NPS Form 10-900-b
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United States Department of the Interior
National Park Service

National Register of Historic Places Multiple Property Documentation Form

This form is used for documenting multiple property groups relating to one or several historic contexts. See instructions in *How to Complete the Multiple Property Documentation Form* (National Register Bulletin 16B). Complete each item by entering the requested information. For additional space, use continuation sheets (Form 10-900-a). Use a typewriter, word processor, or computer to complete all items.

X New Submission ___ Amended Submission

A. Name of Multiple Property Listing

The Historic Highway Bridges of New Mexico

B. Associated Historic Contexts

(Name each associated historic context, identifying theme, geographical area, and chronological period for each.)

Highway Bridge Construction in New Mexico, 1850-1965

C. Form Prepared by

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D. Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this documentation form meets the National Register documentation standards and sets forth requirements for the listing of related properties consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR Part 60 and the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation. (☐ See continuation sheet for additional comments.)

Lynne Sebastian State Historic Preservation Officer   5-28-97
Signature and title of certifying official   Date

State or Federal agency and bureau

I hereby certify that this multiple property documentation form has been approved by the National Register as a basis for evaluating related properties for listing in the National Register.

Signature of the Keeper   Date of Action

United States Department of the Interior
National Park Service

National Register of Historic Places Continuation Sheet

Section number ______ Page ______

SUPPLEMENTARY RECORD

NRIS Reference Number: N/A

Property Name **County** **State**

Historic Highway Bridges of NM
Multiple Name

This documentation is accepted for purposes of nominating properties for listing in the National Register of Historic Places subject to the following exceptions, exclusions, or amendments, notwithstanding the National Park Service certification included in the documentation.

Beth Boland
Signature of the Keeper

7/23/97
Date of Action

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Amended Items in Nomination:

The registration requirements (Section F, p. 51) are not sufficient to assure that bridges would still be eligible under Criterion A after a move. As the significant historical associations of these bridges in the area of transportation is described in the statement of historic context, integrity of location is very important and retention of materials and design and an appropriate new setting after a move would not ensure continuing association. Bridges may continue to meet Criterion C in such circumstances, but integrity under Criterion A will need to be entirely justified in the individual nomination documentation. This was confirmed by Mary Ann Anders of the NM SHPO.

DISTRIBUTION:

National Register property file
Nominating Authority (without nomination attachment)

E. Highway Bridge Construction in New Mexico, 1850-1965

Despite its location in the desert Southwest where rivers and year-round streams are few, bridges have played a key role in the development of New Mexico's highway system. The most prominent and sophisticated components of any overland transportation system, bridges were constructed during the Spanish colonial and Mexican periods. During the late Territorial period as proponents of the Good Roads Movement pushed political leaders to improve the territory's wagon roads, county governments constructed numerous bridges in urban areas and along key roadways. While many of these bridges were simple wooden structures reflecting traditional building techniques, some were new bridge types incorporating new materials such as structural metals and concrete. Later, following statehood and the centralization of road building authority under the State Highway Commission, the New Mexico State Highway Department assumed responsibility for the designing and contracting of most new bridges along the state and federal road systems. As engineers sought to make these systems more efficient and safe, their plans and designs increasingly reflected unique responses to the engineering challenges presented by a particular site. In the years following World War II, these efforts overcame notable topographic barriers, resulting in the construction of two remarkable bridges. Although many of the state's historic bridges have been removed as standards for roadways have been raised, those that remain offer evidence of how overland transportation has evolved in New Mexico over the past century.

Overland Transportation in Prehistoric and Colonial New Mexico

Systems of overland transportation in New Mexico date to the prehistoric period. Around 1100 A.D. an extensive road system emanating from Chaco Canyon in northwestern New Mexico marked efforts to improve travel and communication among Indian pueblos throughout the Southwest. Later, the Pueblo tribes, the descendants of the Chacoan road builders, built trails linking many of the pueblos across the central highlands of New Mexico as well as in the Rio Grande Valley. When they found it necessary to cross small streams, these prehistoric road builders occasionally fashioned hand-hewn log bridges. When Coronado's expedition first explored the area in the early 1540s, the party's historian, Casteñada, reported that the stream flowing between the two room blocks of Braba, the present Taos Pueblo, "was crossed by bridges constructed of very well hewn beams of pine timber" (Bloom 1925:5).

While the Rio Grande, the central waterway of the Pueblo world, presented a more formidable challenge than could be met with a simple hewn log bridge, the nineteenth-century archeologist, Adolf F. Bandelier, noted a Tewa legend in which the summer and winter people, separated by the river, attempted to bridge it. Laying a "long feather of a parrot over the stream from one side" and a "long feather of a magpie from the other" so that the plumes met, wizards constructed a "remarkable bridge" (Bloom, 1925:5). Unfortunately, bad sorcerers "caused the bridge to turn over, and many people fell into the river, where they were instantly turned into fishes." In addition to providing an explanation of the refusal of Navajo, Apache and some Pueblo Indians to eat fish, the account also underscores the long tradition of people in the Southwest envisioning bridges over the rivers that impeded movement over the land.

The coming of the Spanish resulted in sporadic efforts at bridge building in the region. The first effort on the part of Europeans to construct a bridge in what is now the United States occurred in 1540-41 during Coronado's expedition. As the expedition moved down the Pecos River near what many hold to be present-day Puerto de Luna, it was forced to construct a bridge. Referring to the river as the Cicuye, Casteñada noted that the party worked for four days, constructing a bridge that permitted the party of over 1,000 soldiers and Indian allies as well as livestock to venture eastward in search of the mythical city of gold, Quivera (Bryan 1969:np).

Over the next two and a half centuries as the Spanish took hold of New Mexico, their efforts to centralize control of the region included projects to develop reliable trade and communication routes. Most of these efforts were devoted to developing a Royal Road, or Camino Real, linking the silver mining center of Zacatecas to El Paso del Norte, present-day Juárez, Mexico and northward to Santa Fe, capital of province of New Mexico. The river and the agricultural settlements lining the Rio del Norte, as the Spanish called the Rio Grande, were the lifeline linking New Mexico to the heart of the Spanish colonial empire in Mexico. After it crossed the river at El Paso, the Camino Real ran on the east side of the river. During most of the year the pueblos and isolated Spanish settlements on the west bank of the shallow, meandering river could be reached without bridges. At shallow natural crossings, fords, or vados, sufficed; and during particularly cold winters when the river froze, travellers simply walked across the ice. During the spring runoffs following winters of heavy snows and during the summer monsoon season, however, the river swelled, often flooding, and became impossible to ford.

In 1680, for instance, as Governor Antonio de Otermin led the over 2,500 refugees fleeing south to El Paso following the Pueblo Revolt, he discovered that even when he reached the riverbank north of El Paso, the high river prevented the garrison from sending supplies to his hungry and haggard party. When a wagon attempted to cross the river and was swept away, the refugees finally resorted to forming a pack train, or arrieta, consisting of all of their remaining mules and horses, and forded the river to obtain the much-needed supplies (Bloom 1925:6). Eighty years later, as additional settlement occurred on the west bank of the Rio Grande, the caprices of the river prevented reliable access to these settlements. In 1760, the priest in Albuquerque, who also ministered to the parish in Atrisco on the west bank, complained that he feared for his life crossing on the river's frozen surface and recommended a bridge (Simmons 1991:np).

Experiences such as these suggest that during the Spanish colonial period, administrators became aware of the challenges that subsequent military surveyors, railroad engineers and, finally, road engineers would confront. They would all learn that any reliable overland transportation system, even in the desert Southwest, required bridges that anticipated and could withstand the infrequent but destructive flooding of the region's rivers as well as the freshets that could transform normally dry arroyos into short-lasting torrents. While the Rio Grande and its tributaries, such as the Rio Puerco and Rio Chama, were the principle concerns of the Spanish, the state's other major drainages, the San Juan, Gila, Pecos, and Canadian and their tributaries were also capable of periodic flooding and would pose similar challenges to subsequent efforts at settlement.

Most often these floods were seasonal. The warmer temperatures of late spring brought the melting snow from the Rocky Mountains down into the floodplains. Ideally the spring runoff brought the waters that filled the gravity-based ditches, or acequias, feeding the long-lot fields lining the rivers. Following winters of heavy snowfall, however, the runoffs brought floods that washed away the acequias' headgates as well as vados, rendering rivers impassable. Later in the year, when moisture left over from tropical storms pushed north into the state, afternoon thundershowers drenched the earth. Running off the land faster than it could be absorbed, water rushed into dry arroyos scouring and eroding their earthen walls as it raced toward streams and rivers below. These extreme conditions, rivers swollen with melted snow and "cloudburst" streams, as 20th century road engineers called them, created the need for bridges even in the desert Southwest.

Recognizing the obstacles nature imposed and the ability to overcome them with bridges proved to be two different matters well into the 20th century. In 1791, Governor Fernando Chacon undertook a bridge project at Belen, summoning residents of the area to use their oxen to haul rocks to the Rio Grande's bank in preparation of a bridge. According to his decree one group of workers was to construct a bridge while another group defended Belen's plaza from Apache raids. The project, however, received little support and the Rio Grande remained unbridged (Bloom 1925:6).

A few years later, in 1797, Chacon undertook a second project, this time at El Paso where the Camino Real crossed the river. Fifty-four men were dispatched by Don Francisco Bernal, the Lieutenant Governor of El Paso and the project director, to travel up the river some 200 miles to obtain timber in the cottonwood groves near Socorro. So poorly supplied was the expedition that the men were forced to "strip themselves of their humble jewelry" in order to purchase additional supplies (Bloom 1925:7). Lacking draft animals, after obtaining the timber they lashed it together to form rafts and floated down the Rio Grande. Near present-day Rincon, New Mexico, the rafts collided with submerged cottonwoods and their remaining supplies were lost. Starving and with little clothing, they finally arrived in El Paso with the timbers and undertook construction of the bridge. Completed by 1800, it measured over 500 feet long and was seventeen feet wide with piers consisting of wood caissons filled with sand and rock and sunk into the river bed (Morehead 1957:120-121). Despite these elaborate efforts to insure its permanence, the bridge was repeatedly washed out and reconstructed over the next two decades (SANM II, Roll 14:999). So difficult was the river to span with any permanence that at the time of Mexican independence in 1821, not a single bridge crossed the upper Rio Grande.

Mexican control of the Department of New Mexico brought some changes to the isolated area. Of major significance was a shift in the new government's trade policy. While Spanish colonial authorities had resisted any contact with its young, expansive neighbor to the north, the new Mexican Republic welcomed trade and encouraged the exchange of goods between New Mexico and the western American frontier. Following the opening of the Santa Fe Trail in 1821, caravans of heavy Conestoga wagons began moving over the trail between Missouri and Santa Fe, following either of two routes from western Kansas into New Mexico where they joined above Las Vegas, New Mexico. From there the trail wound through Glorieta Pass to Santa Fe, the nominal end of the trail. Approximately half of the goods and wagons that reached Santa Fe, however, continued south over the old Camino Real, now known as the Chihuahua trail, to reach the rich mining districts of northern Mexico. Motivated by the promise of economic reward, the Santa Fe traders sought to improve the trail at its worst points. As a result, a few rudimentary culverts and bridges of masonry and timber were constructed over small streams and arroyos along the trail (State Engineer 1915:38). The Department's network of roads, however, remained largely a series of rutted and fragmented corridors. At Stony Ford on the upper Canadian River, at San Miguel del Bado on the Rio Pecos, and just below Albuquerque and at Socorro on the Rio Grande, fords provided the only means of crossing New Mexico's major rivers.

Photographs of bridges at Rio Grande Pueblos in the late 19th century offer our most tangible glimpse of the possible appearance of these early bridges. Even as he noted the bridge described in Pueblo legends, Bandelier also noted that by the late 19th century some Pueblos had resolved the challenge of crossing the Rio Grande by constructing a sizeable bridge across the river. At Santo Domingo Pueblo, where the tribe's fields lined both sides of the river, villagers had constructed a bridge about 400 feet in length. With "forked beams planted into the river, with the upper ends passing through each other, forming a kind of lock," these roughly-crafted piers supported a series of horizontal logs, enabling a person to pass in single file over the Rio Grande (Bloom 1925:5). Much as Bandelier feared, the bridge, "though of admirable construction if the material and implements used are taken into consideration" proved unable to "resist a heavy flood" and was soon washed away. Other accounts suggest that the Pueblos made use of metal axes and other tools introduced by the Spanish to craft these bridges. Typically they included wicker-work piers filled with stones that were placed at intervals and spanned with log beams.

Bridges and Roads in Territorial New Mexico

Following the Mexican-American War and the Treaty of Guadalupe-Hidalgo in 1848, the newly created Territory of New Mexico, like other territories on America's westward-moving frontier, became dependent on the growing presence of the army. As the army shifted from its initial occupation of New Mexico's towns to constructing a series of forts to protect settlements and trade from Indian attacks, federal spending for public works projects and supplies brought an infusion of cash to the territory. Among these public works projects were road improvements. Termed "country roads" by Col. John James Abert, commander of the Army's Corps of Topographical Engineers, the roads were simply cleared ways in which army work parties removed trees and brush, leveled the steepest grades, and built small bridges over streams. The army never intended to complete these "country roads" but simply to enable settlers to pass from place to place and to link the army's forts (Goetzmann 1959:350). In fact, in 1855, Secretary of War Jefferson Davis effectively ordered officers assigned to western road projects to give priority to completing the entire distance of a road first and, only then, to use any leftover appropriations to improve difficult stretches.

Underlying Davis' decision to limit improvements on these western roads were several considerations. Among them was the conviction that most of the roads were simply a stopgap measure designed to serve the western regions only until engineers had completed surveys for the railroads that most easterners envisioned would shortly open the west. Captains A.A. Humphries and Amiel W. Whipple and Lt. Edward Fitzgerald Beale, the officers in charge of much of the military road construction in New Mexico in the 1850s, for example, recognized that their success in surveying and building wagon roads across the territory was but a prelude for the railroads to follow (Jackson 1952:256). Moreover, despite the federal government's appropriation of funds and lands for canal and railroad construction and a few roads such as the National Road and military roads in the Mississippi Valley, the overriding attitude of most leaders remained that road and bridge construction was a responsibility of local governments.

These attitudes help to explain the absence of improved roads and bridges during much of New Mexico's territorial period. The territory's immense size, its sparse population located mostly in its few irrigable valleys, and its low revenues--an economic liability compounded by Congress' often ungenerous appropriations to both the territorial government and to the military--did little to encourage road and bridge construction beyond the improvement of a few selected trails (Lamar 1965:90). When the Territorial Legislature did request funds for bridge projects, as in 1854 when it asked Congress for $40,000 to build two bridges across the Rio Grande near Albuquerque and at San Juan Pueblo, the plea went unheeded (Simmons 1983:404).

With the exception of a pontoon bridge built at Albuquerque in 1876 and another timber bridge at Espanola, the Rio Grande remained unspanned until the last decades of the territorial period. Instead, when the river's volume rose in the spring and late summer, prohibiting fording the river, residents as well as the army often resorted to crossing the river using small ferries. Territorial records and newspaper accounts refer to ferries located at numerous sites including San Juan Pueblo, Ft. McRae, Engle and Mesilla. During periods of flooding, the boats along the river were the only means of linking settlements on the opposite banks, and they were often in great demand. In 1864, the army's seizure of a civilian's flatboat during a flood at Mesilla precipitated a court case. Eight years later during the spring runoff all westbound coach traffic was detained in Albuquerque and "compelled to cross at the ferry at Albuquerque" (Yeomans vs. Dana and Thayer, 1864; Santa Fe New Mexican May 7, 1872). The ferry, described as a "primitive craft, being a low, narrow barge...somewhat shaky as its deck timbers" had been constructed under the supervision of Major James Carleton about 1856 as part of his efforts to spur civic improvements (Simmons 1983:168).

Newspaper accounts citing floods on the Rio Grande and its tributaries, as well as the upper Pecos and Rio Mora drainages make frequent references to the collapse of small bridges during the late 19th century. How widespread these small bridges were is unclear, but frequent references to bridge washouts suggest that by the arrival of the railroad in 1879 many small bridges and culverts over small streams, arroyos and acequias aided travel in the populated agricultural valleys. All of the small bridges dating to this period were of timber beam, also called pike-and-beam, construction and consisted of timber or log stringers spanning between timber piers or, sometimes, log cribs spaced from ten to thirty feet. Smaller crossings consisted of a single span often resting on masonry or timber abutments and stone culverts.

After the pontoon bridge at Albuquerque was swept away by floods in the late 1870s, local businessmen formed the Albuquerque Bridge Company, raising $22,000 through the sale of stock by 1881. Commenting on the plans for a new bridge, a local editor proclaimed its potential benefits for users and the community.

> There are many pedestrians who cross the river every year, who would pay a few cents for crossing comfortably on a bridge rather than wade. Horsemen will pay to go safely over a bridge, rather than run the risk of missing shifting fords, or sticking in quicksands. Owners of carriages, carts and wagons will pay to cross their vehicles by bridge, without delay, rather than subject themselves to the dangers and drawbacks of fording. Where communication is now weekly between Albuquerque and towns on the opposite side of the river, it will be daily and more frequent on the building of a bridge (New Mexico Press Feb. 7, 1881).

On December 12, 1882, the bridge, a pony truss consisting of eleven spans with crudely-fashioned timber-truss panels resting on delicate piers, was opened to the public. For five cents pedestrians could cross the river, and horsemen were required to walk their mounts. No amount of optimism, however, could prevent these fragile timber bridges from succumbing to the devastations of the territory's periodic floods. With most timber spans shorter than the twenty-five ft. spans characteristic of the timber beam bridges of the 1920s and 1930s, the wooden decks rested on shallowly-planted piers or cribs, not the pile-driven piers of later decades. The clutter of closely planted piers, decks only a few feet above normal waterflow, and modest earthen approaches rendered both bridges and their approaches vulnerable to the boulders, trees, drowned livestock and other debris rushing downstream during floods. Roots and snags pummelled the piers, or, often worse, became trapped between the piers and the low-clearance bridge deck, damming the river. As pressure rose, bridge portions often gave way. Meanwhile, if a river overflowed its banks, churning water, often more abrasive with the stones and gravel it carried, scoured the banks and vulnerable earthen approaches, eroding them and, in extreme cases, washing them away. Sometimes the spans of a bridge remained, isolated from the riverbank where earthen approaches had once existed.

In 1872 and then again in 1874 widespread flooding took its toll, disrupting travel both in towns and rural areas. In 1872 the summer monsoons brought high waters rushing off of the Sangre de Cristo Mountains and down the Santa Fe River, destroying "every vestige of the new bridge in process of construction" at the capital city (Santa Fe New Mexican Aug. 20, 1872). Two years later both a heavy snowmelt in June and then July rainstorms washed away bridges. The former caused the Pecos River to run over its banks, placing the bridge at San Jose del Bado in "a very precarious position," and the latter washed away the Johnson bridge at Santa Fe (Santa Fe New Mexican June 2, 1872; July 21, 1874). Farther downstream the rocks and debris rushing down the Santa Fe River so thoroughly scoured the bridge on the road to nearby Aqua Fria that an abutment and pier were washed away.

Particularly destructive was the flood in the spring of 1884, the worst along the Rio Grande in decades. In late May warm weather accelerated the melting of the past winter's heavy snowpack. Compounding the flooding from the runoff were unusually long and heavy rainstorms over the entire upper Rio Grande watershed. By May 28th, the river began breaching its banks in the Mesilla Valley and near Socorro. On June 2nd another heavy rain caused the river to overflow its banks near Albuquerque where it reached a mile in width. By mid-afternoon the western 170 ft. of the bridge had been washed away. The next day, as Governor Lionel A. Sheldon called for flood relief committees and sent an appeal to Washington for aid, the river also demolished the wagon bridge at Espanola (Santa Fe New Mexican June 4, 1884). Although what remained of the bridge at Albuquerque was repaired and it served residents until May, 1891 when debris smashed it to pieces washing its timbers downstream as far as Socorro, spanning the Rio Grande remained but temporary.

In contrast, the iron bridges of the Atchison, Topeka and Santa Fe Railroad (AT&SF) and the Denver and Rio Grande Railroad (D&RG) remained standing. Crews had feverishly dumped carloads of rocks to save the bridge at San Marcial, and the D&RG bridge over the Rio Chama "had sunk a little," but the heavier construction and higher clearances above the river of these bridges had enabled them to prevail when the timber beam bridges had failed. In other floods, railroad engineers would sometimes leave train cars loaded with coal on bridges to help forestall wash outs. The success of these railroad bridges in withstanding some of the territory's worst flooding was instructive for the construction of future wagon road bridges as well.

The AT&SF had first entered the territory in 1879, winning a race to cross over Raton Pass and then following the Santa Fe Trail to Las Vegas and down into the Rio Grande Valley. Within three years the railroad had succeeded in extending its system south to Deming where it connected with the Southern Pacific (SP) and extending its own system to California when it acquired the Atlantic and Pacific Railroad line west along the 35th Parallel when the latter went into receivership. During the last three decades of the territorial period other railroads followed. By the time of statehood in 1912, transcontinental lines as well as a network of regional lines transported passengers as well as the state's timber, mining, ranching and agricultural products and linked most of New Mexico's important towns. As the railroad came to dominate overland transportation in the territory, wagon roads fell into disuse. Sections of the Santa Fe Trail, the Camino Real, and the wagon roads linking military posts and outlying villages continued to serve local traffic, but their former role as the primary corridors of travel had been largely reduced to providing access to depots and railroad shipping points.

The rise of these western railroads also perpetuated the neglect of wagon road and bridge construction. No longer the primary means of connecting important towns and shipping goods over great distances, roads remained a local matter best treated by town and county governments. Typically county commissions made decisions regarding road and bridge projects, often concerning themselves with little more than developing a road that connected the county seat with the closest railroad. Since few of these governments could afford to hire engineers to oversee these projects and since few wanted to make the unpopular decision of adding to residents' tax burden to finance expensive improvements, such projects often received minimal financing. Expenses were further minimized through a continuation of the corvée system inspired centuries earlier in France in which local governments required taxpayers to meet some of their assessments by working on road projects. Most New Mexico counties relied on these often unskilled, involuntary workers to build and maintain their roads and small bridges. As a result, roads and bridges varied in design and quality, often embodying the least expensive materials and making little effort to compensate for the "cloudburst" flooding that had proven so destructive to earlier efforts to build lasting bridges.

The bridge building techniques, designs and materials used to construct many of these road and bridge projects gradually improved, however, influenced by the engineering skills brought to the territory by the railroads' engineers. Just as the railroad accelerated the rate with which new architectural styles and mass-produced building materials entered the territory, bridge construction also benefitted from the coming of the railroad. Masonry, iron and steel, and sturdier, often multi-tiered timber railroad bridges were required to meet the needs of the heavy, relatively high-speed rolling stock. These offered models that began to appear in wagon bridges as well. Most notable was the railroads' practice of preparing and then shipping standardized iron members to the bridge site where an experienced crew, which had constructed a masonry or concrete abutment, bolted or riveted the structural elements together. This efficiency and economy as well as the stronger building materials soon began to appear in some wagon bridge construction as well.

The Hot Springs Boulevard Culvert (S-44) in Las Vegas (1888), the oldest known highway structure remaining in the state, for example, employs rusticated sandstone masonry similar to the abutments and substructures of railroad bridges as well as smaller arched culverts. Constructed over Hermanos Arroyo, an intermittent small stream, the culvert is 188 ft. long with an 18 ft. wide arch. Also in Las Vegas, the Gallinas River Bridge (1549; 1909), with its reinforced concrete allowing flatter and, therefore, longer arches, recalls numerous railroad bridges in the eastern United States employing a similar design. The Rio Hondo Bridge at Picacho (3452), a single span from the three-span Pratt through truss with pinned connections built over the Pecos River at Roswell in 1902, also reflects the railroad engineers' increasing reliance on iron and steel truss bridges for their greater strength and durability. Undertaken by local governments to address local transportation needs, these structures, as well as other road building innovations such as galvanized iron pipe and poured concrete culverts, reflect the influence railroad engineers exerted on wagon bridge building in the territory.

Not only did the railroad engineers introduce new materials and building techniques, but they also introduced a more scientific approach to assessing potential bridge sites and the challenges they posed. Most important to these engineers, who viewed bridges as the most vulnerable and costly link in the railroad's transportation system, were the arroyos and streams that required crossings. Often dry or intermittent for years at a time, these dormant drainages held the potential to turn into raging torrents, the "cloudburst stream" that engineers so feared, following a heavy rain. Understanding the frequency of flooding cycles so that they could build for 100 or 200-year floods was a major part of railroad bridge planning.

When the territorial government secured the aid of the U.S. Geological Survey to measure stream flow at various gaging stations, the AT&SF saw the potential assembling such data held and contributed funds to the project. This aid, which enabled the state engineer to increase the number of gaging stations equipped with automatic gages, led to a better understanding of the infrequent pattern of flooding that had proven so destructive to the fragile timber and beam bridges that had marked earlier wagon roads (Territorial Engineer 1910:149-151). By building bridges that anticipated and could withstand these "cloudburst streams," railroad engineers demonstrated to county road boards and the territorial engineer's office the quality and scale of bridge building required to keep wagon roads open.

This heightened awareness of the need to build bridges that could withstand major floods combined with the new design technologies and materials demonstrated by the territory's railroad bridges led to a gradual improvement in wagon road bridge construction by the turn of the century. The progress was uneven. While poorer counties continued to try to meet their road needs by constructing more of the inexpensive and, often, marginal timber and beam bridges that had characterized all previous efforts, some counties undertook more ambitious projects. These frequently involved local officials unfamiliar with bridge building, who drew up specifications and then solicited bids from bridge companies. With the closest of these companies located in Pueblo, Colorado and El Paso, Texas and more distant ones in the Midwest, officials often found themselves selecting bridges from standardized plans that appeared in catalogues, plans that rarely took into account the particular site, the alignment challenges it presented, and the river bank's potential for harmful scouring during floods.

Even when representatives of the bridge companies appeared to inspect a site, bidding competition among the salesmen often resulted in the proposal of bridge plans and materials that were unsuitable for traffic loads. In 1903, for instance, the town of Raton determined that it required a bridge over Raton Creek. Correspondence between Joseph Brackett, the local official administering the project and Walter Sharp, representing a company in Kansas that quarried stone and constructed masonry bridges, reveals how competition rather than the specific needs of a project determined how companies proposed and bid on bridges. In a letter prior to bidding on the bridge project Sharp informed Brackett that he would come to Raton to bid on the project but that he feared the "steel bridge men" would underbid him, "even below cost," simply to prevent a "stone arch man from getting started in this country" (Colfax County Records, County Clerk Papers 1903-1906). While Colfax County awarded the contract to Sharp, the "steel bridge men" would receive many of the contracts locally awarded during the late territorial period.

Without any centralized authority to evaluate proposed plans for bridges and to oversee the quality of the actual bridge construction local governments remained vulnerable to sales pitches and unscrupulous promotions with little recourse, and the territory's citizens suffered for it. In the years leading up to statehood, however, the social and political context in which bridge building occurred began to change. The bicycle craze that had gripped the nation in the 1880s led to the formation of a Good Roads Movement which soon reached New Mexico. In 1900 the first automobile appeared in the territory, and by 1904 Governor Miguel Otero had purchased the territory's first official automobile. As wealthy, often politically prominent citizens began to purchase automobiles and to seek roads on which to drive them, pressure began to mount on the territorial government to assume more responsibility for constructing and maintaining New Mexico's roads.

The Territorial Legislature's first initiative in road construction occurred in 1905 when legislators designated the Camino Real Highway as New Mexico's principal north-south road. Their intention was to develop a gravel highway that followed the approximate alignment of the old colonial road but also extended northward from Santa Fe to Raton to encourage touring automobilists to visit the state. The legislators appropriated a modest $10,000 for work to improve the road, but little seems to have been accomplished with the fund (State Engineer 1914:8). Four years later, the legislature took a second step toward involving the territorial government in road and bridge construction when it created the Territorial Roads Commission consisting of the governor, the Commissioner of Public Lands and the Territorial Engineer. Funded with a mil levy assessed to each county's property tax, by donations, and unspent funds remaining from the Camino Real appropriation of 1905, the commission undertook a range of road related projects. Some existing roads were selected for improvement and received macadam, sand-clay or gravel surfaces. Included in these improved roads were the "scenic highway" from Raton to the Colorado border, and the roads between Roswell and Carrizozo, Silver City and Mogollon, and Santa Fe and Albuquerque.

New routes between previously isolated towns were surveyed. In the southern half of the state roads between Carlsbad and Monument, Deming and Silver City, Anthony and Dona Ana, and Cloudcroft and Alamogordo were surveyed, while in the north crews surveyed roads between Santa Fe and Santa Cruz, Las Vegas and Santa Fe, Mora and Las Vegas, and Farmington and Gallup. All of these roads, State Engineer Sullivan proclaimed, would make vital agricultural or grazing areas more accessible. Moreover, Good Roads Associations in some of the towns had already committed funds to help complete the roads (Sullivan 1910:172-187).

Finally, under the law authorizing the Territorial Roads Commission the state engineer was empowered to begin conducting "examinations of plans and specifications, contracts, etc., relating to the construction of bridges throughout the Territory, where the expenditure amounts to over $1,000" (Sullivan 1910:143). The law permitted the state engineer to make necessary alterations, amendments and recommendations to these projects. During the first year, Sullivan reviewed plans and specifications for nine bridges, including the Gallinas River Bridge joining the old and new towns of Las Vegas and two bridges over the Rio Grande near Albuquerque at Barelas and Alameda. Publication of his review marked the first effort to list the major bridges spanning the streams and rivers of New Mexico and anticipated the more comprehensive biennial report that the new State Engineer began to produce four years later.

Of significance in Sullivan's discussion of the territorial engineer's responsibility in overseeing bridges are his comments concerning the inadequacies of earlier bridges. Recognizing that the various county commissions continued to exercise their role building bridges "after submitting plans, etc., to this Department for approval," Sullivan observed that in reviewing bridge plans he would draw upon "detailed knowledge of run-off" from the many rivers and streams where waterflow data had been assembled. Warning that "sufficient stress is not placed on the highly torrential character of the New Mexico streams by the designers or contractors," Sullivan promised to correct plans that failed to allow for adequate "openings to allow for floods and save the bridges from washing away" (Sullivan 1910:146).

In practice the ability of the Territorial Roads Commission to carry out all of the projects it had initially undertaken was limited. County commissions resisted giving up their authority over local projects, and the territorial commission's small budget and the few personnel assigned to the State Engineer's office prevented the commission from completing large projects. In the case of the sixty-mile Santa Fe to Albuquerque road, for instance, the commission pursued a more economical strategy of undertaking only "the most difficult parts on a system," leaving the remaining portions to be completed by the counties through which the road passed. Territorial work crews consisting of Cochiti Pueblo Indians and inmates from the state penitentiary under the supervision of the penitentiary warden concentrated only on a 19.5 mile section located between the top of La Bajada Hill and Algodones. Notorious for its multiple hairpin turns as it descended the basalt escarpment of La Bajada Hill and for numerous sandy arroyos south of La Bajada, this road section was one of the most challenging facing engineers. By "demonstrating what can and should be done in the way of building roads, etc.," in difficult road portions, Sullivan hoped to provide a model to the county commissions and their road supervisors who still held much of the responsibility for overland transportation.

Most likely this policy of undertaking demonstration projects derived from similar federal policies adopted by the U.S. Office of Public Roads (OPR). Created in 1893 as the Office of Road Inquiry within the Department of Agriculture, the OPR, had marked the increased involvement of the federal government in road matters. In 1918, it was elevated to bureau status and became the Bureau of Public Roads (BPR). Pressured by an effective Good Roads lobby, pioneer automotive manufacturers, and by a growing recognition that motorized vehicles were the future of transportation, the government had begun to assume responsibility in improving the nation's often dismal roads. The OPR undertook construction of roads on federal lands such as national forests and Indian reservations, an initiative that would add several bridges to New Mexico's road system at no cost to the state in the years to come. It adopted policies such as offering engineering graduates a year of post-graduate study with the OPR as a way of encouraging more students to pursue degrees in civil engineering and then careers in the various states' nascent highway departments. It also developed laboratories to test road and bridge materials, a critical initiative that enabled the OPR to assume leadership in the expanding road construction movement. Unable to undertake the construction of a complete road system, OPR relied on sharing its data with the states and counties by constructing short "demonstration" road sections throughout the country.

These activities also provided an administrative and operative model for nascent state highway departments (the first was formed in Massachusetts in 1894), where many of the young engineers ultimately took jobs. The OPR's initiatives resulted in the gradual centralization and professionalizing of the road and bridge building industry in which materials testing and demonstration road sections led to more standardized construction practices. In the decade preceding the onset of World War I, the model of a centralized highway authority offered by the federal government's OPR became apparent in the creation of most state highway departments. New Mexico, after it achieved statehood in 1912, was no exception. When the first state legislature enacted the new state's laws in 1913, the acts provided for a state highway commission and took the first steps toward giving the State Engineer the authority to oversee road and bridge construction.

Bridge Construction During Early Statehood

In contrast to the act creating the Territorial Roads Commission, the new act took additional steps to strengthen the role of the new commission and State Engineer. Similar to the role OPR had assumed at the federal level, the commission was empowered to investigate and test road materials and carry on experimental road work with its demonstration road sections. Additionally it was given the authority to confer with counties and municipalities on road and bridge construction, to plan road and bridge projects, and to confer on the work carried out by the counties. Administratively, the act created county road boards with members to be appointed by and responsible to the State

Highway Commission. It also eliminated the office of road supervisor, an appointment made by county commissions, substituting a system of overseers, superintendents, or road engineers ultimately responsible to the State Highway Commission.

This new relationship between the county commissions and the newly constituted state authorities did not emerge without resistance. Threatening the hold that the county commissions had held over road projects and patronage, the new law caused much antagonism prompting court cases which sustained the state's new centralized powers (French 1914:9). Nor did the relationship assume a final form based on a single chapter in the state's new constitution. Instead it evolved gradually during the 1910s so that by the early 1920s when the pace of road and bridge building in New Mexico accelerated the State Highway Department stood as perhaps the best example of a state agency that had successfully assumed centralized authority.

In part, this success is attributable to the impetus state highway departments throughout the nation received as a result of the federal government's increased role in developing a national road system beginning in 1916. Briefly stated, Congress had become acutely aware of the public's demand for better roads. Its response was the Federal Aid Road Act of 1916, which authorized the OPR to support state projects along rural postal routes with matching funds over a five-year period. Within two years the shortcomings of the act became apparent. The nation's roads proved inadequate to handle wartime convoys of men and supplies bound for eastern ports, and the criteria of funding rural postal roads was seen as unfair and inadequate by eastern states seeking to build higher type roads as well as by advocates of a national road system. In southern New Mexico, far removed from the eastern seaboard, roads also succumbed to the heavy mechanized units of General Pershing's Punitive Expeditionary Force against Pancho Villa in 1916.

In 1919 Thomas M. MacDonald was appointed to head the BPR, bringing with him an insight to the problems facing highway engineers in largely rural states that he had gained as the chief engineer of Iowa's highway department. Adding to his clout was the professional organization composed of state highway engineers, the American Association of State Highway Officials (AASHO), formed in 1914. In 1921, when the Federal Aid Road Act was scheduled to expire, MacDonald, aided by the effective lobbying of the AASHO, convinced Congress to pass the Federal Highway Act of 1921, which strengthened and refined the federal government's commitment to developing a national highway system. Central to the act was the guiding principle of developing a system of connected federal highways to be constructed by the states with matching federal funds. These Federal Aid Projects (FAP), including the funding of bridge projects, provided matching funds for 7 percent of each state's highway system. The portions to receive FAP funding were be selected by the states with the approval of the BPR. While MacDonald realized that the large, lightly-populated western states would not be able to complete this federal system immediately, he advocated a policy of "getting the road through" first and, then, improving sections as needs required and budgets permitted. Calling this process of road improvement "staged construction," MacDonald set the tone for New Mexico's road and bridge construction over the next three decades (Federal Highway Administration 1976:100-110).

MacDonald had also learned that in order to develop a well-coordinated, efficient highway system centralization of authority was essential. The scientific approach to materials and site testing, a tenant of the engineering mind, implied that once these tests had been completed an informed selection of road alignments and bridge sites and standardizing their specifications naturally followed. Applying this thinking to road administration, MacDonald and the growing profession of engineers trained in road and bridge construction viewed a centralized authority as offering the greatest efficiency and economy. As a result, Federal Highway Act of 1921 encouraged state highway departments to assert even greater authority in initiating, carrying out and inspecting road and bridge projects. The highway departments, in turn, became absolutely accountable to the BPR, which provided them at least 50 percent of their budgets for most major projects. (Because of a provision in the 1921 law obligating the federal government to pay all costs for road construction across federal lands, federal monies accounted for approximately 63 percent of New Mexico's highway construction during the 1920s and 1930s).

As lagging state highway programs in other states, particularly in the South, demonstrated, however, federal initiative alone did not confer success on all highway departments. In the West, where most large states were marked by small isolated populations and modest revenues drawn from property taxes based on low land valuations, successful highway and bridge construction programs also proved to be a particular challenge. New Mexico's early efforts to improve its road and bridge system succeeded to the degree they did because, much as Thomas M. MacDonald brought vigorous leadership and vision to the BPR, the state's first State Engineer, James Adams French, brought similar qualities to his office.

Born in Washington D.C. in 1866, where he studied civil engineering at Georgetown University, French headed west to pursue his career. As did many other engineers at the close of the 19th century, he found that the opening of the west to farming, mining and overland transportation systems presented a range of professional opportunities from surveying in Alaska to constructing railroads in the Northwest. Later, he worked on irrigation projects in the Yakima and Imperial Valleys and designed sewage and storm drainage systems before entering the Civil Service in 1903 and being assigned to the Elephant Butte Reclamation Project. When New Mexico's first state governor, William MacDonald, appointed him State Engineer, a position that initially included responsibility for both the state's water and roads, "Big Jim" French was well qualified for the task. During the period 1912 to 1926, when he died of a heart attack at the wheel of his automobile while returning to Santa Fe from a field trip, French spent a total of ten years serving as State Engineer.

During his tenure French was largely responsible for shaping the State Highway Department and bringing an unprecedented professionalism to road and bridge building in New Mexico. French shared his vision of what the state's road system might become when he published a map depicting the state's roads in

1914. An idealization rather than a depiction of a road system that actually existed, the map represented French's plans for bringing the far-flung communities of the state together with a viable overland transportation system. Like the BPR's MacDonald, French emphasized the scientific aspects of highway work, travelling about the state to inquire about soil and drainage conditions, assess the quality of roads and bridges, and develop cost estimates for roads over various types of terrain. By 1914, when he published his first biennial report, French had arrived at some disturbing conclusions. The condition of the few "inter-county" roads, as they were called, was "deplorable," making it "practically impossible to travel from county to county with any degree of comfort" (State Engineer 1914:13). Turning to the state's bridges, French admitted that when he had assumed office he knew the "methods previously followed in bridge building had been slipshod and unsatisfactory" and that he had determined to "remedy these conditions as far as possible, by permitting only men skilled in bridge engineering to design bridges and supervise their construction" (State Engineer 1914:10).

For French the solution to building better bridges lay in rewriting the laws to eliminate the practice of bridge companies submitting bids to county commissions, the previously-mentioned practice that resulted in companies lowering their bids and using cheaper materials in order to secure a contract. Instead, French proposed, all bridge requests should be submitted first to the State Engineer to make an accurate survey and map of the location and to prepare plans and specifications which the counties would then use as the basis for competitive bidding. After selecting the contractor and making the necessary adjustments in the county tax levy to fund the project, the county commission would then employ the State Engineer as project supervisor, compensating the engineer's office for its efforts. Finally, after the State Engineer had inspected and approved the project, the county commission would reimburse the contractor (State Engineer 1914:49-51).

By shifting responsibility of the entire bridge construction process to the State Engineer's office, French argued that New Mexico would receive better quality bridges. His efforts to involve his office at the outset of the process underscore his awareness that standardized bridges, especially the through and pony truss metal types offered by salesmen and in catalogues, failed to take into account that "each and every bridge site requires a special study, no two being alike, and in construction, different types of both substructure and superstructure are demanded" (State Engineer 1914:11). As the BPR strengthened its ties with the various states' highway departments, demanding greater centralization of control over road work within each state, New Mexico followed in step. By 1919, French realized his efforts for greater centralization in the State Highway Department when the legislature voted to rescind the policy of the state and the counties sharing from their 50 percent share of federal highway monies and gave the State Engineer the authority to determine all state road and bridge construction and improvement projects.

As French's campaign for greater control over bridge construction approached realization, the number of bridge projects undertaken by county commissions declined. Some of the best remaining examples of those local efforts to construct bridges are the concrete arch Gallinas River Bridge (1549), the concrete truss Variadero Bridge (3964) over the Rio Conchas, and the concrete rainbow arch Bridge of the Hidalgos (701) in Santa Fe. The two former bridges, designed by George Morrison, a Las Vegas engineer, are located in San Miguel County, which prospered with Las Vegas, one of the state's leading railroad and mercantile centers, as its hub. The latter, located on Grant Avenue over Arroyo Mascaras, reflected the decisions of officials of the capital city to introduce a bridge design popular in the Midwest but unique in New Mexico. Seeking ways of merging modern design and materials with their efforts to promote the city's past, they settled on reinforced concrete, which has a massiveness more in keeping with the city's adobe revival architecture than an open steel truss. They furthered its historic architecture by embellishing the ends of the bridge's floor beams with decorative concrete corbels reminiscent of the wooden corbels of Spanish missions.

While French and his small department worked to gain greater authority in road and bridge decisions, they went about their job of documenting and inspecting bridge projects. These first efforts at documenting the state's roads and bridges appear in the State Engineer's biennial reports which French began. During the first two years of statehood, 72 bridges were built in New Mexico. The vast majority were classified as wooden trestle bridges; other types included concrete slab and steel bridges, some with timber approaches. Reflecting French's efforts to centralize the State Highway Department's authority, only eighteen of these bridges were built by the various counties; and half of those undertaken by the counties were designed by the State Engineer's office. The Office of Indian Affairs of the U.S. Department of the Interior had also contracted for a 250 foot-span Pratt through truss bridge at Shiprock.

French's survey of the work undertaken by his office also provides a good indication of how he was seeking to improve the quality of the state's bridges and where the state had chosen to direct its limited resources. Most of the steel bridges planned by his office had a carrying capacity of 100 pounds per square foot of roadway and were designed for a fifteen-ton roller, or live weight. Some with wooden decks were designed for ten-ton wagons. All steel bridge designs were also proportioned to minimize excessive stress; the required number of rivets was increased by 25 percent over previous standards, and bolts--a standard component in earlier steel bridges--were banned in favor of rivets unless the State Engineer granted special permission. French noted further efforts to strengthen bridge substructures by adding concrete abutments and creosote-treated pile foundations driven from forty to sixty feet into the ground (French 1914:32). Finally he insisted that bridges be built to the high-water lines of waterways, resulting in longer bridges with greater clearances for debris-laden flood conditions. With these new regulations in place, French felt that though they might have a higher construction cost, the longer life of these new bridges would cost taxpayers less than under the old system.

Reflecting the state's priority to improve the Camino Real Highway, many of the bridge projects were devoted to improving NM

Highway 1. Seventeen bridges, mostly of timber beam design, were constructed along a stretch of five miles of arroyo-lined roadway between San Antonio and San Marcial. Additionally, two multi-span steel truss bridges were built across the Rio Grande at Belen and near Socorro. Farther north, steel truss bridges were constructed across the Vermijo, Mora and Sapello Rivers. The latter, undertaken by Mora County but with the approval of the State Engineer, was designed by George E. Morrison. With a four-span pony truss bridge across the Rio Grande at Arrey in Sierra County and an eight-span timber beam bridge near Domingo in Santa Fe County, NM 1 accounted for over one-third of all of the bridges constructed in 1914. The following year the New Mexico State Highway Commission published its first tourist-related pamphlet entitled Through New Mexico on the Camino Real. As it encouraged motorists to drive through the scenic state, the pamphlet extolled the quality of the new Camino Real, offering numerous photographs of the improved roadway and new bridges that had transformed a once arduous trip into one of relative comfort and safety (New Mexico State Highway Commission 1915).

French classified 26 of the bridges in his first report as large and noted that the costs for the 22 bridges for which information was available totaled $138,000 (State Engineer 1914:34). The costs of individual bridge projects ranged from $14,000 for the five-span pony truss bridge across the Rio Grande at Belen to $480 for a steel trestle bridge across Coyote Creek in Mora County. Most of these large bridges employed steel spans, especially Pratt and Warren pony trusses that featured compression-tension configurations mirroring similar through truss bridges but with lower web heights and without overhead struts and braces. Timber, now treated with creosote, continued to be used over many arroyos. French's list of bridges also included a steel I beam over Blue Canyon in Socorro County and a concrete slab bridge over an arroyo in Santa Fe County, types that would become more common in later years.

The vast majority of the bridges were designed by the State Engineer, who also constructed four wood trestle bridges varying in length from 279 to 42 ft. Only four were designed by the bridge fabrication companies that constructed them, and they, most likely, were among those undertaken by counties but whose plans were submitted to the State Engineer for approval. None of the companies that fabricated the bridges were located in New Mexico, which lacked large iron and steel fabricators. Instead they were located along railroad shipping lines in neighboring Colorado and Texas, and in the Midwest. The Midland Bridge Company of Kansas City and the Missouri Valley Bridge and Iron Company of Leavenworth, Kansas accounted for twelve of the 26 large bridges. Although none of the large bridges dating to that initial biennial period remain, the widespread bridge construction marking French's first years as State Engineer offers a clear sense of how the new department led by its visionary chief engineer had transformed road and bridge construction practices in the state.

During the next biennial period the State Highway Department continued its vigorous bridge-building program, overseeing the construction of 108 bridges (State Engineer 1916:23-29). Thirteen of the bridges were of steel, 94 of timber and one of concrete. In contrast to the concentration on the Camino Real Highway in 1913-14, bridge projects were now more dispersed throughout the state. None of the new steel bridges, for example, were located along NM 1 or crossed the Rio Grande. Instead they crossed the Gila and San Francisco Rivers in the southwestern quadrant of the state, the Rio Mora and other tributaries of the Canadian River, and the Pecos River and several of its tributaries. By carrying out bridge projects along these other waterways, French was beginning to realize his goal of linking the far-flung areas of the state. Having already classified the state's roads into four categories, and confident that many of the miles of roads could be cut and graded rather inexpensively, French viewed bridge construction as the critical link in pushing the road system forward.

Most notable among these projects was the bridge over the Gila River near Cliff (1382) completed in 1915. A Warren through truss design with three spans of 112 ft. each flanked by 20 ft. timber approaches, the bridge was funded by the State Highway Department and fabricated by the El Paso Bridge and Iron company. Sought by local boosters since 1863 when Fort West was constructed at the nearby confluence of Mangus Creek and the Gila River and the potential for mining in the area became apparent, the bridge demonstrated the state's commitment to linking Silver City to the Mogollon mining district and, more broadly, to opening the upper Gila region to automobile traffic.

The Gila River with its wide, meandering channel was given to seasonal flooding which isolated the area's ranching and mining communities. So broad was this floodplain, so wide that it was impractical to attempt to bridge it with a single span. French followed an approach he advocated in similar settings elsewhere. Concrete piers were set into the riverbed to a depth of about ten feet and then built to an elevation at least ten feet above the normal level of waterflow before being capped to support the metal truss superstructure. Timber abutments protected the timber approaches which were inclined upward from the roadway to meet the level of the bridge deck. To compensate for this incline the road grade approaching the bridge was also slightly raised. In so doing, French reasoned that in times of extreme floods the overflow of the Gila River would be able to pass "around one or both ends of the bridge," perhaps washing away the more easily replaceable earthen approach to the bridge rather than the bridge itself (State Engineer 1916:24).

Although James French's appointment as New Mexico's State Engineer was interrupted for four years between 1919 and 1923, the pattern he established of centralization of authority over all aspects of road and bridge construction continued into the 1920s. This trend toward centralization was aided by the Federal Highway Act of 1921. Under this act, federal matching funds were designated for the construction of seven percent of each state's road system, a Federal Aid Project (FAP) system that was to create the basis of a federal highway system. The act marked the shift from a period of "propagandizing for highways" to the "task of actual road building" (Seely 1987:53). New Mexico's highway department also began to show tangible accomplishments Aided by the enactment of a gasoline tax in 1919, the second such tax in the nation, the State Highway Department found itself in an improving financial position. Able to issue debentures against the anticipated receipts of the gasoline tax, the department secured the funds it needed to match the increased federal monies available for FAPs.

Most of the FAPs undertaken in the early 1920s resulted in graded gravel roads, not the hard-surfaced asphalt and concrete roadways that marked the completion of federal highway projects in the late 1930s and 1940s. With the BPR's emphasis on "staged construction," a greater priority rested on constructing serviceable roadways and the bridges that were the indispensable links for "getting the roads through" than completing high grade roadways. Under this philosophy, roads had crossed normally dry arroyos simply by treating them as "dips" in which a concrete spillway crossed the arroyo bottom. As roads were upgraded and engineers sought to assure an unbroken flow of traffic, these occasionally-flooded spillways were no longer acceptable. Gradually the highway department replaced them with creosote-treated timber bridges.

Railroad engineers had determined that this building material offered a life of forty years, a lifetime at least double that of untreated timber. Increasingly highway department engineers turned to this bridge type to get the road through (NMHJ 2/28:7-9). They found that the solid creosote-treated beams shipped from the forests of the Pacific slope permitted a relatively inexpensive, low-maintenance bridge. The design's adaptability to widening the deck also permitted engineers a flexibility not found in the more expensive, rigid truss designs. Further encouraging use of this bridge design was the federal government's decision to distribute trucks and other surplus machinery to state highway departments as a part of the demobilization following World War I, a distribution that brought over 300 trucks and 40 cars to New Mexico. Innovative mechanics soon found that they could easily adapt the War Department's surplus Nash Quad chassis and Fordson trucks to bridge construction equipment. Soon these converted truckbeds were able to transport derricks and pile driver rigs as well as timbers and repair equipment. These new capabilities permitted the highway department to drive piles 40 to 60 ft. into river beds as well as to repair the piers, or bents, of beam bridges and widen decks when necessary (NMHJ 12/24:14).

Despite their susceptibility to fire, the timber beam bridge design became the mainstay of New Mexico's great period of bridge construction in the 1920s and lasted as a design type in the state road system until the 1950s. With chainlink-like fencing attached to vertical posts forming guardrails and horizontal beams, or felloes, forming a curb, the bridges became especially popular for spanning small arroyos. In the southern part of the state, where the Elephant Butte Dam now regulated the flow of the Rio Grande, reducing its waterway to a well-defined channel, several new timber beam bridges spanned the river. Extending to lengths of several hundred feet and supported by fifteen or more bents at 25 ft. intervals, these timber beam bridges were standard along NM 1. In 1926, when the roads in the federal highway system were assigned numbers, NM 1 became US 85. More recently the roadway has served as a local road through the farm communities of the Mesilla Valley. Throughout this road's history many of the timber beam bridges have remained . The Radium Springs Bridge over the Rio Grande (2591; 1933) stands as one of the best examples of that bridge design.

While the timber beam type accounted for the majority of bridges constructed in New Mexico during French's tenure as State Engineer, his bridge department also experimented with other bridge designs. In the early years, both pony and through truss steel bridges continued to be used. The lighter weight, pinned-connection bridges of the territorial period, however, gave way to riveted bridges with greater dead weight and live weight capacities. Despite strengthening the structural elements of these bridges, engineers, in their quest for safety, grew less satisfied with the basic through and pony truss design. Not only were they relatively expensive, requiring skilled work crews and the use of an elaborate falsework, or temporary wooden skeleton to support the initial portions of the span, but they were also vulnerable to accidents. While trussed superstructures permitted ample clearance above waterways susceptible to flooding, they stood directly alongside the roadway, exposed to moving vehicles capable of damaging the bridge. To engineers, the truss bridges were "fracture critical" structures in which damage to a single compression or tension element within the structure was capable of causing the entire structure to collapse. As vehicles became heavier and faster, and larger trucks required higher clearances, steel truss bridges became even less desirable.

Despite these drawbacks, the construction of steel truss bridges along the state's main roads continued during French's last years as State Engineer and through the 1930s. When a particular site demanded it, engineers favored the Parker through truss design, a variation on the Pratt through truss, whose polygonal top cord allowed for better stress and bending distribution throughout the structure. Notable Parker through truss designs appeared in two bridge projects across the Animas River at Aztec (119; 1929) and Cedar Hill (3681; 1933), with Warren pony truss approaches leading to both bridges' principal spans; across the Rio Puerco (2530; 1933); and across the San Juan River at Shiprock (1792; 1937). Increasingly, however, the locating and designing of these bridges reflected engineers' effort to mitigate the liabilities of the exposed superstructures. Rather than locating a bridge based primarily on an economical, generally perpendicular, crossing of a waterway, engineers began to design bridges so that they became an integral part of the overall highway. The practice of having roadways make arduous and dangerous turns to approach a bridge gave way to approaches that permitted traffic to flow smoothly from the road onto the bridge. The Rio Felix Bridge (357; 1926), a Pratt through truss, for instance, was designed with its end trusses offset by one panel in order to permit the roadway to enter the bridge in a continuous straight path while crossing the drainage at an angle.

Clearly, the solution to exposed superstructures lay in using designs that removed them from potential damage by vehicles. In this era before widespread use of large concrete slab and, later, reinforced concrete bridge designs, engineers sought to shift the load-bearing trusses beneath the bridge deck. However, this solution was applicable only at sites with deep canyons or gorges so that in times of flood high water and debris would not damage these so-called deck truss. In 1927 the Percha Creek Bridge (1519), a steel deck with a Warren type truss, was completed as the highway department began its long-awaited Black

Range Highway project that would connect Silver City and the Grant County mining districts with the Rio Grande Valley.

Permitting a longer span than the through and pony truss designs was the steel arch bridge. In 1922, the department completed its first bridge using a steel arch design. The Canadian River Bridge at Logan was 734 ft. long and employed steel two-hinged arches resting on steel piers with concrete foundations. Designed to carry a 15 ton live, or roller weight, the bridge was heralded as the department's most notable achievement when it opened. Crossing a gorge 100 ft. above the river, the bridge served U.S. 54 until it was replaced in 1954. Thirty-one years would elapse after the construction of the Canadian River Bridge before New Mexico had a comparable steel arch bridge, the Los Alamos Canyon Bridge (7622) funded by the Atomic Energy Commission.

Also introduced to the State Highway Department's list of bridge designs in the early 1920s was the suspension bridge. A design type often associated with the great suspension bridges spanning large waterways and straits, modest versions of the design had been used by San Juan and Chaves Counties at Aztec and Hagerman before statehood. Economical, light and graceful, and assembled with relative ease since they required no expensive falsework during construction, their success prompted the highway department to study the type and finally construct two suspension bridges (NMHJ 9/24:6). Of particular interest to French and his designers was the location of the two towers on either side of the river supporting the cables, which carried the deck, and the cable anchorages located well behind the towers. Because the cables permitted wide spans, the towers could be located on bluffs above the rivers where they were secure from the threat of flooding and bank scouring. The fact that the Aztec bridge had been the only bridge in the San Juan-Animas drainage area to survive the flood of 1911 further encouraged French.

Prompting some uneasiness was the knowledge that the Hagerman Suspension Bridge had collapsed in 1920, succumbing to a "struggling, frightened swaying herd of 200 cattle crowding every square foot of bridge floor" (NMHJ 9/24:6). Designers, however, dismissed this accident in which one of the cables pulled free of its anchorage as one caused by poor judgement. More challenging was finding a design solution to the lack of rigidity, vertical oscillations, and deflections that had afflicted the earlier suspension bridges. Bridge engineers determined that they could overcome these drawbacks by adding a stiffening truss alongside the bridge deck that would eliminate the oscillations and deflections. Using wood beams they applied the trussing to the 150 ft. main span of the Rio Chama Bridge at Abiquiu and to the 174 ft. span of the Otowi Bridge (369). Built in 1924, both bridges were significant, not only as the first of their type undertaken by the State Highway Department, but because of the accessibility they offered to large, previously isolated regions of the state.

By the time James French returned for his second tenure as State Engineer in 1923, the relationship between the BPR and the state highway departments had solidified. With the states assured of a continual flow of federal matching funds and with Thomas MacDonald and his district engineers firmly in control of reviewing and approving the various states' FAP proposals, the federal highway system, long-sought by the Good Roads Movement, began to take shape. The AASHO, which held professional meetings annually and effectively lobbied Congress with its scientifically-informed expertise, provided MacDonald with the political leverage he needed to advance his program. French was active in the AASHO, serving on the committee that designated the numbering of the federal highway system in 1925. In 1926, the AASHO also published a book of highway and bridge specifications meant to help state highway departments cope with rising construction standards as vehicles became heavier and faster.

Reflective also of MacDonald's efforts to help the large western states complete their many miles of federal roads were bridge projects undertaken on federal lands in New Mexico and financed completely by the federal government (Seely 1984:58). Just as the Office of Indian Affairs had constructed the single-span San Juan River Bridge on Navajo Tribal lands at Shiprock in 1914, various agencies of the federal government undertook other bridge projects. In 1925, the Office of Indian Affairs contracted for the construction of two steel pony truss bridges across the Rio Grande at Cochiti and San Juan Pueblos (1578). Explaining that both villages faced the challenge of getting to their fields on the opposite side of the river, C.J. Crandall, Superintendent of the Northern Pueblos, discussed how previous "cheap wooden bridges" had failed during floods (NMHJ 1/25:11). The U.S. Forest Service also undertook several bridge projects on national forest lands. In 1921 it constructed four timber truss bridges across the Pecos River above the village of Pecos. Although three of those bridges were eventually removed, the northernmost, a Howe through truss design, remains. Later, the Forest Service would construct other bridges, including the San Francisco River Bridge (599; 1926) near Alma, that contributed to State Highway Department's success in completing its portions of the FAP system.

On October 13, 1926, as he was making a field trip near the village of Encino, James Adams French suffered a heart attack at the wheel of his car and died. For all of the contributions he had made to conceiving New Mexico's state highway system and nurturing it through its earliest stages of development, people chose to remember him primarily as a bridge builder (NMHJ 10/26:6). Literally, it was a tribute achieved by the construction of hundreds of bridges during his tenure as State Engineer, an achievement still announced on the bridgeplates of some of the state's bridges dating to the French period. Figuratively, it was a tribute to the progressive engineering mentality that had brought a professionalism to two critical areas in the state's early years, transportation and water management.

French's legacy as a bridge builder remained apparent not only in the bridgeplates bearing his name but in the centralized organization of the State Highway Department. As early as 1923, when French sought to share the work of the highway department with the general public by publishing the New Mexico State Highway Journal, under editor Ray W. Bennett, the role that bridges played in the department's mission was apparent. An early departmental organizational chart depicted the Drafting and Bridge Department as a major component of the department (NMHJ

12/1923:10). By the late 1920s, the division was headed by E.B.Van de Greyn, who, like French, had migrated west to New Mexico after completing his schooling. From the late 1920s through the early 1950s, Van de Greyn served as the department's Bridge Engineer, overseeing the design, maintenance, inspections, and long-range planning for future bridge and culvert needs. His annual report, included in the NMHJ, is an indicator of the trends in bridge construction in New Mexico.

His report for 1929, for instance, dwells on the devastating floods of August and September that forced the division to devote much of its energy to repairing and renovating damaged bridges. In the same report, Van de Greyn discusses new procedures to document, photograph and inspect all of the state's bridges. For the first time, the division began maintaining information files on all bridges having a span greater than ten feet. By 1930, over 1,450 bridges had been photographed, and loading signs had been placed on 1,000 bridges (NMHJ 1/31:32-33). By the early 1930s, heavier truck loads and higher speed vehicles prompted Van de Greyn to turn his attention to widening bridge structures and seeking safer alignments and grades in which "the road location should determine the bridge site" (NMHJ 6/32:36-41). This broader approach to bridge construction matters also introduced the issue of the "aesthetics of bridges." Noting that the general public is "willing to pay for this feature, thereby relieving the engineer from the pressure to design for the lowest possible cost regardless of appearance," Van de Greyn first raised the question of how bridges should appear within the emerging landscape of highway construction (NMHJ 6/32:36-41).

Although Van de Greyn's report offered no characterization of the aesthetics associated with bridge designs, most likely he subscribed to values similar to those embraced by many of the NMHJ's advertisers. Clearly, the popularity of truss bridge designs had already peaked as the use of newer, stronger materials became more widespread. While treated timber beam bridges remained the mainstay of New Mexico's bridge program, and truss bridges were used at a few selected sites, steel beam and, increasingly during the New Deal projects of the later 1930s, reinforced concrete beam bridges became integral parts of major road systems. Lacking steel superstructures and smoothly aligned to the approaches of wider roadways, these unobtrusive bridges conformed to the streamlined aesthetic of modern industrial design. In a series of advertisements for concrete bridges the Southwestern Portland Cement Company of El Paso, Texas urged drivers to "Notice the Bridges!" proclaiming that a "well designed, placed and built" concrete bridge "almost becomes part of the landscape" (NMHJ 4/30:4; 8/30:4). This emphasis on a bridge aesthetic in which the structure is merely another unobtrusive element in a well-integrated road system suggests how far new materials had permitted bridge engineers to progress. No longer a notable element linking two points long separated by broken terrain, the modern bridge had become a less conspicuous component of the travel experience.

Bridge Construction from the New Deal through 1965

In his 1931 report, E.B. Van de Greyn noted that heavier truck loads were "proving a problem for this State and undoubtedly for other states" (NMHJ 12/31:34-35). Of particular concern were the old steel truss and untreated timber bridges built for six-ton loads that were no longer able to bear the now common fifteen-ton loads safely. As the state managed to replace these bridges, Van de Greyn predicted that many of the old truss bridges would "be placed on roads where heavy loads are not expected," a prophecy that accounts for the location of many of the truss bridges that remain on local roads to this day. Upgrading these bridges in a state system that now included 1,800 bridges, however, posed a challenge to the highway department that could only be met with increased federal assistance.

Much of that assistance came in the form of the programs under the aegis of the New Deal. The center of President Franklin D. Roosevelt's efforts to invigorate the nation's economy, or "prime the pump," through public works projects, the New Deal spawned several federal programs that directly, or indirectly, affected road and bridge building. While some were designed to promote large scale capital improvements, such as many of the Public Works Administration projects, and others were designed primarily for work relief, such as the Works Projects Administration projects, New Deal projects in their various forms brought considerable improvements to New Mexico's roads and bridges. In fact, with the exception of the Los Alamos Canyon Bridge (7622; 1951), built to meet Cold War needs, and the Rio Grande Gorge Bridge (6462; 1965), a spectacular span that united remote parts of New Mexico long separated by a previously impassable barrier, the bridge projects completed during the New Deal marked the end of construction of what we consider as the state's historic bridges.

Much as road historian, Bruce Seely, refers to the nation's "golden age of road building" as extending from 1921 to 1936, New Mexico's great age of road and bridge building, conceived under James French in the 1910s and nourished by the federal aid system of the 1920s, extended into the 1930s, aided by the New Deal. Projects undertaken during this last burst of construction ranged from small timber beam bridges on secondary roads to the Don Gaspar Avenue Bridge (3023; 1934), a 52-foot concrete arch bridge in Santa Fe, and the San Juan River Bridge at Shiprock (1792; 1937), with its six-span, 1,007-foot length making it the longest Parker through truss bridge in New Mexico. Federal agencies also continued to work through the BPR to construct bridges on federal lands. The Forest Service completed a Warren deck truss span over the San Francisco River near Luna (2211; 1934), and the Bureau of Reclamation completed a timber span bridge with concrete piers across Percha Creek (2510; 1937) along then U.S. 85 (now NM 1) near its Caballo Dam project.

At the same time, the State Highway Department received outright grants as well as portions of its annual FAP matching funds from the federal government to improve highway safety through the elimination of grade crossings. Although grade crossings had existed since the railroad first entered the territory in 1879, little attention was paid to the hazards they presented until the 1920s. Then, as more people began driving and cars became faster, the number of accidents at railroad crossings began to mount. In 1927, the NMHJ offered an editorial on the topic, noting that 39 such accidents claiming five lives and numerous injuries had occurred the previous year (NMHJ

7/1927:12). A few years later, a train collided with a Pickwick bus near Isleta Pueblo, killing nineteen passengers (Albuquerque Journal 4/11/31:1). Admitting that there was little likelihood of eliminating 350 grade crossings throughout the state, the editorial concluded that better warning signs and signals, crossing protective devices, and "extreme care on the part of drivers" would help to reduce the problem. Although some grade separations, such as those at Texico (S-115; 1924), Algodones (2542; 1927), and Manuelito (1928) were completed in the 1920s, usually with the cooperation of the railroad lines, it wasn't until New Deal programs made sufficient funds available that grade separation construction began in earnest.

In rural areas where roads included in the federal highway system frequently crossed railroads, the least expensive solution often involved realigning the highway to eliminate crossings. Such was the case with the realignment of U.S. 66 in 1937, for instance, when four grade crossings were eliminated in western New Mexico by realigning the highway south of the railroad. In other instances, however, engineers constructed overpasses, sometimes referred to as viaducts, or underpasses, depending on the characteristics of the particular site, to separate the grades. In towns and cities where rail grades were well established near depots and railroad yards, engineers generally resorted to excavating roadways and constructing underpasses. Albuquerque received two such underpasses, while others were constructed in Deming, Clovis, Fort Sumner, Lordsburg and Raton. Most of the rural overpasses tended to be timber or steel beam bridges supported by concrete piers flanking the railroad tracks. To provide adequate clearance many had substantially inclined earthen approaches. Underpasses, on the other hand, were often more ornate, reflecting the abstract geometric detailing associated with New Deal public works projects in the concrete work of their pilasters, columns, pedestrian stairs and sidewalks. The Fort Sumner Underpass (1938) with its molded concrete columns and guardrails provides a good example of such a New Deal project.

By 1940, when many New Deal programs were shifting to projects devoted to building the nation's military preparedness, the effects of Roosevelt's eight-year public works initiatives were apparent in New Mexico's road and bridge system. In part, these efforts had been aided by the state's governor from 1935-1938, Clyde Tingley, an ardent New Dealer who had campaigned on a platform committed to bringing more automobile tourism to New Mexico. Asserting that the state possessed the scenic, recreational and cultural resources to attract tourists, Tingley argued that it only needed better roads to draw them. When he was elected, Tingley sought to make good on his promise. A Bureau of Tourism was created within the State Highway Department and began a major campaign to promote the state, even changing its nickname from the Land of Sunshine, often confused with Florida's nickname, to the Land of Enchantment. During his administration, U.S. 66, the major federal road connecting the Midwest with southern California was completed with a hard surface, and U.S. 85, the modern alignment of old Camino Real and NM 1, was nearly completed.

Critical to the completion of U.S. 66 was a major realignment through New Mexico in which the mileage was reduced from 507 to 399 miles. This streamlining of the highway was, in part, achieved through the efforts of Tingley and other boosters who succeeded in 1933 in securing FAP funds to complete a 250-foot Parker through truss span across the Rio Puerco west of Albuquerque. Often dry, but given to devastating flash floods, such as the one in 1929 that washed out several highway and railroad bridges along it and the Rio Grande into which it drains, the Rio Puerco had long been regarded by bridge engineers as an "outlaw" (NMHJ 10/24:15). In order to prevent yet another washout, engineers had driven piles well below the riverbed and then incased them with massive concrete abutments on which to build the bridge.

As a result of Tingley and the State Highway Department's push to improve the state's main highways, New Mexico's portion of the federal highway system was relatively sound when the Department of Defense surveyed a network of potential military defense roads. Bridges along U.S. highways 66, 80 and 85 were generally judged to be adequate for wartime shipping needs. As a result, much of the preparation devoted to highway improvements occurred along access roads leading to various military installations. After 1941, however, as steel, tar and asphalt shortages began to limit non-essential construction, bridge projects and maintenance were deferred. In those few projects that were carried out, highway department officials displayed resourcefulness in their use of building materials. In renovating the Howe-design timber truss bridge over the Pecos River at Terrero (239), for instance, contractors substituted steel hangers from other truss bridges that had been scrapped and salvage rail for the structure's lower cords (Roads and Streets 4/1945:26).

Despite such efforts, the post-war years revealed that many of the state's older bridges were outdated and and did not meet changing traffic needs. Some truss bridges were scrapped, others removed to local roads as engineers shifted increasingly to steel beam and reinforced concrete structures. The Cold War buildup that followed the conclusion of World War II also affected bridge construction in New Mexico, especially with efforts to improve the shipment of people and materiel to and from the national laboratories at Los Alamos. A one-span K-truss bridge, the last through truss bridge constructed in New Mexico, was completed next to the Otowi Suspension Bridge in 1948; and, in 1951, the Atomic Energy Commission completed the Los Alamos Canyon Bridge (7622), the state's second steel arch bridge.

In 1956 the federal government moved to a new era in road construction with the passage of the Federal Aid Highway Act of 1956. Creating a 41,000-mile network of super-highways, the act placed over 1,000 miles of the new interstate system in New Mexico and included sections of I-10, I-25 and I-40. Impressive by technical standards, the system gradually spread across the state's landscape bridging innumerable arroyos, intermittent streams, as well as major rivers with standardized, reinforced concrete slab bridges. The system also added numerous spans at its many interchanges and as it passed through urban areas such as Albuquerque, Gallup and Las Cruces, its elevated roadway spanning many urban streets.

In contrast to this drive toward standardization of bridges along a thoroughly standardized interstate highway system, in 1963, the State Highway Department undertook a project to span the Rio Grande Gorge (6462) west of Taos. Though of a grander scale and using stronger alloy metals than used fifty years earlier, this bridge project recalled the thinking of James French when he urged engineers to see each bridge project as presenting its unique set of challenges. In this case the challenge lay in linking two remote parts of New Mexico, long separated by the 650-foot chasm of the Rio Grande, with a bridge capable of withstanding extreme weather conditions and bearing the heavy truck loads associated with a federal highway. By 1965, the bridge had been completed, dedicated with a speech given by New Mexico's Governor Jack Campbell that sounded reminiscent of French's idealism about building bridges, and, a year later, awarded the American Steel Institute's "First Prize for Long Span Bridges in 1966."

Preservation of Historic Bridges in New Mexico

Completing the Interstate highway system in New Mexico as well as the ongoing efforts of the New Mexico State Highway and Transportation Department (NMSHTD), as the highway department was renamed in 1987, to improve its state road system brought the total miles of roads on the two systems to over 12,700 by 1991. Approximately 2,950 bridges, hundreds of them standardized slab designs consisting of steel, reinforced concrete and precast concrete beams, are now components of these systems. As this modernization process moved forward, many of the earlier bridges were removed or relegated to county and local roads where traffic and live loads are lighter. A few bridges have even been sold to individuals and relocated on private property.

As this modernization process was moving ahead in New Mexico and other states, the Office of Engineering of the Federal Highway Administration, prompted by the provisions of the National Historic Preservation Act of 1966, sought to bring state highway departments and state historic preservation officers together to inventory, rank and preserve notable historic bridges. As its part in this effort, NMSHDT contracted with Steven R. Rae, Joseph E. King and Donald R. Abbe to inventory and rank all of the state's historic bridges, and to recommend notable structures for preservation (Rae 1987:1). Since the publication of the New Mexico Historic Bridge Survey in 1987, several bridges have been set aside for preservation and interpretation, and NMSHTD is committed to including others as well. This multiple property submission is intended to recognize those bridges as well as others determined to be eligible for inclusion in the National Register of Historic Places.

F. Associated Property Types

The New Mexico Historic Bridge Survey, published in 1987, included a section listing and describing the state's various bridge types and recorded examples. All of the bridge types represented by the individual properties included in this multiple property submission are discussed in the Historic Context section and summarized in this section. The summary is drawn largely from the discussion provided in the 1987 publication. Since all of the individual bridges included in this submission share many of the same physical and associative characteristics, they are treated as a single property type. Each particular bridge design, however, is noted as a property subtype and accompanied with a brief description and statement of significance. Other subtypes, including various pony truss, concrete beam and steel beam designs that include potentially eligible bridges, may be added to this submission in the future. The registration requirements treat the general property type and reflect the identification and evaluation methods discussed in Section H.

Outline of Property Subtypes

1. Masonry and Concrete Arches
2. Concrete Truss Bridges
3. Concrete Rainbow Arch Bridges
4. Pratt Through Truss, Pinned Connection Bridges
5. Pratt Through Truss, Rigid Connection Bridges
6. Warren Through Truss Bridges
7. Warren Steel Deck Truss Bridges
8. Parker Through Truss Bridges
9. Parker Pony Truss Bridges
10. Timber Beam Bridges
11. Suspension Bridges
12. Timber Through Truss, Howe Design Bridges
13. Railroad Underpasses
14. Steel Arch Bridges

1. Masonry and Concrete Arches

Description:

Generally built in the late territorial period after the arrival of the railroad in 1879 and inspired by the arched culverts and bridges appearing along many early railroad lines, masonry and concrete arches represent an attractive, strong, durable and low maintenance bridge design. In New Mexico masonry arch openings measured from 18 to 48 feet in length, while concrete arch bridges, with their greater span lengths, measured from 52 to 154 feet. All of the five structures within this category were undertaken as municipal projects, beginning with the Hot Springs Boulevard Culvert in Las Vegas (1888) and ending with the Don Gaspar Avenue Bridge in Santa Fe (1934), a New Deal Project.

Labor intensive and requiring skilled masons, each of the bridges reflects the basic characteristics of stone and concrete arch construction. Closed spandrel walls, often with extended wing walls, serve as the retaining walls for fill material on either side, and the arch barrel and roadway surround the fill on the bottom and top. Parapets or balustrades serve as an extension of the spandrel wall. The state's three stone arch bridges consist of semi-circular arches while the reinforced concrete arch bridges, marked by a low rise to span ratio, employ spans with longer elliptical arches. Decorative elements in stone arch bridges include coursed ashlar masonry with rusticated dressing and slight mortar joints, dressed voussoirs, or wedge-shaped stones forming the arch ring, the keystone and the datestone. Decorative elements in arch bridges consisting of the more plastic concrete include classical elements found on the Gallinas River Bridge, mirroring similar details on nearby commercial buildings' facades, and a modest horizontal molding on the Don Gaspar Bridge.

2. Concrete Truss Bridges

Description:

An unusual bridge type that suffered from the material disadvantage of substituting concrete, with its poor tensile strength and excess weight, for normal steel members, the concrete truss bridge type appeared in four New Mexico bridge projects. The design was unique in that concrete was poured over steel reinforcement rods in a molding form and then lifted into place. Bridge spans varied from 40 to 55 feet in length, and the number of spans ranged from two to four. Each span consisted of two discreet concrete truss sections connected by concrete floor beams and a deck. After the concrete elements had gained sufficient strength they were lifted into place and assembled (Morrison 6/14:1232).

3. Concrete Rainbow Arch Bridges

Description:

Based on a design patented by James Mason in 1912, the concrete rainbow arch entails concrete arches located on each side of the roadway to support the bridge deck by means of vertical concrete members. Since concrete is not a good material for carrying tension, steel reinforcements were added to the vertical members to strengthen their support of the deck. Typically spans extended from 50 to 150 feet.

4. Pratt Through Truss, Pinned Connection Bridges

Description:

The Pratt through truss design, patented by Thomas and Caleb Pratt in 1844, is characterized by its diagonal members acting in tension and its vertical members acting in compression. Prior to the use of pneumatic riveting machines, which appeared in New Mexico increasingly after 1910 and permitted riveting at the construction site, pinned connections were used. This design involved connecting the structural members by inserting round pins through eyelets at each member's end, permitting rotation of the members around the joint, movement theorized to eliminate bending stress. Turnbuckles were often used in the diagonal rods to reduce the structure's tendency to vibrate and to add rigidity. Based on the span lengths of the remaining bridges using this design, spans ranged from 80 to 130 feet. These lightweight bridges, featured as standard designs in bridge company catalogues, were widespread in territorial New Mexico, were easy to erect and could easily be moved from site to site as conditions required.

5. Pratt Through Truss, Rigid Connection Bridges

Description:

As vehicle weights and loads increased and as pneumatic riveting machines permitted riveting at the construction site, the Pratt through truss with pinned connections design gave way to the Pratt through truss with rigid connections design. Instead of simply pinning the structural elements together, crews used rivets to join the elements, adding further rigidity by setting end posts in gussets. These techniques added greater stability and load-carrying capacity to the basic Pratt through truss design. Although span lengths varied, during the 1920s and early 1930s this design was adapted with a standard span length of 101 feet and used on projects throughout New Mexico. So uniform were these plans that bridge fabrication companies were able to send the various bridge components to the site where crews of bridge construction companies assembled them. Like the earlier Pratt through truss bridges with pinned connections, these bridges could easily be moved, and many were dismantled and moved to new locations as bridges on main highway systems were upgraded.

6. Warren Through Truss Bridges

Description:

Developed and patented in 1848 by British engineers James Warren and Willoughby Monzani, the Warren design is characterized by its triangular-shaped panels composed of diagonals acting alternately in tension or compression. Vertical members from the top point of the triangular panels to the bottom chord were often added to provide stiffening. Normally, rigid metal beams were used for all members. Span lengths ranged from 112 to 254 feet.

7. Steel Deck Truss Bridges

Description:

Distinguished from a pony or through truss bridge design in that the top chords, not the bottom chords, carry the traffic load, deck truss bridges were used in New Mexico where deep canyons provided an adequate clearance to place the truss under the roadway. Steel deck truss designs used in New Mexico included the Warren steel deck truss and the continuous deck truss, the latter limited to the Rio Grande Gorge Bridge. The Warren steel deck truss design was similar to that of its through truss and pony truss counterparts with its characteristic triangular-shaped panels composed of diagonals acting alternately in tension or compression. Vertical members from the top point of the triangular panels to the bottom chord were often added to provide stiffening. Normally, rigid metal beams were used for all members.

8. Parker Through Truss Bridges

Description:

The Parker through truss bridge design was similar to the Pratt through truss design but one in which a polygonal top chord replaced the horizontal chord of the Pratt. This variation permitted better stress and bending distribution throughout the structure, as well as for the construction of longer spans. In New Mexico's bridges Parker truss spans ranged from 100 to 250 feet, while Pratt truss spans ranged from 100 to 150 feet. A further elaboration of the Parker truss design was the Camelback characterized by its polygonal top chord having exactly five slopes with a horizontal top chord at the center flanked by sloping intermediate and end post elements.

9. Parker Pony Truss Bridges

Description:

The Parker pony truss bridge design was similar to the Parker through truss design except that it lacked sufficient depth in its truss panels to permit upper lateral bracing. Inexpensive and easy to construct, the design was popular in New Mexico in the late 1920s and 1930s as the highway department pushed to complete many of its FAP projects. Typically, a Parker pony truss span measured 100 feet with multiple spans used to bridge wider crossings. Five such bridges remain in New Mexico

10. Timber Beam Bridges

Description:

Encompassing the earliest log and plank bridge construction in New Mexico, the timber beam design was refined and standardized in the 1920s when the State Highway Department began to use creosote-treated wood that increased the life of timber bridges. At that point, bridge engineers developed a standard design consisting of 25-foot spans resting on wood piles, or bents, that pile drivers were able to implant 40 to 60 feet into arroyos and riverbeds. Treated floor beams rested on the bents, and stringers extended from beam to beam, forming the 25-foot spans. As engineers refined the design, seeking to eliminate the spring, or bounce, that had characterized movement across earlier flat plank decks, they shifted to placing deck boards perpendicular to the stringers below, creating a denser deck offering a more rigid ride. Vertical posts lined with chain link fencing and timber curbs, or felloes, marked the design's guardrails.

11. Suspension Bridges

Description:

Generally associated with monumental engineering projects such as the Brooklyn or Golden Gate Bridges, the suspension bridge design was used for some New Mexico bridges on a considerably smaller scale. Characterized by a pair of concrete or metal towers set well back from river banks, a pair of cables suspended from each of the towers and secured in concrete anchors paralleling the roadway approaches, and suspenders supporting the roadway deck, the territory's early suspension bridges lacked sufficient rigidity. The two suspension design projects undertaken by the State Highway Department in the 1920s attempted to correct that problem by adding timber stiffening trusses along each side of the roadway. The main spans of the two highway department projects at Abiquiu and Otowi measured 150 and 174 feet with eight and 10-foot wide decks respectively.

12. Timber Through Truss, Howe Design Bridge

Description:

The Howe truss design used for both through and pony truss bridges represents one of several efforts to strengthen truss bridges' length, capacity, and rigidity to meet railroad needs during the 1830s and 1840s. Patented in 1840 by Massachusetts millwright William Howe, the design used timbers for the upper and lower chords and the diagonal compression members but substituted metal for wood in the vertical tension members. This combination of materials improved the spanning and carrying capacities over earlier all-timber designs. Span lengths among remaining Howe truss design bridges in New Mexico ranges from 55 to 75 feet.

13. Railroad Underpasses

Description:

During the late 1920s and 1930s as the State Highway Department devoted more of its resources to highway safety and convenience through the elimination of railroad grade crossings, railroad overpasses and underpasses became a part of the state's urban and rural road system. In instances where an elevated railroad grade permitted, engineers excavated underpasses, sometimes even using the fill to raise the railroad grade to provide improved approach grades for vehicular traffic. Underpass bridges generally consisted of steel I-beam or girder plate spans with concrete piers and abutments. In urban areas, especially as a part of projects carried out with federal funds under New Deal programs, pedestrian walkways and, often, stairways leading to the railroad grade and a nearby depot were included as design elements. Decorative features such as molded columns and pilasters, railings, and lighting fixtures often characterized these public works projects.

14. Steel Arch Bridges

Description:
An attractive structural form adapted for bridge use, the steel arch bridge is usually used to span wide, deep gorges. The design consists of two hinged arches set on foundations and then built toward each other in a cantilever fashion until they are joined at the center. Additional deck truss spans flank the central steel arch portion of the bridge. The arch design reduces the bending movement of the structure, but relies on the ability of the foundations to carry large horizontal thrusts. The two bridges employing this design in New Mexico, the Canadian River Bridge at Logan and the Los Alamos Canyon Bridge, both were designed to cross deep gorges and had lengths of 740 and 820 feet respectively.

Significance:

The different types of bridges constructed for highway use in New Mexico are significant because of their association with the development of overland transportation in New Mexico dating from 1850 to the 1960s when the state completed its last major link in its portion of the federal highway system. They are also significant as responses to particular technical needs in specific situations in order to convey travellers and materials across the state's sparsely populated and challenging terrain. From the first masonry arch structures to the award-winning Rio Grande Gorge Bridge, they reflect changing technical responses to spanning waterways, arroyos and other grades. Because of their key role in the transportation history of New Mexico and their embodiment of the practical application of scientific and engineering principals to a range of bridge design types, these structures are eligible under Criterion A and Criterion C.

As discussed in the historic context, early transportation in New Mexico was limited by the obstacles imposed by the area's difficult terrain. Settlement and, to a large degree, transportation arteries were limited to the valleys lining the few waterways that coursed the dry land. Without bridges, river crossings were restricted to fords and occasional ferries. Even these methods of crossing waterways were limited by periodic flooding, which also had the potential of turning normally dry arroyos into "cloudburst" streams. During the territorial period, especially after the coming of the railroad in 1879 and the grade and bridge building technology its engineers brought, road and bridge construction gradually began to alter these traditional patterns of movement in New Mexico. At first, bridge construction was limited to populated areas and key highways where masonry and concrete arch, timber and beam, and early metal truss design bridges facilitated commercial and urban growth.

With statehood in 1912, the construction of roads and bridges was increasingly centralized under the authority of the State Highway Department. The success of the department in achieving this authority and using it to impose rational engineering principles as it shaped the state's new transportation network made it one of the most successful state agencies during those early decades of statehood. That success was perhaps best symbolized in the hundreds of bridges that it designed and brought onto the federal and state highway systems from 1912 through the 1930s. As the state sought to link distant county seats and open inaccessible areas of the state to settlement and economic development, bridges were the key link in joining these disparate regions together. Designed to meet specific site requirements as well as the load-bearing requirements of heavier, faster vehicles, the state's bridge system emerged as the critical element in creating a modern, efficient transportation system.

Motor travel, especially tourism and regional trucking became key components of the state's economy by the 1930s, and the bridges constructed along the federal and state highway systems facilitated this increased movement of people and goods moved across the state. Bridges permitted movement through areas previously untravelled by automobiles, opening the Mogollon region to travel, making remote National Park Service facilities more accessible, and contributing to a more efficient realignment of federal highways such as U.S. 66 and 85. At the same time, as concerns for improved highway safety grew, especially the need to eliminate dangerous railroad crossings, bridges constructed to separate grades contributed to a safer, more streamlined flow of traffic.

Lacking the buildings and structures associated with a long history of broad-based industrialism found in other regions, New Mexico looks to its bridges as some of its important industrial structures. From the materials and designs introduced by the railroad and adapted to the needs of highway bridges to the modern building materials and designs used for the state's notable recent bridges, the bridges of New Mexico often appear in stark contrast to the state's rugged, largely unaltered, natural landscape. As such, these structures offer striking evidence of the ways in which engineers employed a variety of bridge designs to meet the state's transportation needs.

Registration Requirements:

Road bridges are eligible for listing in the National Register under Criterion A in the area of transportation if they have served as important links in a local road network or in New Mexico's state highway system or its portion of the federal highway system. The historical materials, design and setting must retain a high degree of integrity. As has been discussed in Section E, however, the State Highway Department has had a long-standing practice of moving older bridges to other sites as it has upgraded bridges along heavily used highway systems, or moving them as the only alternative to preserving them in place. Bridges moved under those circumstances but retaining their integrity of historical materials and design have the potential to be eligible if their subsequent location reflects a setting consistent with their original use. A Pratt through truss bridge with pinned connections, for example, may be eligible if it has been removed from a site where its carrying capacity no longer meets the needs of that highway's traffic and relocated on a county road at a site consistent with its carrying capacity.

In order to be eligible under Criterion C in the area of engineering a bridge must demonstrate the characteristics of its subtype. Bridges are considered eligible for engineering significance even if alterations to their form and materials exist so long as their primary technical and visual characteristics are intact.

G. The State of New Mexico

H. Summary of Identification and Evaluation Methods

The multiple property listing for the historic highway bridges of New Mexico is based upon a 1987 inventory and report on the state's historic bridges prepared by Steven R. Rae, Joseph E. King and Donald R. Abbe under the auspices of the New Mexico State Highway and Transportation Department (NMSHTD). This project was carried out in cooperation with the Federal Highway Administration and the New Mexico State Historic Preservation Division (HPD). The purpose of the inventory, as stated in the final report of the project, New Mexico Historic Bridge Survey (1987), was "to identify bridges of particular engineering and historical significance and to gather information to serve as a basis for determining eligibility for the National Register of Historic Places."

The inventory consisted of completing a survey form for each vehicular bridge in the state. This survey included some bridges that were intially used as railroad bridges but were later used by vehicles. Bridges were largely identified by NMSHTD's inspection records but included some bridges not listed in the system. Bridge owners included NMSHTD, counties, municipalities, and private organizations. Bridges were classified as to design types and rated based on thirteen factors that included date of completion, rarity of design, number of surviving bridges of the design type, and degree of integrity based upon the criteria set forth by the Secretary of the Interior. At the same time, the project team researched the history of individual bridges, using the records of the NMSHTD's Bridge Design Section as well as local resources such as historical societies and libraries' archival collections.

These efforts led to a narrative report that traced the history of bridge building in New Mexico, framing it within the larger context of transportation history within the territory and, then, state. That report has served as the basis for determining areas requiring additional research and the selection of the historic context. By tracing the development of bridge and road construction through various periods, the report also contributed to the chronological organization of the historic context section and identified periods in which local governments and then the highway department engaged in major bridge building projects. The research of individual bridges also helped to establish the dates used for the period of significance.

When the project team undertaking this multiple property submission began its work, it reviewed each of the bridge survey forms. Based on the survey and rating results, forty bridges, including two of exceptional historical and engineering merit that are not yet fifty years old, were designated as potentially eligible for register listing. The team then reviewed the list of potential properties with NMSHTD and HPD officials. Key considerations included having as wide a range of bridge subtypes as possible and selecting highly rated bridges within each subtype. The team also considered including bridges on each of the state's major drainages to assure a statewide geographical distribution of properties and including bridges that NMSHTD has designated for preservation purposes. Several of the bridges included in the submission continue to serve the state's highway system. The team then visited each bridge, determining what changes, if any, had occurred since the 1985 photographic survey. The photographs dating to the 1985 survey and included in the individual bridge nominations reflect the current appearance of each bridge.

The Criteria for Evaluation as discussed in National Register Bulletin 15 have been the basis for determining the areas of significance for each property. Criterion A stipulates that properties be "associated with events that have made a significant contribution to the broad patterns of our history," and provides the category of transportation which applies to bridges. Criterion C stipulates that properties "embody a distinctive characteristic of a type, period, or method of construction." The various subtypes of bridge designs qualify under this Criterion for what they reveal about early methods of bridge construction in New Mexico. Bulletin 15 also provides a test for historic integrity based on "location, design, setting, materials, workmanship, feeling and association." Although not all of these aspects apply equally to each property, as a group they provide the basis for evaluating the integrity of each property. Bulletin 15 also provides a discussion under Criterion Consideration G for properties that have achieved significance within the last fifty years, noting that when "sufficient historical perspective exists to determine that a property is exceptionally important" based on "the historic context and the specific property's role in that context" a property of state or local significance may be eligible for listing.

I. Major Bibliographical References

Bloom, Lansing. "Early Bridges in New Mexico," New Mexico Highway Journal, Vol. 3 (Jan. 1925), pp.5-19.

Bryan, Howard. "Where Was First U.S. Bridge?" Albuquerque Tribune. Jan. 25, 1968:B-1.

Colfax County Records, County Clerk Papers, 1903-1906.

Goetzmann, William H. Army Exploration in the American West 1803-1863. Lincoln: University of Nebraska Press, 1979.

Jackson, W. Turrentine. Wagon Roads West. New Haven: Yale University Press, 1965.

Johnson, E. Dana. "New Mexico's First State Automobile," New Mexico Historical Review, Vol. 11 (Jan. 1936), pp:1-3.

Lamar, Howard Roberts. The Far Southwest 1846-1912. New Haven: Yale University Press, 1966.

Morrison, George E. "A Reinforced-Concrete Truss Bridge, Las Vegas, N.M." Engineering News, Vol. 71, No. 23 (June, 1914), pp1232-1234.

New Mexico Highway Journal. Various issues, 1923-1934. In 1934 the NMHJ was no longer published independently but became a monthly inclusion in New Mexico Magazine.

New Mexico Magazine. Various issues, 1934-1964.

New Mexico Press. Feb. 7, 1865.

New Mexico State Engineer. Various biennial reports, 1914-1966.

New Mexico State Highway Commission. "Through New Mexico on the Camino Real" Santa Fe, 1915.

New Mexico Territorial Engineer. Second Biennial Report of the Territorial Engineer, 1909-1910.

Rae, Steven R., Joseph E. King and Donald R. Abbe. New Mexico Historic Bridge Survey. Santa Fe: New Mexico State Highway and Transportation Department, 1987.

"Timber Trusses Built with Salvage Rail in Lower Chords." Roads and Streets. April, 1945,76.

Santa Fe New Mexican. Various issues, 1871-1884.

Seely, Bruce. Building the American Highway System: Engineers as Policy Makers. Philadelphia: Temple University Press, 1987.

Simmons, Marc. "Bridge Building, The Spanish Way," Santa Fe Reporter. Oct. 2, 1991.

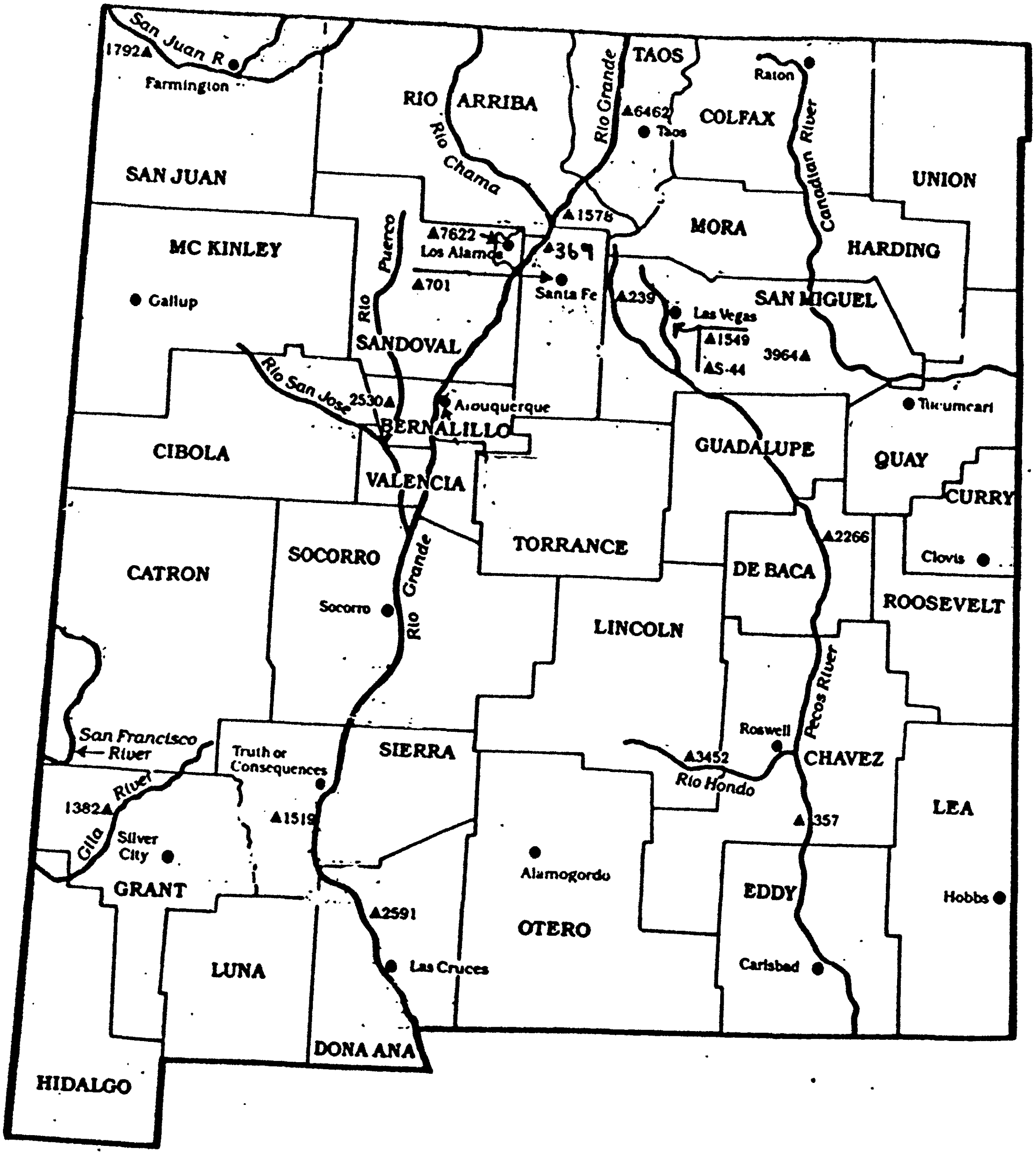
Spanish Archives of New Mexico. Roll 14, Frames 59, 632, 999. New Mexico State Records Center and Archives.

United States Department of Transportation, Federal Highway Administration. America's Highways 1776-1976. Washington D.C.:United States Government Printing Office, 1976.

"Yeomans Royal vs. John Dana and John Thayer." District Court, Dona Ana County, 1864. In the Royal Yeomans Collection, New Mexico State Records Center and Archives.

1914 State Highway Map

Fig. 1



List of Nominated Bridges and Referential Numbers

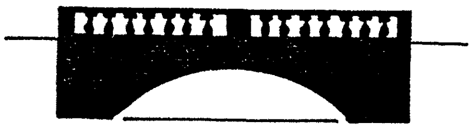
Hot Springs Boulevard Culvert (S-44)
Gallinas River Bridge (1549)
Rio Hondo Bridge-Picacho (3452)
Gila River Bridge-Cliff (1382)
Bridge of the Hidalgos (701)
Pecos River Bridge-Terrero (239)
Variadero Bridge (3964)
Otowi Suspension Bridge (369)
Rio Grande Bridge-San Juan Pueblo (1578)
Rio Felix Bridge-Hagerman (357)
Percha Creek Bridge-Hillsboro (1519)
Rio Grande Bridge-Radium Springs (2591)
Rio Puerco Bridge-Route 66 (2530)
San Juan River Bridge-Shiprock (1792)
Fort Sumner RR Underpass (2266)
Los Alamos Canyon Bridge (7622)
Rio Grande Gorge Bridge-Taos (6462)

Legend

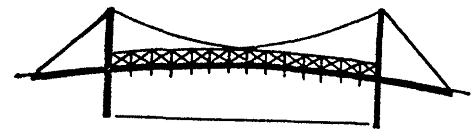
CHAVEZ	County
● Roswell	City
▲ 357	Bridge

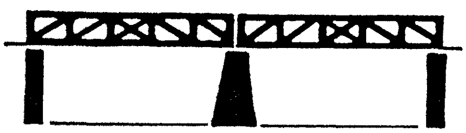
Fig. 2

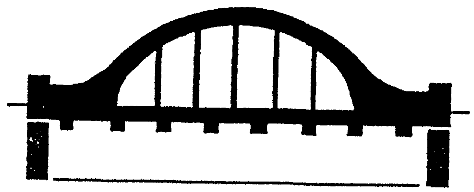
BRIDGE DESIGN TYPES INCLUDED IN THE MULTIPLE PROPERTY SUBMISSION "HISTORIC HIGHWAY BRIDGES OF NEW MEXICO"

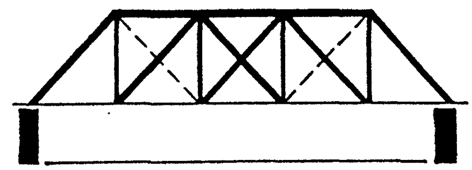

Masonry and Concrete Arches

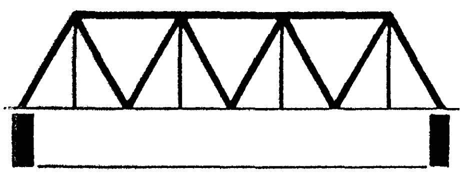

Timber Beam

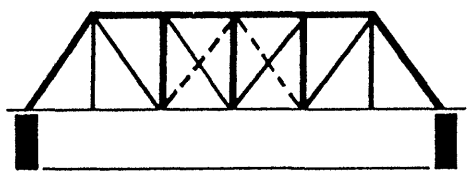

Suspension

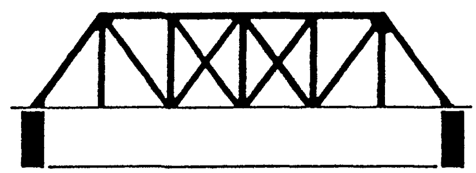

Concrete Truss

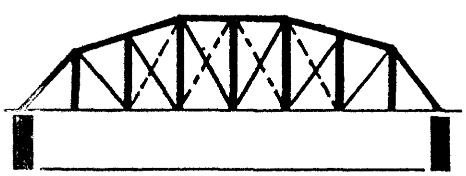

Concrete Rainbow Arch

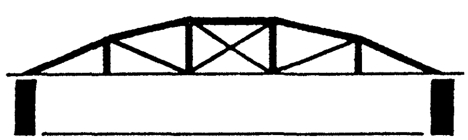

Timber Truss

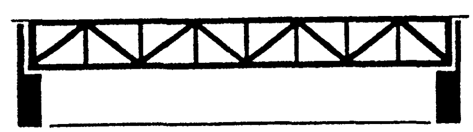

Warren Through Truss

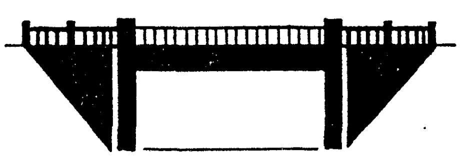

Pratt Through Truss, Pinned Connections


Pratt Through Truss, Rigid Connections


Parker Through Truss


Parker Pony Truss


Steel Deck Truss


Railroad Underpass

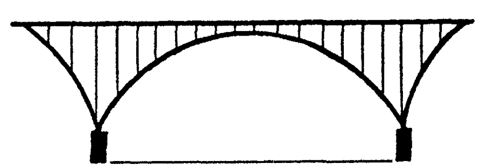
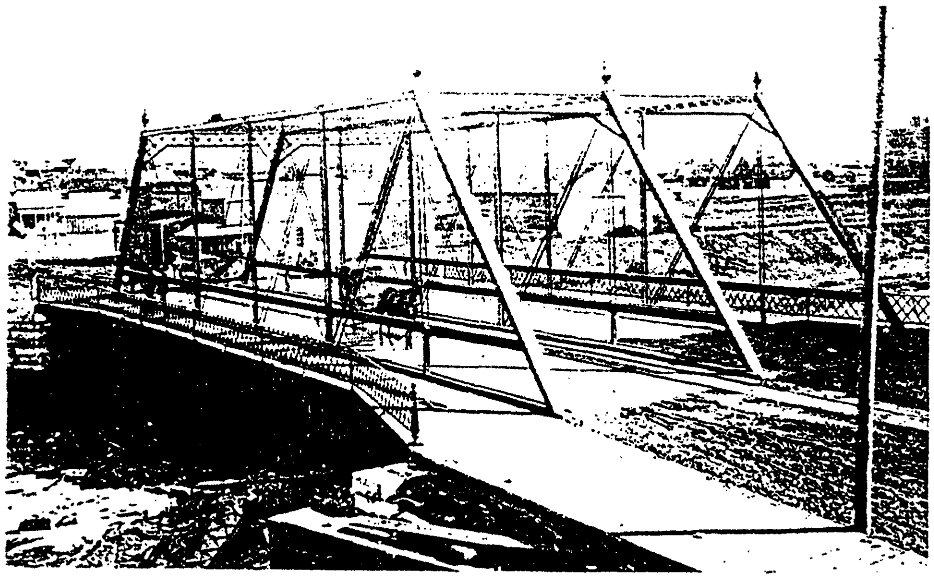

Steel Arch

Fig. 3

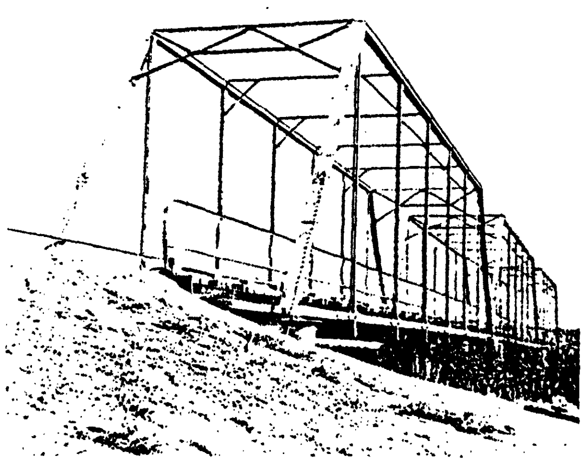


Steel Truss Bridge at Las Vegas. This steel truss bridge was built over the Gallinas River about 1886 and was replaced in 1909 by the existing concrete arch bridge (No. 1549). (Photograph Courtesy of the Museum of New Mexico. Negative No. 56291)

Fig. 4

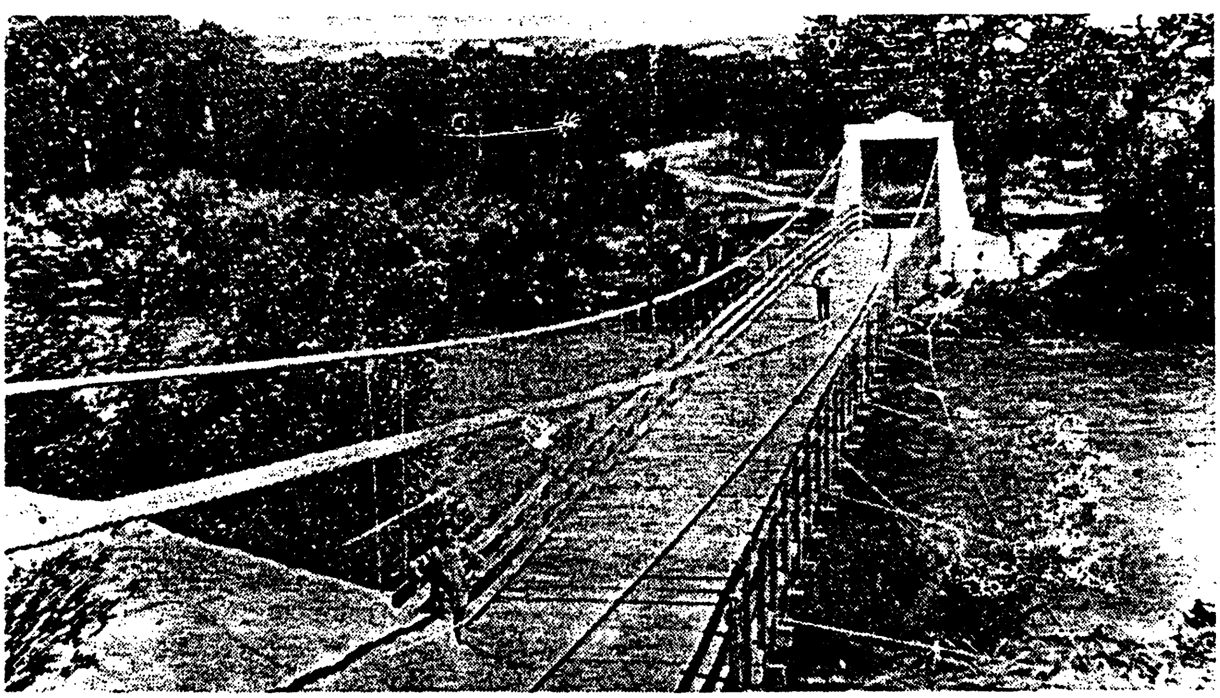
Timber Truss Across the Rio Grande at Espanola About 1912. (Photograph Courtesy of the Museum of New Mexico. Negative No. 61684)

Fig. 5



Pecos River Bridge at Roswell. Originally constructed in 1902, a single span was moved to its present site over the Rio Hondo (No. 3452) after 1938. (Highway Department Files, Inactive)

Fig. 6



Aztec Suspension Bridge Shortly After Completion in 1908. This bridge was the only structure across the Animas and San Juan Rivers to survive the disastrous flood of 1911. (Photograph Courtesy of the Aztec Museum)

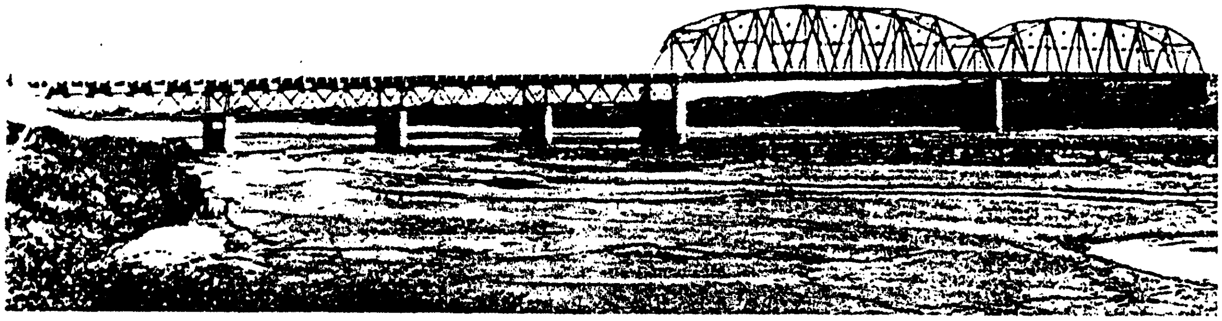
Fig. 7

Canadian River Bridge near Springer. Completed prior to 1916, this bridge was typical of the concrete arch construction used at several locations in the state. (Highway Department Bridge Files, Inactive)

Fig. 8

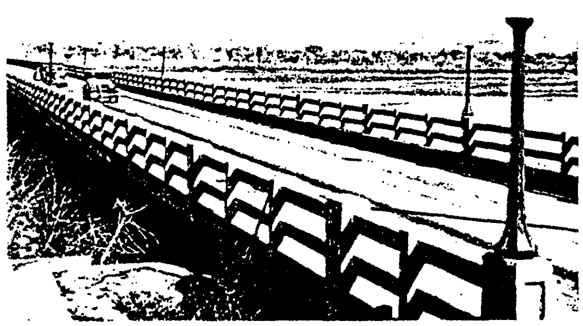
Canadian River Bridge at Logan. This steel arch bridge was completed in 1922 as an early Federal-Aid Project. (Highway Department Bridge Files, Inactive)

Fig. 9



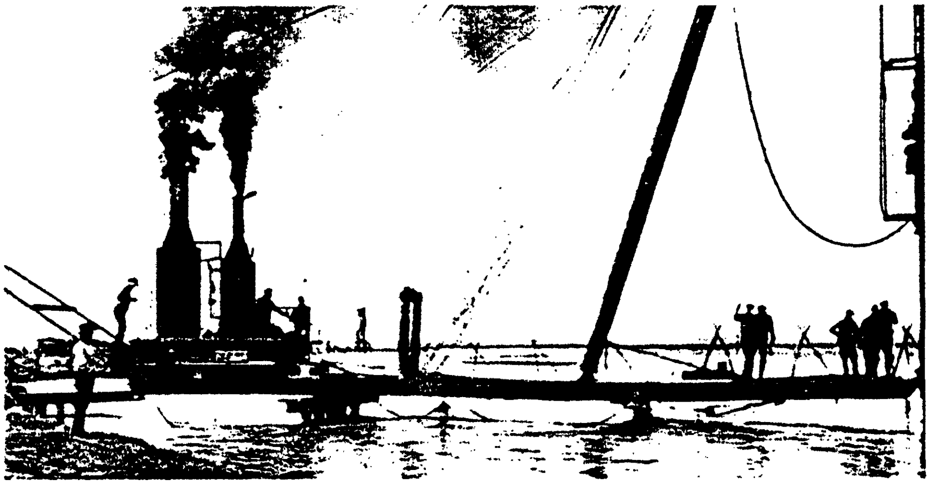
Pecos River Bridge at Fort Sumner. Completed in 1927, the Pecos River Bridge included two through truss spans of 252 feet each and four deck truss spans of 75 feet each. *(N.M. Highway Journal*, September 1927, p. 8)

Fig. 10



Barelas Bridge Across the Río Grande at Albuquerque. Completed in 1928, the Barelas Bridge included timber pilings, steel floor beams and a concrete deck. (Highway Department Bridge Files, Inactive)

Fig. 11

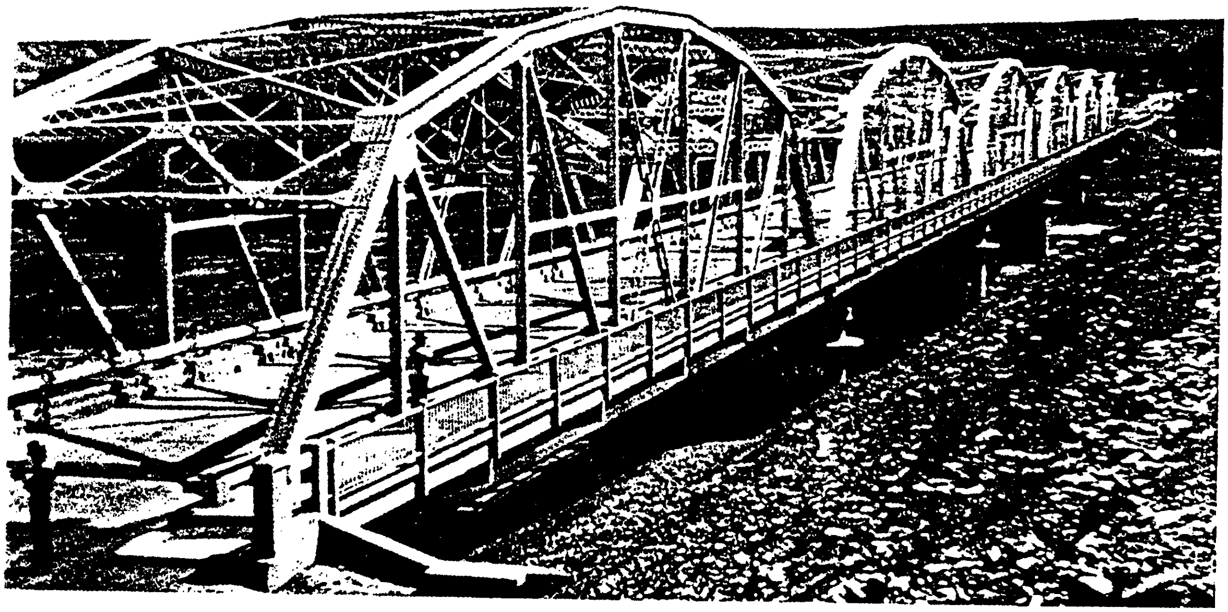


Driving Pilings During Construction of a Treated Timber Bridge Over the Rio Grande at Bernardo in 1931. *(N.M. Highway Journal*, September 1931, p. 29)

Fig. 12

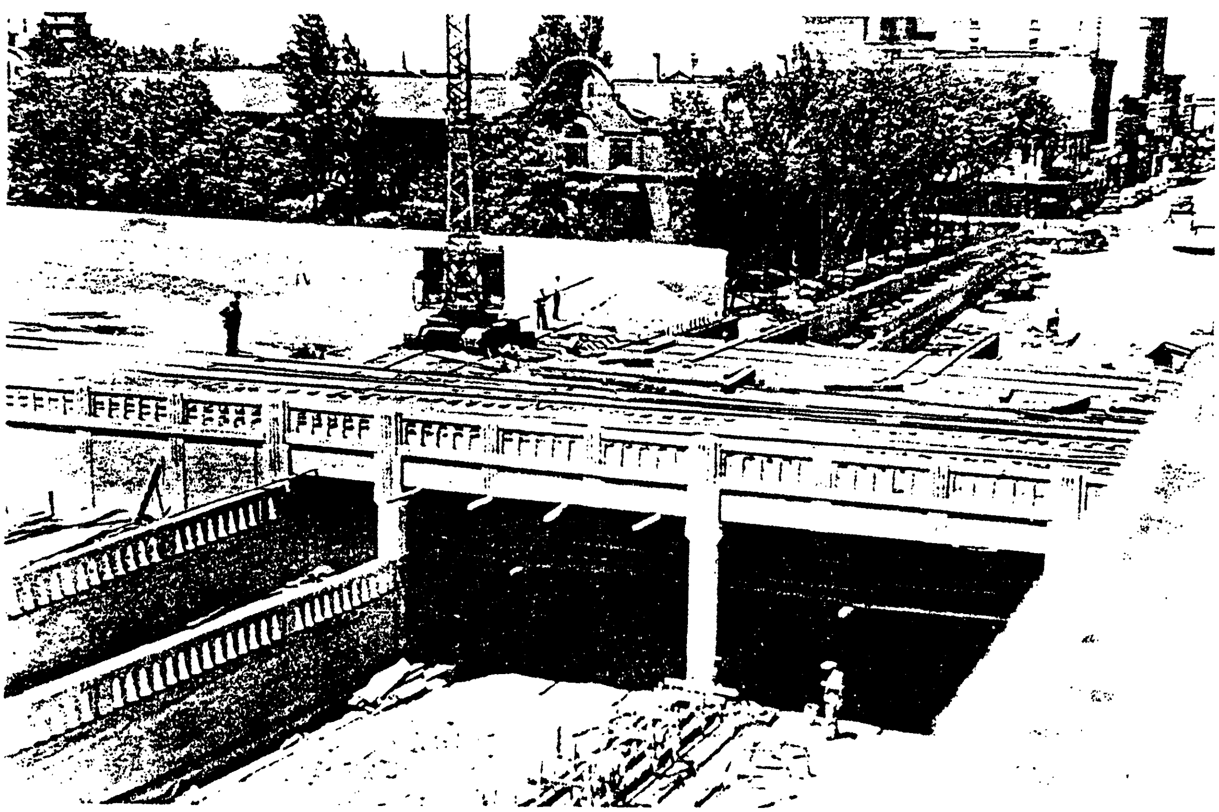
Revuelto Creek Bridge East of Tucumcari. This bridge was completed on US 66 in 1931 using treated timber construction. (Highway Department Bridge Files, Inactive)

Fig. 13



San Juan River Bridge at Shiprock (No. 1792). The San Juan River Bridge at Shiprock was completed in 1937 and represents the high point of steel through truss construction in New Mexico. (Highway Department Bridge Files)

Fig. 14



Central Avenue Underpass (No. 3116) During Construction in 1937. The Alvarado Hotel and Downtown Albuquerque are shown in the background. (Highway Department Bridge Files)

Fig. 15