programs Division (Richard O'Connor, Chief), a division of the National Park Service, U.S. Department of the Interior. The Federal Highway Administration's (FHWA) National Historic Covered Bridge Preservation Program funded the project.

Christopher H. Marston, HAER Architect, served as project leader. The 2009 HAER field team consisted of Anne E. Kidd, field supervisor, Jeremy T. Mauro and Bradley M. Rowley, architects, and Csaba Bartha, ICOMOS intern, Romania. Lola Bennett wrote the history. Jet Lowe produced the large format photographs.

Research sponsored by FHWA led to an agreement between HAER, NSPCB, and Case Western Reserve University (CWRU) to reconstruct the bridge and ship it to Cleveland for extensive testing. The reconstruction of the bridge was led by Timothy Andrews, Barns and Bridges of New England, assisted by Will Truax. Dario Gasparini led the engineering studies at CWRU. Project assistance was provided by David Wright, NSPCB, and Vern Mesler, Lansing Community College.

BOSTON & MAINE RAILROAD, BERLIN BRANCH BRIDGE #148.81 (MOOSE BROOK BRIDGE)
COOS COUNTY
GORHAM
NEW HAMPSHIRE

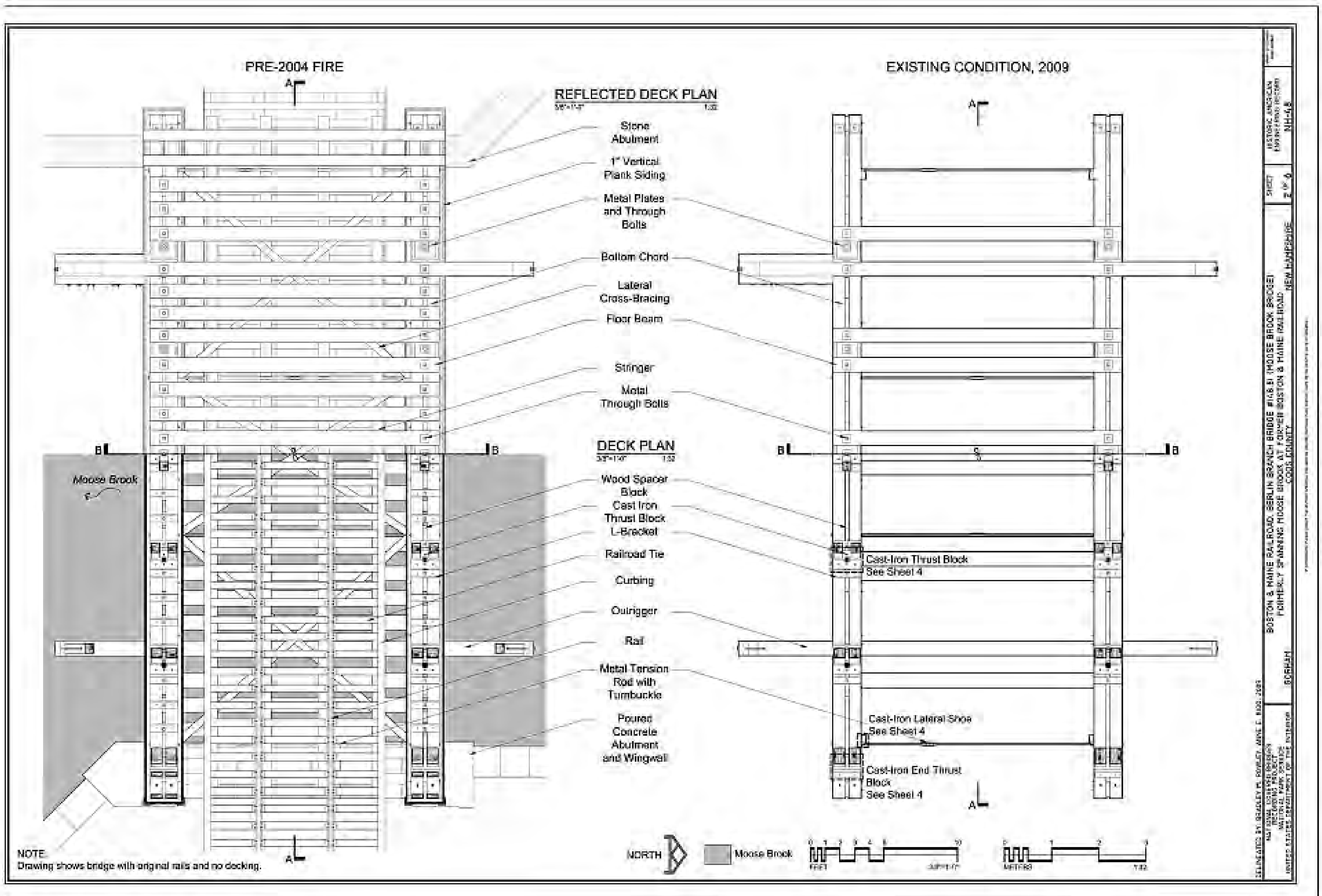


NATIONAL COVERED BRIDGES RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

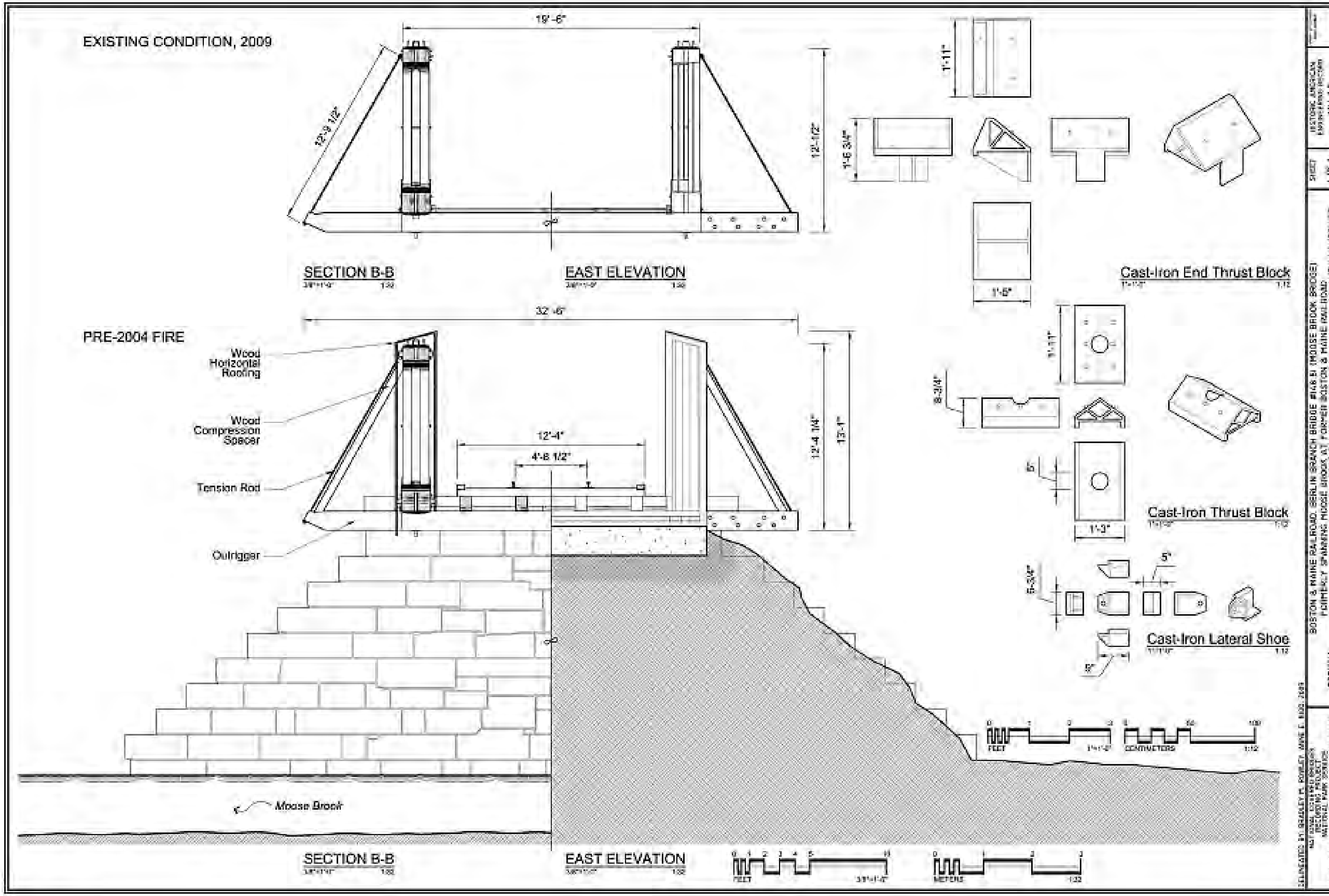
BOSTON & MAINE RAILROAD, BERLIN BRANCH BRIDGE #148.81 (MOOSE BROOK BRIDGE)
FORMERLY SPANNING MOOSE BROOK AT FORMER BOSTON & MAINE RAILROAD
GORHAM COOS COUNTY NEW HAMPSHIRE

SHEET 5 OF 6

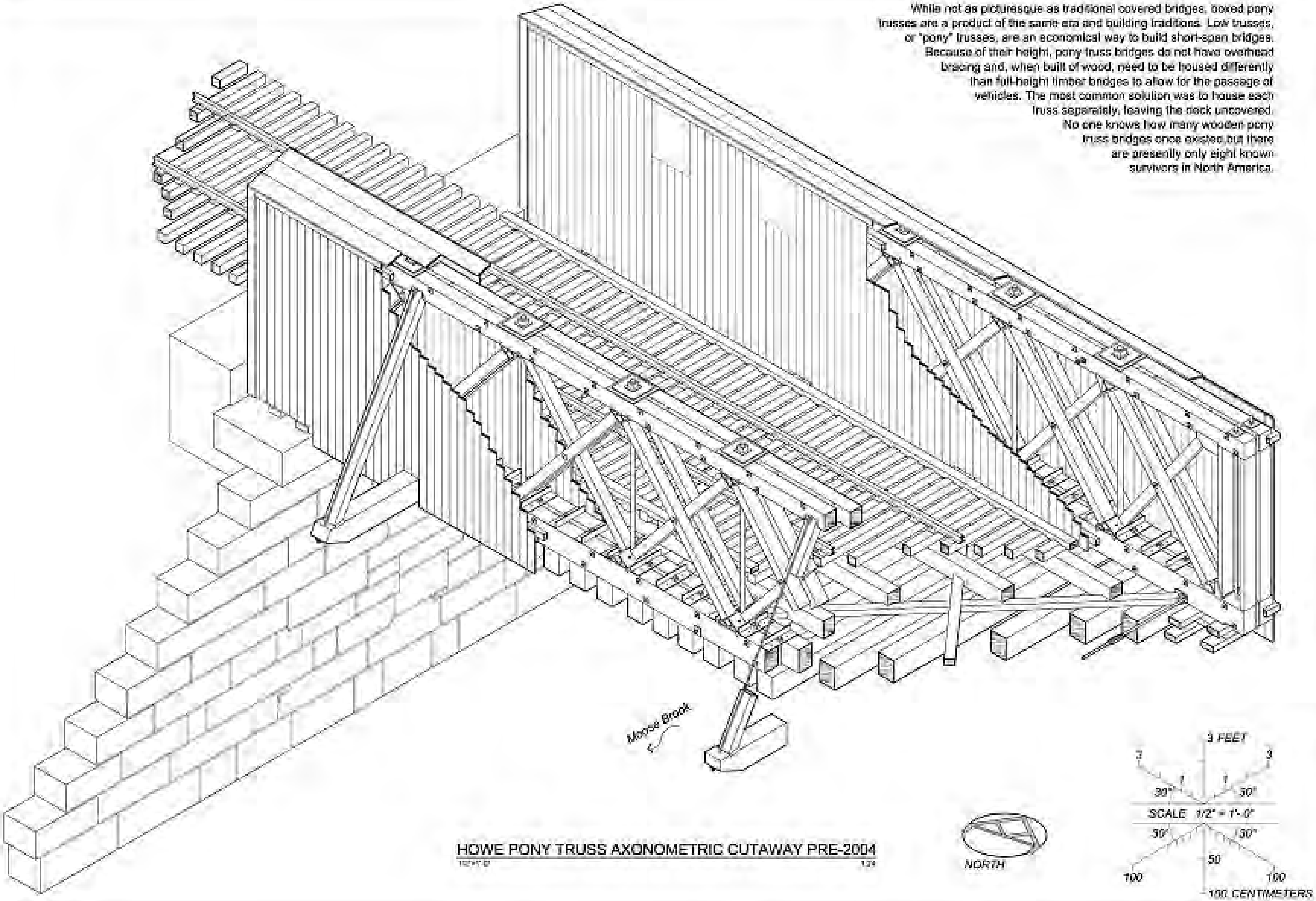
HISTORIC AMERICAN ENGINEERING RECORD
NH-48



PRE-2004 FIRE
EXISTING CONDITION, 2009
REFLECTED DECK PLAN
Stone Abutment
1" Vertical Plank Siding
Metal Plates and Through Bolts
Bottom Chord
Lateral Cross-Bracing
Floor Beam
Stringer
Metal Through Bolts
DECK PLAN
Wood Spacer Block
Cast Iron Thrust Block
L-Bracket
Railroad Tie
Curbing
Outrigger
Rail
Metal Tension Rod with Turnbuckle
Poured Concrete Abutment and Wingwall
Moose Brook
Cast-Iron Thrust Block See Sheet 4
Cast-Iron Lateral Shoe See Sheet 4
Cast-Iron End Thrust Block See Sheet 4
NOTE:
Drawing shows bridge with original rails and no decking.
NORTH
Moose Brook
FEET
METERS
DELINEATED BY: BRADLEY M. FOWLEY, ANNE E. KIDD, 2009
NATIONAL CONSERVATION RECORDING PROJECT NATIONAL PARK SERVICE UNITED STATES DEPARTMENT OF THE INTERIOR
BOSTON & MAINE RAILROAD, BERLIN BRANCH BRIDGE #148.81 (MOOSE BROOK BRIDGE)
FORMERLY SPANNING MOOSE BROOK AT FORMER BOSTON & MAINE RAILROAD
GORHAM
COOS COUNTY
NEW HAMPSHIRE
SHEET 2 OF 9
HISTORIC AMERICAN ENGINEERING RECORD
NH-48


EXISTING CONDITION, 2009
19'-6"
12'-9 1/2"
12'-1/2"
SECTION B-B
EAST ELEVATION
PRE-2004 FIRE
32'-6"
Wood Horizontal Roofing
Wood Compression Spacer
Tension Rod
Outrigger
12'-4"
4'-8 1/2"
12'-4 1/4"
13'-1"
Moose Brook
SECTION B-B
EAST ELEVATION
1'-11"
1'-6 3/4"
1'-6"
Cast-Iron End Thrust Block
1'-11"
8-3/4"
5"
1'-2"
Cast-Iron Thrust Block
5-3/4"
5"
5"
Cast-Iron Lateral Shoe
FEET
CENTIMETERS
FEET
METERS
DELINEATED BY: BRADLEY M. ROWLEY, ANNE E. KIDD, 2009
NATIONAL COVERED BRIDGES RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR
BOSTON & MAINE RAILROAD, BERLIN BRANCH BRIDGE #148.51 (MOOSE BROOK BRIDGE)
FORMERLY SPANNING MOOSE BROOK AT FORMER BOSTON & MAINE RAILROAD
GORHAM
COOS COUNTY
NEW HAMPSHIRE
SHEET 4 OF 6
HISTORIC AMERICAN ENGINEERING RECORD
NH-48

While not as picturesque as traditional covered bridges, boxed pony trusses are a product of the same era and building traditions. Low trusses, or "pony" trusses, are an economical way to build short-span bridges. Because of their height, pony truss bridges do not have overhead bracing and, when built of wood, need to be housed differently than full-height timber bridges to allow for the passage of vehicles. The most common solution was to house each truss separately, leaving the deck uncovered. No one knows how many wooden pony truss bridges once existed, but there are presently only eight known survivors in North America.



HOWE PONY TRUSS AXONOMETRIC CUTAWAY PRE-2004

1/2"=1'-0" 1:24

NATIONAL COVERED BRIDGES RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

BOSTON & MAINE RAILROAD, BERLIN BRANCH BRIDGE #148.51 (MOOSE BROOK BRIDGE)
FORMERLY SPANNING MOOSE BROOK AT FORMER BOSTON & MAINE RAILROAD
GORHAM COOS COUNTY NEW HAMPSHIRE

SHEET 6 OF 6

HISTORIC AMERICAN ENGINEERING RECORD NH-48

Reconstructing the Moose Brook Bridge

Tim Andrews
Barns & Bridges of New England

Arson, spring 2004: view after fire

Pre-2004 details of Moose Brook Bridge

Moose Brook Bridge, ca. 2008

Revealed end post casting, Snyder Brook Bridge

Careful handling to avoid further destruction, Sept 19, 2010

Grinding fouled threads to save both nut and rod

Chalk markings read “BYM RR, Gorham.” Originally built elsewhere, assembled on site

Loading out salvaged materials, October 27, 2010

Hand-planing rough timbers cost less than factory produced, Feb 24, 2011

Lofting truss members based on forensic geometry

Squaring up bottom chord laminates

Hand-tooled housings for truss vertical rods and cast shoes

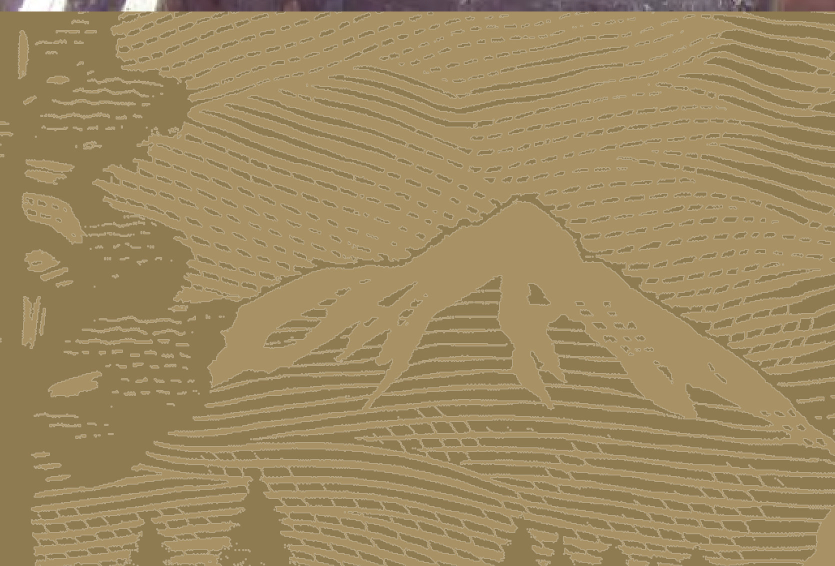
Truss top chord,
Final fit of cast shoe

Fire-damaged end shoe

Arc-welded repairs

Lofting and plumb scribe layout of first diagonals, March 10, 2011

Final fit and assembly of mid-span braces and counters. Third time's a charm.



Two panels left to finish, Mar 24, 2011

First truss assembled, Apr 28, 2011

Homemade wrench, 5" for small nuts; three upper nuts are replications

First truss off loaded at Case Western Reserve University, Aug 17, 2011

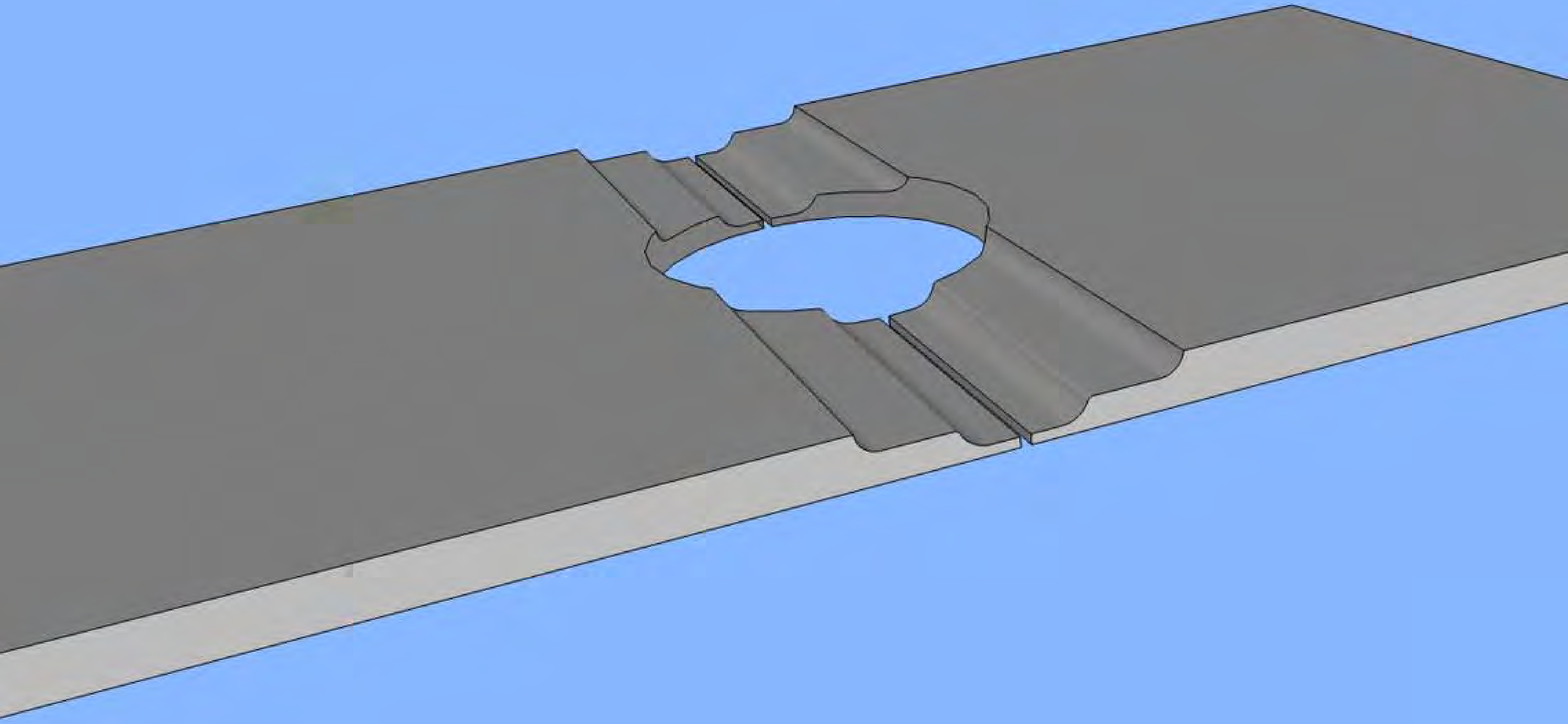
Final assembly of first truss, Aug 17, 2011

Brazing to Repair the Castings

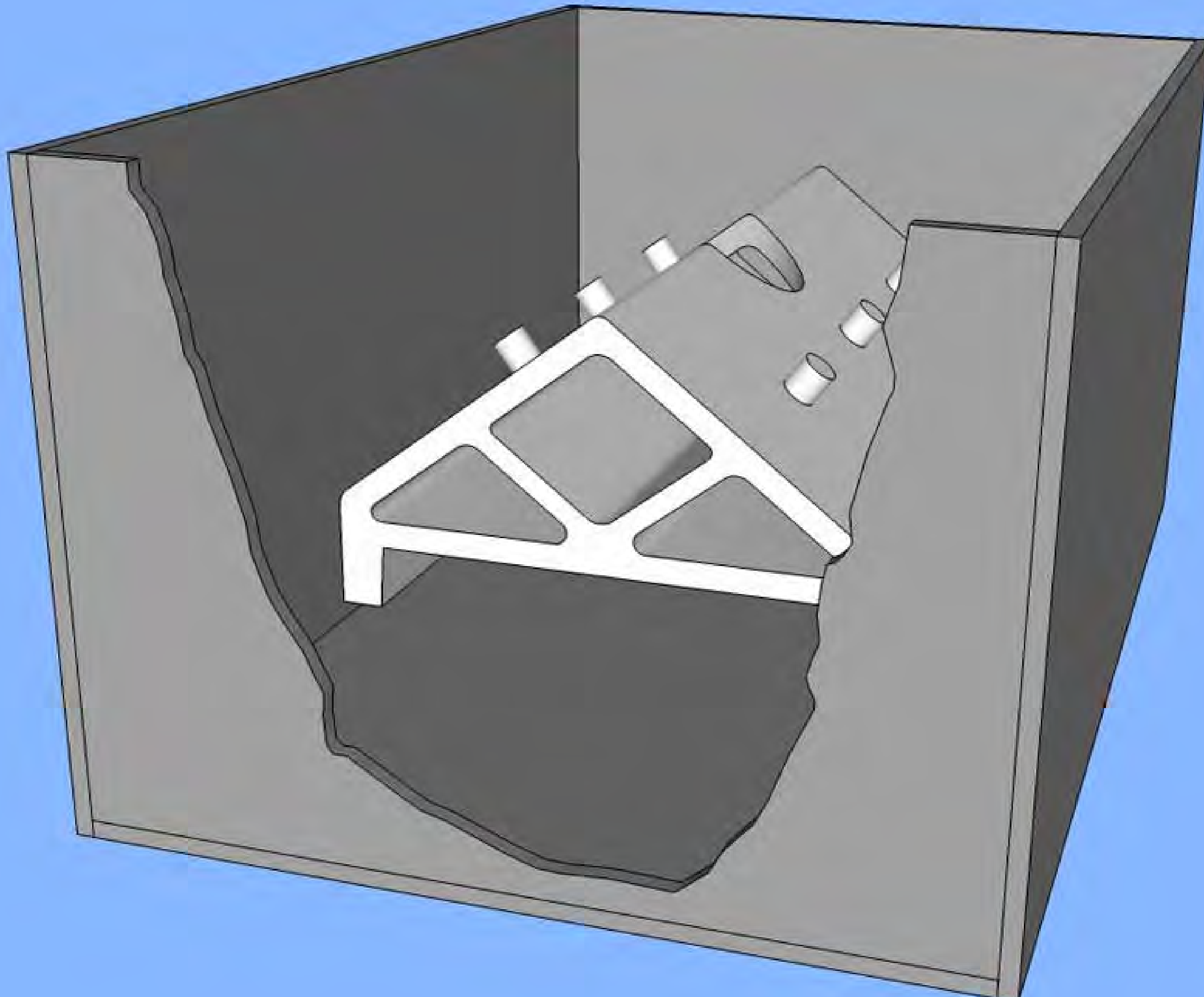
Vern Mesler & Kevin Whitford
Lansing Community College


Braze filler
metal not
bonded to the
base metal

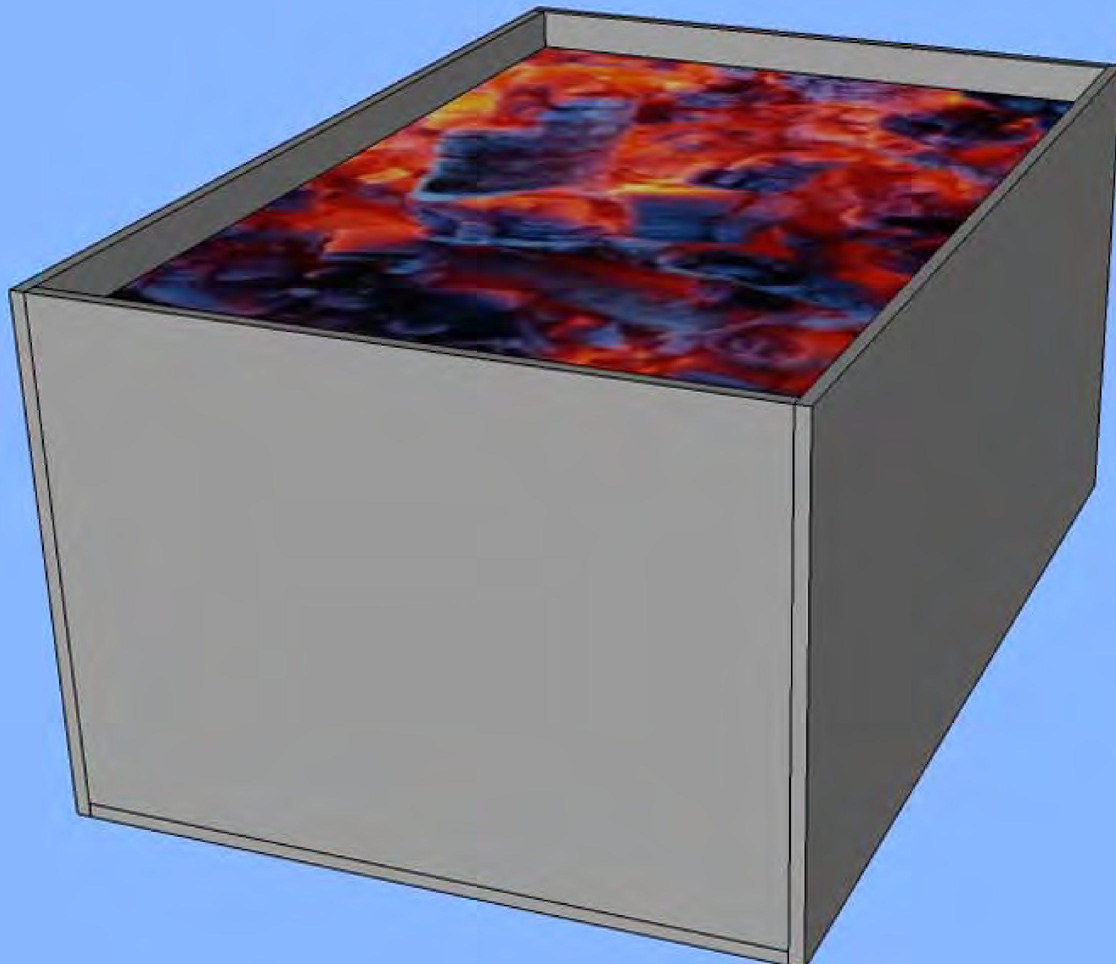

In a previous repair, three layers of braze filler metal had been applied. None of the layers were fused to the previous layers and there was no bonding of the braze filler metal to the cast iron base metal.



Drawing by Vern Mesler 2011



Drawing by Vern Mesler 2011



Drawing by Vern Mesler 2011


STORAGE 55

Assembly of second truss at Case Western, Mar 19, 2012

Tightening bolts on second truss, Mar 19, 2012

Final assembly of second truss, Mar 19, 2012