PDHonline Course C684 (2 PDH)

Touching the Earth Lightly: The U.S. 20 Iowa River Bridge

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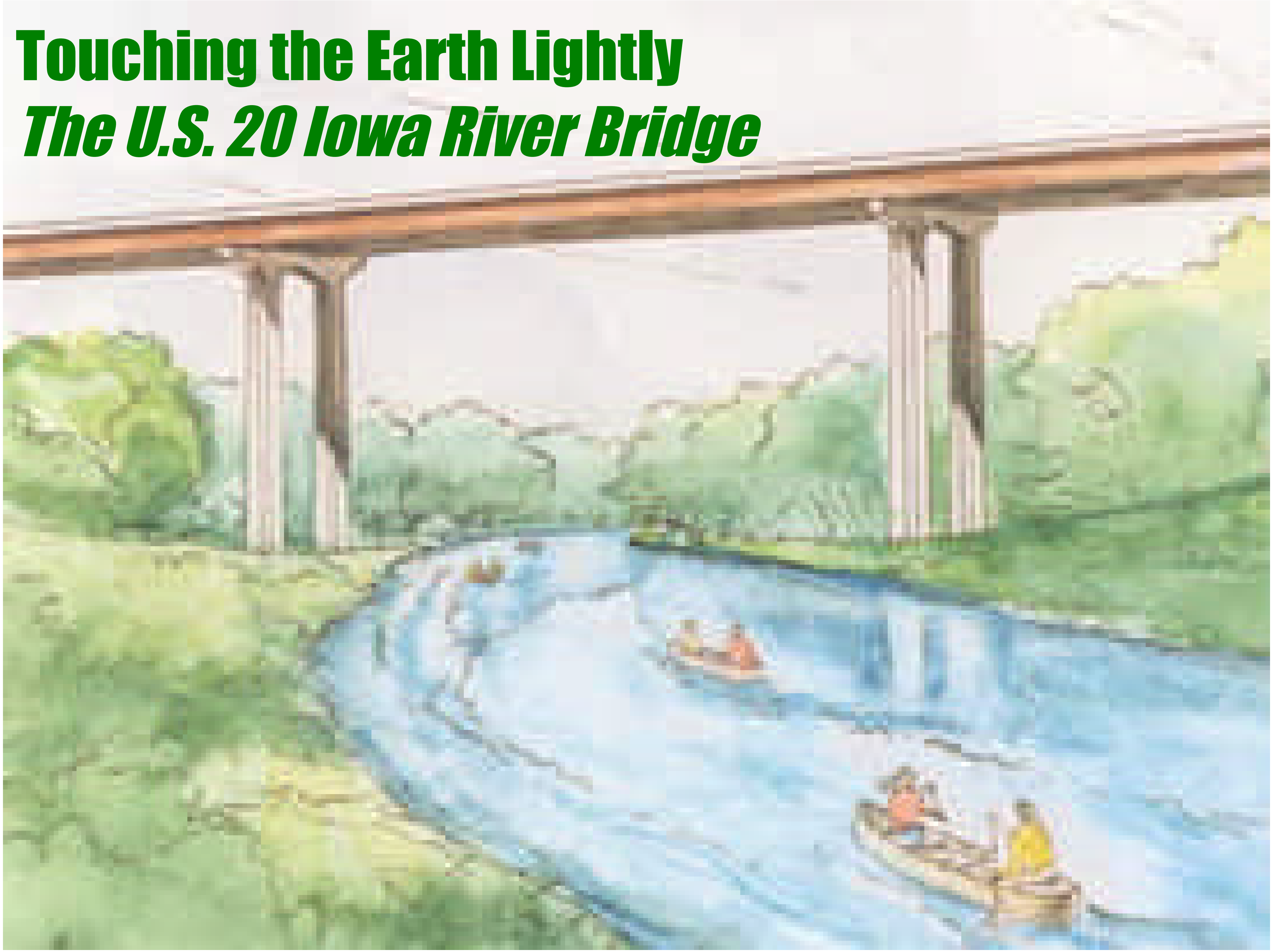
Touching the Earth Lightly

The U.S. 20 Iowa River Bridge



A Highway Runs Through It

"When it comes to bridge design and construction, it's seldom just mathematical and structural requirements that determine the ultimate solution. Very often, external factors – whether it be public opinion, land-use issues, or available funding – steer the structure's course. The environment was the leading factor shaping the final appearance and construction of one of Iowa's newest highway bridges – the U.S. 20 Iowa River Bridge, situated in the heart of the environmentally sensitive and protected Iowa River Greenbelt…"

***Bridge Builder,* January-March, 2003**

"…For years, the reconstruction of four-lane U.S. 20 remained incomplete through Hardin and Grundy counties in central Iowa. Mandates to preserve the Greenbelt, which runs along a 50-mile stretch of riverbank, resulted in two-lane blacktop roads weaving through small communities. The Iowa DOT's goal was to widen and straighten the highway to provide safer and faster passage to motorists traveling the 200-mile distance between Dubuque on Iowa's eastern border to Fort Dodge due west. The challenge was to find a way to bridge the 10-acre Greenbelt valley with the least impact to its native plant and animal species and archaeological treasures…"

***Bridge Builder,* January-March, 2003**

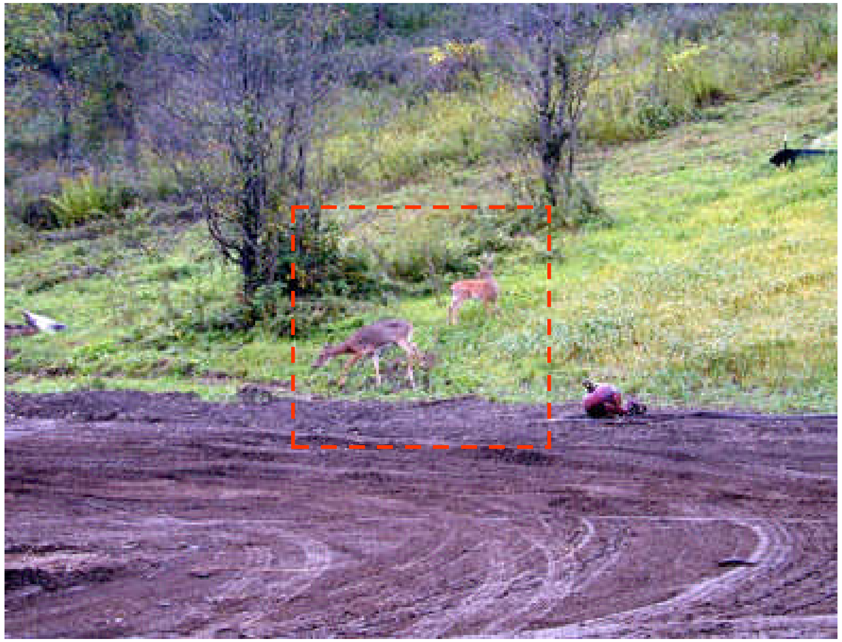
<u>Left</u>: caption: "An east-to-west view across the eventual bridge location"

<u>Right</u>: caption: "IaDOT environmental staff and contractor determine trees to be cut/save"

"…When the $20.5 million bridge opens to traffic later this year, those who drive its 1,630-foot length will be pleased to find 15 miles and 30 minutes have been trimmed off their previous commute. Those who canoe under the structure will scarcely notice its existence. But those who orchestrated the carefully sequenced launch of the 302-foot spans of structural steel will marvel at this accomplishment…"

Bridge Builder, **January-March, 2003**

<u>Left</u>: caption: "Looking south along the Iowa River"



"…HNTB Corp., Kansas City, Mo., design and construction consultant for the project, work-ed closely with the IaDOT and FHWA to meet multiple objectives in designing the bridge. Although environmental sensitivity was the overriding design directive, economics foll-owed closely…"

***Bridge Builder,* January-March, 2003**

<u>Left</u>: caption: "Deer on the site on September 19. This photo was taken within 50-feet of pile driving operations at Pier 2 (during a break in the pile driving)"

"…Environmental sensitivity and economics were overriding design directives. The bridge site is located on 10 acres in the Iowa River Greenbelt. The woodland is a roosting habitat for bald eagles, and the river is home to three endangered or threatened species of freshwater mussels. Residents were vocal about their desire to preserve the site's natural resources…"

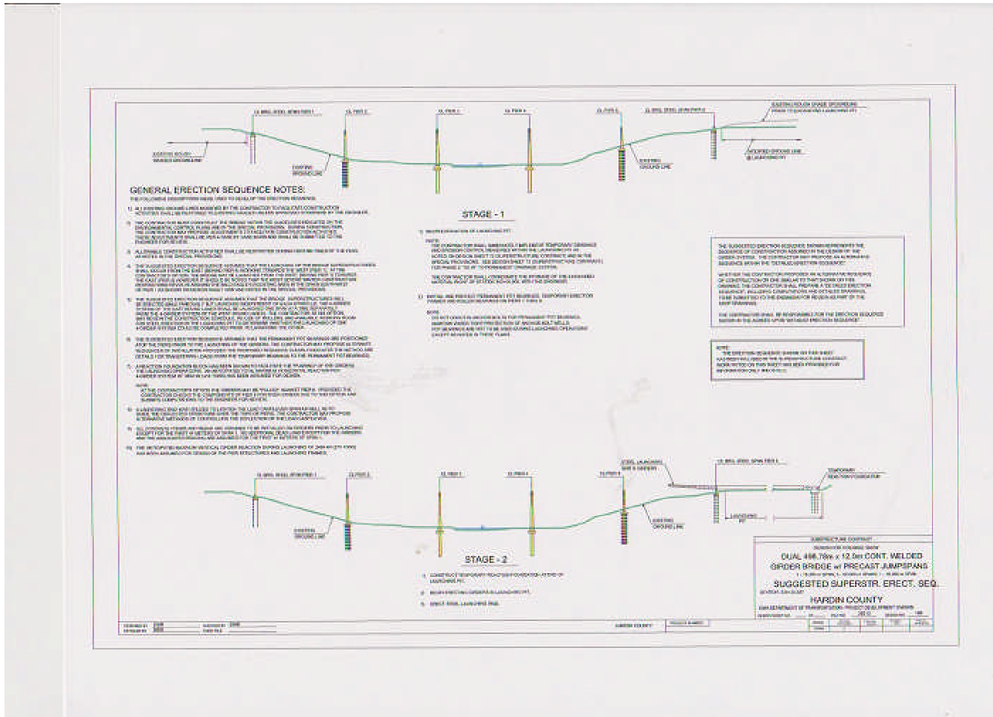
HNTB

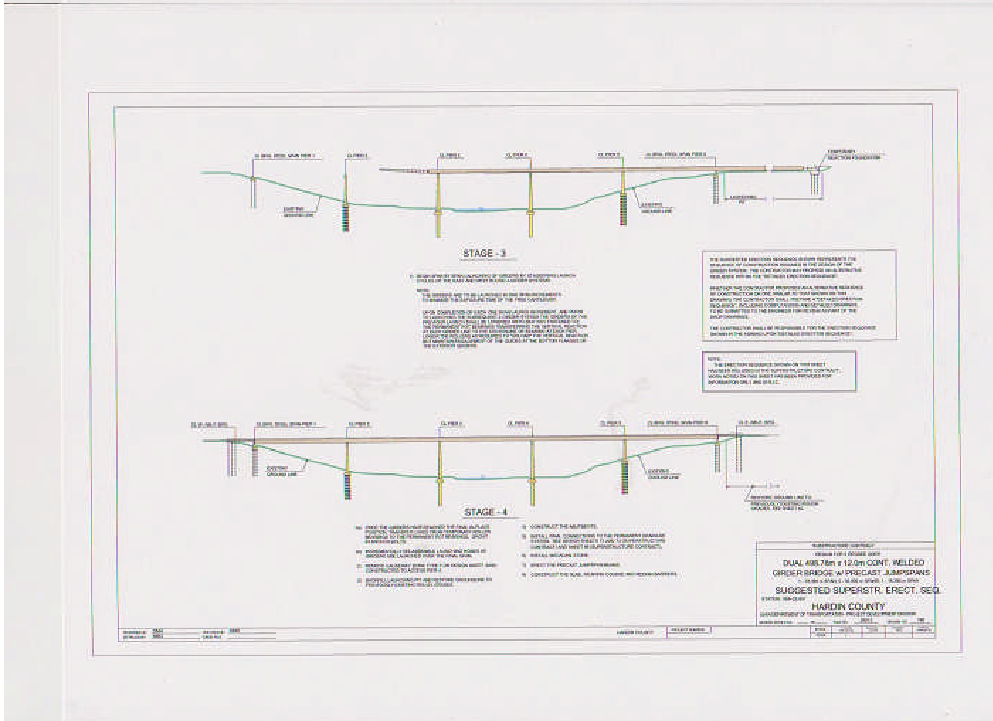
Left: caption: "Looking east across entire bridge site"

Ecological Design

"…Upon final selection of the site in 1996 (the culmination of more than 25 years of planning), HNTB studied six bridge designs ranging from concrete and steel arches to concrete box girders to steel I-girders. Multiple erection methods were evaluated as well. Because IaDOT was not seeking a signature bridge design, several options were quickly eliminated. After evaluating each for cost feasibility, environmental impact, and aesthetic appeal, HNTB recommended a launched steel I-girder design, with longer spans to reduce to reduce the number of piers needed and minimize visual obstructions at river level. Weathering steel material was selected for two reasons: It blends seamlessly into the natural surroundings and eliminates the need for future painting…"

***Bridge Builder,* January-March, 2003**





"IaDOT may have been skeptical about the process initially, but gained confidence that we would deliver. The concept was sound, but the challenge came in building this bridge type in a way that previously had not been proven."

***Dave Ragowski,* HNTB Project Engineer and Project Manager**

<u>Top</u>: caption: "Suggested Superstructure Erection Sequence – Stages 1 & 2"

<u>Bottom</u>: caption: "Suggested Superstructure Erection Sequence – Stages 3 & 4"

"…Erected as two parallel 39-foot-wide deck structures, the bridges consist of five 302-foot spans and one 60-foot precast concrete jump-span at each end of the bridge…Each steel deck structure consists of a system of four 11-foot, 4-inch-deep I-girders spaced at 12-foot centers…"

***Bridge Builder,* January-March, 2003**

Above: caption: "Looking west at upper lateral bracing in girder section 2"

Left: caption: "Looking east from the bottom of Pier 2 following the fourth launch"

"…The deck structures are supported on six cast-in-place reinforced concrete piers, up to 120 feet tall, and two end abut-ments…"

Bridge Builder, **January-March, 2003**

<u>Above</u>: caption: "Looking down at Pier 2 column reinforcing from scaffolding"

<u>Left</u>: caption: "Pier 2 in back-ground after form removal"

"…To protect three small mussel species, the project team had to keep construction equipment out of the river and construct a containment system to prevent fluids in the river, including accidental fuel spills, hydraulic oil from machinery hoses, and even natural water that emerged from constructing drilled shaft foundations through lenses of water above the rock formations. Also, a number of different zones on-site required clearing procedures and environmental protection. The contractor had to construct minimal access paths into the valley, which were removed and restored after completion. A temporary crane mat was constructed in the east river bottom above the high-water elevation to minimize the risk of damage to both the environment and the contractor's equipment…"

Bridge Builder, **January-March, 2003**

"…Even the crystal-clear art-esian water from drilled shaft foundations couldn't be allowed into the river. All that water had to be pumped into tanker trucks and hauled away"

Mike LaViolette, **HNTB Resident Con-struction Engineer**

<u>Left</u>: caption: "Pier 2 cofferdam sheet-piles"

"…Although steel pile foundations would have been less costly, the two central piers are supported on 8-foot-diameter drilled shafts to minimize footing activity near the river banks. The outer piers and abutments are supported by 100-ton piles driven in bedrock. The 1,630-foot bridge will carry traffic approximately 137-feet above the Iowa River…"

***Bridge Builder,* January-March, 2003**

Left: caption: "Augering material from Pier 3 drilled shaft prior to installing the casing"

Right: caption: "Spinning soil from the drilled shaft auger at Pier 3"

"We were not allowed to build haul roads in the project area or build a temporary structure across the river to deliver the large structural components into the valley. The protected mussel species played the biggest role in keeping us out of the river. We also had to build a containment system that would keep all fluids out of the river, including accidental fuel spills, potential vandalism to hydraulic machine hoses, and even natural water that emerged from constructing drilled shaft foundations through lenses of water above the rock formations."

Dave Ragowski, **HNTB Project Engineer and Project Manager**

<u>Top Left</u>: caption: “Installation of the cable-concrete panels to prevent erosion”
<u>Top Right</u>: “Silt basin channel lined with cable-concrete at the west end of the bridge”
<u>Left</u>: caption: “Silt basin channels are lined with cable-concrete over fabric to prevent erosion”



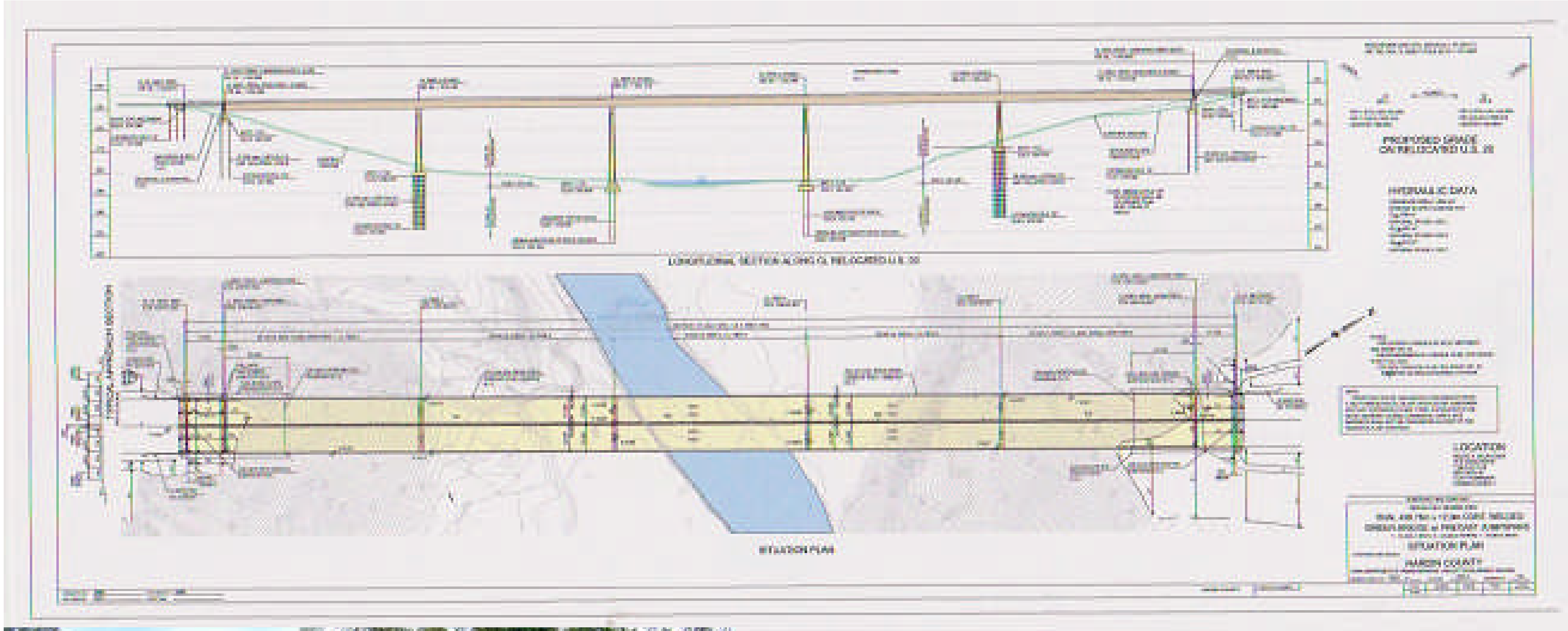
"…A sealed drainage system collects storm-water from the bridge deck. A pair of 14-inch diameter pipelines run the length of each structure and carry runoff to a storage basin near the west abutment, The basin collects runoff and allows solid materials, primarily silt and roadway salt, to settle out. The materials then can be dredged and removed from the site in the future…"

Bridge Builder, **January-March, 2003**

Top Left: caption: "East side silt basin showing precast channel lining"

Top Right: caption: "Silt collected at the East side silt basin"

Left: caption: "Silt basin on west side of river showing start of riprap"



"…The contractor also had to deal with exposed soil that drained toward the bridge from both sides of the valley… A gravel riprap workpad on the east side help keep machinery out of the river…"

***ENR,* April 2002**

<u>Above</u>: caption: "Situation Plan"

<u>Left</u>: caption: "Aggressive erosion control measures on the freshly cleared west valley slope"

<u>Top Left</u>: caption: "Closeup shot of East side of project"

<u>Top Right</u>: caption: "Looking East at the East slope protection silt fence and straw mesh"

<u>Left</u>: caption: "Looking north along the new access road grading"

Left: caption: "Spraying hydro-seed on exposed soil along new access road. Hydroseed consists of seed, ground paper or wood fiber and water. The mixture is sprayed on and forms a crusty coating that anchors the soil until the seed can germinate."

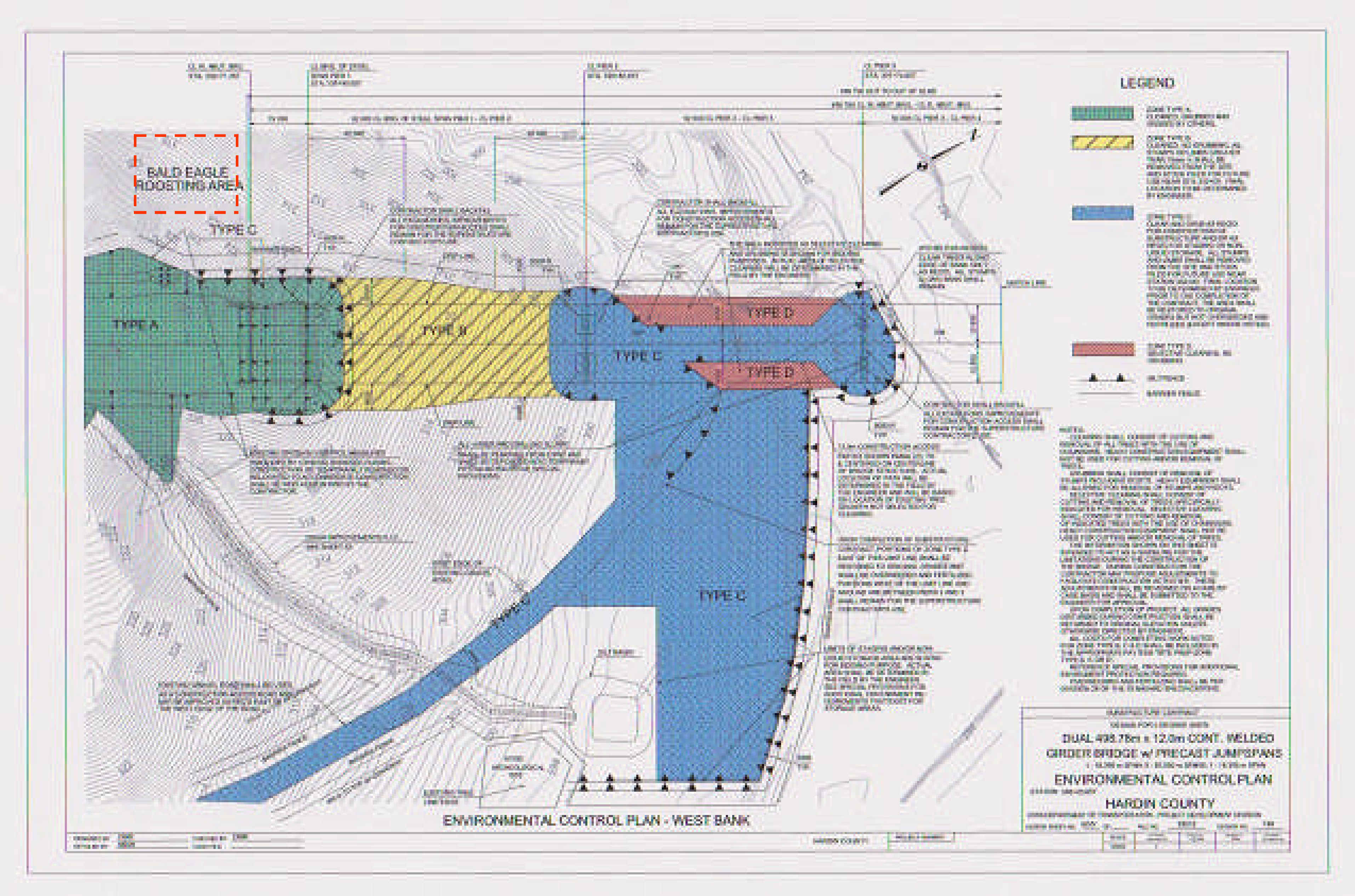
<u>Top Left</u>: caption: "West-to-east view from the eventual western bridge terminus"

<u>Top Right</u>: caption: "Silt fence installed to contain erosion along river. Trees that are to be left are marked with pink paint and pink ribbons."

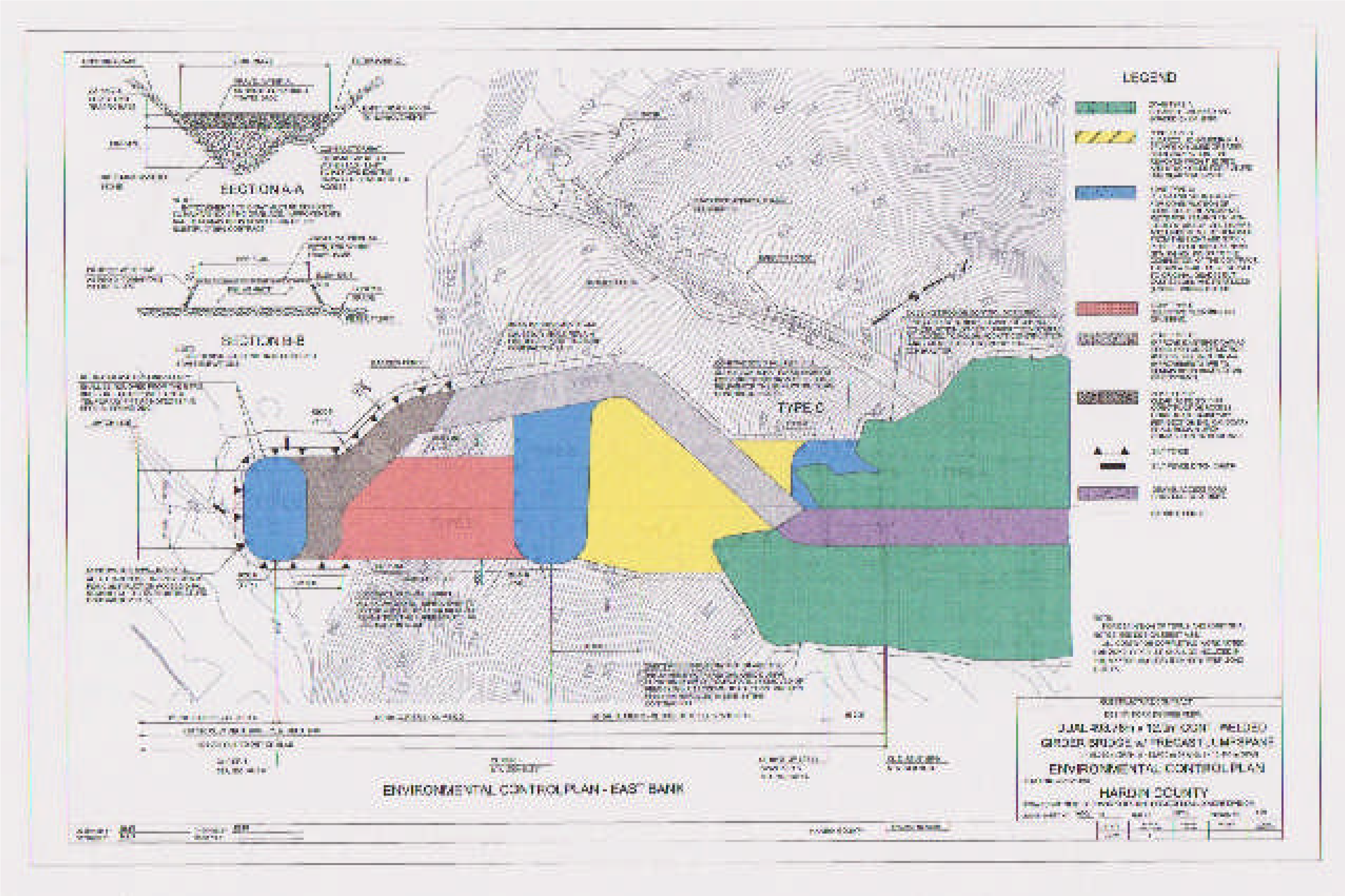
<u>Left</u>: caption: "Newly planted grass begins to line the silt basin channel.

“…The 10-acre site was also segmented into east- and west-slope construction zones. A ‘winter shutdown’ period was designated that prohibited heavy construction activity from November 1 through April 15 on the west slope near the eagle’s roosting area. The east slope was monitored during the same period to determine if noise or other construction-related activity would disrupt the bald eagle roosting habits. Monitoring activities showed that the construction had no adverse on the eagle’s behavior. A number of different zones on the site, which were identified in the plans, required specific site-clearing procedures and environmental protection. Minimal access paths were cleared into the valley, and these will be removed and restored following completion of the bridge...”

***Structural Engineer,* May 2002**



<u>Above</u>: caption: "Environmental Control Plan – West Bank

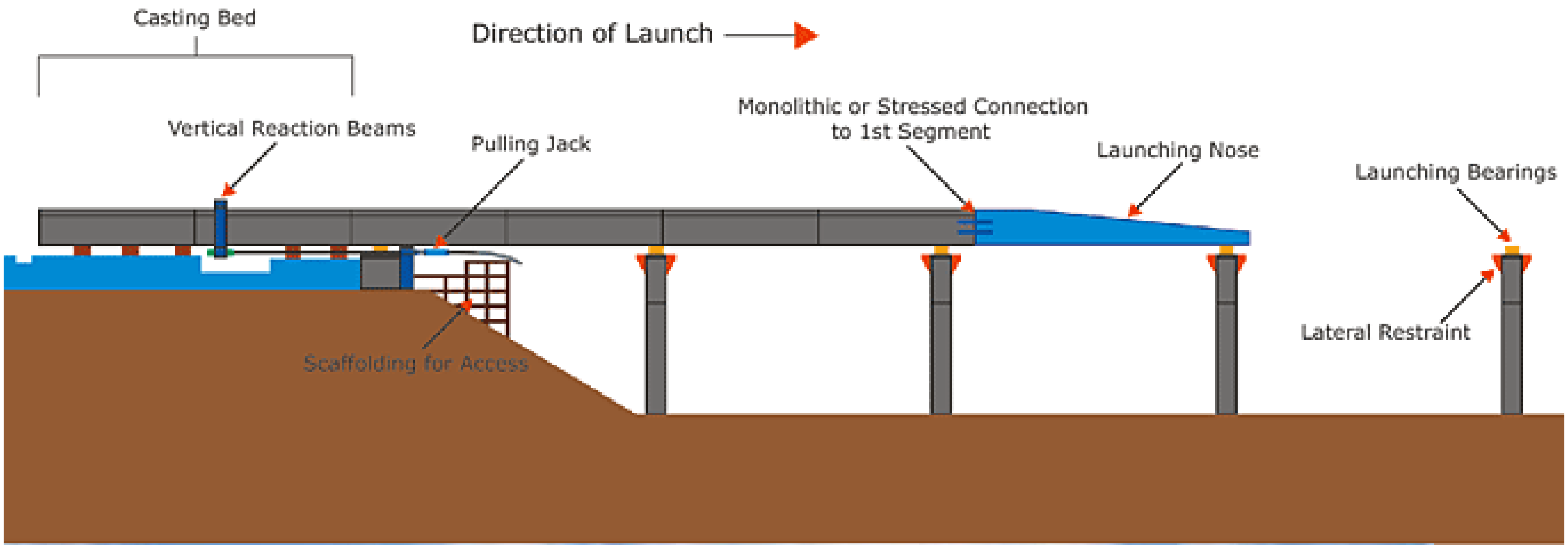


<u>Above</u>: caption: “Environmental Control Plan – East Bank

Incremental Launch

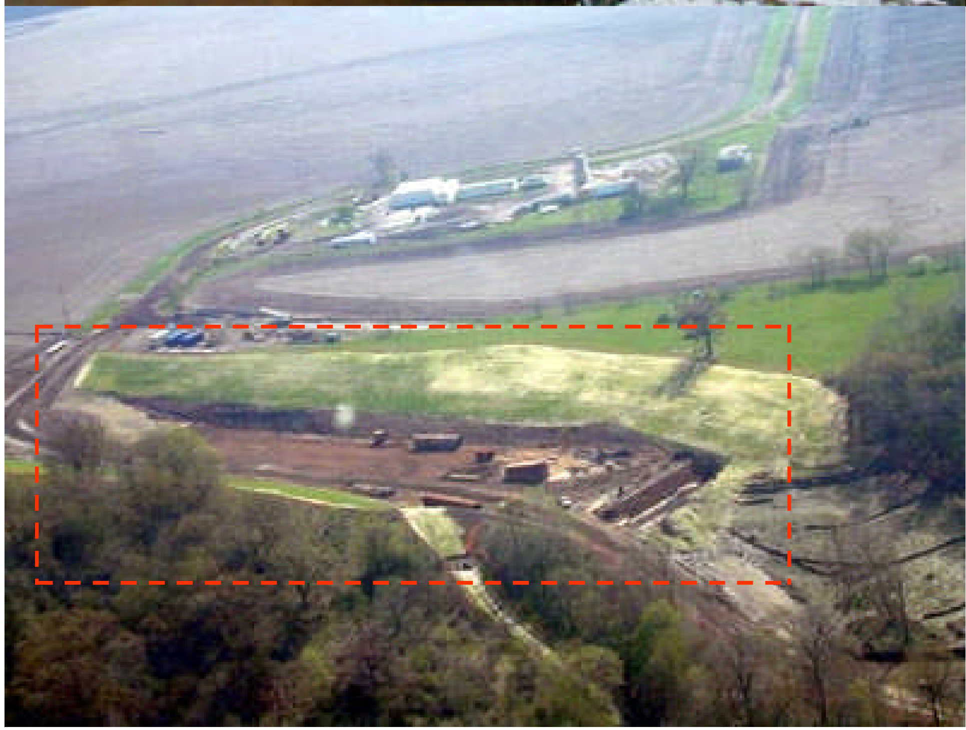
"…Because equipment access was limited and environmental restrictions were strictly enforced, HNTB engineers pushed forward with the launched erection sequence as the method of construction. While it had never been employed for a long-span I-girder bridge made up of 10 million pounds of structural steel, the incremental launching technique had been successfully used to erect more torsionally stable concrete box structures in Europe, as well as a smaller steel box girder railroad bridge in the United States. Contractor Jensen Construction, Des Moines, Iowa, and erection engineer Ashton Engineering, Davenport, Iowa, were up to the challenge. Jensen modified some of the erection sequence's roller and guidance systems to better suit its schedule, available equipment, and materials. The customized equipment pushed approximately 5 million pounds of steel per bridge…"

***Bridge Builder*, January-March, 2003**


Casting Bed
Direction of Launch
Vertical Reaction Beams
Pulling Jack
Monolithic or Stressed Connection to 1st Segment
Launching Nose
Launching Bearings
Lateral Restraint
Scaffolding for Access

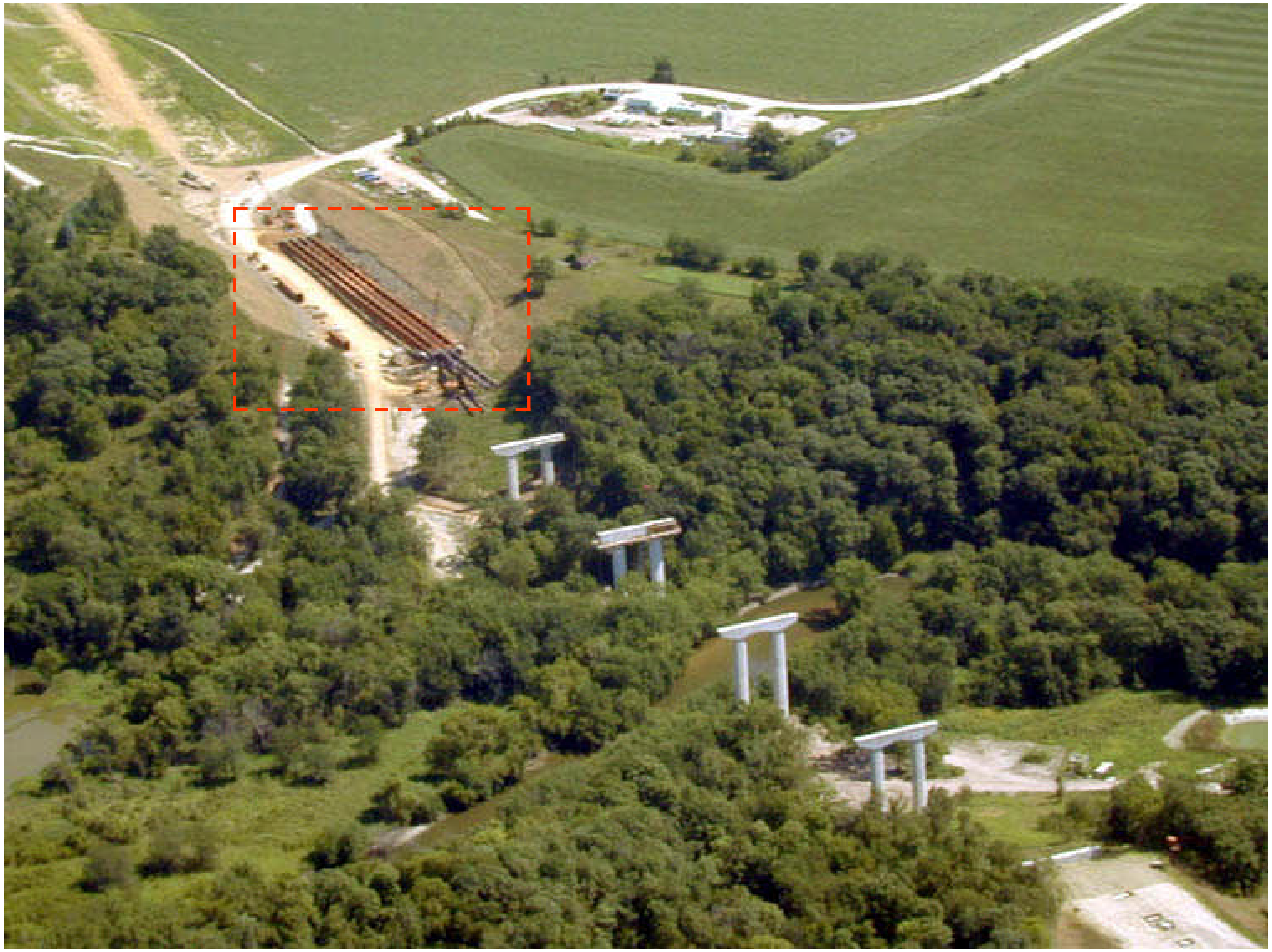
"…Construction of the substructure elements began in August 2000, and preparation of a 15-foot-deep, 600-foot-long launching pit behind the east abutment was completed in November 2000. The launching pit, dug beneath what would later become the approach roadway, was used to construct a number of temporary pile bents where sections of the I-girder superstructure would be assembled on rollers and later pushed incrementally across the piers. Steel assembly for the eastbound bridge began in June 2001. After Jensen completed the steel erection on each span in the launching pit, including all diaphragms and lateral bracing, the steel was launched downhill along a 0.64 percent grade, being pushed by hydraulic pistons toward the west abutment at a pace of about 1 fpm…"

Bridge Builder, **January-March, 2003**



<u>Top Left</u>: caption: "Launching pit excavation is approximately 20% complete as of 12/4/00"
<u>Top Right</u>: caption: "Launching pit excavation is complete on 12/14/00"
<u>Left</u>: caption: "Looking southeast with the launching pit in the foreground; office trailers and concrete plant in the background (photo taken on 5-1-01 from approximately 2,000 feet above the ground)."

Top Left: caption: "Vertical and horizontal launching rollers"
Top Right: caption: "Overview of steel assembly showing first six sections of girders"
Left: caption: "Aerial view of launching pit prior to first launch of bridge sections"



"…After some adjustments were made to the steering mechanism to ensure the spans were guided in the proper alignment, the launching process moved full steam ahead. A temporary 'launching nose' was attached to the front of the leading span to guide its placement and reduce deflection of the 302-foot cantilever. Temporary roller bearings placed on the bridge piers assisted with the process of rolling the sections across the valley…"

Bridge Builder, **January-March, 2003**

<u>Left</u>: caption: "Looking west toward Pier 5 just prior to launching nose touchdown (note: Girder F will touch down first)"

<u>Right</u>: caption: "Launching nose after touchdown on Pier 5"

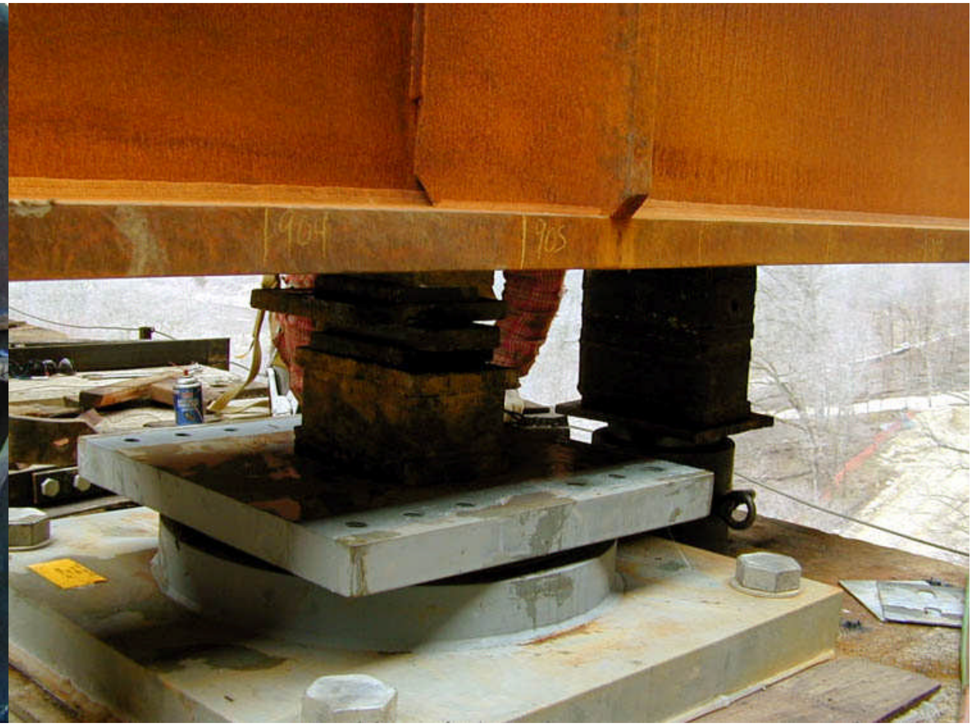

<u>Above</u>: caption: “Tip of launching nose landing on roller used during the bridge launching”

"The trick was always to have enough weight behind the support so the bridge won't tip over as you push it. You're applying a force of 800 kips on the back end of the bridge, and you've got a snake of steel 1,500 ft. long and you're trying to keep it corralled in a straight line…It was a big relief to get past the first launch. There were a lot of nervous people that day. If a launch had ever overshot the next pier, there was no way to back up."

Mike LaViolette, **HNTB Resident Construction Engineer**

<u>Top</u>: caption: "Looking NE at launching nose extending beyond Pier 3"

<u>Bottom</u>: caption: "Aerial photo looking SW showing Piers 1-5 and tip of the launching nose"



"…Following the launch of the eastbound bridge, the contractors' equipment was moved to initiate an identical launching of the parallel westbound bridge in January 2002. Favorable weather conditions aided the project schedule, and crews completed the launch of the tenth and final span in late March. The launching skid was removed, and the full length of the superstructure was jacked up to remove the rollers and then jacked down onto permanent bearings on the piers…to build the bridge's concrete deck, the team developed a method to eliminate the usual ground operation of a crane. A custom designed mobile crane was constructed to run the length of the girders to assist with installing deck drain piping. Ongoing paving of U.S. 20 at the bridge's east end will delay its opening until mid-summer 2003…"

Bridge Builder, **January-March, 2003**

Left: caption: "Glider end after jacking down the bridge section into final position"

Right: caption: "Jacking girders down onto permanent bearings"

<u>Top Left</u>: caption: "Reinforcing steel is in place for the first concrete pour on the deck"
<u>Top Right</u>: caption: "Concrete pump and pipeline used for placing east-bound deck concrete"
<u>Left</u>: caption: "July 2003: View of the completed bridge looking south-west."

The Accomplishment

"…already the bridge is capturing attention. The project has received a Grand Conceptor Award from the American Council of Engineering Companies of Iowa and a Grand Award from the Consulting Engineers Council of Missouri. It also was recognized by FHWA for engineering excellence in pursuit of environmental sensitivity. In addition, the project is a finalist in the Construction Innovation Foundation's NOVA awards program, which recognizes significant advances in the construction industry…other projects in other places will benefit from the U.S. 20 bridge's erection advances. Recently, a steel I-girder bridge in West Virginia was launched, while another bridge in Ohio is under design and scheduled to launch in 2005."

***Bridge Builder,* January-March, 2003**


ACEC
American Council of Engineering Companies
Engineering Excellence Awards Competition
National Recognition Award
Presented to
Iowa Department of Transportation
For the Project
U.S. 20 over the Iowa River Bridge
Engineering Services Provided By
HNTB Corporation
March 2003

"As you view the bridge today, you see the trees growing right alongside it. Once we fully restore the project site, the bridge breaking out of the trees will be the only visual clue that this engineering and construction feat ever took place."

Doug McDonald, **IaDOT Resident Construction Engineer (2003)**

Above: caption: "Aerial photo of the completed bridge and surrounding valley"

Left: caption: "July 2003: View beneath the completed bridge. Note that vegetation has returned to the site post-construction"

"With the Iowa River Bridge, we pushed the limits of conventional construction techniques. We provided the client and the community with a bridge that was aesthetically pleasing, cost-effective and could be const-ructed without compromising the surrounding environment."

Dave Ragowski, **HNTB Project Engineer and Project Manager**

Left: caption: "August 22, 2003: The Ribbon Cutting Ceremony. Group photo showing Iowa Governor Tom Vilsack, Iowa DOT staff and various contractors' staff."

“One doesn’t always want to be the first person to try something, but in this case we had little choice…The only way we could be successful on this project was to form a true partnership among all parties involved. The results exceeded my expectations…The bridge is the golden spike in a corridor project that has been under way since 1969”

Bob Younie, **Construction Engineer - IaDOT District 1**

"…I want to congratulate the Iowa Department of Transportation and its many partners for developing and building the Iowa River Bridge. This project not only addresses important transportation needs but it preserves and protects the surrounding environment as well. It offers all of us an example of how transportation and environmental professionals can collaborate to provide a transportation facility to improve safety, mobility, and opportunities for economic development in an environmentally sensitive manner."

Mary E. Peters, **Federal Highway Administrator (September 16th 2002)**
RE: the IaDOT's' receipt of the Federal Highway Administrator's *Environmental Quality Award* for its work on the *Iowa River Bridge*.