- Frequent overbank flooding; however, the Pochuck Creek is a non-delineated river, so the various frequency flood levels were not accurately identified.
- Serious logjam problems.
- Remote site with poor access.
- The entire area is a NJDEP designated Exceptional Resource Value Wetland, with extensive habitat for a variety of threatened and endangered species.
- No survey or elevation benchmark.
- Design and construction methods would have to be consistent with the ability level of a mainly volunteer, layperson work force. While some machinery would be available for construction, the premise of hand carrying all material to the site and utilization of hand tools was still valid.

In short, spanning the Pochuck Creek presented a unique and peculiar challenge!

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The answer to the referenced problems was to utilize a suspension bridge. Other bridge designs were investigated, but these alternatives failed to address some or all of the critical design criteria. The other designs considered before the suspension bridge were as follows:

- Center pier bridge
- Simple beam bridge of timber, steel, or concrete
- Arch bridge
- Truss bridge

Bridge Design Alternatives

Center Pier Bridge

A center pier bridge was totally unacceptable from both hydraulic and environmental perspectives. A mid-stream channel pier would be a major obstruction to normal and flood flows. It could easily turn into a dam by collecting debris or ice. The heavy construction methods required to build a durable mid-channel pier were beyond the resources of the project partners and would have had unacceptable environmental impacts. Finally, NJDEP regulations strongly discourage a center pier bridge.

Simple Beam Bridge

A simple, single-span beam of various material could span the Pochuck Creek from a structural perspective; however, practical limitations quickly arise. The steep, undercut, and unstable streambanks dictate that any abutments be set back from the banks. This requires that a beam be at least 82 feet long. The abutments would also have to be tall enough to provide proper clearance to floodwaters.

These requirements, in addition to the exceedingly poor soil conditions, quickly result in the bridge abutments needing pile driving and reinforced concrete. These methods are not allowed in an Exceptional Resource Value Wetland. Nor were they within the project budget, the ability of the project partners, or the philosophy of the Appalachian Trail.

Assuming the use of a pair of twin beams for the bridge, a comparison of various materials is very interesting. To span 82 feet, a steel beam would be required to have a 20.8-inch web, with 6-inch flanges, weighing 50 pounds per linear foot (American Institute of Steel Construction Designation is a 21 by 50 section). A southern pine glulam beam would have to be 37-1/3 inches deep by 6-3/4 inches wide, weighing 87 pounds per foot. A precast concrete beam would be 43-1/2 inches deep by 16 inches wide, weighing 623 pounds per foot. Each of the alternatives would be a custom fabricated item.

How does one transport an 82-foot-long beam weighing anywhere from 4,100 pounds to 51,000 pounds down the Appalachian Trail and across a "sea of dark, oozing, quivering, leg-sucking black muck?" A simple beam bridge was not a simple solution.

Arch Bridge

Glulam wood arch bridges are often used for "showcase" facilities, such as the arch bridge at Crab Tree Falls within the George Washington and Jefferson National Forest (GW & JNF) adjacent to the Blue Ridge Parkway in Virginia. The combination of the natural wood grain and pleasing architectural lines of an arch make such structures beautiful. Glulam arch bridges have been used for pedestrian bridges spanning 85 feet or more. While an arch provides additional clearance to floodwaters, the foundation and transportation problems are even more difficult than those of a simple beam. Placing an 82-foot arch would require a crane, which was not an option in this situation.

Truss Bridge

A prefabricated truss bridge of Corten® steel, pressure treated lumber, Prestek® Systems, or Extren® Fiberglass was considered. Each of these materials is utilized for pedestrian truss bridges throughout the nation. Continental Bridge Company of Alexandria, Minnesota, is a well-known manufacturer of prefabricated, self-weathering Corten® steel truss bridges. Over 5,000 Continental bridges are in use in the United States. Steadfast Bridges of Fort Payne, Alabama, and Big R Manufacturing in Greeley, Colorado, are additional manufacturers. These firms provide bridges from 10 to 250 feet in length and 4 to 12 feet in width. A prefabricated Corten® steel truss bridge offers many advantages: the manufacturer often provides the structural design, they come prefabricated, bridges up to 75 feet in length can be shipped completely assembled, and they are virtually maintenance free and vandal-proof. An 80-foot span, self-weathering, steel pedestrian truss bridge carries the Appalachian Trail across the City Stream in Green Mountain National Forest, Vermont.

Truss bridges of wood are also very common. Trusses utilizing timbers (5 inches by 5 inches or larger) provide for spans of up to 140 feet. Trusses utilizing dimension lumber (2 to 4 inches thick) have been used for exterior pedestrian spans of up to 85 feet.

It would appear that a prefabricated truss would be the preferred solution. However, the inaccessibility of the site, span and clearance requirements, poor soils, environmental restrictions in combination with the heavy equipment required to handle a prefabricated bridge, and the extensive conventional foundation required all decision-makers to eliminate a truss bridge as an option.

Suspension Bridge Proves to be the Most Viable Solution

The solution to the unique and peculiar challenges presented by the Pochuck Quagmire was to utilize a suspension bridge. A suspension bridge can be defined in its simplest form as a bridge where the primary structural member is a flexible cable or wire rope. In their most recognizable form, suspension bridges consist of a rigid floor system hung by suspender cables from main catenary cables. The main catenary cables pass over the support towers via cable saddles and are connected to subsurface anchorages. From Lackawaxen to the Brooklyn Bridge, from the Golden Gate to the Verazzano Narrows, and now the diminutive Pochuck, the suspension bridge has provided the answer for challenging long-span crossings. For heavy-loaded vehicular bridges, the suspension bridge is the exclusive bridge type when the clear span exceeds 1,800 feet. For remote pedestrian trail locations that are inaccessible by heavy equipment, suspension bridge engineering provides a solution for clear spans ranging from 75 to 400 feet in length.

For the Pochuck Quagmire, the suspension bridge concept provided the following advantages.

- By their inherent geometry, suspension bridges lend themselves to tall, high clearance, and wide-span situations. This addressed the unstable stream banks and floodwater clearance problems.
- For a given span and loading, they are the lightest bridge system. Suspension bridges are an “efficient” structural solution because of the predominance of tensile stresses and the direct stress paths from the load to the support points. This assisted in addressing the dead load foundation requirements for the extremely poor soil conditions. This also resulted in economic and practical advantages in terms of material, transportation, and workforce costs.
- A structure is the sum of its parts. In this case, all of the material utilized was common construction material, available on relatively short notice.
- The design centered around the off-site prefabrication of the suspended truss walkway by volunteers of the NY-NJ Trail Conference. Common carpentry skills were sufficient to complete the project.
- All the material and prefabricated elements were transportable to the remote site.
- The towers provided support for an overhead erection cableway which, in turn, doubled as guy lines.

Historical Significance of Suspension Bridges to the Appalachian Trail

Interestingly, there is a direct historical parallel in the use of a suspension bridge for the Appalachian Trail route in the metropolitan New York area. Benton MacKaye presented his concept of the Appapachian Trail in 1921, when the NY-NJ Trail Conference was a fledgling one-year-old organization. In 1923, the NY-NJ Trail Conference built the first section of the Appalachian Trail in Bear Mountain-Harriman State Park, beginning at the west bank of the Hudson River and working southwestward toward New Jersey.

The next year, 1924, the Bear Mountain Vehicular Suspension Bridge, the longest suspension span in the world at the time, opened across the Hudson River. The bridge provided for passage of the Appalachian Trail over the mighty Hudson River as well as being the first roadway over the Hudson between New York City and Albany. The cablewire and steel rope for the bridge were manufactured by John A. Roebling & Sons Company of Trenton, New Jersey, as were the wire rope used on almost every major suspension bridge in the 19th and 20th centuries. John Roebling is revered as the father of modern suspension bridges.

The offices of the NJDEP Division of Parks and Forestry are also located in Trenton, a stones throw from the former Roebling Mills. The NJDEP acquired the first of its recreational pedestrian suspension bridges in the same era. The 350-foot long Cranberry Lake Pedestrian Suspension Bridge located in Allamuchy State Forest was constructed in 1928. It seemed appropriate that the NY-NJ Trail Conference would be utilizing a suspension bridge to provide a critical “Missing Link” of the Appalachian Trail in its 75th anniversary year.