

HAER
ARIZ
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DEAD INDIAN CANYON BRIDGE

HAER No. AZ-46

Spanning Dead Indian Canyon on Cameron Approach Road

Grand Canyon National Park vicinity

Coconino County

Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD

National Park Service

P.O. Box 37127

Washington, D.C. 20013-7127

HISTORIC AMERICAN ENGINEERING RECORD

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DEAD INDIAN CANYON BRIDGE

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Location: The 301.83'-long bridge is located on the Navajo Indian Reservation between Stations 902+92.06 and 905+93.89 of the abandoned 1930s alignment of the Cameron Approach Road to Grand Canyon National Park. This is 150 yards south of today's approach road, Arizona Highway 64; 15.1 miles west of Arizona Highway 89; and 14.0 miles east of the park boundary. Coconino County, Arizona.

Date of Construction: 1933-34

Type of Structure: Metal Warren deck truss highway bridge

Use: Not in use

Designer/Engineer: U.S. Department of Agriculture, Bureau of Public Roads (BPR).
U.S. Department of Interior (USDI),
National Park Service (NPS).

Builders: Vinson & Pringle, Phoenix, Arizona

Owner: Unknown

Significance: Dead Indian Canyon Bridge is significant for its association with the Cameron Approach Road, constructed in 1931-35 as the first modern automotive road linking the south rim of Grand Canyon National Park to the eastern Navajo Reservation and regional highways in northeastern Arizona. The bridge is also illustrative of roads and road structures built within special federal legislative authority to connect western national parks through a park-to-park highway system.

Project Information: Documentation of Dead Indian Canyon Bridge is part of the NPS Roads & Bridges Recording Project, conducted in summer 1994 under the co-sponsorship of GCNP and HABS/HAER. This report was researched and written by Michael F. Anderson, HAER historian, September 1994.

INTRODUCTION

Dead Indian Canyon Bridge is a 301.83'-long, metal, single-intersection Warren deck truss highway bridge constructed by Phoenix, Arizona contractors Vincent & Pringle in 1933-34.¹ The bridge was one of three built to span Lee, Dead Indian, and Tappan canyons along the 31-mile long approach road from Arizona Highway 89 near Cameron, Arizona, to Desert View within Grand Canyon National Park. Although in excellent condition, it was abandoned after several decades of use when a new alignment replaced most of the 1930s Cameron Approach Road. Today, the bridge connects a well-preserved, several mile long segment of the old alignment within the Navajo Indian Reservation.

HISTORICAL CONTEXT

When the National Park Service assumed control of Grand Canyon National Park in 1919, no road of any type proceeded directly east from the park toward the trading post and scattered Navajo residences at Cameron, Arizona. Early park tourists could reach Cameron by the old wagon road connecting Grand Canyon Village to Grandview, thence along the wagon road toward Flagstaff, where, short of the San Francisco Peaks, a county road branched off to the northeast and eventually arrived at the Navajo Reservation. This route, which followed for a short distance the ancient Moqui Trail used for centuries by Havasupais and Hopis, offered a time-consuming and exhausting trip, however, which few tourists chose to take.

As the Atchison, Topeka & Santa Fe Railroad and its concessioner partner, the Fred Harvey Company, succeeded in attracting growing numbers of tourists to Grand Canyon in the 1910s and early 1920s, they realized that their Canyon guests desired excursion trips to the eastern Navajo reservation at Cameron and Tuba City. The preferred trip--having guests awake at the El Tovar Hotel, eat breakfast, visit the reservation, then return for dinner on the same day--was unattainable with horse-drawn carriages along the serpentine course described above, but might be achieved by automotive buses which Harvey began to employ for other tours in the middle 1910s. What the concessioner lacked was a road which could carry the new buses and eliminate some of the miles between Grand Canyon Village and Cameron.

The Fred Harvey Company spent \$3,000 to build such a road in 1923-24 which went a long way toward achieving the objective, but fell far short of modern automotive standards. Called the Navahopi Road, it left the old Flagstaff-Grandview stage road near its terminus at Grandview and continued beyond Hull Tanks, the Berry Ranch, Trash Tank, and the Old Hibben Tank (close to

the alignment of today's Forest Road 307) as it descended the Coconino Plateau's eastern escarpment to the basin below. Here, Harvey buses could obtain gasoline at Sanford Rowe's service station before descending the remainder of the plateau along Lee Canyon and the infamous Waterloo Hill to the Painted Desert, Cameron, and Tuba City. A 1928 variation left the new East Rim Drive (see HAER No. AZ-44) about four miles west of Desert View along a short connecting spur, which cut out a long segment of poorer road in the Grandview vicinity. By the new alignment or the old, however, it was a miserable excuse for an automobile road. Impassable in wet weather and steep, rocky, and dusty under the best of conditions, many a Model A met their end along its 40-mile length.²

Fred Harvey maintained this road from 1924 through 1929, spending about \$30,000 for improvements and \$1500-2000 per year on blading and rudimentary repairs. When it became a popular route for tourists not associated with Harvey, however, such as those using it as an east entrance to the park and as a regional loop road, the concessioner threatened to end his maintenance activities. Harvey was justifiably upset, as the County Board of Supervisors and the Tusayan National Forest supervisor consistently refused to spend a dime on maintenance or repairs. GCNP Superintendent Minor Tillotson, in his arguments for a highway to replace the Navahopi Road, agreed with the concessioner, noting that in 1929 8 percent of south rim visitors came by way of Navahopi Road while only 3 percent of these rode Harvey buses.³

Tillotson's arguments for a new east approach road to Grand Canyon National Park were many and legitimate. The park had embarked on a massive road building program in 1927, and by 1930 had already completed an automotive South Entrance Road (see HAER No. AZ-45) and East Rim Drive. With federal funding assistance, the State of Arizona had recently (1929) completed Navajo Bridge across the Colorado River near Lees Ferry. Arizona's highway commission, with further assistance from the Bureau of Public Roads, was busily engaged in improvements to Highway 89 north from U.S. 66 at Flagstaff across the 1911 Cameron suspension bridge and Navajo Bridge toward the Canyon's north rim and southern Utah national parks. The old Navahopi Road represented an obvious weak link, not only to the NPS concept of a park-to-park highway system, but also to an intra-park automotive connection between Grand Canyon's south and north rims.

Minor Tillotson, GCNP engineer from 1923 to 1927 and superintendent from 1927 to 1939, was more than anyone else responsible for Grand Canyon's early transportation system, and was as concerned with regional roads as he was for park roads. He argued tirelessly for a new east approach road, exercised his considerable political savvy to gain cooperation from the many

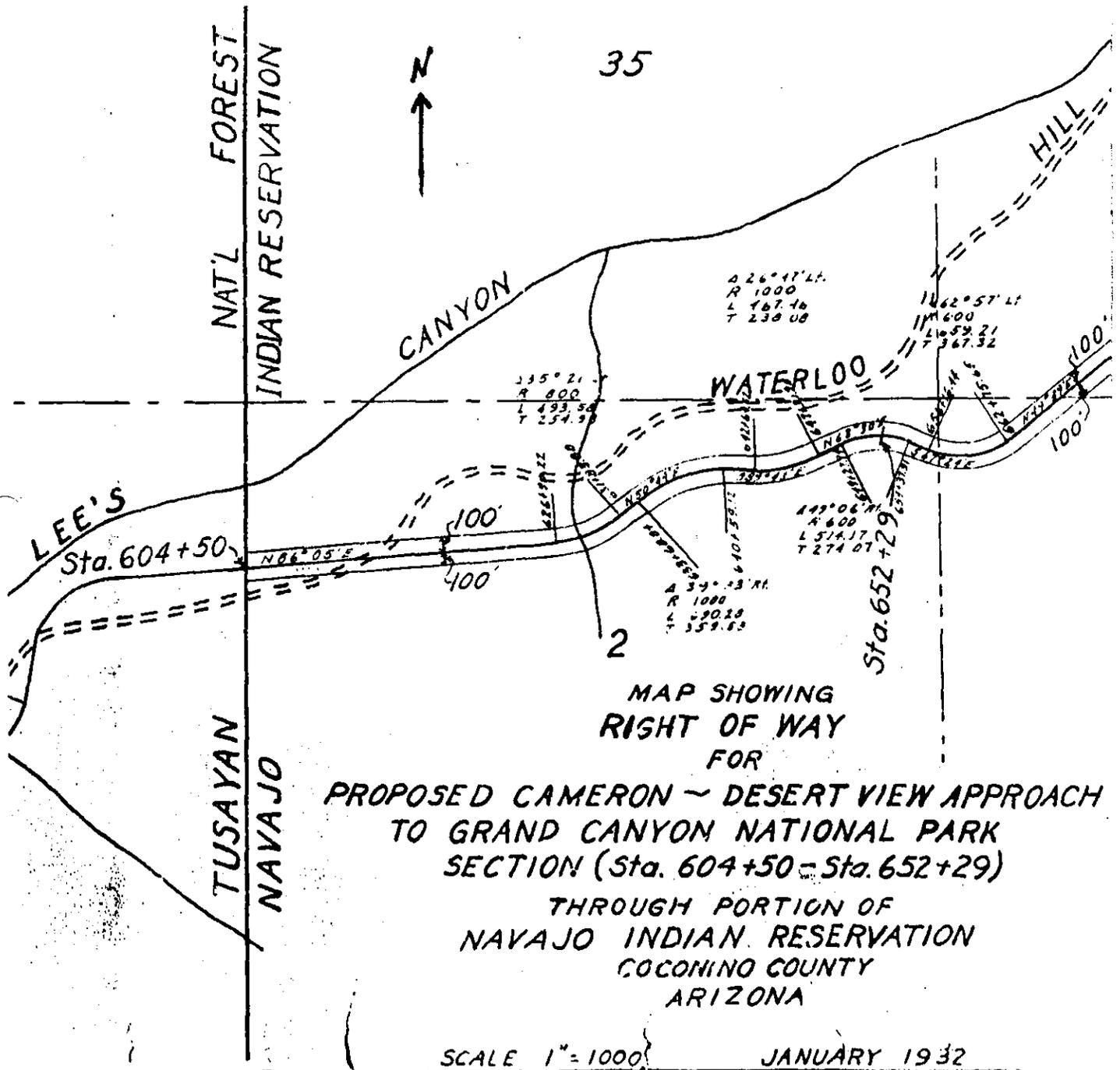


Figure 1. Sketch Map identifying the old Navahopi Road in relation to the new Cameron Approach Road. Dead Indian Canyon Bridge is another five miles east. (GCNPL)

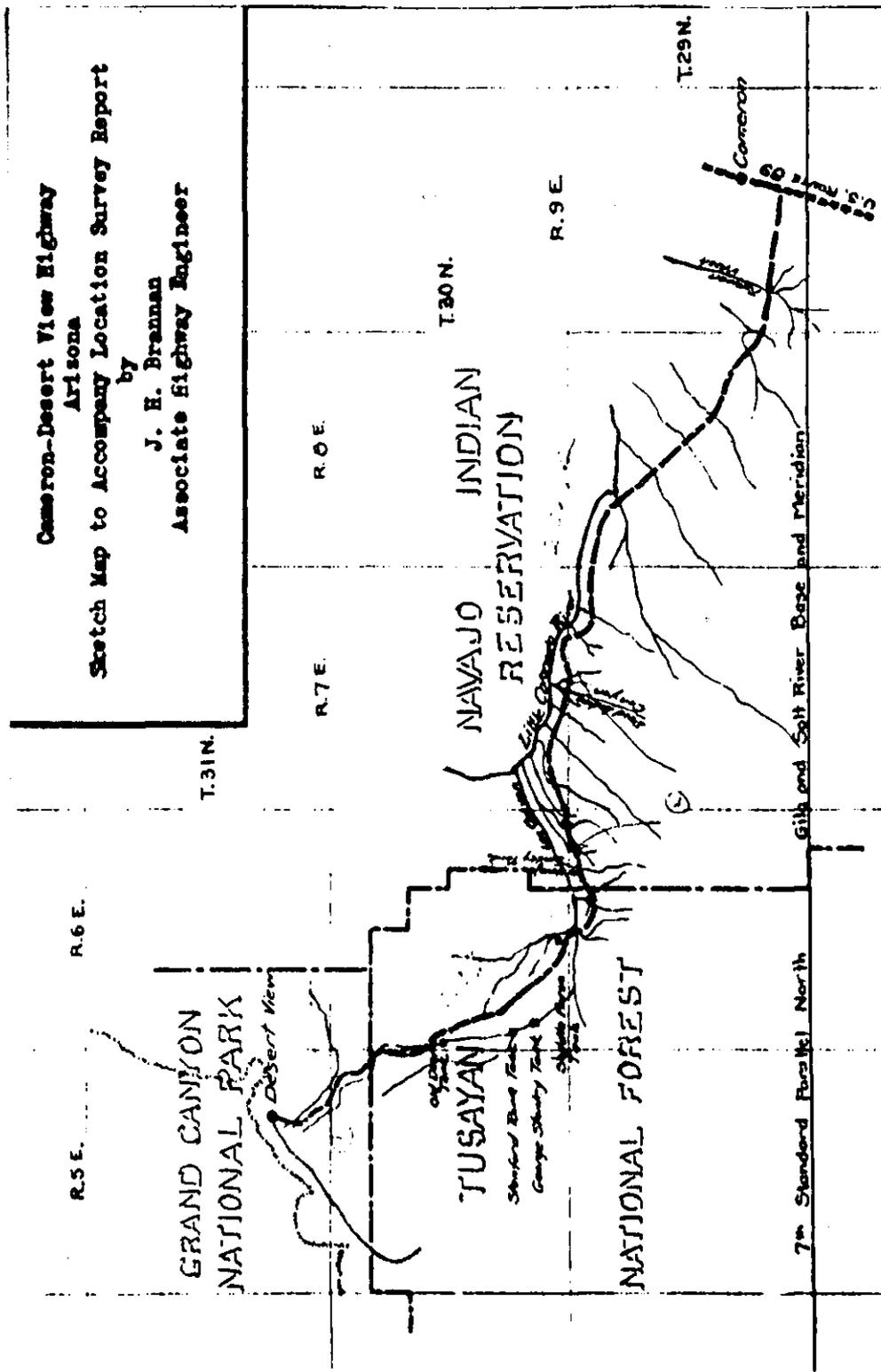
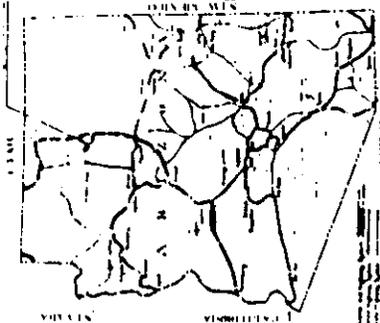


Figure 2. Sketch map showing the surveyed new roadway from Desert View to Cameron. Note the central location of Dead Indian Canyon. (GCNPL)

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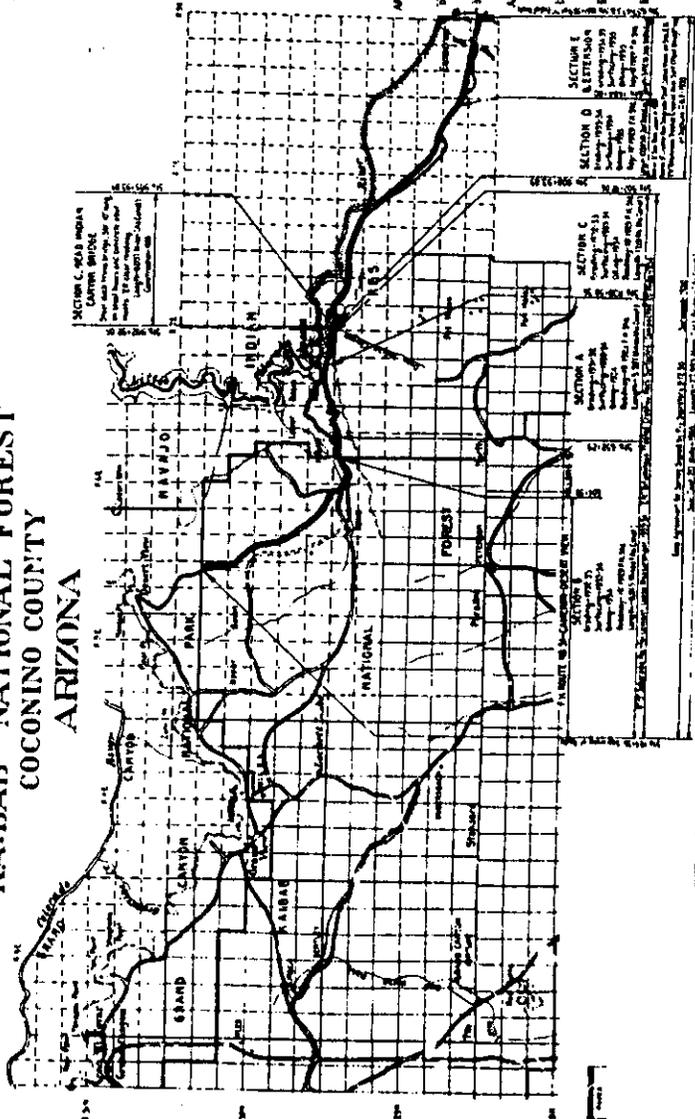
PLANS FOR PROPOSED
NR-SECTIONS A,B,C,D & E, SEAL COAT
CAMERON-DESERT VIEW APPROACH TO GRAND CANYON NATIONAL PARK
ROUTE NO. 31 - CAMERON-DESERT VIEW
8.3 MILES-CLASS

ARIZONA FOREST HIGHWAY SYSTEM
KAIBAB NATIONAL FOREST
COCONINO COUNTY
ARIZONA



INDEX TO SHEETS	

APPROVED FOR CONSTRUCTION -
Cameron-Desert View Approach to
Grand Canyon National Park.
NR-Sections A, B, C, D, E, Seal Coat
(See 104736-5e (857,67) and 5e
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INDEX MAP

APPROVED - U.S. BUREAU OF THE
FOREST SERVICE
DESIGNER: [Name]
DRAWN: [Name]
CHECKED: [Name]
APPROVED - NATIONAL ROAD 3
DESIGNER: [Name]
DRAWN: [Name]
CHECKED: [Name]

PREPARED BY
U.S. DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

Figure 3. Formal location map from Grand Canyon Village to Cameron, 1935. (GCNPL)

land management agencies affecting the project, and helped sway a federal government spiraling deeper into economic depression to fund the project through completion. A brief review of these challenges which Tillotson overcame in the years 1930-35 helps illustrate the contexts within which the road, and its associated Dead Indian Canyon Bridge, achieve historical significance.

Tillotson first overcame objections of the U.S. Forest Service and solicited support from the Arizona highway department and Bureau of Indian Affairs to effect a survey of the proposed approach road. He attended a forest highway conference in San Francisco in December 1929 where he managed to convince District Forester F.C.W. Pooler to ante up \$5000 for the survey, despite Pooler's objection that pending legislation to change park, forest, and reservation boundaries would leave little of the roadway within Tusayan National Forest. This minor coup gained tacit (though passive) approval for the road from the forest service. At the same meeting, Tillotson gained the cooperation of Arizona state highway engineer W.W. Lane, who also promised \$5000 for a survey. The superintendent rather easily convinced his own bureau to allocate a matching \$5000 which he had promised without approval.⁴ The combined \$15,000 funded a preliminary reconnaissance and location survey (1930).

Approval to construct a road across the Navajo Indian Reservation was not especially difficult, but required Tillotson's attention to details. He first uncovered the fact that county records listed certain reservation sections as property of the Atchison, Topeka & Santa Fe Railroad. With the help of other NPS officials, he proved that the railroad had in fact applied for these grant lands ("in lieu" sections outside the 40-mile, odd-section grant along the 35th parallel first assigned to the Atlantic & Pacific Railroad), but had been refused by the General Land Office in 1887 because they were unsurveyed. Tillotson then maintained continuous interface with the BPR and Bureau of Indian Affairs as the former completed final survey of each section of the approach road and the latter approved the right of way for each.

Approval of 19.85 miles of right of way across the reservation was typically, but not always, readily forthcoming. The NPS kept up a running dialog with Indian commissioners C.J. Rhoads then John Collier, and Navajo Reservation superintendent C.L. Walker, who all agreed the land to be traversed was essentially worthless to anyone and that the road would prove a boom to the native economy (Navajos do not appear to have been consulted). One humorous snag arose when Acting NPS Director Arno Cammerer wrote John Collier and refused to pay thirty dollars to two Indian allottees (De-na-chee and A-sos-pi) for 16 acres of right of way. Cammerer wanted Collier to waste his time investigating whether the lands could legally be taken without compensation. Collier,

who knew full well how much the NPS hated billboards, hot dog stands, and other human clutter along their approach roadways (and knew their frustration at not being able to do anything about it), responded in a round about way that the NPS should not worry about the money, that the Indian service would talk to the allottees and

invite their attention to the future benefits they might derive from the highway such as...bringing in tourists to purchase Indian blankets, pottery, jewelry, etc., from them, increasing the value of their land especially in the matter of possible revenue to them through the erection of refreshment stands and tourists' camps or else renting their land for such purposes.⁵

Without a doubt, NPS administrators from Horace Albright on down shuddered at this image, and although there is no evidence, it is a good bet that someone among them came up with the cash.⁶

With the cooperation of effected land management agencies and a survey assured, Tillotson went to work on the much more difficult task of rounding up money to fund roadway construction. As early as 1929, the NPS had applied for "7% money"--federal funds set aside for highway construction within the various states. The superintendent felt this would be approved (it was), but worried that under the conditions of a proposed National Approach Road Bill then wending its way through Congress, additional funds for roads under the 7 percent system would be restricted to thirty miles, and not more than 40 miles within any one county.⁷ The latter restriction would not present a problem, but the former might, since the initial survey outlined a roadway a little more than 30 miles long. Tillotson later overcame this obstacle by convincing all concerned that 3.5 miles of the proposed highway was within the national park, thus, this portion was technically an "entrance" road (Grand Canyon Route #10, see HAER No. AZ-44) not an "approach" road.

The National Park Approach Road Bill which Tillotson placed his hopes on became law 31 January 1931. It was actually an amendment which re-funded and redefined a similar act of 1924 allocating funds and authorizing the NPS to construct roads and associated structures outside the bounds of national parks. The 1924 act had resulted from heavy lobbying by Stephen Mather and Horace Albright (among other park advocates) who wanted to build a park-to-park highway system and recognized that states did not always have the money or a similar interest. This act, in combination with an agreement between the NPS and BPR to work cooperatively with national park road projects, had initiated the golden era of park road building and spawned crucial roads and bridges outside

park boundaries like the Rockville, Utah, steel Parker through truss highway bridge (HAER Nos. UT-39 and Ut-72) built by the NPS in 1924 along Zion National Park's west approach road. The 1931 act helped perpetuate the golden era by allocating \$1,500,000 per year for the same purposes for at least two years.⁸

As Tillotson documented the proposed road's qualifications for funds, including the fact that it ran 100 percent within federal lands (90 percent was required) and did not exceed the mileage limitations (initial survey outlined 3.47 miles within GCNP; 8.34 miles within Tusayan NF; and 19.85 miles within the reservation = 31.66 miles), he soon realized how much competition existed and how few road miles could be built for the allocated amount. Half a dozen potential projects arose immediately, including the Red Lodge-Cooke Road at Yellowstone (which would use up nearly all of the first year's funds), the General Grant-Sequoia Approach Road, and the Moran Junction-South Boundary Approach Road (also at Yellowstone). Meanwhile, Tillotson learned that money would not be forthcoming from the Arizona highway department (temporarily broke) nor from the forest service (permanently disinterested).⁹

Tillotson's rapid progress in documenting the approach road's qualifications, gaining necessary approvals from the Department of Agriculture and Bureau of Indian Affairs, and working with the BPR to complete surveys, plans, and specifications, resulted in Secretary of the Interior Ray Lyman Wilbur's designation of the highway as a national park approach road in October 1931. The Second Deficiency Act for fiscal year 1931 allocated funds for the first section (Grand Canyon Route #10). Over the succeeding four years, Tillotson would work with the BIA, BPR, USFS, as well as NPS directors Albright and Cammerer, highway engineers, and landscape engineers to find funds wherever available and nurse the Cameron Approach Road toward completion. Ultimately, nine separate projects and approximately \$1,060,000 would be required to complete the 31.6-mile road from Desert View to Arizona Highway 89 near Cameron by 1935. Construction of Dead Indian Canyon Bridge would be the third of these projects.¹⁰

HISTORY OF THE STRUCTURE

Location and Survey

Unlike most roads for which GCNP administrators were concerned, the Cameron Approach Road would not approach nor run within the park along reasonably flat terrain. From Cameron to Desert View, the proposed roadway would climb in elevation from about 4370' along the floor of the Painted Desert to 7438' among the pines, pinons, and junipers of the Coconino Plateau. This climb had to be accomplished in two major leaps: from the desert to Coconino

Basin along Waterloo Hill (or some close variation thereof) and from the basin up the Coconino escarpment to East Rim Drive, either at Desert View or some point along the drive which would not, in any event, be much lower in elevation. These two steep inclines presented the greatest difficulties to surveyors.

BPR Senior Highway Engineer C.G. Morrison completed a study of this general route in summer 1929. For the upper ascent, Morrison recommended a new road which closely followed the old Navahopi Road from the Coconino basin at Rowes Ranch to East Rim Drive nine miles west of Desert View. In August 1930, Tillotson, Assistant Park Superintendent P.P. Patraw, Park Engineer C.M. Carrel, State Locating Engineer Percy Jones, Highway Engineer J.H. Brannan, and Highway Engineer W.R. F. Wallace completed a preliminary reconnaissance and rejected Morrison's upper line, favoring instead an alignment which left the old Navahopi Road one mile east of Rowes Ranch to run west and north across Lee Canyon, thence northwest past Walton Tank to Desert View.¹¹ This upper alignment was eventually constructed along these lines.

The 1930 party considered several alternatives for the lower ascent from the Painted Desert. One which crossed Lee Canyon farther to the north was rejected because it would have to swing too far south thereafter to head the many drainages falling from the Coconino Plateau. Another might follow the existing Navahopi Road which descended rather precipitously along Waterloo Hill through steep, broken country. The party rejected this line as well, since grades would prove too steep for an automobile road. All came to agree that the road would cross Lee Canyon near its southern box (north of today's alignment) then swing south to the toe of the Coconino escarpment, where it would then follow along the toe heading the majority of drainages which dropped steeply to the Little Colorado River gorge. The new alignment would run from 200 to 300 yards south of the Navahopi Road and require deep cuts and fills, but descend to the desert in less than 8 percent grades. The reconnaissance envisioned a bridge at Tappan Wash and Lee Canyon, but not at Dead Indian Canyon.¹²

BPR Associate Highway Engineer J.H. Brannan and ten men completed the approach road's location survey between August and December 1930. In staking a line up Waterloo Hill, Brannan came face to face with Dead Indian Canyon and wrote that "a 300 foot steel bridge is contemplated over this canyon." Brannan reported that many major structures would be required along the line, including bridges at Tappan Wash (40') and Lee Canyon (50'), but the bridge at Dead Indian Canyon would be by far the largest.¹³ Landscape Architect Thomas Carpenter walked the proposed line in 1931 and suggested numerous changes to line, grade, and structures which would limit as far as possible proposed cuts and fills and

otherwise make the road more scenic and limit scarring of the adjacent landscape. Of Dead Indian Canyon he noted that the

largest bridge on the project will be at Station 903 to Station 906, approximately 300 foot total span. The line is on a 1000 foot radius and the profile indicates approximately a level grade.... A steel bridge of deck truss or arch type would appear to be suitable for a bridge crossing this deep ravine.¹⁴

Nothing specific concerning design and specifications for Dead Indian Canyon Bridge was found in the course of this study, but the author is aware that drawings did exist and the NPS division of landscape engineering in San Francisco reviewed and approved the drawings. There is also evidence which suggests that this office may have actually created the architectural drawings, but that is far from certain. Though precise specifications are unknown, it is certain that bids were submitted for a 301.83'-long, 24'-wide, bridge with three deck truss spans on reinforced concrete abutments and steel piers.¹⁵

As road crews made their way down Waterloo Hill on the Section C grading project in August 1933, the BPR advertised for bids to construct the Dead Indian Canyon Bridge. Vinson & Pringle of Phoenix, Arizona, submitted the low bid of \$44,938.70 (105 percent of engineers' estimates) and USDI awarded the contract 27 September 1933, to be financed by National Industrial Recovery Act funds. Until the bridge could be completed, traffic would pass from the new road--already graded from Desert View to the bridge site--eastward by way of a temporary 1300'-long connecting road to the old Navahopi Road.¹⁶

Construction

Vinson & Pringle moved twelve men to the project site 1 October 1933 and began to set up operations as they awaited delivery of materials. They placed their main camp at Schweikert's Ranch seven miles west atop the Coconino Basin and a cement & tool shed along the road just west of the bridge site.¹⁷ As BPR engineers continued reference and staking work and workmen began excavation for Abutment #1 (west side), Harry Langley, NPS landscape architect, visited the site and discussed bridge and roadside features with the contractor. One certain topic of discussion concerned Chief Landscape Architect Thomas Vint's decision to change project specifications which at first called for simple concrete bridge structures. Vint would ultimately succeed in changing all culvert headwalls, water tunnels, and many bridge elements from concrete to masonry, matching structures which had already been constructed from Desert View to the bridge site.¹⁸

As October progressed, the contractor continued to move supplies on site while excavating for Abutments #1 and #2 and Towers #1 (west side) and #2. Excavation was at first by hand until a compressor could be secured, then proceeded rapidly. As an example of concern for the landscape, workmen transported nearly all shattered rock and dirt down to the stream bed using a chute rather than leaving it scattered along the canyon slope. Rock for reinforced concrete came in by rail from Phoenix to Grand Canyon, and was trucked to the work site along East Rim Drive and Sections A, B, and C of the new approach road. Sand for concrete came from a pit in Cameron and water from Tappan Spring, both hauled to the site over the old Navahopi Road.

By the end of October, two truckloads of form lumber, one carload of cement (640 sacks), and reinforcing steel arrived as did more workmen (totalling 23), each of whom put in a federally-regulated 30-hour week of three 8-hour shifts and one 6-hour shift. These men completed excavation of Abutment #1, 75 percent of Abutment #2, Tower #1, and 40 percent of Tower #2 during the first month of construction. They encountered no problems other than an unexpected layer of red shale which required deeper excavation, widening, concrete filling, and steel dowel reinforcement as well as redesign of Abutment #1. Stone masons also began to quarry rock by the end of the month, using boulders from the Dead Indian Canyon stream bed from the bridge site to a point several hundred yards downstream where the Navahopi Road crossed the canyon. On 30 October they began to construct the masonry fascia for Tower #1's footings.

Gazing at Dead Indian Canyon Bridge today, one cannot help but admire the pleasing appearance of structural steel edged on all sides (tower footings, abutments, wing walls) by fine ashlar masonry. The masonry is owed to Thomas Vint, as his earlier request (demand?) to replace or veneer concrete structures with masonry found its way into project Change Order #1. By this order, the contractor would adhere to exacting specifications for masonry construction, and would be carefully supervised by the on-site BPR engineer. In some instances, the engineer could require masons to build a sample section showing the size of stones, joints, and pointing, then approve or require change before building finished structures. In construction, stones had to be laid with the major axis horizontal so that no four corners would end up contiguous. Mortar joints had to be 0.75"-2.5" wide with 1.0"-1.5" preferred, and pointed to a depth of one inch or more while the mortar was still wet. Mortar stains had to be removed from stone while wet, and structures protected from sun light for three days, or the section would be rejected.

Masons could not use just any old rock convenient to the site. Acceptable stones were of limestone (the geologic layer of the

plateau above) or hard sandstone measuring 6" x 15" or larger, the object being a length to height ratio of 2.5:1 (1.5:1 through 3:1 was acceptable). Masons chose each stone for color variation and texture in weathered and unweathered surfaces. The NPS preferred a weathered surface, and stone could be "plugged and feathered" to achieve the effect, but they accepted unweathered stones as long as masons did not bunch them together in the structure's face. Specifications required variety--not more than 10 percent could be of equal size.

These are only a few of the minute requirements placed on the contractor's masons which resulted in the beautiful intact walls, abutments, and footings seen today. For their efforts, the NPS paid Vinson & Pringle not a cent more than the bid price for concrete material (\$22.00 per cubic yard); in fact, substitution which totalled 154 cubic yards of masonry structures lowered the contract price by \$701.00.

BPR computations for the value of the bridge's masonry work (\$3,388) also reveal something of the salaries paid to workmen during these early years of the great depression. Stone masons earned \$10.00 per day; stone cutters, \$8.00; truck drivers, \$5.00; and common laborers, \$4.00.¹⁹ Although Tillotson had assured Navajo Superintendent Walker that an attempt would be made to hire local residents, it appears that all workers were brought to the project from afar by Vincent & Pringle. They were in fact--by contract agreement with the federal government--hired through the County Reemployment Service office at Flagstaff. These men, who numbered from 12 to 25 as required, started out working 30-hour weeks, but in November by common agreement went to a 40-hour week in recognition of the distance to their homes.

In November 1933, contractor's workmen completed all excavation for abutments and towers. Masons finished veneers for concrete pedestal bases--four pedestals for each of the two towers--and for concrete abutments. Structural steel from the Kansas City Steel Company began to arrive by rail to Grand Canyon Village and by truck to the bridge site in mid-month. Structural steel subcontractors Murphy, Gordon, and Van Dyke, with five steel workers, began erecting a stiff-leg derrick on the west canyon slope between Abutment #1 and Tower #1. They planned to erect Span #1 (west side) and #2 using this derrick and a "gin-pole." By the end of the month they had built the derrick and with two gin-poles, a 35 HP steam hoisting engine, and miscellaneous tools and rigging placed both towers and Span #1 between 26 November and 2 December. A riveting gang followed closely behind to complete the structures.

Despite the onset of winter snow and sleet and only four hours of sunlight per day (in the plateau's shadow), the subcontractor

placed all steel structures by 20 December 1933. Steel erection began with Tower #1, then progressed in the order of Span #1, Tower #2, Span #2, and Span #3. Workmen assembled trusses for Span #2 on the ground where they pinned and bolted connections, adjusted the camber, and riveted the bottom chord before raising the whole into place. Downstream trusses were completed before upstream trusses. Steel workers required a 45'-high timber gin-pole between Tower #2 and Abutment #2, and had a rather hazardous time with snow, sleet, rain, freezing temperatures, high winds, and icy steel. Nonetheless, the two gangs employed completed operations (including painting rivet heads with red lead) on New Years Day. All subcontractor's workmen and equipment left the job site by 3 January 1934 and the BPR shut the entire project down for the winter a few days later.²⁰

The project resumed on 19 March 1934 while temperatures still ranged from 20 to 40 degrees and weather remained unsettled. After spending a week on reestablishing their camp and cleaning up from the winter's wear, Vinson & Pringle's workmen started to erect forms for the roadway deck and concrete abutments while masons resumed work on veneers. Workers poured the reinforced concrete deck beginning on the east side of the bridge in mid-April and completed all three spans in mid-May.

With completion of the roadway deck by 15 May 1934, only myriad details and cleanup remained of the project. Masons completed the wing walls, and extended the southeast wall to meet the nearby low cliff face (with drain hole) as an aesthetic touch. Workmen laid forms and poured the concrete curbs. The structural steel subcontractor returned to install the steel handrails, and put five painters to work covering the railings, trusses, and other steel surfaces with two coats of a Sherwin-Williams Light Slate #408. He had to keep replacing these men because most were unemployed house painters scared to death of hanging out in the breeze.²¹ Laborers raked remaining waste rock down the canyon's slopes to the stream bed, and backfilled along abutments and tower pedestals. Others applied an acid and copper stain to the deck's concrete surface (which is why it appears green to this day). Another task entailed trimming some of the tower strut ends to permit free expansion and contraction of the truss.

As workmen completed erection and painting of handrails in the first week of June, the BPR allowed traffic over the bridge even before final inspection. Vehicles passed through an 18'-wide temporary lane flanked by "slow" signs, oil torches, and red lanterns. Vinson & Pringle completed all project work on 9 June 1934. Harry Langley and Minor Tillotson accepted the bridge within a few weeks, and Tillotson considered it

an excellent piece of work on which commendation is due the contractors, the Bureau, the resident engineer A.W. Schimberg, and all others concerned.

Since the Morrison-Knudsen Company on nearly the same day completed their contract to grade Section D of the approach road from the bridge east for eleven miles, the first motorists over the bridge enjoyed an excellent road nearly the entire distance to Cameron.

All concerned judged the Dead Indian Canyon Bridge project a complete success. Despite severe weather, long material and equipment transport distances, and jittery painters, Vincent & Pringle and their subcontractors completed the bridge on schedule and within budget. Both engineers and landscape architects judged the elegantly-simple, streamlined structure to be a beautiful piece of work. Close inspection today reveals the quality of steel, concrete, and masonry construction. In contrast to the adjacent roadway with its eroding subgrade and weed-invaded asphaltic surface, Dead Indian Canyon Bridge with a little superficial maintenance would appear as if built yesterday.

Major Repairs and Alterations

Soon after Congress passed the 1931 National Park Approach Road Act, NPS Director Horace Albright assumed the posture that the National Park Service would not be responsible for maintenance of park approach roads. At Grand Canyon there had always been some tension, if not conflict, between the NPS, State of Arizona, and Coconino County on this subject ever since the new south approach road had been started in 1928.²² With the Cameron Approach Road, the difficulty in securing a maintenance agreement with the state was exacerbated by the fact that regional state highways had not yet caught up with modern standards and the state kept no road equipment within 75 miles of the new roadway.

This problem was surmounted by 1933 with an agreement that the BPR would maintain the various sections of the road for two years after their completion. Maintenance would then fall to the state. This agreement was later modified to postpone state maintenance until the entire roadway from Desert View to Highway 89 had been completed and surfaced. Pursuant to this compromise, the Arizona State Highway Commission and USDI penned an agreement in 1935 whereby the state assumed maintenance responsibilities for the entire road.²³

The State Highway Commission (called the Arizona Department of Transportation (ADOT) today) no doubt maintained the approach road from 1935 until it was later bypassed by today's alignment.

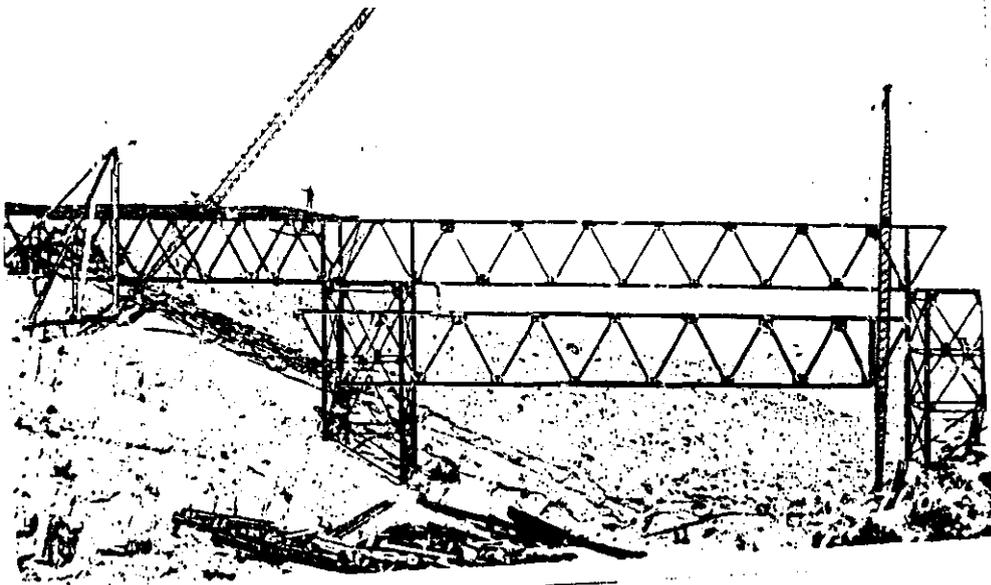


Figure 4. Raising the upstream truss for Span #2. (Narrative report, GCNPL)

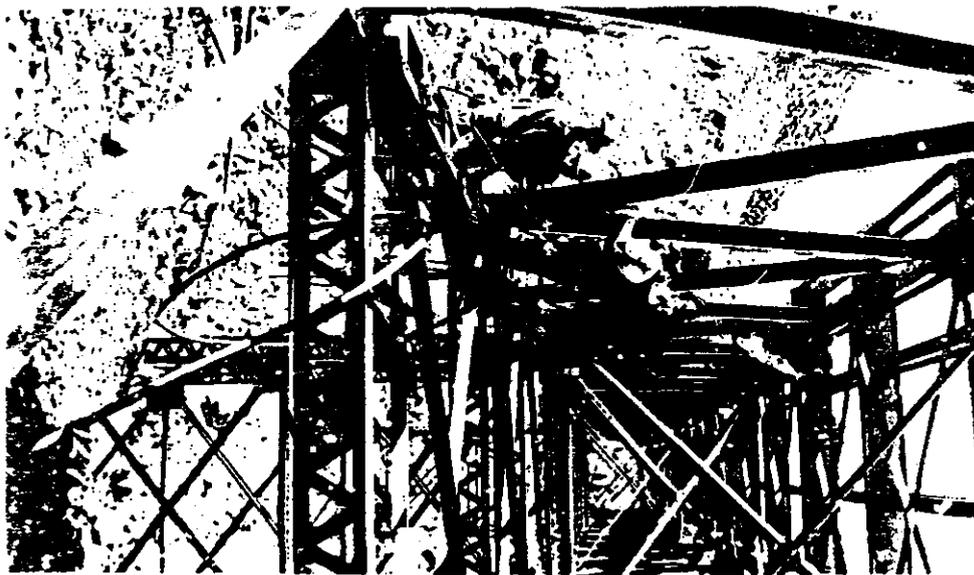


Figure 5. Riveting the lower cord, Span #1, facing Abutment #1. (Narrative report, GCNPL)

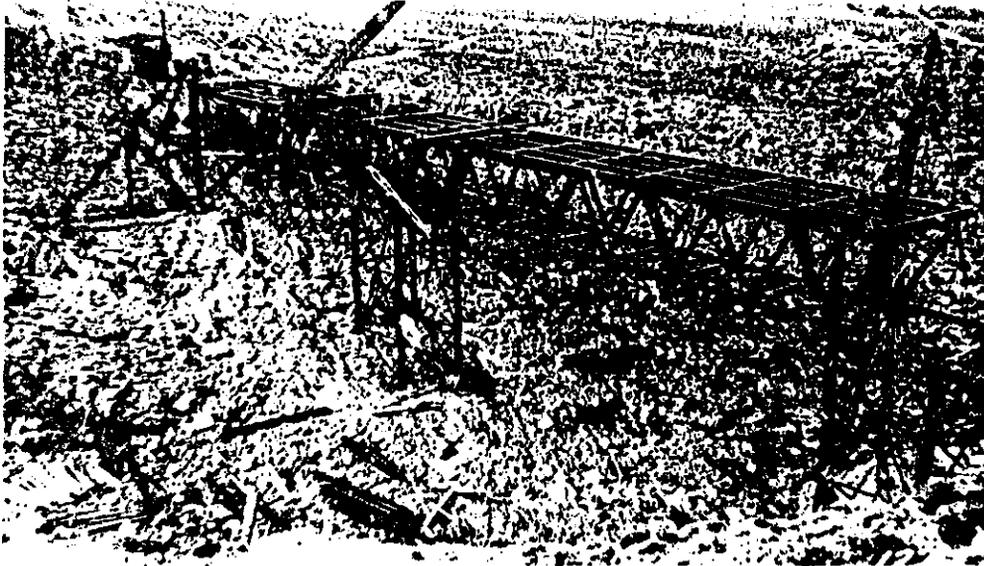


Figure 6. Erecting structural steel, December 1933. (Narrative report, GCNPL)



Figure 7. View of the Navahopi Road crossing with the bridge site in the background, upstream. (Narrative report, GCNPL)

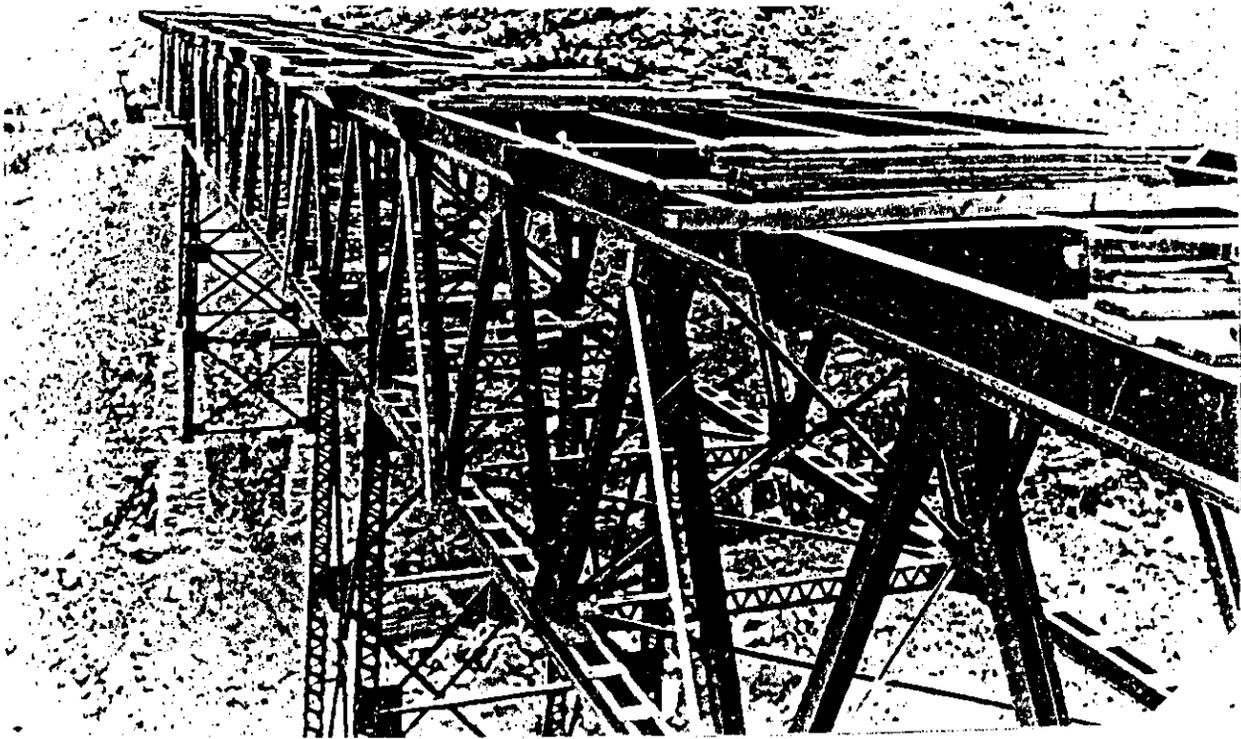


Figure 8. Above and below, the bridge with structural steel completed, January 1934. (Narrative report, GCNPL)



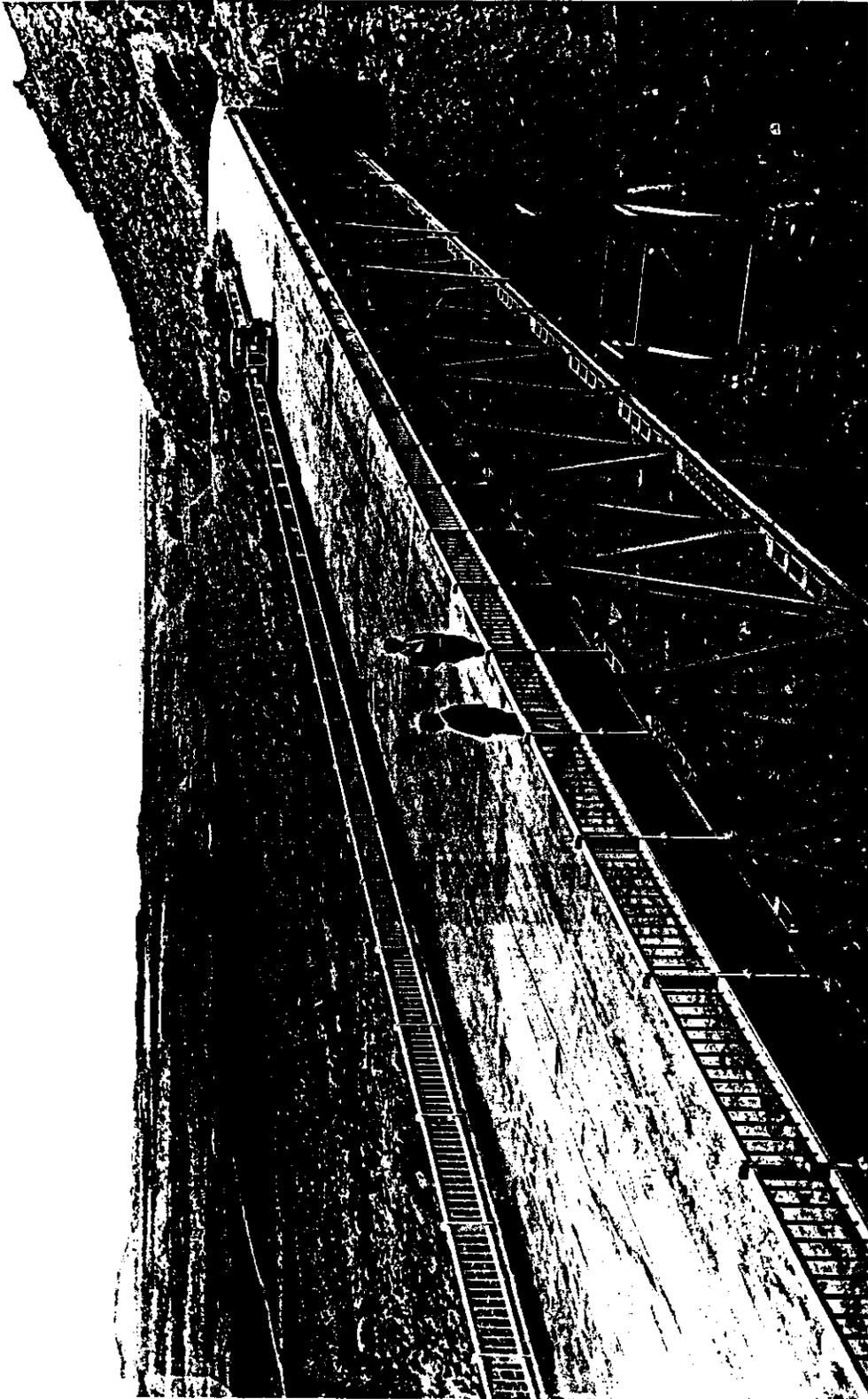


Figure 9. Dead Indian Canyon Bridge soon after completion, facing east toward the Painted Desert. Men on the bridge are BPR Engineer J.H. Brannan and NPS Landscape Architect Harry Langley. (GRCA Image #2920, GCSC)

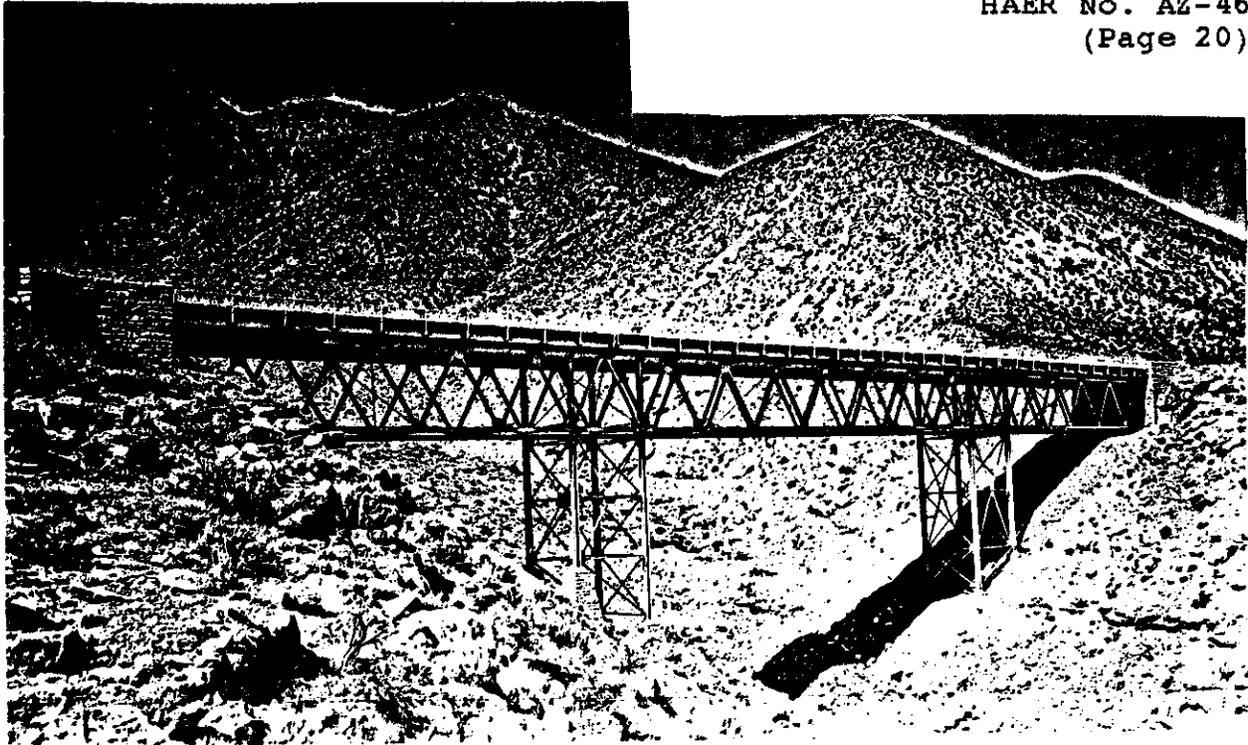


Figure 10. The bridge, facing southwest toward the top of the Coconino Plateau, 22 June 1935. (GRCA Image #2917C, GCSC)



Figure 11. Looking across the bridge deck from graded approach road, facing west, 22 June 1935. (GRCA Image #2919, GCSC)

The federal government certainly inspected the bridge itself periodically, as it does all national highway bridges. The author found no evidence, however, that the bridge required repairs after construction nor evidence that it was altered in any way. This supposition derives from the author's comparison of construction photographs and narratives with recent field observations, and the fact that the state abandoned the structure long before it reached the end of its useful life.

DESCRIPTION

The bridge today continues to span Dead Indian Canyon, about 150-200 yards upslope from today's Arizona Highway 64, some fifteen (odometer) miles west of Arizona Highway 89. It can be reached by parking along AZ 64 directly north of the structure, climbing the hill, and scaling a bit of barbed wire; or by turning onto modern spurs which connect the old roadway with the new, then driving along the old alignment until encountering earthen berms within 1/4 mile of the bridge. The remaining walk along the old alignment is easy and informative.

Because of adjacent road cuts, this latter access--obviously that taken by motorists when the road was in use--denies a view of the bridge itself other than its wing walls, wearing course, curbing, and handrails. Attention is, in fact, directed to the remarkable landscape of the painted desert below and the Coconino Plateau above. This is yet another example of the NPS and BPR spending time and money to create aesthetically-pleasing road structures which are never seen through normal use. There are dozens more examples of exquisite masonry water tunnels and culvert headwalls within three miles of the bridge, only a few of which can be admired from the roadway.²⁴

The bridge itself appears as constructed in 1934 with only minor deterioration evident. Approaching from the east, weeds and brush which invade the roadway's asphaltic surface are also beginning to obscure the flared masonry wing walls. The southeast wall measures 21'-long, 40"-high, 2'-thick, and sits on a 6"-high masonry pad which extends toward the roadway a little. The wall is as lovely as when built, with a few minor exceptions. Mortar is cracked as the wall approaches the deck and the massive top stone beside the bridge deck is missing, pushed over the side where it lies along the canyon slope. The first eight sections of handrail on the southeast side (about 66 linear feet) are also missing, although the metal vertical posts are still attached to the deck.

Moving west across the deck, the concrete roadway measures 24'-wide curb to curb, and exhibits an odd green coloration probably

resulting from its 1934 acid and copper treatment. This suggests that the rough-aggregate concrete deck surface is original, and it is in excellent condition. Concrete curbs are 10" x 10" and run the length of the bridge with handrailing immediately above. A U.S. Coast and Geodetic survey monument labeled "P62/1934" is mortared into the north side curbing about ten feet from the east end of the bridge. There are expansion plates separating the deck spans, and small weep holes at the toe of the curbing spaced about 35' apart. These holes are on both sides, directly across from each other, and lead into 3" to 4"-wide pipes which pierce the deck and run along diagonal members to the base of the truss. These original, unobtrusive drain pipes are painted the same slate gray as the structural steel--another example of NPS aesthetic concern.

The southwest end of the bridge is also missing a few handrail sections, and the southwest wing wall missing its massive top end stone. The wall, which is flared and extended to the nearby low cliff face, measures 24'-long, 30"-high, and 2'-thick. It has an 18" x 18" drain hole at roadway level which allows water running from west to east along the south side of the roadway to pass into the canyon. The extension to the cliff face is an aesthetic touch, added to the project through a change order; the drainage hole, a necessity created by the extension. This wall, too, is in excellent condition other than mortar cracking nearest the deck and the missing cap stone. The northwest wing wall measures 16'-long, 40"-high, and 2'-thick and is in fine shape. Each of these wing falls reflects Thomas Vint's careful specifications for multi-toned limestone walls, carefully mortared and pointed.

Underneath, abutments are of poured reinforced concrete (2" x 6" forms) with one weep hole at dead center four feet above ground level. Each has masonry fascia which extends the full length of north and south facing sides, but the concrete is undisguised facing through the truss. Masonry tower pedestals on the east side extend 10'-high above the slope, and are 8' x 8' at the base, tapering to 3'-8" square on top. Pedestals on the west are not as large, at least not above ground level.

The concrete deck rests on a series of steel I-beam longitudinal stringers (five abreast) with steel I-beam lateral floor beams spaced every 18 to 20 feet. The single-intersection true Warren deck truss (without verticals) is reinforced with crosshatch steel rods which form top lateral, bottom lateral, and sway braces for each panel for the entire length of the truss. Structural steel members are stamped "Illinois--S--USA," and are riveted other than the pinned connections where towers interact with the truss.

Motorists since 1934 have been less concerned with the nearby landscape than the bridge's builders. Today there is all manner of human debris along canyon slopes and in the streambed ranging from bits of wood, metal, and glass to bottles and cans to an old service station cash register. Portions of highway signs are also found, including one which may be a remnant of one of the two original 12" x 24" signs which read "Dead Indian Canyon."²⁵

CONCLUSIONS/SIGNIFICANCE

There is nothing unique about Dead Indian Canyon Bridge in an engineering sense, but it contains disparate elements which in combination might classify it as "unusual." First, it is a true Warren truss structure in that web triangles are equilateral, unlike many twentieth century bridges with unequal-sided triangular trusses which also carry the Warren name. Second, it is a single-intersection truss without verticals which is less common than double-intersection or vertically-braced triangular trusses. Speculatively, NPS engineers designed the single-intersection truss for Dead Indian Canyon so that the structure, when viewed in elevation (as most people view it today, but few viewed it in 1934), would present a less cluttered appearance. Configuration for aesthetic reasons may also explain ample reinforcement through relatively slender rods which form less noticeable top lateral, bottom lateral, and sway braces.

A third characteristic which contributes to the structure's individuality is the use of masonry wing walls and masonry facades on abutments and tower footings. As noted earlier, these features were virtual afterthoughts of NPS Chief Landscape Architect Thomas Vint, who had long experience working with design of masonry bridges including those at Zion National Park. The spare use of masonry with this bridge is unusually striking. On the one hand, it is a sleek, modern structure of few frills, an economical 300'-long, 24'-wide span costing only \$45,000. On the other hand, it appears almost a natural feature of the surrounding landscape as masonry wing walls and abutments tie it horizontally to adjacent slopes while masonry tower footings tie it vertically to the rocky canyon bottom.

Truss configuration and a pleasing combination of modern steel with rustic masonry make Dead Indian Canyon Bridge an interesting and somewhat unusual engineering structure, but its significance is perhaps best realized through its association with the 1931-35 Cameron Approach Road. In a local and regional sense, the road is perfectly illustrative of Grand Canyon's 1925-39 golden era of road building wherein the NPS and Superintendent Minor Tillotson transformed the park's transportation system from rutted wagon roads to modern automotive highways. Dead Indian Canyon Bridge

is that transformation in microcosm; a physical and conceptual transition from wheel tracks across a steep and treacherous wash along the old Navahopi Road, the poorest of the poor segments of "Waterloo Hill," to an unnoticed span of imperceptible grade barely 300 yards upstream. Between the two lies the 100'-deep roadway fill of today's Arizona Highway 64, a reminder that roads are built to suit current needs with available technology and our bridge was only one step along an evolutionary path.

In a larger regional and national sense, the Cameron Approach Road and Dead Indian Canyon Bridge help in their own small ways to illustrate the concept of a park-to-park highway system, first envisioned and enunciated by an avid motorist, Stephen Mather, and foremost in the minds of many early park advocates. Until the motoring public grew to such numbers that they threatened the health of our national parks, all western park superintendents and NPS central administrators strove to implement this idea. Their efforts--in combination with the engineering expertise of the Bureau of Public Roads, improved state road commissions, big road building dollars after World War I, public works projects of the great depression, lobbying efforts of the western railroads, and the incessant caterwauling of state Good Roads associations, local chambers of commerce, and individual motorists--produced the first automotive highway grid in the American Southwest. The National Park Approach Road acts of 1924 and 1931 were just two relatively insignificant results of the overall movement, but they do evidence the National Park Service's role. The 1931-35 Cameron Approach Road, of which Dead Indian Canyon Bridge is a vestige, illustrates that role.

ENDNOTES

1. J.A.L. Waddell, Bridge Engineering (1916), 470-72.
2. M.R. Tillotson to Frank Kittredge, NPS Chief Engineer, letter, 16 January 1930, Misc Construction D30--Desert View Cameron Approach Road May 1929-Dec 1931, GCNP Library (GCNPL); USDA, USFS, "Tusayan National Forest," map, 1919, GRCA 28716, Grand Canyon Study Collection (GCSC).
Several early maps including this one show a road as far as Rowe's Ranch in the 1910s, but there was no road maintained for autos until the Harvey Company built theirs in 1923-24.
3. Tillotson letter, 16 January 1930.
4. M.R. Tillotson to the Director, letter, 17 December 1929, Misc Construction D30--Desert View-Cameron Approach Road May 1929-Dec 1931, GCNPL.
5. John Collier to John E. Balmer, Supt. Western Navajo Reservation, letter, 19 September 1933, Misc Construction D30--Desert View-Cameron Approach Road Feb 1933-Oct 1933, GCNPL.
6. C.J. Rhoads to the Director, letter, 30 September 1931; P.P. Patraw to C.L. Walker, letter, 24 October 1931; C.L. Walker to Tillotson, letter, 13 January 1932; Tillotson to Walker, letter, 14 May 1932; C.J. Rhoads to the Secretary of Interior, letter, 28 December 1931; John Collier to Horace Albright, letter, 24 May 1933; all in Misc Construction D30--Desert View-Cameron Approach Road May 1929-Dec 1931 and Jan 1932-Jan 1933 and Feb 1933-Oct 1933, GCNPL.
Collier had written to Albright 24 May 1933, just a few months before the minor dispute, and said that his office was "heartily in accord" with the NPS on keeping hot dog stands, etc off the roadway. His about face clearly expressed indignation, and a touch of humor, concerning the idiocy of Cammerer's objection to paying thirty dollars for a right of way for a million-dollar highway.
7. Tillotson letter, 16 January 1930.
8. 43 Stat. 90; U.S.C., Title 16, p.390, Sec 8, approved 9 April 1924; H.R. 12404, House Bill approved 31 January 1931; [Horace Albright] to all superintendents, memorandum, [1931], Misc Construction D30...May 1929-Dec 1931, GCNPL.
9. M.R. Tillotson to the Director, letter, 31 January 1931; Horace Albright to M.R. Tillotson, letter, 11 February 1931; G.L. McLane, highway engineer, to M.R. Tillotson, letter, 21 February 1931; P.P. Patraw, assistant superintendent, to [Tillotson], memorandum, 26

February 1931; M.R. Tillotson to the Director, letter, 18 March 1931; A.E. Demaray, Acting Director, to H.K. Bishop, BPR, letter, [1931]; all in Misc Construction D30...May 1929-Dec 1931, GCNPL.

10. NPS Acting Director to the Secretary of Interior, memorandum, [October 1931], with attached concurrence of the Secretary; A.E. Demaray to the Superintendent, letter, 23 October 1931; USDI, "Scenic Highway to Connect North and South Rims of Grand Canyon," press release, 9 December 1931; all in Misc Construction D30...May 1929-Dec 1931; "Cameron--Desert View Approach Road, Approximate Total Cost of Construction," undated, Misc Construction D30--Desert View-Cameron Approach Road Mar 1935-Dec 1935, GCNPL.

11. W.R.F. Wallace, "Preliminary Reconnaissance, Desert View-Cameron Route," August 1930; Ansel F. Hall, Chief Naturalist, "Report on Preliminary Reconnaissance of the Proposed Desert View-Cameron Highway," 14 August 1930; both in Misc Construction D30--Desert View-Cameron Approach Road May 1929-Dec 1931, GCNPL.

12. Wallace Reconnaissance, August 1930.

13. J.H. Brannan, "Location Survey Report, Cameron-Desert View Survey, Grand Canyon Route 1, Section E," 6 April 1931, Misc Construction D30...May 1929-Dec 1931, GCNPL.

14. Thomas E. Carpenter, "Report on Inspection of Survey of the Desert View-Cameron Road, Approach Road to Grand Canyon National Park, August 16, 18, 21 and 22, 1931," report with photographs, 5 September 1931, Misc Construction D30...May 1929-Dec 1931, GCNPL.

15. The author noticed a detailed engineering drawing for the bridge in the drawers on the second floor of the Grand Canyon RR depot in September 1993 while working on another project. When he checked these drawers in summer 1994, the drawing was gone. The index does not indicate that this drawing is in the collection, but it is there somewhere unless removed within the last year.

See Thomas C. Vint, Chief Landscape Architect, to Tillotson, letter, 17 February 1933, Misc Construction D30--Desert View-Cameron Approach Road Feb 1933-Oct 1933, GCNPL, a cover letter for architectural drawings Vint sends to Tillotson. Vint's office either reviewed and approved these plans from the BPR, or created the drawings and sent copies to the BPR and Tillotson. Which is unclear.

See also "Grand Canyon National Park Construction Projects," project summary for August 1933, in the same file as above.

16. "Grand Canyon National Park Construction Projects," progress report of projects, undated; C.H. Sweetser, District Engineer, "Extra Work Order No. 1," 17 May 1933; both in Misc Construction D30--Desert View-Cameron Approach Road Feb 1933-Oct 1933, GCNPL.

17. J.C. Schweikert purchased Rowes Ranch from Sanford Rowe in about 1928-29 for \$5,000 with the intention of operating Rowes service station for the increasing number of passing tourists. When the new road was built within a few years, it bypassed the ranch by nearly 1/2 mile. He apparently did not hold a grudge and allowed the contractor to use his ranch for a construction site.

18. Thomas C. Vint to Dr. L.I. Hewes, letter, 4 October 1933; USDA, BPR, "Narrative Report," 9 October 1933; both in Misc Construction D30--Desert View Cameron Approach Road Feb 1933-Oct 1933, GCNPL.

On-site BPR engineers filed weekly reports for this and other park projects. Lacking a completion report on the bridge, the author has used these reports from October 1933 through June 1934 to describe construction. These are all found in files of the same name as above, with only the inclusive dates changing, all on microfiche in GCNPL. Hereafter only sources other than these reports are noted.

19. Change Order No. 1, "Masonry Specifications--Dead Indian Canyon Bridge," [October 1933], Misc Construction D30...Feb 1933-Oct 1933, GCNPL.

20. H. Langley to W.G. Carnes, Office of National Parks Acting Chief Architect, letter, 24 January 1934, Misc Construction D30...Nov 1933-May 1934, GCNPL.

21. Harry Langley to G.L. McLane, letter 12 October 1933, Misc Construction D30...Feb 1933-Oct 1933, GCNPL. Langley identified the paint type more than six months before it was delivered and expressed concern that the same shade had turned blue on the Rio Puerco Bridge. Narrative reports note the paint used as "gray", the same as seen today, and it is assumed this is the slate shade Langley identified.

22. Horace Albright to M.R. Tillotson, letter, [October] 1931, Misc Construction D30--Desert View-Cameron Approach Road May 1929-Dec 1931, GCNPL.

23. C.H. Sweetser, BPR District Engineer, to M.R. Tillotson, letter, 26 January 1935; T.S. O'Connell, State Highway Engineer, and the secretary of Interior, "Cooperative Agreement," 19 March 1935; both in Misc Construction D30--Desert View-Cameron Approach Road Mar 1935-Dec 1935, GCNPL.

24. The following description is obtained from the author's field studies and field photographs, 5-6 June 1994. HAER photographer Brian Grogan also developed several large format photographs for this project in July 1994.

Technical descriptions are assisted by the author's reading of Waddell, Bridge Engineering, and T.Allan Comp, Senior Historian,

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and Donald Jackson, Civil Engineer, Historic American Engineering Record, "Bridge Truss Types: A Guide to Dating and Identifying," technical leaflet, undated, Washington Office.

25. G.L. McLane to M.R. Tillotson, letter with attached sign types, 27 May 1935, Misc Construction D30--Desert View-Cameron Approach Road Mar 1935-Dec 1935, GCNPL.

SOURCES CONSULTED

Anderson, Michael F. Field observations, notes, and photographs,
5-6 June 1994.

Brannan, J.H. "Location Survey Report, Cameron-Desert View
Survey, Grand Canyon Route 1, Section E, 6 April 1931."
GCNPL.

Carpenter, Thomas E. "Report on Inspection of Survey of the
Desert View-Cameron Road, Approach Road to Grand Canyon
National Park, 5 September 1931." GCNPL.

Hall, Ansel. "Report on Preliminary Reconnaissance of the
Proposed Desert View-Cameron Highway, 14 August 1930."
GCNPL.

O'Connell, T.S. and Secretary of the Interior. "Cooperative
Agreement, 19 March 1935." GCNPL.

USDA, BPR. Weekly Narrative Reports for bridge construction,
October 1933 - June 1934. GCNPL.

USDA, USFS. "Tusayan National Forest, 1919." Map, GCSC.

Waddell, J.A.L. Bridge Engineering. 1916.

Wallace, W.R.F. "Preliminary Reconnaissance, Desert View-Cameron
Route, August 1930." GCNPL.

Many letters, memoranda, minor reports, and work orders
identified in the endnotes are found in the following files at
Grand Canyon National Park Library:

Misc Construction D30--Desert View-Cameron Approach Road May
1929-Dec 1931.

Misc Construction D30--Desert View-Cameron Approach Road Feb
1933-Oct 1933.

Misc Construction D30--Desert View-Cameron Approach Road Nov
1933-May 1934.

Misc Construction D30--Desert View-Cameron Approach Road Mar
1935-Dec 1935.