Thomas Vint & NPS Design Staff, 1934
Lying Lightly on the Land:
Tundra Curves, Trail Ridge Road, Rocky Mountain NP
Blue Ridge Parkway’s Belcher Curve
Award-winning Book

America’s National Park Roads and Parkways

Drawings from the Historic American Engineering Record

Edited by Timothy Davis, Todd A. Croteau, and Christopher H. Marston
Using HAER Documentation

- Preservation
- Restoration
- Interpretation
- Planning
- GIS Support
- Publications
Using Documentation: Restoration

Longmire Community Lodge,
Mount Rainier
Golden Gate Viaduct Interpretation Sign
Yellowstone NP
Using Documentation: General Management Plans

General Management Planning

Parks planning a decision making process, and general management planning the broad-based process of defining goals for national parks. General management plans are required for all units in the national park system and are intended to set the parks management direction for the next 10 to 20 years. The general management plans that the National Park Service is undertaking by a core of park staff and NPS planning professionals. Participation by the park staff, park partners and neighbors, and the general public will be crucial in making the plans a success.

The Blue Ridge Parkway’s general management plan process is in progress to take several years to complete. A summary of the proposed time frame is presented below. You will have opportunities to share ideas and comments throughout the process.

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What is the vision for the future of this park?

Developing vision for the park’s future involves meeting the WHAT question: the primary role of the general management plan is to decide on a set of strategies to achieve the goals of the park. This involves creating a vision for the future of the park and setting priorities for the next 20 years. The vision statement outlines the desired future state of the park and provides a framework for decision making. The vision statement is a guiding principle for the park’s future and helps to ensure that the park’s goals are aligned with the overall goals of the National Park Service.

How do we accomplish our vision for the future?

Although it may be necessary in some cases to develop specific activities in the general management plan, more open-ended questions are posed in the implementation plans. For example, the vision for the park’s future includes a focus on the park’s natural and cultural heritage, and the protection of the park’s resources. The vision for the park’s future is also guided by the environmental goals of the National Park Service. The vision statement outlines the desired future state of the park and provides a framework for decision making. The vision statement is a guiding principle for the park’s future and helps to ensure that the park’s goals are aligned with the overall goals of the National Park Service.

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Using Documentation: GIS Support

Henry Hudson Parkway, 2005
Using Documentation: Publications
National Building Museum Exhibit
America's National Park Roads and Parkways

Drawings from the Historic American Engineering Record

Edited by Timothy Davis, Todd A. Croteau, and Christopher H. Marston
Yellowstone: Cork Screw Bridge on Grand Loop Road 1904
Yosemite:
Old Big Oak Flat Road 1903
For more than two decades following the discovery of the Yosemite Valley in 1851, the only access to the Valley was by rough pack and mail trails. In 1864, the Yosemite Valley and the Mariposa Grove of giant sequoias were set aside by Congress as a perpetual reserve, but it would be another ten years before the first road reached the area.

Many to capitalize on tourism, citizens of Mariposa and Tuolumne counties sought to entice Yosemite bound visitors by constructing toll roads into the Valley. By the early 1870s, private toll roads were under construction from Coulterville, Big Oak Flat and Mariposa. A great road building race ensued. Each community hoped to finish its road first and thereby capture the tourist trade.

Dr. John W. Hay, who had founded the Coulterville Road before the others on 17 June 1874. His hopes for a transportation monopoly were dashed only two years later when the "Chinese Camp and Yosemite Turnip Truck," founded by John S. Ford, reached the Valley. From the south, a cart road was followed by Albert Henry Wadsworth, who pushed another toll road from Mariposa to the Big Oak Flat road, and in to the Valley in 1876. North of Yosemite Valley, the Great Sierra Highway was completed through the High country to reach Oak Fox in 1871. Though not built for the tourist trade, this road would serve into the present Tioga Road, which at a height of nearly ten thousand feet, is the highest mountain highway in California. By 1871, the early roads and a major engineering feat of this period of all these early roads were built across the rough, mountainous terrain was being turned to gravel roads. In 1875, the Valley Furnace, the Board of Commissioners of the Yosemite Grant, finally developed the system of carriage drives, connected by roads and small bridges.

Yosemite was designated a national park in 1890. The United States General Land Office, in 1891, made the park a part of the national park administrative and managed affairs until 1916. During this period, the Yosemite Valley, one of the most beautiful and awe-inspiring sections of the park, was opened to the public and the roads were improved. The first automobile on an unpaved road was in 1896, but 13 years later, Yellowstone National Park was opened to the public. Although they were being by the park's acting military administrator in 1902 the first automobile had barely arrived, and in 1913, Secretary of the Interior, Alfred M. James, proposed the first automobile road in the park. By 1920, the first automobile road was built in the park.
Glacier National Park

Going to the Sun Road

Glacier National Park

1933

The Glacier National Park Roads Recording Project was undertaken during the summer of 2000 and is part of the Historic American Engineering Record (HAER), a multisite program to document historically significant engineering and industrial works in the United States. HAER (Eac. Delaware, Chief) is administered by the Historic American Buildings Survey/Historic American Engineering Record (E. L. Masters, Chief), a division of the National Park Service, U.S. Department of the Interior. The project was funded by the U.S. Department of Transportation’s Federal Lands Highway Program (Art Hamilton, Administrator) through the NPS Park Roads and Parkways Program. Sue Delorme, Program Manager, and coordinated by Glacier National Park (Randy Jones, Superintendent) and the NPS Cooperative State University Program at Montana State University, Billings.

NPS Director Stephen Mather forwarded Wright's proposal and engaged U.S. Bureau of Public Roads' engineer Frank Kittredge to determine its feasibility. Kittredge analyzed Wright's alternative on both technical and aesthetic grounds. Impressed by Kittredge's detailed and capital report, Mather established an official partnership between the NPS and the Bureau of Public Roads (now the Federal Highway Administration) that still governs park road building today. NPS landscape architects guide the basic location and design of park road projects while federal highway engineers provide technical expertise and oversee construction contracts.

The construction of Going to the Sun Road was an epic process. Several technical challenges, harsh working conditions, and chronic funding shortages stretched the construction period over several decades. The lower portions were completed by the mid-1930s, but Going-to-the-Sun Road was not officially opened until July 15, 1936. Work on the guard rails continued for several more years and the road was not completely paved until 1952. Maintaining the road's scenic character and historic integrity has remained a constant challenge.

Going to the Sun Road's dramatic beauty and status as a terminus contribution to the history of park road development has earned it much accolade. The American Society of Civil Engineers named it a National Civil Engineering Landmark in 1986. In 1997 Going to the Sun Road was declared a National Historic Landmark—the first park road in America to receive this prestigious designation.
Eastern Parks of the 1930s

The history of Great Smoky Mountains National Park has always been intimately linked to the history of its motor roads. The movement to establish the park began when Wills Davis promoted the idea during a Knoxville Automobile Club board meeting in 1929. Alleged at excessive logging and destruction of federally funded roads, the Automobile Club sponsored the Smoky Mountains Conservation Association to lobby the federal government for a national park in the Smokies. When Congress finally authorized establishment of the park in 1930, the Knoxville Automobile Club held a celebratory banquet.

The motor roads of Great Smoky Mountains National Park did not simply materialize with the establishment of the park. Long before tourists began motoring over Newfound Gap and racing traffic jams in Cades Cove, the Cherokee, white settlers, and loggers greatly influenced the Smokies' motor road system. After migrating to the region more than a thousand years ago from the upper Ohio River, the Cherokee had established a network of footpaths throughout the mountains for foraging, for hunting, and, on some occasions, for crossing the area. Today's roads from Cataloochee along the southwest boundary of the park follow one of these Cherokee trails. White settlers migrated to the Smokies during the 1830s and 1840s along these same Cherokee footpaths. After widening many of them, Congress also began building new road routes through the mountains that traversed into parks throughout such as the Pisgah, Brevard and Rich Mountain roads near Cherokee. Under these initiatives, loggers sought out the more inaccessible regions of the Smoky Timber Forest including the Little River Lumber Company began loggin in 1907 and by the mid-1930s had cut approximately 85 percent of what was one of the largest virgin deciduous forests on earth, leaving behind a legacy of abandoned railbeds that were easily transformed into park roadways such as Little River Road.

Immediately after the federal government officially established Great Smoky Mountains National Park in 1934, the National Park Service began planning Newfound Gap Road, a state-built road running up and over the Appalachian divide in the northwestern corner of the Smokies. Although during the early 1930s the Park Service built several main roads in eastern parks including Skyline Drive in Shenandoah and Cades Cove Mountain Road in the Smokies, none posed the technical challenges of Newfound Gap Road in the Smokies. To eliminate sharp curves and steep grades, the Park Service constructed a loop-on structure as well as a tunnel and several bridges along the almost thirty-mile highway. As important as these technical changes were aesthetic improvements. The Park Service added numerous overpasses to provide materia with better access to the park’s breathtaking scenery and made the road itself more appealing by extensively landscaping shoulders and using native materials in the construction of bridges and tunnels whenever possible. Due to this meticulous and “rustic” approach, and because it passes through an incredibly diverse scenery, Newfound Gap Road is today considered one of the finest park roads in the country.

While road boosters such as Wills Davis saw the national park as a means of developing roadways through the Smokies, during the 1930s others envisioned the preservation of wilderness also began influencing the motor road system of Great Smoky Mountains National Park. The notion that American wilderness was worth protecting was in a very real sense born in the Smokies, when Robert Marshall, Bernard McKee, and a local lawyer named Henry Borin met in Knoxville. Committed to preserving the wilderness, they organized opposition to the construction of several proposed highways along the Appalachian divide. By the time this campaign resulted in the founding of the Wilderness Society, one of America’s most influential environmental organizations, but it also defeated plans for a “Skyway” along the crest of the Smokies. Passage of the Wilderness Act in 1964 limited the motor road expansion of the proposed Northshore Road along the southern boundary of the park between Bryson City and Fontana Dam.

Funding for road improvements throughout the national park system increased dramatically during World War II, a twenty-year program aimed at expanding and rehabilitating the infrastructure of national parks. While the Park Service undertook numerous road projects in Great Smoky Mountains National Park, none compare to the work done on the Roaring Fork Motor Nature Trail. Due to past experiences with Wilderness advocates, Park Service designers kept the road narrow and one-way for most of its length, and aligned it to follow the hills and forms of the natural terrain. The result is a ten-mile road through a wild landscape unlike other motorways in the park and Jackson projects nationwide.
Military Parks

Gettysburg vintage tour bus & Vicksburg
THE MERRITT PARKWAY
FAIRFIELD COUNTY
CONNECTICUT

The Merritt Parkway is the first divided-lane limited-access highway in Connecticut. Located in Fairfield County, it extends thirty-eight miles from the New York State line in Greenwich to the western embankment of the Hudson River in Stratford. Conceived in the 1920s as an inland route to relieve traffic congestion on U.S. Route 1 in the southwestern part of the state, construction of the Merritt Parkway began in 1934 and was completed in 1940.

As an extension of the well-developed Westchester County parkway system, the Merritt was an important link with the Metropolitan New York City area to the south. As an “express through route,” the highway was Connecticut’s self-proclaimed “gateway to New England” providing motorists with a speed, modern alternative to the old Boston Post Road.

Designed in-house by the Connecticut State Highway Department, the Merritt Parkway was a collaboration between staff engineers, architects, and landscape architects. The road they created represents a transitional phase in American road design. By combining the aesthetics of recreational and scenic parkways with the efficiency of high-speed motorways, the Merritt’s designers integrated the divergent characteristics that distinguished American highways built before and after World War II.

Following the trend begun on parkways in New York City and Westchester County, the majority of the 17 bridges on the Merritt Parkway were designed as concrete rib frame designs and could support a greater load than a traditional bridge of equal span. Although the highway was restricted to passenger car traffic only, the bridges were designed to carry trucks and function well in that capacity during World War II. The steel rib frame was used for several bridges while concrete arches, concrete T-beams, and steel arches replaced the concrete rib frame in a few locations.

The Merritt Parkway bridge designers explored the decorative capacities of concrete rather than following the more expensive rustication treatment popular at the time. Cast stone was formed to imitate a cut-stone facade and then applied in large sheets to conceal construction costs. Precast sgraffito panels and reverse plaster molds were used to decorate pylons, rails, handrails, and wing walls. In the sgraffito process, layers of colored concrete are scored away in different patterns and depths to expose the color beneath. Reverse plaster molds, also called wax molds, were integrated into the framework to cast the ornamental reliefs while risers and panels featuring floral, animal, and geometric themes embellished the steel and concrete rib frames. The Merritt’s bridges were inspired by styles prevalent in the commercial architecture of the 1930s but here they introduced Art Deco and Art Moderne into a new highway context.

In designing the landscape, the Merritt’s architects turned to established parkway precedents, such as integrating the roadway into the existing landscape and creating a progression of individual and changing vistas. Inspired by Westchester County parkways such as the Henry Hudson River and the Saw Mill River, the Merritt’s landscape designers planted in a naturalistic manner, relying largely on native trees, shrubs, and ground coverings in the right-of-way,ripper, and median. The effects they created were an important part of the driver’s experience on the Merritt Parkway. As the roadway originally wound through the Fairfield County countryside, each successive grade or curve provided a new view of rolling farmlands and wooded areas.

Motorists traveling at 40 mph, the prescribed speed limit, could easily perceive the roadside vistas of lakes, rocky outcroppings, or bridges designed to visually enhance their journey.

The aesthetic goals of the Merritt’s designers were tempered somewhat by the principles of roadside development, a national movement that favored the creation of roadside views but not at the expense of safety, utility, or economy. The designers were mindful of practical considerations such as sight lines, plant removal, and reuse, and overall maintenance.

Following its opening, the Parkway played a crucial part in the rapid commercial and residential development of Fairfield County. It served then, and continues to serve, as an important therapeutic feature for motorists between Connecticut and New York. Despite higher speed limits and escalating commuter traffic, the Merritt retains much of its original character.
Going-to-the-Sun Road

HAER Photographs & Histories
Built in America

Overview

The Historic American Buildings Survey (HABS) and the Historic American Engineering Record (HAER) collections are among the largest and most heavily used in the Prints and Photographs Division of the Library of Congress. The collections document achievements in architecture, engineering, and design in the United States and its territories through a comprehensive range of building types and engineering technologies, including examples as diverse as the Pueblo of Acoma, houses, windmills, one-room schools, the Golden Gate Bridge, and buildings designed by Frank Lloyd Wright. Administered since 1933 through cooperative agreements with the National Park Service, the Library of Congress, and the private sector, ongoing programs of the National Park Service have recorded America’s built environment in multiform surveys comprising more than 350,000 measured drawings, large format photographs, and written histories for more than 75,000 historic structures and sites dating from pre-Columbian times to the twentieth century.

This online presentation of the HABS/HAER collections includes digitized images of measured drawings, black and white photographs, color transparencies, photo captions, data pages including written histories, and supplemental materials. Since the National Park Service’s HABS and HAER programs create new documentation each year, digital images will continue to be added to the online collections. The first phase of digitization of the Historic American Engineering Record collection was made possible by the generous support of the Shell Oil Company Foundation.
HAER Internship Program
Mt Rainier – Rigid Frame Arch

STEVENS CREEK BRIDGE
1941

This reinforced concrete rigid frame, two-beam design bridge is borne by five arched concrete girders. The outside girders, spanner, and wing walls are faced with stone masonry, including windows for the girders, which give the structure the appearance of a masonry arch bridge. The style was intended for structures like this and other improvements to harmonize with the natural setting of the National Park Service's so-called Rustic Style of architecture, which inspired structures and other improvements to harmonize with the surrounding natural environment. The structure was completed in January, but the structure sits on a foundation, with the exception of the downstream wing walls, built on a temporary fill.

The Stevens Creek Bridge was contracted to Portland, Oregon builder Sam Osborn in December 1938. Construction began the following spring. All of the work, with the exception of the placing of some masonry and final concrete, was completed before winter weather forced a shutdown in November. Work resumed in May 1941 and the structure was completed in July.
Yosemite – El Capitan 1933

EL CAPITAN BRIDGE CONSTRUCTION DETAILS

concrete deck
wood sidewalks
30′ railroad log stringer
reinforced log sill
concrete cap

15′-0″ x 48′
reinforced log sill

5′-0″ x 1′/4″ anchor rods
stone pier

TYPICAL RAIL CONNECTION AT PIERS

Scale 3/6″ = 1′-10″
Rock Creek – Measured Site Plan
PAVING & DRAINAGE

The Maryhill Experiments

From 1909 to 1913 Good Roads promoter Samuel Hill financed and built the Maryhill Loop on the Washington waterfront on the Columbia River. Hill spent over $100,000 of his own money to show the public that paving was the road surface of the future.

Under the direction of Samuel C. Lancaster, the roads at Maryhill were built on an experimental basis using different paving methods for their durability. In three cases, a stoned "waterbound" asphalt concrete road, made by laying coarse gravel on an asphalt oil and sandstone, was surfaced with various ingredients of hot asphalt oil and crushed stone. These thick mixtures never adequately bound the road surface. In the fourth method, no stone was added to the oil and dust was not included in the paving. This allowed the thinner oil to penetrate the stone layers more thoroughly, but left an insufficient surface. In the next two cases a standard macadam road was sealed with a mixture of oil and sand. The resulting mixture was then rolled, but the water bond nature of the laying still prevented penetration of the surface treatment. Finally, Lancaster built an ordinary oil bound macadam road with no asphalt treatment.

Ultimately, Hill and Lancaster paved the Historic Columbia River Highway with Vegetables, a patented hydraulic pavement of crushed rock and asphalt. The engineers attributed its durability to the use of stones as large as one inch even though 1/2 inch was the norm. It consisted of a 2-inch layer of dense asphaltic concrete, which was laid white hot on a subgrade of broken stone or old macadam road. After rolling, the surface was given a black coat of asphalt.

Drainage Structures

A road is only as good as its subbase and water is its natural enemy.

The designers of the Historic Columbia River Highway were familiar with the legendary rains of the Pacific Northwest and knew the difficulties of road maintenance in the Columbia River Gorge. Their ingenuity in preservation efforts represent one of the earliest uses of concrete, drain tile and gutters to channeled water away from the subbase.

French Drains were the most commonly used method on the Highway for intercepting water before it reached the subbase. In this system, trenches of not less than eighteen inches were dug alongside the road and filled with broken stone or gravel bottom. Drain tiles were added for larger water volumes.

Pipe Culverts carried excess drainage and small waterways below the subbase. They were also used along the Highway under intersecting roads. The earliest pipes were constructed of wooden slats. They were later made of concrete, corrugated clay tile with specified diameters between 12 inches and 36 inches.

Box Culverts permitted large volumes of water to safely pass under the roadway. In some cases these large reinforced macadam structures were made large enough to serve as live stock underpasses or cattle crossings.

Drop Inlets are small catch basins that direct runoff from the gutters and drainage into storm sewers. In the drawing below, large removable boxes were placed between a French Drain and the road to permit easy access to accumulated debris.

Gutters were used in several locations. These shallow paved drainage channels carried runoff from the road to inlets where it was directed away from the subbase. Side drains were gutters built on the outside edge of the curb.

Curbs served several functions in the Historic Columbia River Highway. They rested on top of the road surface, preventing it from running off into the subbase, and also helped to stabilize the road edge and present a more finished appearance. In addition, curbs acted as a restraint to vehicles leaving the pavement at hazardous points.
Great Smokys-Evolution of Roads

**EVOLUTION OF MAJOR ROADS**

Long before tourists began motoring over Newfound Gap, Native Americans created a networked network of footpaths through the Great Smokys. This process began after the Cherokees, a branch of the Iroquois nation, moved to the region more than a thousand years ago from the upper Ohio River. To link their two principal trails running parallel on either side of the Smokies, the Cherokees cut three footpaths across the mountain. The Cataloochee Trail, the Tuckaleechee-Southwestern Trail, and the Indian Gap Trail were each used for hunting, for socializing with kinfolk in other areas, and, on occasion, for moving war.

Much as their Native American predecessors, early white settlers also traveled extensively throughout the mountains. Those settling during the 1820s and 1830s in Cataloochee and Cades Cove first followed the Cherokee footpaths they had followed in the region. Soon they also began constructing a host of new wagon roads throughout the mountains as they could visit neighbors, attend religious services and schools, and transport hogs and wagon loads of produce to distant markets in Maryville, Knoxville, and beyond.

Unlike early settlers, loggers sought out the more inaccessible land within the Smokies. Here, where no farmer had cleared, planted, or harvested, they found one of the greatest virgin deciduous forests on earth. Timber companies such as the Little River Lumber Company began cutting in 1901 and by the mid-1930s had logged approximately eighty-five percent of what would become the national park. To transport this timber from forest to mill, timber companies relied on an elaborate system of logging railroads that eventually reached the Smokies’ highest peaks.

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**1900 - 1934**

**1934 - Present**

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**A.D. 800**

**1800 - 1900**

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**North Carolina Turnpike**

**Gap Highway**

**1904**

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**Great Smoky Mountains Railroad**

**Road Built**

---

**Civil War**

**Logging begins in eastern Appalachians**

---

**Ripley’s Nick**

**Unpaved Road**

---

**NPS Mission 66**

---
Bridges of Zion
Blue Ridge – Regional Maps

THE HIGHLANDS

The highlands is the most varied portion of the Blue Ridge Parkway. The roadway departs both the Blue Ridge escarpment and the Commonwealth of Virginia here. From the state line, the roadway follows the undulating topography of the Blue Ridge south to the town of Blowing Rock.

FENCES AT MILEPOST 244

The change in terrain allows the roadway to traverse fast agricultural land, stream valleys, mountain sides and ridges tops. This variety allowed roadway designers to incorporate all the tools for providing visual variety...

LITTLE GLADE MILL POND

ALLIGATOR BACK

THE LUMP

CASCADES AT E.B. JEFFRESS PARK

To Asheville

To Roanoke
BRPR – Parkway Design Principals

PARKWAY PRINCIPLES

Limited Access

The Bronte River Parkway employed a series of design features that became hallmarks of parkway development throughout the nation. Since most of these enhancements improved safety and efficiency as well as aesthetics, the basic design principles embodied in the Bronte River Parkway were adopted by mainstream highway engineers and played a prominent role in the development of the modern high-speed motorway.

Grade-separated interchanges dramatically improved safety at intersections. Limiting access from surrounding streets and properties further enhanced safety and efficiency while eliminating the unsightly commercial establishments found along many roadways. A broad right-of-way provided additional protection against highway and other visual intrusions while offering designers more freedom in placing the roadway and enhancing the surrounding landscape. The roadway was laid out in graceful curves that followed the contours of the land, offering greater driving ease and safety at high speeds. Medians improved safety and could be used to add visual interest or preserve attractive landscape features. The parkway landscape was comprehensively designed to offer modern motorists an updated version of traditional park scenery.

Improved Intersection

Landscaping

Medians

Broad Right of Way

Curving Roadway
Colonial Parkway - 1930s Construction

ROADWAY DESIGN

HISTORICAL ROADWAY CONSTRUCTION (1930s)

- Steel rail framework
- 10" x 12" x 7" blocks
- Steel backed inner panel
- 6" x 10' x 0'-11 1/2"

DETAIL OF ROAD REHABILITATION

- 7" Reinforced Portland Cement Concrete

- Surface detail

- Trench cover (concrete slab material)

- Joint filler (precast material)

- Reinforced concrete slab

- Detailed road structure

- Workers breaking surface of roadway after acid wash to expose the aggregate finish
**Grading & Alignment**

**Maximum grades**

Crowning is the standard grading practice in which the road surface is sloped so that water drains away from a high spot in the middle instead of collecting dangerously on the surface. In curves, however, these slopes combine with curve redirects to pull vehicles off the road. Curved banking, sloping the road toward the inside of the curve, was developed to take advantage of the curve's centrifugal forces. Today, this superelevation permits drivers to maintain highway speeds in curves that would normally require slowing down to keep a vehicle on the road. The designers of the Historic Columbia River Highway decided that "any curve necessitating a superelevation was dangerous and speed should be decreased," and in any case should be enough to prevent side-slip to passengers in a machine at 25 miles an hour, but that the general rule should be never a speed of 15 miles per hour. In the end, superelevation was used primarily for drainage purposes.

**Equipment**

Contractors' machinery used men, horses and heavy machinery to excavate the roadbed for the Historic Columbia River Highway. In one instance, 30 men, equipped with a steam shovel with a 24-cubic yard shovel, 4 hydraulics Rand air drills, two 15-ton derricks, and thirty 4-yard coal cars could move 1,600 cubic yards of earthwork and rock every 8-hour day.

**Continuous curves**

The Historic Columbia River Highway is a route of continuous curves. In addition to providing an ever-changing scenic view, these maneuvering curves served several purposes. Their interwinding paths were longer in length than straight shots, allowing more lenient grades between the same points. Continuous curves could also follow the natural terrain better than straight courses, including the road for the extreme cut and fill that characterizes today's flatter highways and byways. Perhaps most significantly, connecting continuous curves eliminated potential flat spots in between where crowning might remain level until the next curve. Water collecting there could be potentially hazardous to drivers and also lead to pavement breakdown.

**Loops**

In some locations, the steep terrain of the available land couldn't accommodate the standard minimum radius or maximum grade. For example, from Green Point the road wound around the foothills of Latahata, making it necessary to descend 450 feet in 40 lane feet. To develop a route between these points, and prepare the maximum grade of 5 percent, the engineers bought the road site and built on itself down the mountainside, turning several times on curves with radii less than a 100 feet turning radius. To compensate for this deviation from the standard 120 foot radius, engineers installed the grade 1 percent for every 50 feet reduction in turning radius.
**Yellowstone Construction Evolution**

**ROADWAY CONSTRUCTION METHODS AND EVOLUTION**

Archaeological digs prove that throughout history, traveling used the same or similar corridors for travel throughout the Park. For centuries, geese trails have led Native Americans to hunting grounds which also proved convenient for travel to distant destinations. These same trail corridors were then used by the trappers and later for explorers who sought to the birth of the first National Park in 1872. After the official opening of the Park, visitors continued to drive every year, creating the need to vastly improve and expand the existing road system. Parks were widened and re surfaced to accommodate incoming wagons and coaches. Although airliner, these narrow roads offered uniforms that were expensive to maintain, Yet, when visitor numbers increased, the narrow, rough, one lane dirt roads through the Park became too much for the vehicles and improvements were made. Of the many improvements, water tunnels were constructed to bypass the many dry and rocky sections of dirt roads. Through bridges and grandson sections, washed out areas were raised to a good level over winged roadway construct. This raised surface averaged cost less with drainage attains using both sides.

When new road building allowed a crawl in 1920, the existing roadway surfaces demanded funds for re surfacing, widening and annual maintenance. Further attempts at controlling dust were made by applying layers of gravel and asphalt to roadway surfaces. Roads continued to widen and straighten, with thinner pavement that completely solved dust and erosion problems while reducing maintenance costs. Throughout the Park, main road sections have changed little since the 1920s, but have seen many routes, many major projects and considerable maintenance improvements. Today, a twenty year road rehabilitation program, action is being taken to create bicycle lanes and to increase recovery areas for both lanes, covering many areas, a substantial change in the visitor experience.

- Although a ability and rough processes, early trails and roadways followed local topography allowing an intimate wilderness traveling experience where both driver and passenger participated. An enter numbers increased, becoming, chance and large machines allowed for smaller techniques that straightened roadways.

- Later, large doses and heavy earth moving equipment allowed construction of even wider and straighter road surfaces, creating a much faster travel processer through the park. Although roadway design today is wider, straighter and somewhat safer, opportunity for driver experience and participation is creating a driving a much faster travel processer through the park.

**EARLY ROADS**

1930's-1940's

1950's-1960's
**BW Parkway in road Context**

**Evolving Roadway Types**

U.S. Route 1 typified the problems associated with early highways. While it was paved with modern asphalt and concrete, most design features were unchanged from those and buggy days. The road itself was a hazardous mix of sharp curves, long straightaways, and uneven grades. Multiple at-grade intersections existed from roadside properties, and the lack of median dividers resulted in an unsafe and inefficient transportation corridor. Billboards, gas stations, roadside services, and telephone poles obscured the same right-of-way, distracting motorists and obscuring roadside scenery.

Parkways provided an attractive and efficient alternative to conventional highway construction. Carefully designed roadways with gentle grades and sweeping curves were safer and more attractive than traditional alignments. Median strips, grade-separated interchanges, and strip centers improved access from cross streets and surrounding properties. Pedestrian safety and efficiency were enhanced. A wide, tree-lined right-of-way screened out unsightly roadside development and provided opportunities for landscape enhancement. Protective metal trucks and other commercial traffic made driving safer and more comfortable.

Interstate highways employed many of the basic design features pioneered by motorway builders. Interstates emphasized speed over scenic values. Wide, straighter roadways with additional lanes and longer merging zones accommodated higher speeds and traffic volumes but took up a larger portion of the right-of-way. Access was tightly controlled, and visual and aesthetic protection was often limited, especially at interchanges. Landscape enhancements were minimal, and the roadway dominated the forward view. Grade-separation structures were larger and less artistically designed. Interstates accommodated all types of modern motor traffic, including large trucks and buses.
Yosemite – Bridge Evolution

**Bridge Evolution**

19th Century - 1920s

1. Log Bridges
   - Yosemite's original bridges were simple wooden structures, typically consisting of a single log beam supported by piles driven into the riverbed.
   - The earliest log bridge is believed to have been constructed in the early 19th century.

2. Wawona Covered Bridge
   - The Wawona Covered Bridge was built in 1875 and was a covered wooden structure, offering protection from the elements.
   - It was destroyed by fire in 1899 and was later rebuilt with a metal frame and wooden deck.

3. Timber Truss Bridges
   - As wooden bridges became more popular, timber trusses were employed to increase structural strength.
   - Yosemite's earliest truss bridge is believed to have been constructed in the 1880s.

4. Steel Truss Bridges
   - Steel truss bridges became more common in the late 19th century due to their durability and strength.
   - Yosemite's first steel truss bridge was built in the 1890s.

5. Reinforced Concrete Bridges
   - Reinforced concrete bridges were introduced in the early 20th century.
   - Yosemite's first reinforced concrete bridge was constructed in the 1920s.

6. Early Rustic Concrete Bridges
   - Rustic concrete bridges were popular in the early 20th century for their aesthetic appeal.
   - Yosemite's first rustic concrete bridge was built in the 1920s.

1920s - Present

7. Rustic Stone Arched Bridges
   - Many of Yosemite's bridges were constructed of stone, reflecting the park's natural beauty.
   - Yosemite's first stone arch bridge was built in the 1920s.

8. Rustic Arches with Subway
   - Several of Yosemite's bridges incorporate arches with subway passages for the transportation of water or electric lines.
   - Yosemite's first arch bridge with a subway was built in the 1920s.

9. Rustic Steel Girder Bridges
   - Steel girder bridges became popular in the early 20th century for their strength and durability.
   - Yosemite's first steel girder bridge was built in the 1920s.

10. Concrete Girder Deck Bridges
    - Concrete girder deck bridges were introduced in the early 20th century.
    - Yosemite's first concrete girder bridge was built in the 1920s.

11. Reinforced Concrete Open Spandrel Arches
    - Open spandrel arches were popular in the early 20th century for their aesthetic appeal.
    - Yosemite's first open spandrel arch bridge was built in the 1920s.

12. Contemporary Rustic Bridges
    - Modern rustic bridges are designed to blend in with the natural environment.
    - Yosemite's most recent bridge is a contemporary rustic design, built in the 2020s.
Origin of a Park Bridge Type

THE RIGID FRAME CONCRETE ARCH

The rigid-frame concept was developed by the Bronx Parkway Commission engineer, Arthur G. Hayden, in 1922. This innovative design derived from the need to construct a large number of attractive spans for bridges and grade-separated interchanges along the Bronx River Parkway.

Prior to Hayden's innovation, most grade-separations were constructed with conventional arches, which required much larger structures to provide the same amount of usable vertical clearance, or with steel or concrete girders, which offered uniform clearance but were considered unsatisfactory for roadway use. The rigid-frame arch retained a support of the true arch's graceful curvature but offered a broader span of maximum clearance. Its strength was derived from a rigid connection between horizontal and vertical members that spread the load more evenly throughout the entire structure. The rigid-frame arch was also relatively cheap to construct. Its greater structural strength permitted thinner cross sections and required considerably less concrete to stabilize the abutments. The more efficient profile also produced significant savings in related construction costs since the overall height difference between the crossing roadways was minimized and less fill was required to construct suitable approaches to each grade-separation.

The rigid-frame bridge was ideal for parkway use because it was economically and structurally efficient, had a pleasing profile, and was readily adaptable to wide variety of architectural treatments. It was widely used in parkway development throughout the country and spread rapidly to other roads, where its practical qualities made it ideal for large-scale production.

Construction Process

1. Footings
   Footings for the bridge and abutment wing walls are formed and poured. Monitoring bars are placed 3 ft above footings to prevent reinforcement of vertical legs. Keyways are placed adjacent to footings.

2. Falsework and Vertical Legs
   Falsework for concrete arch and stone arch rings is erected. Vertical legs are formed and poured. Any architectural detailing on the outside face of vertical legs is cast with the forms.

3. Stone Arch and Wing Walls
   Stone arch rings and wing wall foundations are laid. Stones are started to concrete in steel anchors, embedded in the stone and hooked into drill holes in a row of stones.

4. Concrete Arch and Wing Walls
   The concrete arch and abutment wing walls are cast against the stones. The concrete arch can be cast in one piece or in multiple longitudinal bays.

5. Finish Masonry
   Masonry parapets are completed and finished with coping stones.

6. Grading and Paving
   Abutments are backfilled when roadway approaches are filled to the desired grade. Roadways are then paved with a bituminous wearing surface.
Rock Creek – Melan Arch 1902

BOULDER BRIDGE CUTAWAY

CROWN SPLICE

ARCH DETAILS
SCALE: 3/4" = 1'-0"

CRAMPING

3/4" x 3/8" WROUGHT IRON CRAMP

SPRINGING STONE

3/4" x 5/16" x 22 1/2" TIE PLATE

ARCH LATTICE STEEL GIRDER

EARTH FILL

ARCH CONCRETE

SPANDREL WALL

NEWEL STONE

WING WALL

PARAPET STONES

MACADAM

ARCH STONES

ARCH TRUSS

BEACH DRIVE

BOULDER Facing
Yellowstone – Crawfish Bridge 1936
Colonial Parkway – 1936-49

WILLIAMSBURG TUNNEL CONSTRUCTION

NORTH PORTAL ISOMETRIC

CONSTRUCTION OF TUNNEL ADJACENT TO HISTORIC STRUCTURE

PLACEMENT OF CONCRETE
Gettysburg – Drainage Systems

DRAINAGE

On 4 July 1863, after the three days of intense fighting, heavy rains began to fall washing out the already rutted local roads. Rivers and streams throughout the region flooded, impeding the Confederate Army’s retreat and drowning some wounded where they lay swaying aid.

Soldiers did it rain as hard as it did that day, but successive stages of Gettysburg National Military Park’s development have contended with drainage issues to protect the agricultural lands and the avenues from flooding and erosion. The Gettysburg Battlefield Commission instituted a comprehensive and carefully designed drainage system to increase the durability of their Tolbert roads. Contributing aesthetically to the formal commemorative landscape, nearly 13 miles of stone-paved gutters were placed along the avenues while stone catch basins and culverts diverted water under and away from the road beds.

Fieldstone and brick gutters lined many of the avenues during the War Department Era of the Park. Due to high maintenance and cost all of the gutters have been removed or covered with asphalt. Others have been replaced with concrete gutters by the National Park Service.

Traces of the original system remain visible in the park. Beginning in 1933, the National Park Service extended the system and introduced new design and safety standards, contributing to Gettysburg’s variety of drainage details.
Crater Lake – Guardrails

Roadside barriers were designed and constructed to provide safety for both motorists and pedestrians. Most of the original patterns of stone guardrails constructed between 1930 and 1938, can be found along the East Rim Drive. An extremely high level of craftsmanship, displaying special attention to composition and artistic layout, can be seen in this area from Sun Watch to Rim Drive. The walls are made of local andesite rock, obtained at the Watchman quarry and cut and trimmed for each specific site. Through derived from a standard design, the stonework pattern varied intentionally irregularly with avoidance of right angles and design this to better harmonize with the park settings. The original stone walls were built of huge rough blocks with narrow, instead mortar joints. In order to provide variation, the 12–16 foot stone walls were broken by 5 feet crevices, consisting of 12, 15 or 16 square blocks. Most stone guardrails along the West Rim Drive have been reconstructed, largely some of their original appearance and design pattern. The two main types of flat stone walls found on the West Drive, recently reopened, differ markedly in scale and pattern. Few of the original wood guardrails still exist. The barriers at the Crater Lake observation stations, installed in the 1930s, are the only modern wood rails. Wood reflection posts, usually in combination with stone walls, can be seen all along the Rim Drives. In a few places, the old wood posts were used as vertical support elements for the standard “A” metal rails.
Crater Lake – Entrance Stations

During the 1920s and 1930s, visitors entered Crater Lake National Park through one of five entrance stations: North, South, West, North or South. In 1938, parking areas were built alongside five park entrances. Situated near the entrance sign, the south and west stations were located along Highway 92. In 1931, the south and west checking areas were combined with the north station to one southern checking area. The north entrance station was originally positioned at the junction of the Diamond Lake Road and the river. In 1958, this location was abandoned and relocated to the northern boundary. The east entrance served visitors who entered from Highway 623. Access to the station was from the west, but the station was demolished soon after.

Four entrance signs located along the park’s access routes are the initial orientation features for visitors. The south and east entrance signs are located at the park’s boundaries along Highway 92. Both of those signs were originally historic construction and demolished in the 1970s only to be reconstructed through careful analysis of historic drawings and photographs in 1989. The design of the north and east entrance signs culled for the below to be constructed of masonry. The north sign located near the junction of Highway 18 and the Diamond Lake Road was demolished in 1970 but reconstructed in 2009. The original base of the exit sign along the Ponderosa Road left remains intact although the board was replaced in 1994.
Great Smoky – Motorist Experience

**MOTORIST EXPERIENCE**

The roads in Great Smoky Mountains National Park offer a wide range of experiences for the motorist. Scenic overlooks and planned vistas were designed throughout the park to direct the visitor’s eye. The roads traverse a variety of topography and provide differing views ranging from gentle terrains, deep river valleys, climbing mountain roads, steep gravel switchbacks, overhanging ridges, historical and natural points of interest.

1. **Points of Interest:** Secure roads are designed to showcase specific natural and historic points of interest. Roads such as Cattail Creek provide visitors with access to historic structures and intimate natural scenery from their vehicles.

2. **Deep River Valley:** The Little River and Laurel Fork roads twist and turn between narrow gorge walls and offer panoramic views of the scenic river and valleys. The road, carried by a meandering wall, is gently laid up the free. Canopy is dense and gorge walls are tall.

3. **Sleepy Switchbacks:** Rich Mountain Road and other similar gravel roads maintain the character of historical pioneer travel through the Smoky Mountains. The single-lane roads follow the topography of the land up, over, and around ridges in a series of switchbacks.

4. **Sweeping Ridges:** Roads such as the Foothills Parkway follow ridges which offer gentle curving alignments and wide, open views. Broad views of distant mountains and valleys are presented through areas cleared of trees.

5. **Mountain Canyons:** The Headfound Gap Road climbs to the side of mountains through wind of its ascent with dramatic views of nearby peaks, ridges, and valleys. This roadway is nestled into the steep slopes, using retaining walls and many pullouts are provided to enjoy the scenery.

6. **Gentle Valleys:** Areas such as Cades Cove and Cataloochee present the historical landmarks of pioneers and the open landscapes which they cleared. The Cades Cove Loop meanders along the edge of pasture and forest.
EXPERIENCING THE LANDSCAPE

GEOLOGIC LANDMARKS

View to Union Peak
At 7,508 feet Union Peak, which lies in the southwest corner of the park, the eruption of Mt. Mazama. On a clear day the young and potentially active volcanoes of Mt. McLoughlin and Mt. Shasta can be seen to the left of Union Peak.

View to North
The Punch Bowl formed when ash, pumice and avalanche of scoria ejected from Mt. Mazama covering the landscape. Red Cone, easily identifiable by its color is linked to Mt. Mazama's magma chamber, while Mt. Thielsen is associated with volcanic activity prior to the eruption.

View to Mazama Rock
Mazama Rock is part of the Chemehuevi lava flow which occurred just prior to the collapse of Mt. Mazama. The lava was still hot and liquid at the time of the eruption, causing it to flow down into the newly formed caldera.

View to Klamath Marsh
The rich history of the Klamath Marsh begins with the Modoc Indians who inhabited the upper marsh for nearly twelve thousand years. Both the Klamath and Modoc tribes were eventually defeated by white settlers and the army who established Fort Klamath in 1863.

View to Pinnacles
Shallow lakes such as Wheeler Creek and Annie Creek produced seething gases which formed cylindrical vents known as fumaroles. High heat and chemical reactions3 altered the walls of the fumaroles, protecting them from erosion. The pinnacles themselves were exposed after loose materials surrounding the vents was washed away by streams.
Generals Hwy – Landscape Design

TUNNEL ROCK
GENERALS HIGHWAY

In 1834, a tunnel was excavated through this massive granite rock, located on the Generals Highway about one mile from the Ash Mountain Headquarters. The excavation by members of the Civilian Conservation Corps (CCC) secured proper road alignment of the highway. The original road, constructed by the Mount Whitney River Company, traveled around the rock to the east, similar to the current by-pass. In 1936, the CCC constructed masonry support walls on both sides of the tunnel to stabilize the earth walls. The CCC also built a stone staircase climbing to the top of the rock. The drawing on this page was adapted from an historic photograph and shows both the rock excavated from the boulder and the tunnel prior to the construction of the masonry support walls.

Drawings based on field measurements, historic photographs, and original design documents.

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Adapted from historic photo & 1934.
Bronx River Parkway

PARKWAY SECTIONS

Section A-A
Above 1,287 feet
Cemetery Road, Greenburgh

Section B-B
Woodland Vicinity, White Plains

Section C-C
Greenburgh Nature Center Park, Hartsdale

Section D-D
Widened section below
Sprain Brook Parkway Junction
Colonial – Panoramic Views

PARKWAY VIEWS

JONES MILL POND

HALFWAY CREEK

LOOKING EAST OVER HALFWAY CREEK

LOOKING WEST INTO JONES MILL POND
Blue Ridge – Parkway Management

**RIDGE**

- Good location for leg stretcher trail
- Native stone curb
- Stone-lined gutter moves water from roadway

**PLATEAU**

- Maintain forest to separate rears of agriculture
- Scenic easement to maintain views of vernacular architecture
- Agriculture lease continues so that visitor can still determine parkway property line

**VALLEY**

- Provide picnic areas along leg stretcher trail
- Stone-faced concrete bridge
- Use three small openings instead of one large one to maintain “stream scale”

**MANAGEMENT ZONES**

- **RIDGE**
  - Red Spruce
  - Eastern Hemlock
  - Red Spruce
  - Fraser Fir
  - Red Maple
  - Mountain Ash
  - Blueberry

- **MIDSLOPE**
  - Grassy Baldcypress
  - Redbud
  - Mountain Laurel
  - Potentilla
  - Northern Hardwood Forest
  - American Beech
  - Yellow Birch
  - Yellow Birch
  - Milkweed
  - Dogwood
  - Goosberry

- **PLATEAU**
  - Chestnut Oak
  - Mountain Maple
  - Yellow Birch
  - White Oak
  - Red Oak
  - Northern Yellow Birch
  - Flowering Dogwood
  - Rhododendron
  - Chestnut Oak
  - Scarlet Oak
  - Tuliptree
  - Sassafras
  - Mountain Laurel

- **VALLEY**
  - Pine – Oak Forest
  - Virginia Pine
  - Pitch Pine
  - Scarlet Oak
  - Mountain Laurel
  - Blueberry

- **RICH CREEK FOREST**
  - Tuliptree
  - American Basswood
  - Sugar Maple
  - Magnolia
  - White Oak
  - Dogwood
  - American Hornbeam
  - Wild Hydrangeas

Blue Ridge Parkway
National Park Service
April 1982

The Midslope consists of climbing and descending sections of road in order to cross major rivers and planes, necessitating the use of viaducts and tunnels to avoid the largest cuts. In this transitional zone, the potential for erosion and rockslides makes Midslope a challenge to manage.
With the narrow confines of the parkway, some unique solutions were needed to maintain the pastoral setting through which the roadway passes and to control future development. The parkway achieves this through agricultural leases and scenic easements. Along many portions, land is leased to individuals who use the land for pasturing animals, hay fields, and for growing row crops. These provide both an agricultural setting along the road and openings to see out from the roadway. In certain sections, additional land is covered by scenic easements, which restrict the rights of the owner to develop their land or remove scenic landscape components. The successful implementation of these programs allows the view of the pastoral countryside to remain and the boundary lines to disappear.

SCENIC EASEMENTS