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Recommended Guidelines
for the
Restoration, Maintenance and Use
of the
CARRIAGE ROADS
at
Acadia National Park

Prepared for:

North Atlantic Regional Office
National Park Service
U. S. Department of the Interior
15 State Street
Boston, MA 02109

Prepared by:

Rieley & Associates
Landscape Architects
109 Second Street, S. E.
Charlottesville, VA 22901

May, 1989

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INTRODUCTION

The Carriage Roads at Acadia National Park were built between 1913 and 1940 by John D. Rockefeller, Jr. The roads, and their accompanying stone bridges and romantic gate lodges, were conceived by Rockefeller, and executed by an exceptional group of designers and builders. This group included engineers, Charles P. Simpson, Paul D. Simpson, and Walters G. Hill; architects Welles Bosworth, Charles Stoughton, and Grosvenor Atterbury; landscape architect Beatrix Jones Farrand; and local Mount Desert Island builders Alanson E. Clement, Chauncey D. Joy, Byron W. Candage, Samuel Candage, S. F. Smallidge and others.

The construction of this remarkable system of roads was begun around Rockefeller's Seal Harbor property in 1913. It eventually expanded into the adjacent Park property and extended more than 57 miles through some of the most spectacular scenery in our country. The great majority of this system (more than 51 miles) is within Acadia National Park. These carriage roads are an important part of the Rockefeller legacy to Acadia National Park (to which he donated more than 11,000 acres of land), and the National Park Service.

During John D. Rockefeller's lifetime, he maintained the carriage roads with his own personnel and resources. They were maintained to his own high and exacting standards. Since his death in 1960, maintenance has fallen to the National Park

Service. Because of inadequate funding and low use, maintenance has been spotty and generally insufficient to keep the roads from falling into disrepair. The present condition of the carriage roads is, in many ways, very different from their original and intended state. The binder has eroded away, the crown has been lost, vegetation is growing in the ditch-lines, and in some cases the drainage system has failed to the point where water now runs down the surface of the road, exposing the foundation stones. Coping stones have been lost. Vistas have grown over. Much of the carriage road system is in need of reconstruction more than it is of repair.

These roads, and their ancillary facilities, deserve restoration and preservation for two important reasons. The first is that this road system is an important historic and cultural resource. It represents the finest example of broken stone roads designed for horse-drawn vehicles still extant in America. Secondly, these roads offer a great opportunity for access by visitors to beautiful parts of the Park, therefore relieving crowding on the automobile roads, and provide marvelous views of the island, without the noise, fast pace and danger of the automobile roads. Because these quiet roads are appealing in the winter as well as the summer, their increased use would provide greater opportunity for enjoyment of the park throughout the year.

This report will discuss the original construction of the carriage roads, proposed techniques for reconstruction, and guidelines for the maintenance and use of the reconstructed roads.

CONSTRUCTION

Background

Any discussion of the construction of the carriage roads at Acadia National Park must begin with the fact that the drives in question are not "carriage paths" or "carriage trails." They are roads, built to the highest standards of rural roads of the time. In 1913, when the building of the first segments of the carriage road system commenced, the great majority of roads being constructed in America fell into three categories: earth roads, gravel roads, and broken-stone roads. While brick roads were built in the nineteenth century, and experiments with coal tar, bituminous,[1] and concrete surfacing were underway during the first decade of the twentieth century, these represented a minuscule amount of the total mileage of roads in 1913.[2]

Earth roads were the cheapest, and by far the most common roads of the time.[3] They were dusty in dry weather, and muddy in wet. Many earth roads were impassable during much of the year. Because of the temporary nature of earth roads, they were converted to gravel or broken-stone as soon as finances and volume

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[1]Froidure, "Fight against Dust and Wear on Macadamized Roads", in *Institution of Civil Engineers, Minutes of Proceedings,* Vol.CLXXVI, PT. 2,(London: 1908-09), 344.

[2]A. C. Rose, *Historic American Roads* (New York: Crown, 1976).

[3]I. O. Baker, *A Treatise on Roads and Pavements* (New York: John Wiley & Sons, 1913), 71.

of traffic warranted. The best earth roads were built with properly formed and well-drained road beds so that their conversion to higher grade gravel or broken-stone roads was limited to upgrading the surface material.

Gravel roads were intermediate, in both cost and durability, between earth roads and broken stone roads. Figures A and B illustrate the kind of gravel roads which existed on Mount Desert Island before the introduction of "engineered" roads. Gravel may be defined as " . . . a mass of small, more of less rounded fragments of stone which have been broken out and shaped by the action of water or ice."[4] The depth of gravel would vary from 2 to 8 inches, depending on the frequency and weight of traffic. The gravel would often be mixed with a binding material, such as clay or rock dust to assure that it would pack together tightly. Gravel roads were recommended for country roads not having heavy traffic, for little used village streets and for park roads.[5]

The carriage roads at Acadia fall into the third category--broken-stone roads. These roads were much more costly and durable than either earth roads or gravel roads. Broken-stone roads are most closely associated with the names of two Scottish engineers who greatly advanced the technology of road building in the late eighteenth and early nineteenth centuries:

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[4]Baker, 146.

[5]Ibid.



Figure A.

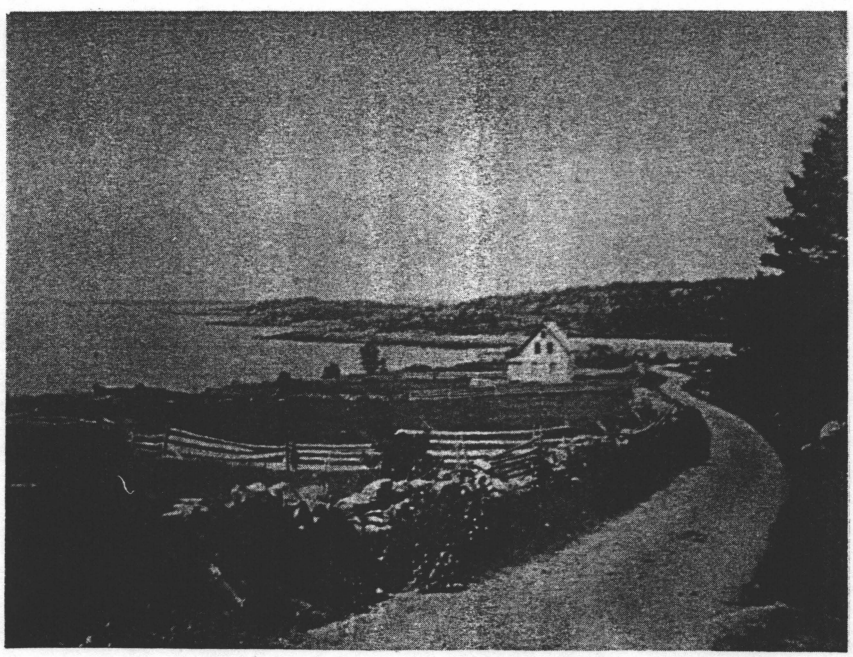


Figure B.

Thomas Telford and John Louden McAdam. Telford, like the French engineer, Tresaguet, before him, advocated a base layer of heavy foundation stones, six to seven inches in depth, with smaller stones in the upper layers of the road.[6] Central Park, in New York contained nine and a half miles of telford roads built between 1869 and 1878.[7]

McAdam believed that the "telford" road was unnecessarily expensive and that the load-bearing capacity of the natural soil was adequate if properly surfaced and kept dry. He wrote, "that it is the native soil which really supports the weight of traffic; while it is preserved in a dry state it will carry any weight without sinking."[8] McAdam prescribed a system of successive layers of relatively small stones (the largest passing a 2-inch ring, or no larger than would fit in a man's mouth).[9] The final layer would consist of smaller stones which would pack together and provide a water-tight surface. The action of iron wagon and carriage wheels on the road would grind the stone into "fines" which would fill the voids between the stones and further

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[6]J. P. M. Pannell, *Man the Builder* (New York: Crescent, 1964), 31.

[7]William P. Judson, *City Roads and Pavements*, (New York: The Engineering News Publishing Company, 1909), 139.

[8]Pannell, 35.

[9]Baker, 217.

compact the top layer of the road into a hard, impervious surface.

The first "macadam" road in America was completed between Hagerstown and Boonsboro, Maryland in 1823.[10] It has been estimated that these new roads enabled a horse to treble its hauling power.[11] During the nineteenth century, advances in technology obscured the differences between telford and macadam road building systems. The first mechanical rock crusher was invented by Eli Whitney Blake in 1858.[12] About the same time, the revolving screen for assortment of various sizes of stone fragments was introduced.[13] (Concrete bins, used in rock crushing and sorting operations at Rockefeller's Pocantico Hills estate are still extant.) The first use of the steam road roller was made on roads in Central Park, in New York City, on June 4, 1869.[14]

With this new technology, and three-quarters of a century of practical experience and observation, by the turn of the century, civil engineers and road builders developed a broken-stone road

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[10]Rose, 36.

[11]Pannell, 36.

[12]Charles W. Wixom, *A Pictorial History of Road Building*, (Washington: American Road Builder's Association 1975), 41.

[13]Baker, 213.

[14]Rose, 67.

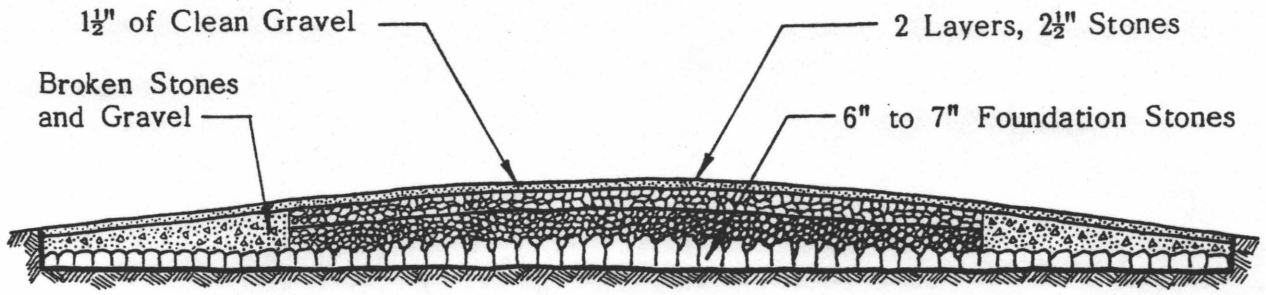
which combined the strong foundation and superior drainage of the telford road with the economy of the macadam road.[15] Figure C illustrates the evolution of the American broken stone road. The crusher and sorter allowed for the economical production of more uniform base stones and graded surface material. The steam road roller greatly hastened the process of compacting the surface layer of stone and binder into a hard, water-proof surface, which had previously relied upon much lighter horse rollers or simply wagon and carriage traffic to achieve. This macadamized road was described as "impervious to rain and so smooth and hard on the surface that the horses' hoofs would ring upon it."[16]

While broken-stone roads were generally referred to as "macadam" during the nineteenth century, in this century the same term has been used to describe "bituminous macadam" roads, in which asphalt or bituminous material is used as a binding agent between the surface stones. "Tarmac" is an abbreviation of "tar-macadam." For this reason, our discussion will refer to the construction technique of the carriage roads by either the term "broken-stone road," or the term used by Rockefeller and his first engineer, Charles P. Simpson-- "rock-filled road."

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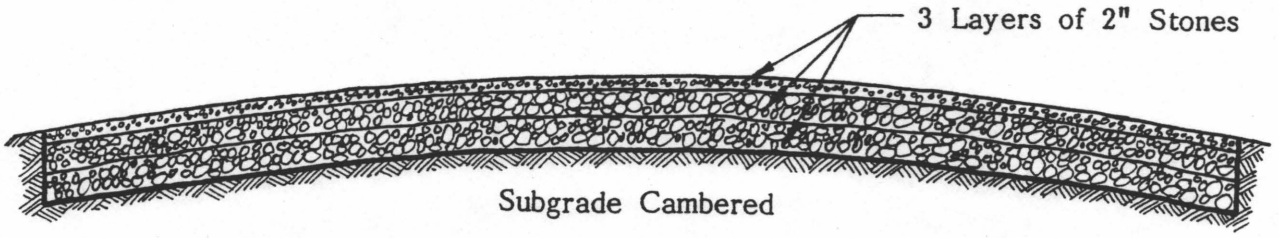
[15]Albert I. Frye, *Civil Engineer's Pocket-Book* (New York: D. Van Nostrand Company, 1913), 1099.

[16]Wixom, 61.



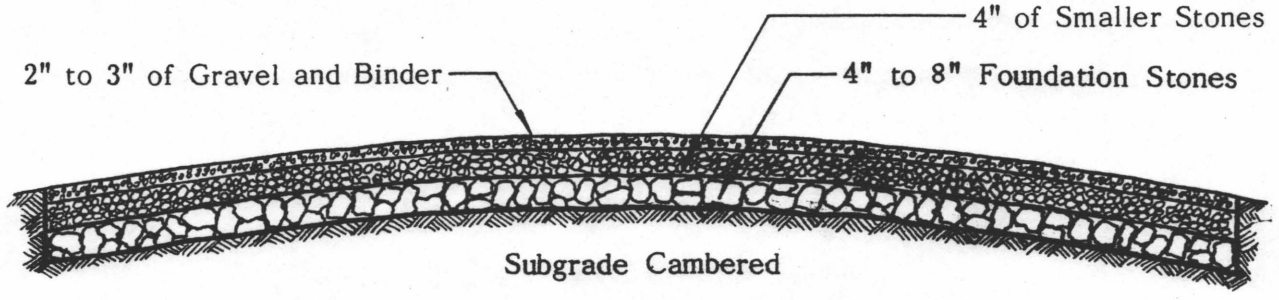
Subgrade Horizontal

TELFORD ROAD, ENGLAND, LATE 18TH CENTURY



Subgrade Cambered

MACADAM ROAD, ENGLAND, EARLY 19TH CENTURY



Subgrade Cambered

BROKEN-STONE ROAD, AMERICA, EARLY 20TH CENTURY

EARLY PAVEMENTS

FIGURE C.

Specifications

The carriage roads at Acadia National Park were built according to plans and specifications developed by Charles P. Simpson, and later by his son Paul D. Simpson, under the direction of their employer, John D. Rockefeller, Jr. The earliest set of specifications found is from 1916 for the Gardiner-Mitchell Hill road (Appendix I). These same specifications were amended only slightly for future carriage road projects of Mr. Rockefeller on Mount Desert. Rockefeller's letter to A. E. Clement, the road builder, in conveying the specifications and contract for the Little Harbor Brook road a year later state that "this road is to be of the same width, character, and quality as the Gardiner-Mitchell Hill-Jordan Stream Road . . . ."[17] The correspondence and specifications confirm that the same type of construction was used in the early roads on Rockefeller's land as on much later roads in the Park. Because the carriage roads were built according to written specifications and plans, under a contract, it is possible to establish many details about the original construction of these roads.

[17]John D. Rockefeller, Jr., to A. E. Clement, Sept. 24, 1918, Rockefeller Archive Center. (All correspondence referred to hereafter is housed at the Rockefeller Archive Center unless otherwise noted.)

Character of Road

The specifications for the Little Harbor Brook road (Appendix I-A) state that "the road to be built shall be what is known locally as a rock filled road, with a top surface of clay and bank gravel, such as may be found in the vicinity of the work or the finer grades of crushed rock may be substituted for gravel. In general the road is to be of the same character as the Sea Cliff Drive and the Gardiner-Mitchell Hill-Jordan Stream Road, to which reference is made as a standard for road bed, retaining wall, gutters, etc. The road shall be built true to line and grade as established on the ground by the engineer or as shown on plans, with no humps, hollows, yanks or crocks, and the lines, particularly on curves, shall be true and even. All wet and low places shall be filled with rock."[18]

Reference to the plans in these specifications, and other correspondence, indicates that the road was carefully engineered and aligned both horizontally (plan) and vertically (profile). While civil engineers of the time were well acquainted with the principles of horizontal and vertical alignment, these were most commonly applied to railroad track alignment rather than roads. Some park and estate roads were designed in plan and profile, but it was not common.

[18]Specifications for Little Harbor Brook Road, September 25, 1918, Rockefeller Archive Center.

Road builders of the early twentieth century were very concerned with gradient, or the steepness of the road; however, because of the slow rate of speed of both horse-drawn and motorized vehicles, sharp turns were allowed. A radius of as little as 30 feet at the outside edge of the roadway was recommended for four- and six-horse teams.[19] For this reason, horizontal alignment was not considered critical and was usually determined in the field by the construction crew, "requiring knowledge of the country and a good deal of common sense, but not much technical skill."[20] The primary reason for designing a carefully aligned roadway on paper prior to construction, particularly in the case of a horse road, was to produce a beautiful, flowing line in the landscape. This aesthetic concern is confirmed by the specification's requirement that "the lines, particularly on curves, shall be true and even." Horizontal and vertical curves were calculated and shown on the plans. "Off-set" stakes were set in the field as the road was constructed to assure conformance with the design (Figure D.).

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[19]Herschel Clemens, "Prize Essay on Road Making," *Massachusetts State Board of Agriculture Report*, 1869, 207-63.

[20]F. W. Cron, "Fitting the Highway to the Landscape," *The Highway and the Landscape*, W. B. Snow, Ed., (New Brunswick: Rutgers University Press, 1959), 82.



Figure D. Subgrade Preparation

Note Offset Stakes on Left

Width and Crown

The specifications state that "the road shall be 16 feet in traveled width inside the gutters, fences or walls except where a greater or lesser width is specified, and will be crowned so as to be 8 inches higher in the center than at the edges."[21] A 16-foot roadway in a rural area was a substantial width, at the time. The standard cross-section for state-aid roads in New York showed 12 to 16 feet of broken-stone surface, at the turn of the century.[22] This width was altered in some places by Rockefeller. The Little Harbor Brook road, for example, was built at 16 feet in width, except for a section in the flat land which was built 10 feet in width, with the possibility of upgrading later to 16 feet. The Jordan Stream Road, which is now considered a part of the carriage road system, was never so regarded by Rockefeller. It was designed and built as a 10-foot bridle path. Neither does it have the same alignment qualities as the true carriage roads. The great majority of the carriage roads were designed and built at the full 16-foot width.

The requirement for 8 inches of crown, from center line to the shoulder, or a rate of 1 inch per foot, was generous, but within the accepted norm. A 1903 road construction text states

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[21]Little Harbor Brook Road Specifications.

[22]*Report of the New York State Engineer and Surveyor*, 1899, 321.

that "broken-stone roads made of soft stone and maintained by periodic repairs frequently have an original crown of one twelfth--an average slope of 1 inch to 1 foot or 1 in 12."[23] The same source goes on to state that "there is a slight advantage of a very high crown for a broken-stone road, particularly for one that is not frequently cleaned. If the crown is great, the rains will better wash the surface clean. Dirt upon the surface is not only unsightly, but is also detrimental since it holds the water and softens the surface."[24]

The Little Harbor Brook Road specifications prescribe that "This crowning [is] to be even and to be made in the rock fill and verified before the top surface is put on. In placing the rock fill due allowance must be made for settling and wear during construction so that the crown of the road when finished shall be 8 inches."[25]

A less pronounced crown was often employed. A 1909 text says, "The convexity or crown of the roadway is usually made one-half inch to three-fourth inch per foot each way from the center-line for widths up to sixteen feet. . . ."[26] The stipulation that allowance be made for settlement, so that the finished crown

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[23]Baker, 202.

[24]Ibid.

[25]Little Harbor Brook Road Specifications, 3.

[26]Judson, 177.

would be 8 inches, is the only instance in which the specifications were underlined for emphasis. Later drawings indicate that this crown was reduced to 6 inches on the 16-foot roads, or a crown of 3/4 inch per foot. This important aspect of the original construction of the carriage roads has been largely lost over the years. The crown, where it still exists at all, is substantially less than it was designed originally.

Foundation

The foundation of the road was to "be of broken rock finished with at least 4 inches of small rock and to be crowned 8 inches from edge to center of road. Upon this will be put a light coating of fine screenings or coarse gravel sufficient to fill up the spaces between the stones so that the top dressing will not sift through." While the size of the foundation stones are not specified, the bottom course of broken-stone roads was typically composed of stones 3 to 4 inches in greatest dimensions (Figure E.), for softer stones; and 2 to 2½ inches, if built of hard, tough stone.[27] The stones exposed by erosion or wear on the carriage roads generally measure in the 3 to 4 inch range, but some larger stones may be found. The foundation stones were installed to a depth of 6 inches to 7 inches (after rolling) on the carriage roads. This was a very substantial base. The stan-

[27]Baker, 217.

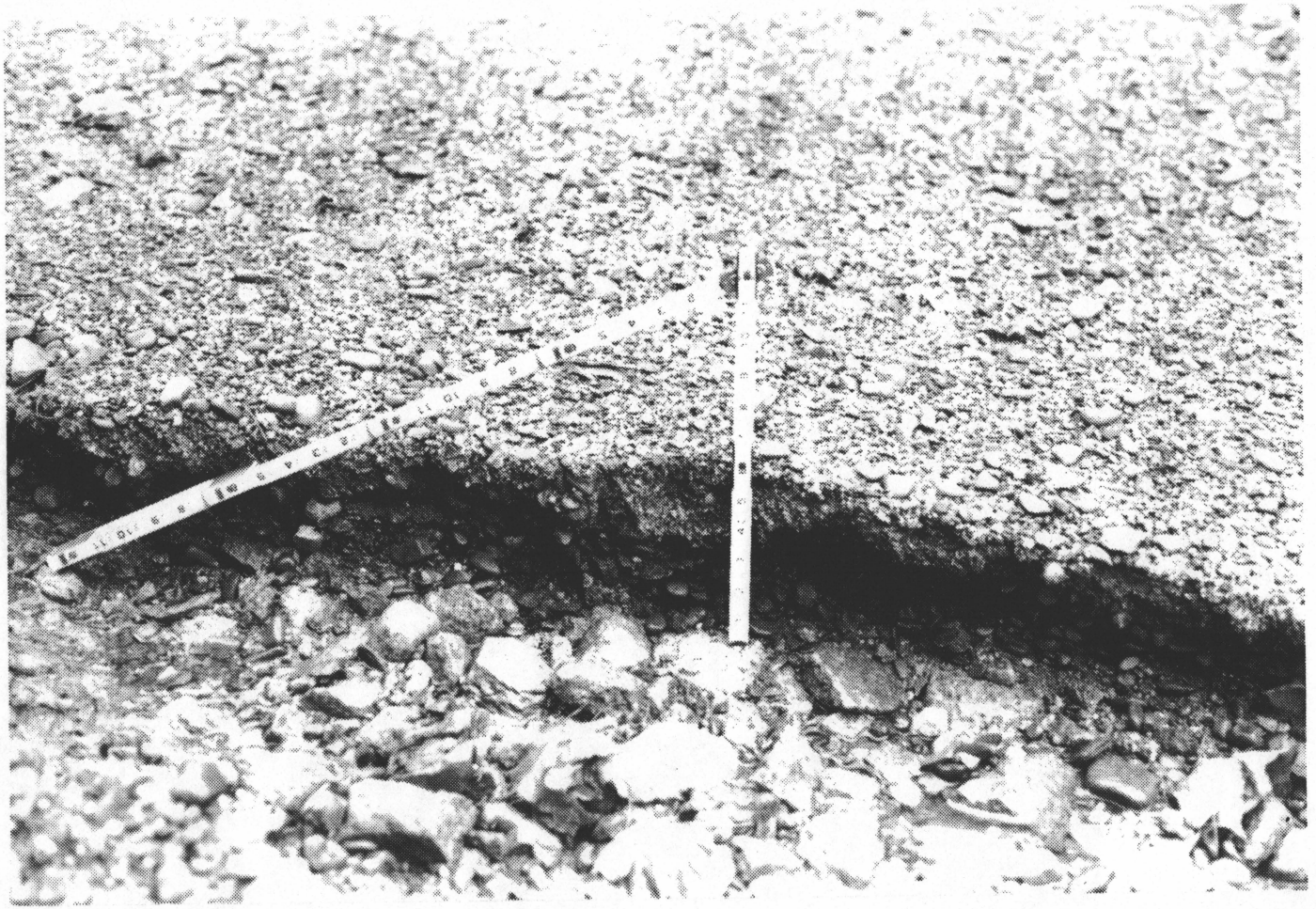


Figure E. Exposed Foundation Stones

dard cross-section for state-aid roads in New York, at the turn of the century, shows a 4 inch base.[28] The average depth of foundation stone (or first layer of macadam) on broken stone roads in 30 American cities in 1907 was 6.67 inches.[29]

Middle Layer

The foundation course was topped with 4" of "smaller stones".[30] While the size of these smaller stones is not specified, it was customary to use stone in the 1 inch to 2 inch range.[31] This open-graded material would assure good drainage, and would fill some of the voids of the larger foundations stones. Upon this was to be spread a thin layer of screenings or gravel, to prevent the finish surface from sifting through.

Finish Surface

The contractor was directed to "finish with 2 inches of gravel that will pass through a sieve of 1½ inch mesh and one inch of clay as a binder; all to be rolled upon completion when

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[28]*New York State Engineer and Surveyor Bulletin No.1*, April, 1899, 9.

[29]Halbert P. Gillette, *Handbook of Cost Data for Contractors and Engineers* (Chicago: The Myron C. Clark Publishing Co.), 1914, 350-351.

[30]Specifications, 4.

[31]Ibid.

wet with a roller not less than 2 tons in weight."[32] The gravel size of 1½-inch and smaller was consistent with current practice.[33] Binder material was considered essential for the performance and durability of a broken stone road. Baker writes, in *Roads and Pavements*:

> The interstices between the fragments of stone should be filled with a fine material which will act mechanically to keep out the rain water and thereby keep the subgrade dry, and also to support the fragments and prevent them from being broken, and which will act physically and possibly also chemically to bind or cement the fragments into a single more or less solid mass. The proper binding of the stone is the most important part of the construction of a broken-stone road.[34]

That clay was used as the binder material on the carriage roads, as specified, is confirmed in a letter from A. E. Clement to Rockefeller in which Clement writes, "[t]he teaming of this date was for hauling clay for a binder . . . which was put on with the rock."[35] Clay was not considered to be the ideal binding material. While it is cheap, easy to apply, and will give a smooth road without rolling, it is easily affected by water and frost, and likely to be very dusty in dry weather, and muddy in

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[32]Specifications, 4.

[33]Baker, 218.

[34]Baker, 229.

[35]A. E. Clement to John D. Rockefeller, Jr., December 1, 1916.

wet weather.[36] Because clay dissolves in rainwater over time, its binding effect will eventually be lost and the stones will loosen or "ravel." This condition has occurred on the carriage roads, where the original hard, smooth surface has become loose, in many locations.

The preferred binder material was rock dust or screenings, the finest product of the stone crusher, from ½- or ¼-inch to dust.[37] The preferred stone for binder material was "trap rock,"[38] a generic term for extrusive igneous rock such as the dolerites and basalts.[39] Limestone has excellent cementing properties, but it often lacks toughness; granite (which is most available on Mount Desert) is strong but lacking in cementing properties. Sources do not agree on the use of granite dust to bind broken-stone roads. One source reports that "the screenings crushed from granitic rocks and from gneiss have in some cases been successfully used to bind the crushed rock from which they were screened. In other cases, during 1901, perfect results have been obtained from granite screenings which would not 'bind' by mixing with them an equal quantity of carefully-chosen local

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[36]Baker, 229.

[37]Baker, 230.

[38]Judson, 160.

[39]Joseph M. Trefethen, *Geology for Engineers*, (New York: D. Van Nostrand Co. 1959), 63.

sand."[40] Another source states, however, that "Sand and gravel may be employed to fill the voids, but very little if any clay or loam should be used. Crushed granite should never be used."[41]

The carriage road specifications go on to require that the surface be rolled "when wet with a roller not less than 2 tons in weight."[42] Rolling was an extremely important part of the construction of the broken-stone road. The top layer, in particular, was rolled to "pack or bind the pieces into place, to prevent their being knocked out by the horses' feet. Rolling accompanied by sprinkling is necessary also to work the binding material into the interstices so as to make the surface watertight."[43] The specifications' requirement that the surface be rolled "with a roller not less than 2 tons in weight" suggests that a horse-drawn roller (Figure F.-top) was used in the early road construction. When the specifications were revised for work on the Park land in 1922, this was changed to a ten-ton roller, which would have been a steam road roller (Figure F.-bottom and Figure G).

If the surface layer is of the correct composition and is thoroughly rolled, it will produce a smooth, hard, waterproof

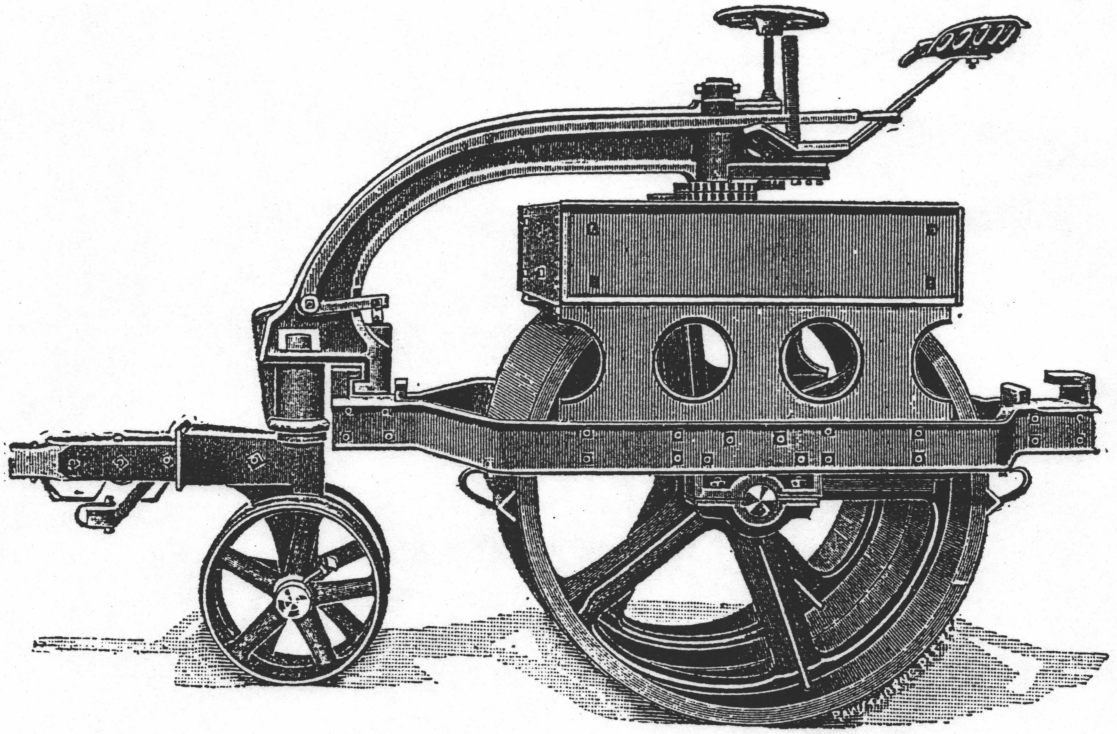
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[40]Judson, 161.

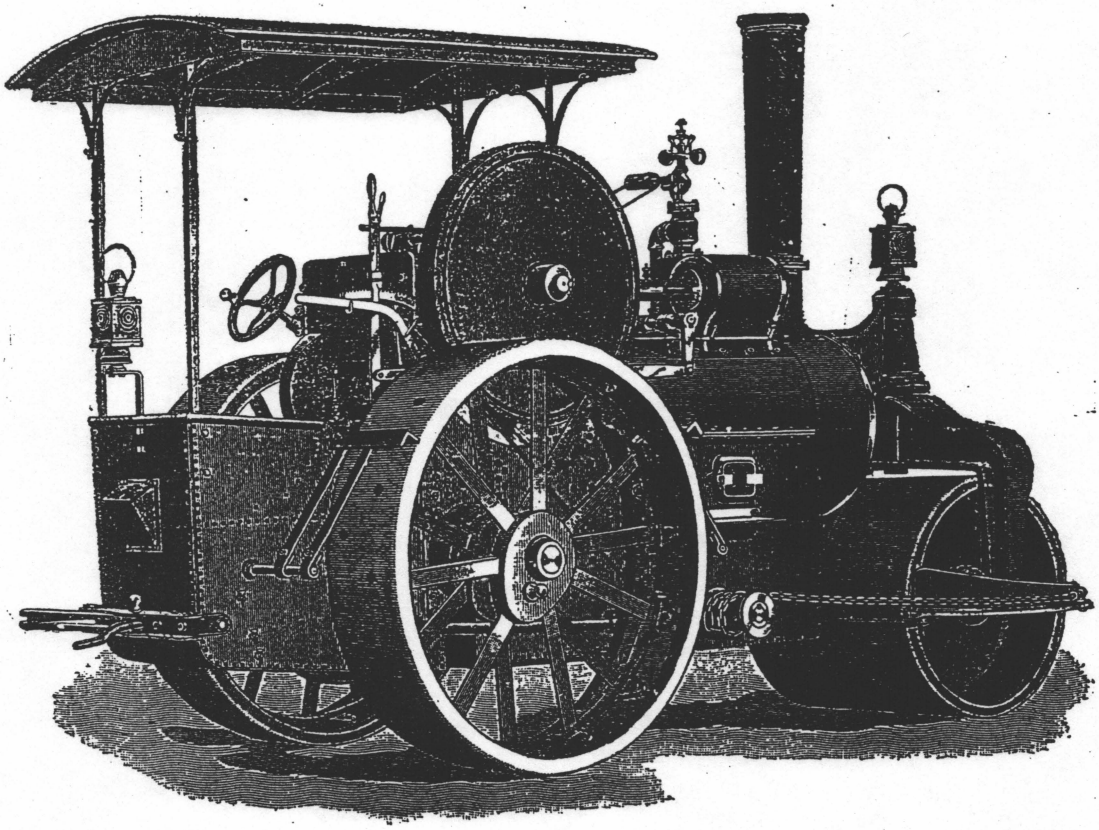
[41]Frye, 1099.

[42]Specifications, 4.

[43]Baker, 226.



—Reversible Horse Road Roller.



—Steam Stone-road Roller.

Figure F.



Figure G.

Steam Road Roller - Construction of Carriage Roads

surface which "resembles a mass of concrete, and in several places has proved to be self supporting when the earth beneath it has been washed out. . . ."[44] (Figure H.)

Even the harshest critics of the carriage roads acknowledged the quality of the engineering and surfacing. George Wharton Pepper, who led two unsuccessful campaigns against the carriage roads wrote:

> I am familiar with the [carriage] road which is intended to girdle the Sargent-Jordan Mountain. It is a very fine piece of engineering. It is wide enough for automobiles and in the finished arts has an excellent parkway surface.[45]

Gutters, Drains, and Culverts

In 1935, John D. Rockefeller, Jr., wrote to George Dorr that "my experience in road building has been that the greatest economy in maintenance is obtained by the greatest care and thoroughness in designing and constructing the drainage system." This conviction was evident in the specifications for the drainage system of the carriage roads. They stated that the gutters were to be at least 2 feet in width and deep enough to carry off the water.

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[44]Judson, 175.

[45]George W. Pepper to John A. Peters, March 17, 1924, Acadia National Park files.

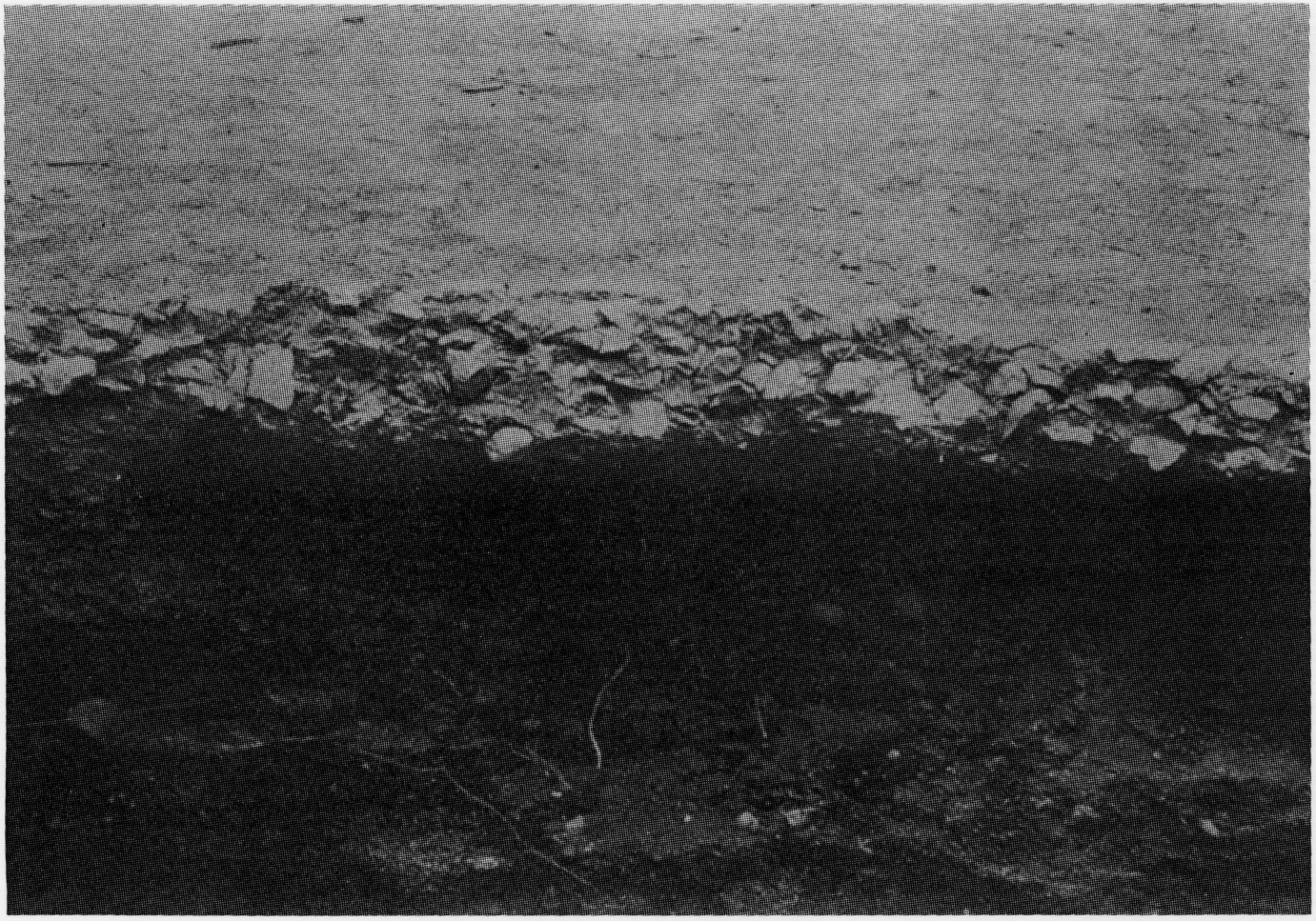


Figure H. Macadam Roadway, Six Inches Thick, Overhanging a Washout

Culverts were to be of stone or of iron pipe. If iron, they were to be at least 10 inches in diameter (this was upgraded in 1922 to 12 inches). Stone culverts were preferred and metal culverts were to be used only where there was insufficient depth for a stone culvert. Stone or concrete head walls were specified for both ends of all metal pipe. A catch basin was to be built at the entrance to each culvert, at least 18 inches square, with its bottom at least a foot below the bottom of the culvert "so as to form a receptacle for leaves and debris and prevent the stopping up of the culvert."[46] This kind of catch basin was built into the drainage systems of many cities and urban parks, but it was, and still is, very uncommon on rural roads.

Stone culverts were preferred for practical, as well as aesthetic reasons. "If a ditch drains a hillside having a southern exposure, the midday sun of winter will supply a trickle of water which will freeze at night, and under this condition such pipe culverts will soon freeze solid, and sometimes burst. . . .Box culverts of rubble masonry. . . are much preferable to pipes, being less ready to freeze and less liable to be damaged if frozen."[47] That this condition was a real concern on the carriage roads is evident in S. F. Ralston's (superintendent at The Eyrie) letter to Rockefeller in 1925:

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[46]Specifications, 5.

[47]Judson, 36.

> I went over the roads after the heavy rain fall to try and determine the cause of the damage, and found in most instances that the culverts were entirely closed with ice, some places for the entire length of the culvert. It rained many times during the winter when it was but a few degrees above the freezing point, and the rains were almost always followed by freezing temperatures, sometimes after it quit raining, the temperature fell to zero and at times to 6 and 8 degrees below zero, and the water running into the culverts, which were surrounded by frozen ground, and the frost in the culverts and the lowering temperature gradually filled them with ice. It was a condition that could not be guarded against.[48]

Culverts were designed at frequent intervals to prevent the concentration of runoff, and to interrupt the natural drainage pattern as little as possible.[49]

Retaining Walls

Retaining, slope, parapet, and breast walls of very large stones were specified. No round cobble stones were allowed. The stones were generally between 1 foot and 6 inches in thickness, and at least 4 feet in length. The walls were designed to have an 1½-inch per foot batter (or vertical slope) and be 18 inches thick at the top. As in the case of the drainage structures, the engineer was given broad authority to direct the extent and location of the walls. Retaining and breast walls were employed over long stretches of the carriage roads to prevent large cut

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[48]S. F. Ralston to John D. Rockefeller, Jr., April 14, 1925.

[49]Specifications (1922), 4.

and fill sections on side slopes. This method was employed, to disturb the terrain as little as possible and save the largest number of trees (Figure I.).

The Result

In December of 1930, Charles E. Peterson, a young landscape architect with the National Park Service, first came to Acadia National Park to make an inspection of the automobile road being constructed by the Park Service to the summit of Cadillac Mountain. The following summer, Rockefeller invited him for a drive over some of the carriage roads which he had constructed in the Park and on his own lands. Mr. Peterson, who was one of the chief designers for both the Colonial Parkway and the Skyline Drive, recalled in 1988 his impression of the design and construction of the carriage roads:

"I got a phone call from The Eyrie which said 'Mr. Rockefeller would like you to join him to drive carriage roads.' So, I got up early one morning, and he drove me. He was a good driver, loved to do it, and we spent the whole morning out. . . ."

Of the roads he said, "I admired them. . . . They couldn't have been done more beautifully. . . . They avoided damage to the

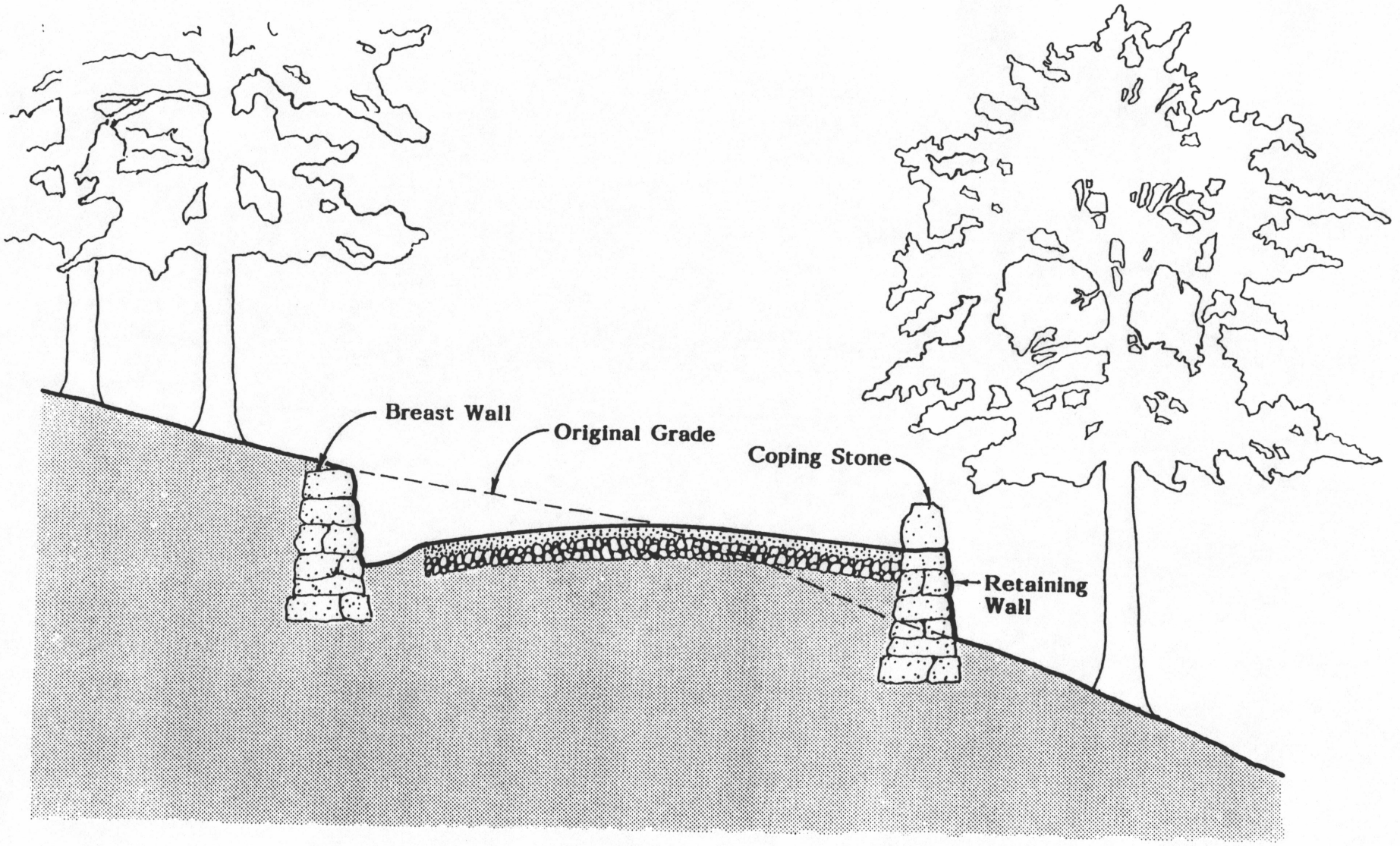


Figure I. Typical Section at Breast and Retaining Walls

landscape, they met the key points at the views, and in detail they were wonderfully done." [50]

When the carriage roads were begun, in 1913, they represented the state-of-the-art in rural road building. Carefully aligned and structurally designed, they represented a remarkable marriage of current technology with rustic detailing and respect for the land through which they traversed. By the time the last section was built, in 1940, the system was already a technological anachronism. Carriages had been replaced by automobiles. Broken stone roads had been superceded by bituminous roads. As they stand, they are a remarkable testament to Mr. Rockefeller's insistence upon high quality, his consistent vision over more than 20 years, and the talent and dedication of his engineers and road builders. They do not appear today as they were constructed, or as they were intended to be kept. They have never had the amount or type of use for which they were constructed. They are, however, a remarkable remnant of our road building history. Surely, this is the last system of broken-stone roads of this extent and quality remaining in America.

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[50]Charles E. Peterson, conversation with the author, April 15, 1988.

RESTORATION

A plan for the restoration of any section of the carriage roads should begin with a detailed analysis of the existing conditions. Where they exist, the original construction documents should be consulted. Field control points should be located to establish vertical and horizontal control relative to the original datum points. These points were set by Rockefeller's engineering crews at the time of the original construction, and are still extant. They should be used as the basis for an existing conditions survey of the section identified for restoration. The section should be surveyed, and base maps prepared showing existing elevations at the same locations as those shown on the original drawings. From this information comparative plan and profile sheets could be prepared. These base sheets would also be useful in recording problems and failures in the road structure, drainage system, retaining and breast walls or coping stones. These sheets could also be used to plot the location and limits of vista clearing and roadside cleaning. In addition, the work area should be thoroughly documented with photographs, recording the existing condition for a historic record prior to any reconstruction work.

Once the base maps have been prepared and the problem areas identified, restoration design documents can be prepared to fully describe the work. These should include plan and profile sheets,

typical cross-sections, estimates of quantities of materials, and specifications. These plans should be as complete and as carefully prepared as the original plans. The original design should guide the restoration work, although modern equipment and specification nomenclature (e.g. Maine Highway Department, AASHTO, FHWA and ASTM) should be employed in the preparation of construction documents. Plans for the restoration of Beatrix Farrand's planting designs may also be prepared with this base information in hand. While each of these plans will specifically indicate the necessary reconstruction, some of the issues that will be encountered will include the following:

DRAINAGE

The proper functioning of the drainage system is absolutely essential to the long-term preservation of the carriage roads. The fact that the roads have remained in as good condition as they have is a testament to the original design and construction of the drainage system. However, the drainage system has begun to fail in many places. There is a need for reconstruction of many portions of the drainage system, and a critical need for a higher level of maintenance, which will be discussed in the following section. An example of how maintenance and reconstruction is linked is that of concentrated runoff being diverted to the road surface. As vegetation has grown up in the ditch-lines

and culverts have silted in, runoff has been diverted across the road surface in many places, with very damaging results. Figures J. and J-1. illustrate the results of unchecked woody vegetation which has caught leaves and other debris, forming a dam in the ditch-line, and diverting runoff into the roadway, which then washed out the road surface and middle course of stone to the foundation stones. Inadequate drainage maintenance, in this case, has caused a condition which will require reconstruction of both the drainage gutters and the road itself. Proper restoration and maintenance of the drainage system will prevent this kind of destruction of the carriage roads.

Ditches or Gutters

Runoff should be determined by hydrologic calculations. Reconstruction plans would then indicate any areas in which the existing ditch section is inadequate to carry runoff from a 10 year (10%) storm. Either the ditch section or the spacing of culverts would be adjusted to assure adequate drainage. The original trapezoidal ditch shape may be efficiently reconstructed by bolting a wing attachment of the correct shape to the blade of a motor grader. Where stone-lined gutters exist, these must be repaired by hand. Where the ditch-lines have shown erosion, stone lining should be included in the restoration work. Because of the high quality of the original design and construction, the



Figure J. Unchecked Woody Vegetation in Ditchlines



Figure J-1. Runoff Diverted Onto Roadway

great majority of the work will be in restoring the drainage system to its original condition, rather than in adding new structures.

Stone Culverts

The original culverts were either stone (preferred) or iron pipe, where clearance was insufficient for stone. The stone culverts were very well built and are in generally good condition (Figure K.). Some reconstruction and repair work, however, will be required, particularly at the head walls of the stone culverts. This work should be undertaken only by a mason qualified in restoration of historic stone structures, after careful analysis of the particular structure. Unlike the roads and bridges, there are no design drawings for the stone culverts. These were designed "on the ground" by the engineer. Similarly, culvert headwall reconstruction plans can most efficiently be produced by notations on photographic, diazo reproducible images, rather than with measured drawings. Any replacement stones must be carefully selected to match the existing stone in color and character. Mortar must be designed to match the existing, with consideration being given to its appearance after weathering for several years.



Figure K. Stone Culvert

Metal Culverts

Many of the metal culverts have rusted out and failed (Figure L.). Some of these have been replaced with corrugated metal pipe. In several locations, this pipe protrudes out of the ground with no flared end-section or end-wall as originally specified. When metal pipes are replaced, consideration should be given to replacing them with concrete pipe. Concrete pipe will not rust, it is smooth, like the original metal pipe, and the ends should in any case be obscured by inlet basins, head walls, or in some cases, where a headwall would be out of view from the carriage road or any adjacent trail, by flared end sections. This pipe should be a minimum of 12 inches in diameter (or larger as determined by hydrologic calculations for a 10 year storm), properly bedded in gravel, and laid true to grade with a laser-level. Any section of the road which requires major repair, such as the replacement of foundation stones, should have all of the metal pipes replaced while this work is underway to prevent future disturbance of the road bed.

In the great majority of cases, the pipe locations should replicate those of the existing pipe. Changes should only be made where it is clearly necessary--for instance, where erosion is occurring at the outlet of the pipe, or water is standing in the ditch-line. These conditions are quite rare, because the original drainage system was so well designed and constructed.



Figure L. Rusted Out Metal Culvert

Great care must be exercised in the design of reconstructed drainage system elements to assure their consistency with the original design and construction techniques.

ROADWAY RESTORATION

The amount of reconstruction of the roadway itself will vary widely throughout the carriage road system. Some sections of the road are in almost as good condition as when they were built (e.g. section on the west side of Jordan Pond over the rock slide). Some of them are so deteriorated that they are in need of major reconstruction (e.g. some sections of the Jordan-Sargent Mountain Road, above Chasm Brook Bridge). One of the most important considerations in the restoration of the carriage roads is in working toward the proper cross-section of the road.

Crown and Superelevation

Maintenance was clearly a concern in the original design of the carriage roads. In relation to the crown of the road, Baker wrote, "With a broken-stone road, the method of making repairs has more weight in determining the amount of the crown than in the case of either an earth road or a gravel road."[49] A road which is built with relatively low crown (e.g., ½ inch per foot)

[49]Baker, 203.

requires "the system of continuous repairs" whereas a steeper crown (e.g., 1 inch per foot) may be maintained "periodically".[50]

As established in the previous chapter, these carriage roads were constructed with an ample crown of 6 to 8 inches, for the sixteen-foot roads--a slope of 3/4 inch in 1 foot to 1 inch in 1 foot. This crown has been substantially lost on much of the carriage road mileage. In most cases, this is probably the result of stone in the middle of the road having gravitated toward the edges of the road, thereby reducing the crown. If the proper crown remains on the foundation layer of stones, as designed, the road may be regraded to restore the crown.

In some instances the road is superelevated, or "banked", at the curves. Where the plans or existing conditions indicate that this was the original configuration, the road should be super-elevated instead of crowned.

In restoring the crown or superelevation of the roads, reference should be made to the vertical profiles prepared by the engineers of the road. Park Service files contain plan and profile drawings of much of the carriage road system. Bench marks, for vertical control, are still extant adjacent to the roads in many locations. By following the gradients and vertical curves of the original road, the long, smooth transitions in grade may be preserved or restored as the work progresses.

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[50]Ibid.

Foundation Stones (Lower Course of Macadam)

In some locations, the foundation stones themselves must be replaced. When this is the case, after the centerline has been established and recorded with off-set stakes, the stones should be removed to the sub-grade, the sub-grade regraded to the required crown (1 inch per foot), the sub-grade rolled with a vibratory roller to 100% compaction (Standard Proctor), and new foundation stones installed. The compacted sub-grade should be set at 12 inches lower than the finished elevation. The foundation stones will compress to approximately 70% of their loose depth.[51] That is, 10 inches of foundation stones will measure 7 inches after rolling. Additional foundation stones may be obtained, when required, from what is known locally as "blown ledge". This is broken, blasted ledge rock, quite similar to that used in the original construction, and locally available. From this material, stones which are larger than 6 inches in any dimension, or larger than 4 inches in smallest dimension, should be discarded or broken. These stones should be spread on the sub-grade to a depth of 10 inches and rolled with a vibratory roller. It is important that both the sub-grade and the founda-

[51]Albert I. Frye, *Civil Engineers' Pocket-Book* (New York: D. Van Nostrand Company, 1913), 1099.

tion stones conform with the crown, or camber, of the final road cross-section.

Middle Layer (Upper Course of Macadam)

Upon the foundation stones, and filling the interstices between them, would be spread 4 inches of smaller stones. This stone would meet ASTM grading C (100% passing a 2" sieve and a maximum of 5% passing a 1/2" sieve). Then, shape to proper crown or superelevation, roll again to 100% compaction. The 4 inches of stone will roll to approximately 3 inches. Care should be taken to conform to the lines and grades established in the restoration plans (based upon the original construction drawings, where available). The middle layer of stone can be most effectively installed with a tailgate paver such as the Layton Track Paver (Figure M.). The park currently has such a paver. When completed, the foundation and middle layers should equal 10 inches in depth, after compaction.

Surface and Binder Course

The surface and binder layers of the road should be reconstructed on most of the carriage roads. The original hard, smooth layer of the road's surface has been almost completely lost. The original clay binder would have had to have been periodically replaced to maintain the cementing necessary to

The Layton Track Paver is designed to lay asphalt, base rock, and other aggregates economically, and to maintain the high standards of quality paving set down by the contractors of our country.

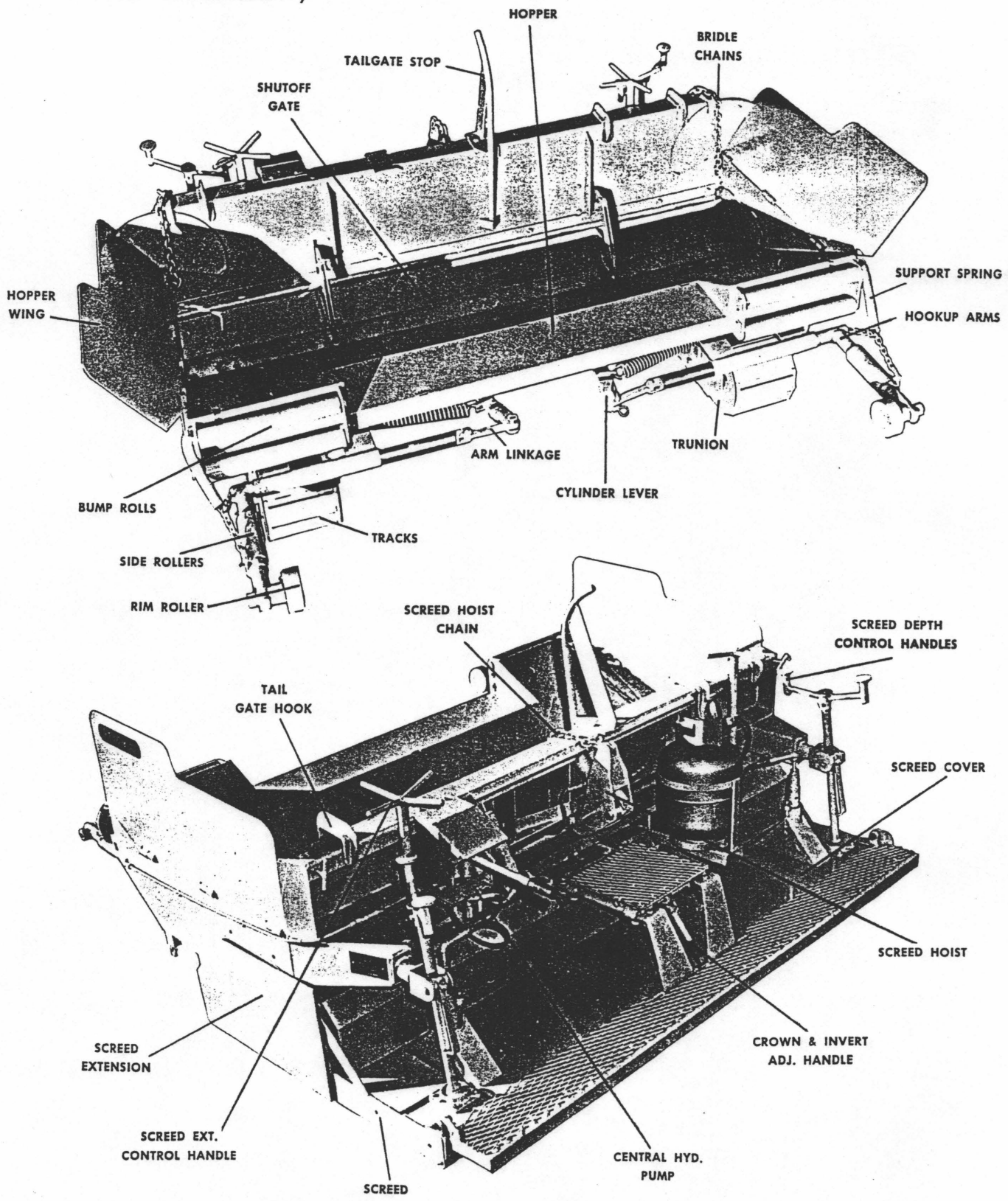


Figure M. Layton Track Paver

maintain this surface. This, of course, has not been done. The cohesion has been lost and the surface has become one of loose gravel. Sources from the early part of the century suggest that resurfacing of broken-stone roads should begin with mechanical scarification of the existing surface.[52] This is generally not necessary in the case of the carriage roads because the surface in most areas has so deteriorated that there is no top crust to break up.

Because of the temporary nature and high maintenance required to preserve the road's surface with the original surface mixture, we recommend testing variations which will restore the original appearance and utility, but will require less upkeep.

This surface layer could be constructed of granite or trap rock "crusher dust" mixed with a binder of soil cement or cementitious limestone screenings. The composition of the crusher dust, by weight, would be as follows:

100% to pass a 1/2" screen

25% to be retained on a 1/8" screen

12% to pass a #200 sieve

(This is effectively equivalent to 3/8" crusher dust as supplied by Harold MacQuinn, Inc., Ellsworth, Maine (Appendix II).
The composition of the soil cement would be:

[52]Baker, 255.

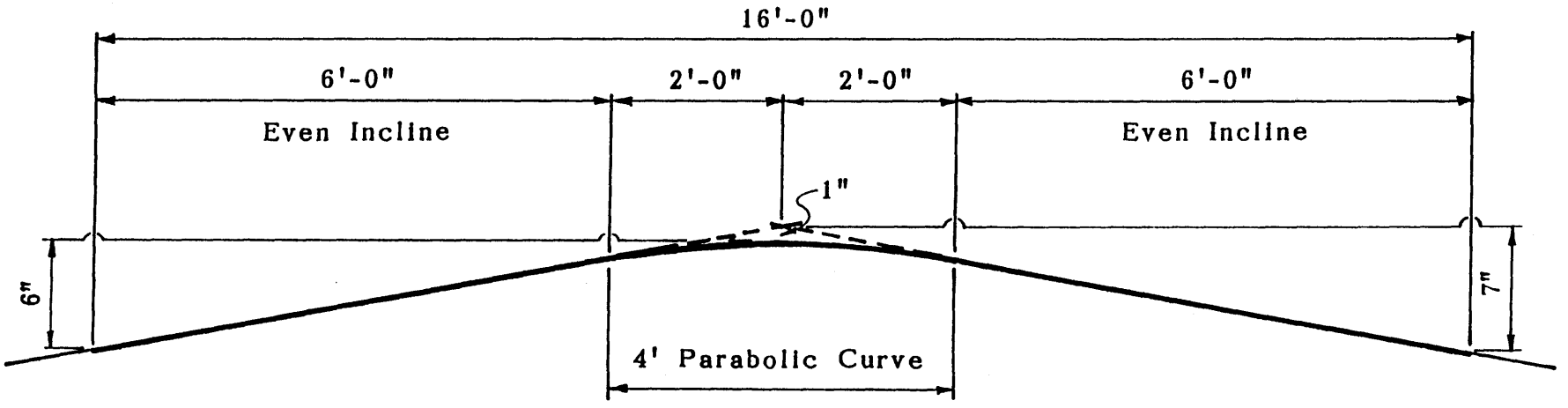
4 parts clay

1 part Portland cement

The crusher dust is to be thoroughly mixed with the soil cement at a ratio of 10 parts crusher dust to 1 part soil cement. If limestone screenings are substituted for the soil cement, common agricultural grade limestone may be used at the same 10 to 1 ratio as the soil cement.

This surface mixture, like the middle course of stone, should be applied with a paving machine such as the Layton Track Paver. Great care must be taken in the transport and application of the material to avoid segregation of the various sizes of aggregate. The spreader box should be kept at least one-half full at all times to prevent segregation of the materials.

After application, the material is to be wetted with a mixture of water and a dust retardant, and rolled to 100% compaction with a vibratory roller. The original road crown profile was a parabolic curve; however, this shape is very difficult to construct and maintain with modern construction equipment. It is suggested, therefore, to build the reconstructed sections with two simple inclined sections joined by a 4 foot rounded section in the middle (Figure N.). While the original crown was 8 inches, later drawings of the road cross-sections, current use and experience suggest that a 6 inch crown would be sufficient for drainage and more suitable for bicyclists and walkers.



PROPOSED RECONSTRUCTED CROWN SECTION

Scale: N.T.S.

Figure N.

An alternate additive to the crusher dust surface course would be the application of asphalt emulsion (CSS-1) to the surface mixture at a rate of 2½%, by weight. This mixture has been used successfully on modern macadam roads in Linn County, Iowa. This would ideally be mixed in an asphalt plant, where the emulsion can be thoroughly mixed with the dried stone in a "pug mill" mixer. The operation could most economically be performed at the beginning or ending of the asphalt plant season. This emulsion, unlike hot plant-mix bituminous concrete, does not rely on heat to liquify the cementing agent. For this reason the plant may be employed for this work when it is not in use for bituminous concrete production. The material may then be stock-piled at the Park (e.g., Liscomb's Pit) until the next construction season. This low percentage asphalt emulsion does not alter the appearance of the stone surface course, but it will greatly increase its durability, and reduce dust and maintenance. The application method would be the same as for the soil cement or limestone binder alternative. This alternative was used as early as 1927, when Hubbard and Kimball wrote:

> There are at present various methods of construction of broken stone and even gravel roads and paths with some tar or bituminous cement, which give a surface not widely different in appearance for that of ordinary gravel or macadam, but which bind the particles so firmly together that the surface will stand at a steep slope without being washed out by rain. . . .[53]

A fourth alternative would be to install the surface course of stone with no additional binder. If properly installed, and periodically maintained, this surface should give perfectly satisfactory results. While slightly cheaper in initial installation, added maintenance cost and continued dust nuisance should also be considered as a part of the long-term cost of this surface. With any of the four compositions it is important to assure that the surface course (after rolling) is kept to approximately 2 inches in depth (± ½"). Too great a depth of surface course will make the road retain moisture, and will lead to accelerated deterioration of the road.

[53]Hubbard and Kimball, 228.

Depth of Layers

Layer:	Loose Depth:	Compacted Depth:
Foundation Stones	10"	7"
Middle Layer	4"	3"
Surface Layer	2½"	2"
Total		12"

Rolling

As noted above, each of the three courses of the broken-stone road must be sprinkled and rolled. The rolling should begin at the shoulders, roll longitudinally, and work toward the center.[54] Rolling in this way prevents pushing the crown out of line or flattening it. Careful rolling is essential to obtain a good shape to the road surface. It is also important to assure that water which falls on the road will drain off the road surface rather than through it, which will saturate the sub-grade and accelerate the deterioration of the road.

After compaction and solidification using any of the compositions outlined above, the road surface will replicate the original road surface. It will be hard, smooth, and water-tight, as a proper broken-stone road should be. Bicycles and horse-drawn vehicles have been segregated on the carriage roads due to

[54]Mansfield Merriman, Editor-in-Chief, *American Civil Engineers' Pocket Book* (New York: John Wiley & Sons, 1916), 1366.

the difficulty of bicycle riding over the roads which have been dedicated to horse traffic. If the roads are properly restored and maintained, this will not be a problem. The hard, smooth surface obtained will be perfectly suitable for bicycles, horses and carriages.

Coping Stones

A remarkable and distinguishing feature of the roads built by John D. Rockefeller, Jr., is the use of coping stones along the edges of the road on steep fill sections or at the top of retaining walls. Most of these large stones have remained where they were placed; however, a significant number have become dislodged and have shifted from their original locations. Some of these have tumbled down the slopes they were intended to mark. [Figure O.]. These stones were set by drilling indentations on each side of the stones. Into these indentations the teeth of stone tongs, or "dogs" were set, and the stones lifted into place with a derrick (Figure P.). The carved depressions can still be seen on the stones. The Park still has some of the old tongs in its possession. These tongs, a small truck-mounted crane, and a knowledgeable crew, could re-set the displaced stones. A 15 cubic-foot coping stone could be expected to weigh approximately 2500 pounds.[55]

[55]National Bureau of Standards Reports.



Figure O. Displaced Coping Stones



Figure P. Stone Lifted with Crane and "Dogs"

In areas in which the roadway is to undergo restoration, the coping stones should be numbered and removed from the roadway, and reset after the road surface has been replaced, in their original positions. Attention must be paid, during both restoration and maintenance, to assuring positive drainage through the coping stones. The development of a ridge in front of the coping stones, diverting drainage over the road surface, has had damaging results in many places on the carriage roads.

VISTA CLEARING

Since vista clearing has been deferred for many years on the carriage roads, the scale of the undertaking to recapture this essential element of the roads has become one more in keeping with restoration than of maintenance. While some of the important views were documented in the Vista Study [Figure Q.], it is important to state that these views represent only a charting of important views described in written documents. The carriage roads were designed to take advantage of hundreds of sweeping and dramatic views of the lakes, mountains, bay and ocean.

The carriage roads were carefully designed to follow the shoulders of the mountains, affording views of the surrounding scenery, but avoiding the crests of the mountains, where they would become a part of the views. Today, however, most of these views have grown in. The fact that one is generally enveloped in

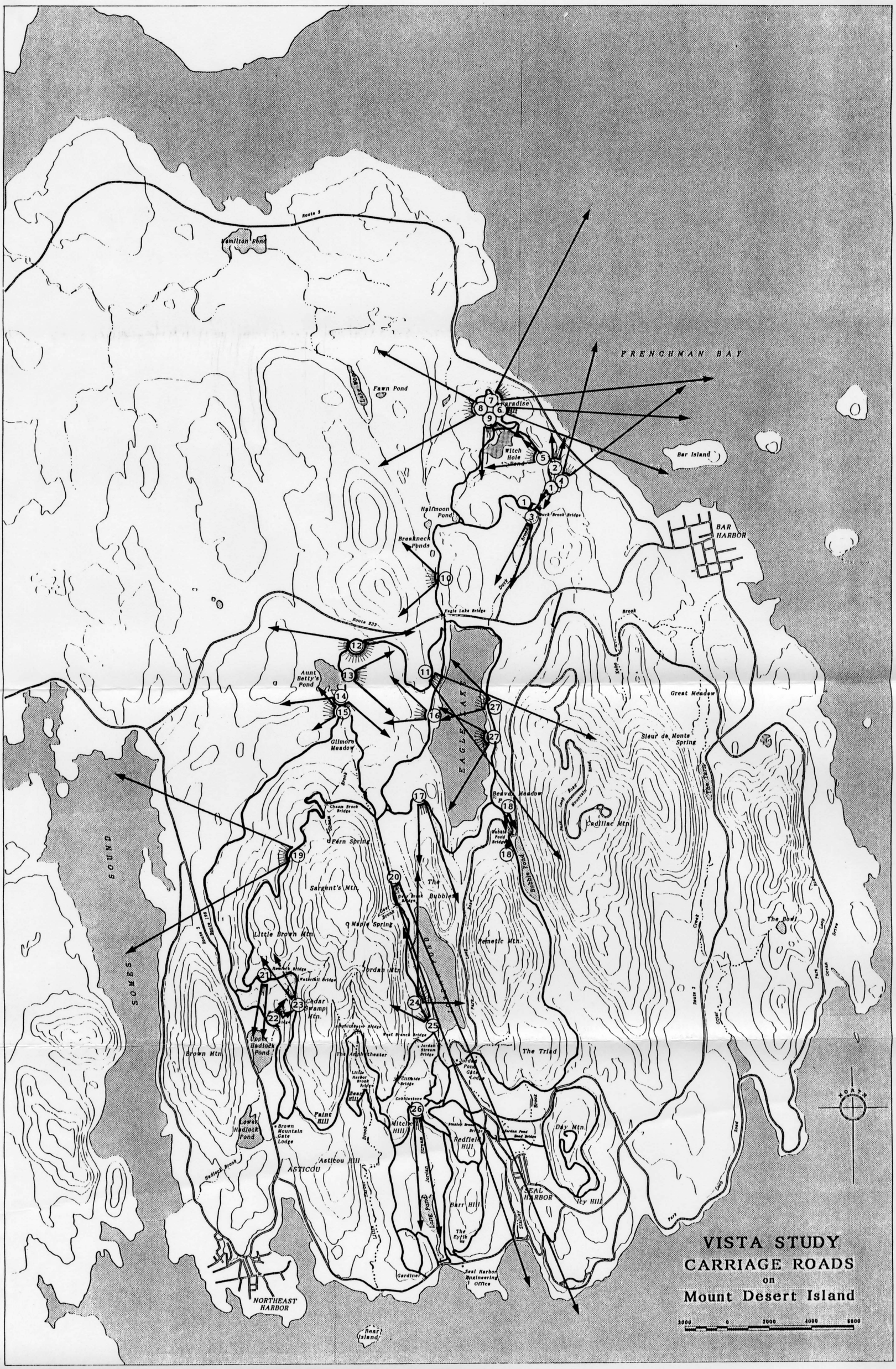

FRENCHMAN BAY
SOMES SOUND
EAGLE LAKE
BAR HARBOR
SEAL HARBOR
NORTHEAST HARBOR
ASTICOU
Hamilton Pond
Fawn Pond
Paradise Hill
Witch Hole Pond
Bar Island
Halfmoon Pond
Breakneck Ponds
Aunt Betty's Pond
Gilmore Meadow
Great Meadow
Sieur de Monts Spring
Beaver Meadow
Cadillac Mtn.
Fern Spring
Sargent's Mtn.
The Bubbles
Maple Spring
Little Brown Mtn.
Penobscot Mtn.
Jordan Mtn.
Cedar Swamp Mtn.
Upper Hadlock Pond
Lower Hadlock Pond
Brown Mtn.
Paint Hill
Asticou Hill
Mitchell Hill
Redfield Hill
The Triad
Day Mtn.
Sea Hill
Barr Hill
The Forth
Gardiner
Bear Island
Seal Harbor Boatmooring Office
Brown Mountain Gate Lodge
Eagle Lake Bridge
Route 233
Route 3
VISTA STUDY
CARRIAGE ROADS
on
Mount Desert Island
3000 0 2000 4000 6000

Figure Q.

a tunnel of vegetation when on the carriage roads does not increase their appeal as a destination for Park visitors. An aggressive and effective vista clearing program is an essential element in any effort to increase visitor use of these roads.

The location, limits, and techniques for vista restoration must be as carefully considered as the other elements of the carriage road restoration. It is essential to reopen, as soon as possible, the documented vistas as well as the views from many of the bridges (Figure R.). The clearing from the bridges would serve two functions. One is to open views from the bridge, the other is to allow better views of the bridges themselves. On many of the bridges, turnouts were designed to afford prospects of the bridges. In many cases these views are now completely obscured by trees.

This is not to say that all of the trees in a certain view-shed should be cut. Great care was taken to save handsome trees in the original construction of the carriage roads, bridges and gate lodges. The relative importance of vegetation and views must be balanced within the context of an overall design for a sequence of views of varying character. Vista clearing designs should be developed and used as a guide for establishment and maintenance of important views over the years. Such plans have been used effectively in the management of parkways like the Blue



Figure R. Obstructed View from Chasm Brook Bridge

Ridge Parkway for years. All vista plans and on-site decisions should be made with the assistance of Park landscape architects.

The maintenance of the vistas on the carriage roads may be aided by the selective removal of plants, favoring sun-loving shrubs. Once established, these plants will shade the ground and retard the development of non-tolerant pioneer tree species, while remaining low enough to permit views over.

The importance of keeping the vistas open was emphasized in 1988 by landscape architect Charles W. Eliot, II, author sixty years earlier of *The Future of Mount Desert Island*. He wrote:

> The tree growth--with no forest fires since 1949--is changing the island and Park from Champlain's "Isle de Monts Deserts"--the hills kept bare by the forest fires set by the Indians to foster the berry crops--to the "Island of Wooded Hills." Since we certainly do not want and must prevent and fight any forest fire, we will have to cut the trees blocking those views.[56]

[56]Charles W. Eliot, II, Letter to the author, November 27, 1988.

PLANTING RESTORATION

One significant attribute of the carriage roads which was substantially lost in the 1949 fire was the planting done on the recommendation of Beatrix Farrand. She was a well-known and respected landscape architect and longtime resident of Mount Desert Island. It was her advice Rockefeller sought when planting design was needed to knit the new roads back into the landscape. She, like Rockefeller, was meticulous in her attention to detail and their correspondence (with her accompanying notes) documents a carefully planned, extensive planting design which framed important views, provided a setting for the gate lodges and bridges, and enhanced the experience of travelling along the roads. Since sufficient information is available to recreate this planting, restoration is recommended for two reasons: First, the planting was the final step in Rockefeller's plan for the development of the carriage road system, and its implementation was the crowning touch. Second, Beatrix Farrand's work continues to play an important role in the history and development of landscape architecture as a profession. Her work at Acadia is the only example of her talent as it was applied in a national park setting. If this restoration is undertaken, it is suggested that first priority be given to the bridge planting plans.

SUPPLEMENTARY CONSTRUCTION

While the great majority of the construction work needed on the carriage road system is in restoration of the original road system, the current use of the roads would suggest some associated projects. One is consideration of a redesigned access from the Wildwood Stable to the carriage road. The makeshift connection which exists now makes for a very difficult turn to get to the stables, and generally lacks the quality of the carriage road system. Another example is the parking area off of the Brown Mountain Road north of the Brown Mountain Gate Lodge. There is no sign which indicates that there is an entrance to the carriage roads at this point, and the connection itself is very rough and narrow. This is a convenient access point to one of the more spectacular sections of the carriage roads--that along the northwest flank of Sargent's and Little Brown's Mountains. More direct and commodious connections to the carriage roads should be made from two Park buildings which have been constructed since the carriage roads were completed: the Park Visitor Center, and Park Headquarters.

When the Park Loop Road was realigned at the north end of Bubble Pond in the 1940s, the alignment was moved away from the carriage road overpass (Bubble Pond Bridge). This bridge is now a relic with no function (Figure S). The carriage road now crosses the Park Loop Road on grade at one of the tightest curves



Figure S. Abandoned Road at Bubble Pond Bridge

on the road. This presents a dangerous conflict between automobile traffic and the bicycle, equestrian, and pedestrian users of the carriage roads which will become increasingly hazardous as use of the carriage roads increases. Plans should be considered to construct a new carriage road bridge, consistent in style and materials with the other carriage road bridges, over the realigned Park Loop Road.

A more ambitious project, but one which would be of great value in making the carriage roads more accessible to more visitors, would be completion of the leg of the carriage roads planned by Rockefeller which would connect Bar Harbor to Eagle Lake. Two alignments were established (Figure T.) by Walter Kidde, Constructors, under the direction of Rockefeller and with the assistance of Frederick Law Olmsted, Jr. The design drawings still exist and both lines are completely within Park boundaries. Construction of one of these roads (or a 12' wide version) would greatly aid the visitor in gaining access, by foot, bicycle, or cross-country skis, onto the carriage road system. Further, it would fulfill the dream of John D. Rockefeller, Jr., of connecting the villages of Bar Harbor, Seal Harbor, and Northeast Harbor with a beautiful system of motor-free sylvan roads. While priority must be given to conservation and restoration of the existing carriage roads, as visitation in the Park continues to

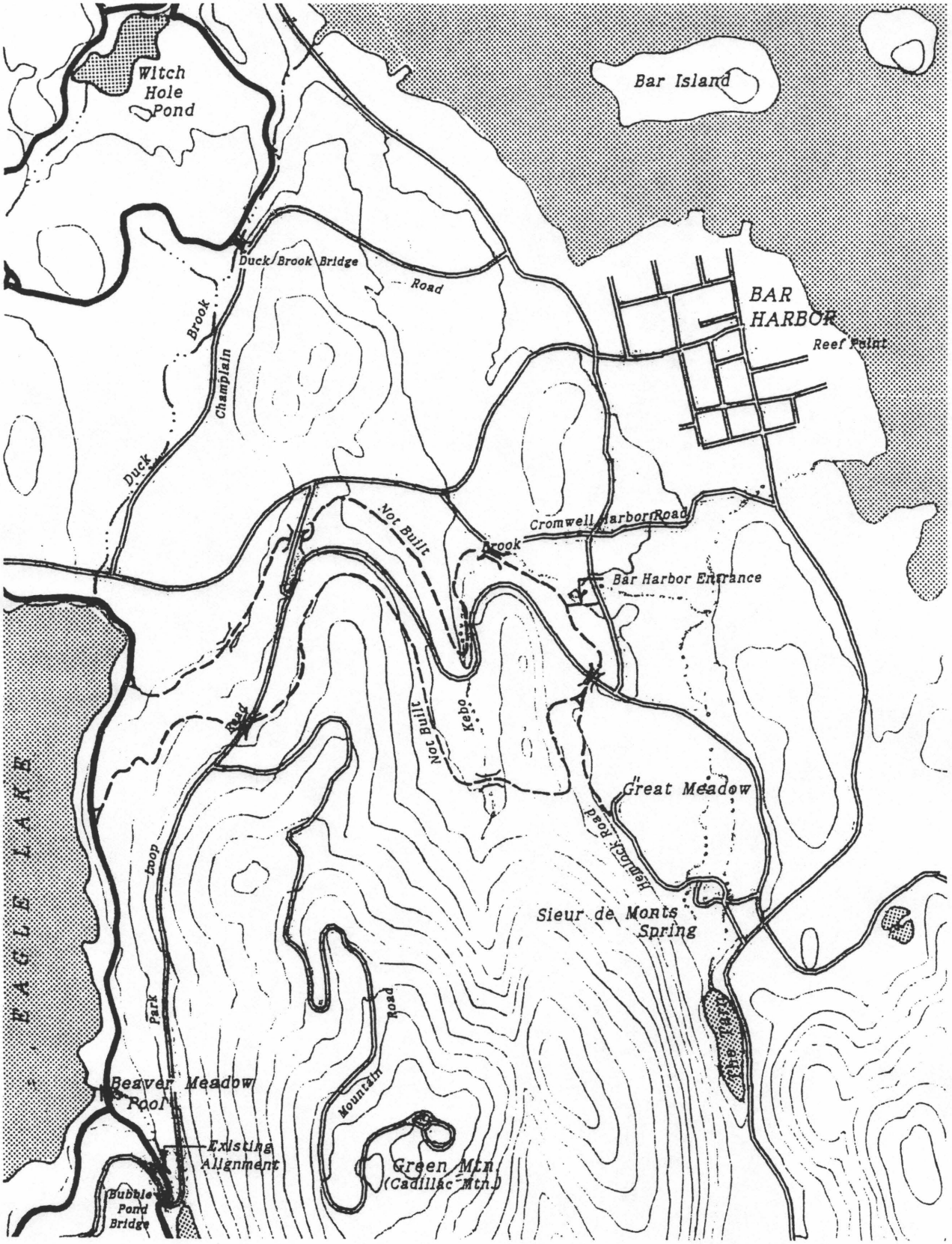


Figure T. Unbuilt Kebo Valley Roads

increase, the completion of this final link in the system would provide a much needed access point from Bar Harbor.

COST

The cost for restoration of the carriage roads will vary greatly based on location and condition of the given section. Estimates have been prepared for a "typical" section which would require repair (not complete replacement) of the foundation stones, regrading and addition to the middle layer, and replacement of the surface layer. Also included is repair of stone ditch-lines, culverts, breast walls and retaining walls, and resetting coping stones. Costs for research, design, field engineering and construction inspection have also been included (Appendix III).

These figures should be used for general preliminary planning only. Specific cost estimates should be prepared as plans are developed for each project and actual quantities can be calculated. Projections for cost were based on general hourly rates by private contractors. Savings could be anticipated if the work is accomplished by Park personnel.

It is highly recommended that a demonstration project be identified for restoration. The project should be selected on the basis of need and the range and extent of reconstruction necessary. It would be most useful to test different restoration

methods on different sections (e.g., surface course with stone dust binder in one area and soil cement binder in another) and carefully monitor the time and expense on each section. This will give Park administrators a more firm basis on which to phase the complete restoration of the carriage road system.

WORK FORCE

With all public work, it is necessary to determine the quantity of work to be performed by private contractors and that to be performed by in-house work force. In the case of most road construction or reconstruction, this work would typically be undertaken by private contractors, with the subsequent maintenance undertaken by public maintenance crews. In the case of the carriage roads, there are compelling arguments for the restoration work to be undertaken by Park personnel.

Broken-stone roads of this type have not been widely built by private road contractors for more than a half a century. It is now a specialized type of historic restoration. It requires a specially trained group of craftsmen. This requirement does not answer well to the competitive bidding requirements of government contracting.

While the use of modern construction equipment will aid a great deal in the restoration of the carriage roads, the scale and construction methods necessary for this restoration work do

not lend themselves to the kind of large-scale road construction equipment typically employed on road construction work today. A front-end loader, small dump truck, motor-grader, back-hoe, derrick truck, water truck, tail-gate track paver, vibratory roller and hand tools are the only construction equipment necessary for this restoration work. The Park currently owns most of the necessary equipment.

The Park maintenance staff includes personnel who are knowledgeable, skilled, and committed to the proper restoration and maintenance of the carriage roads. While current funding limitations make it impossible for this staff to appreciably slow the deterioration of the roads, much less restore them, it is a group from which the core of a restoration team should be formed. Because the Park maintenance staff cannot lose personnel and continue to perform its other work, this approach to the restoration of the carriage roads would mean adding maintenance staff equal to the size of the carriage road restoration crew.

MAINTENANCE

Present Condition

As discussed in the previous chapter, the present condition of the carriage roads is, in many ways, very different from their original and intended state. The binder has eroded away, the crown has been lost, vegetation is growing in the ditch-lines, and in some cases the drainage system has failed to the point where water now runs down the surface of the road, exposing the foundation stones. Coping stones have been lost. Vistas have grown over. Much of the carriage road system is in need of reconstruction more than it is of repair. Once the carriage roads have been restored, it is essential that an adequate level of maintenance be undertaken to preserve them in an attractive and serviceable condition. In the areas where restoration cannot be undertaken at once, it is even more imperative that the roads be maintained to prevent further deterioration. An adequate maintenance program will include attention to the following concerns:

Ditches

One of the most pressing, and fortunately easiest to accomplish, tasks is that of cleaning and shaping the ditch-lines. The ditches (or "gutters", as they were described in the specifications) should be kept clean and free of woody

vegetation. Cleaning and shaping the ditch-lines with a motor grader where woody vegetation is becoming established, would be the most cost-effective method. Once properly shaped, hand pruning of the woody vegetation in the ditches would be sufficient for several years, allowing the grass and mosses to grow. Removal of woody vegetation in stone-lined ditches must be accomplished by hand. In this case, the vegetation should be cut close to the ground, rather than pulled, to avoid damage to the stone work. The use of safe and N.P.S. approved herbicides could assist greatly in controlling woody vegetation which sprouts from the roots after being cut (e.g., maples).

Care should be taken to conform to the original profile of the ditch-line. Many of the ditches were designed as a trapezoidal section, with a one-foot flat section on the bottom of the ditch [Figure U]. Because the hydrologic characteristics of a trapezoidal ditch is different from a "V" ditch (i.e., the water runs slower and causes less erosion in a trapezoidal ditch), this type of ditch should be restored and retained. A custom blade can be fitted on a motor grader which will form the typical trapezoidal ditch, as originally designed. After reshaping, the ditch-lines should be seeded with grass (shade tolerant varieties, where necessary).

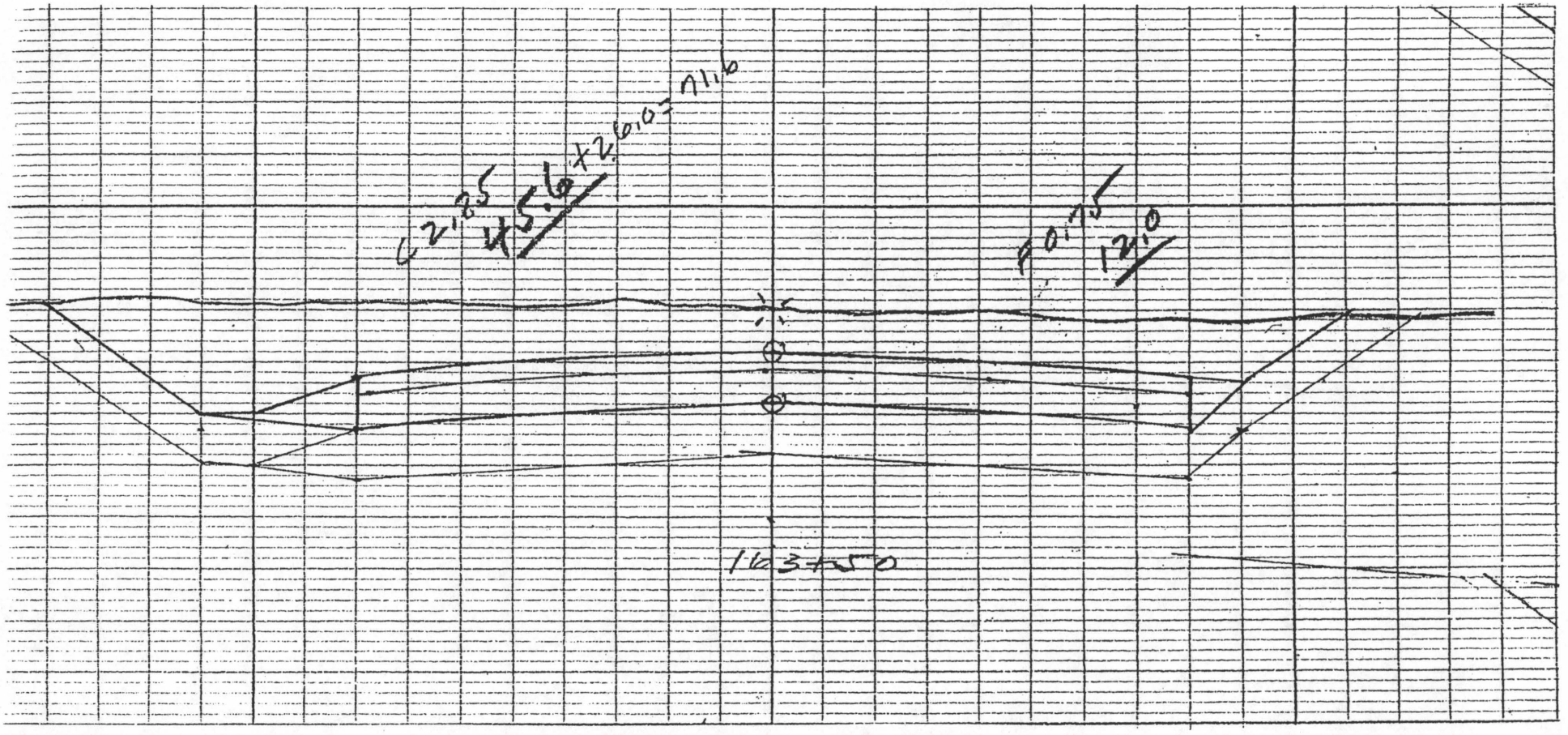


Figure U. Aunt Betty's Pond Road
Section showing crown and ditch profiles.
Drawn by Paul D. Simpson, 1930.

Culverts and Catch Basins

Both stone and metal culverts should be kept free of silt and accumulated vegetation, as should the catch basins at the inlet of culverts. This routine maintenance should be scheduled to occur twice per year--ideally once during the spring or early summer, and once during the autumn, after the majority of leaves have fallen from the deciduous trees.

While the manual labor of cleaning culverts and catch basins can be accomplished by seasonal labor forces, each crew should contain one maintenance employee knowledgeable about the drainage system, including outlet protection, ditch lining, and stone culvert construction, so that the entire drainage system can be inspected during the routine maintenance.

The original culverts were either stone or iron pipe, The stone culverts were very well built and are in generally good condition. Some repair work, however, will be required, particularly at the head walls of the stone culverts. This work should be undertaken as part of restoration, rather than maintenance, work.

As previously reported, many of the metal culverts have rusted out. Some of these have been replaced with corrugated metal pipe. In several locations, this pipe protrudes out of the ground with no flared end-section or end-wall as specified. These pipes should be replaced as a part of the restoration work.

When this work must be done in advance of the restoration work, consideration should be given to replacing the deteriorated metal pipes with concrete pipe. The concrete pipe is smooth, like the original metal pipe, and the ends should in any case be obscured by inlet basins, head walls, or in some cases, by flared end sections. This pipe should be a minimum of 12 inches in diameter (or larger as determined by hydrologic calculations for a 10 year storm), properly bedded in gravel, and laid true to grade with a laser-level.

During routine maintenance all metal pipes should be checked at the outlet end to see if drainage is following a path under, rather than through, the pipe. This indicates pipe failure, and the pipe should be replaced. Any section of the road which requires major repair, such as the replacement of foundation stones, should have all of the pipes replaced while this work is underway to prevent future disturbance of the road bed.

Stone catch basins were originally placed at the inlet of most of the culverts. These functioned by collecting debris and natural litter. Most of these catch basins, which were originally typically 18 inches deep, have largely silted in. These should be cleaned out at least once per year to guard against future siltation of the pipes.

Crown and Superelevation

Maintenance was clearly a concern in the original design of the carriage roads. In relation to the crown of the road, Baker wrote, "With a broken-stone road, the method of making repairs has more weight in determining the amount of the crown than in the case of either an earth road or a gravel road."[57] A road which is built with relatively low crown (e.g., 1/2 inch per foot) requires "the system of continuous repairs" whereas a steeper crown (e.g., 1 inch per foot) may be maintained "periodically".[58] As established in the previous sections, these carriage roads were constructed with a crown of 6 to 8 inches, for the sixteen-foot roads--a slope of 3/4 inch in 1 foot to 1 inch in 1 foot. After restoration of the proper foundation, middle and surface layers of the road, this crown (or superelevation for the banked curves) may be maintained by annual grading of the surface layer, pulling the material which has migrated to the edges back to the center, smoothing, sprinkling, and rolling. As is the case with new construction or restoration, the rolling should begin at the edges of the road and work to the middle. The road should always be sprinkled with water, or a mixture of water and dust retardant prior to rolling, with a 3-5 ton vibratory roller. If the proper crown remains on

[57]Baker, 203.

[58]Ibid.

the foundation layer of stones, as designed, the road may be regraded to restore the crown.

In sections where the middle layer of stone has migrated to the surface, presenting a rough surface which becomes loose or "ravels", this may be alleviated by the application of a thin layer of surface material (as specified in the Restoration section) filling all depressions, sprinkling, and thorough rolling with a vibratory roller. The best time to accomplish this work is in the early spring, after the frost has gone out of the ground.

Routine maintenance will be required after the new surface has been repaired. Horse dung, vegetation, and loose dust must be removed from the road surface periodically. If allowed to stand on the road, they will eventually soften the road surface and cause deterioration of the road.[59] Horse manure should be scraped to the edge of the road and removed from there periodically.

While literature of the period recommended removal of all vegetation from the surfaces of broken-stone roads, Rockefeller modified this approach somewhat. He wrote to Clement in 1919:

> I am wondering whether you are having the small seedling trees and berry vines and bushes pulled out of the traveled surfaces of all of my roads, as you and I agreed. You will recall we decided that wild flowers

[59]Baker, 251.

and things of that sort might be left, but that the seedling trees and berry vines should be pulled up.[60]

Coping Stones

A remarkable and distinguishing feature of the roads built by John D. Rockefeller, Jr., is the use of coping stones along the edges of the road on steep fill sections or at the top of retaining walls. Most of these large stones have remained where they were placed; however, a significant number have become dislodged and have shifted from their original locations. Some of these have tumbled down the slopes they were intended to mark. In areas where the restoration work will be minor, or where it must be deferred for several years, these stones should be replaced. Using the method described in the Restoration section, employing the old stone "dogs" in conjunction with a modern small truck-mounted crane, a knowledgeable crew could replace the displaced coping stones, redressing one of the most obvious signs of disrepair on the carriage roads.

[60]John D. Rockefeller, Jr., to A. E. Clement, October 28, 1919.

Dust Control

Broken-stone roads, particularly if they suffer from a lack of proper maintenance, are by nature dusty. This is no more than a nuisance for a single carriage travelling along the roads because most of the dust is left in its wake. It is a more serious problem, however, when carriages/buckboards are run in groups because it raises the level of dust and therefore creates an annoyance and a health hazard for both people and horses. While getting dusty is certainly part of the experience of being on the carriage roads, an excessive amount can also limit the enjoyment of visitors who choose to take a buckboard ride while at the Park.

The traditional method of dealing with this problem was by sprinkling the roads with water. In 1917, the year the Cobblestone Bridge was built, the Seal Harbor Village Improvement Society spent almost $1400 on road sprinkling, three times as much as for the next highest expenditure, path construction and maintenance. (Two notable members of the Road and Path Committee of the Seal Harbor V. I. S. in that year were John D. Rockefeller, Jr., and Alanson E. Clement, Rockefeller's chief road-builder.)[61]

[61] *Seventeenth Annual Report of the Seal Harbor Village Improvement Society* (1917), 10.

While park drives and city streets were commonly sprinkled, cost prevented wide use of sprinkling on rural roads. It was estimated in 1913 that it would cost $75.00 per mile annually to sprinkle rural roads.[62] This is the equivalent to nearly $900.00 per mile annually in 1988 dollars.

Using proper materials for the surface of the carriage roads and correct grading and compacting the surface will in help control the dust, as will limiting the use of vehicles with rubber tires. The destruction of broken-stone roads by rubber tires was well known to Rockefeller. A letter from Paul Simpson to Rockefeller stated that " . . . [r]apidly moving light vehicles are very destructive to untreated surfaces on account of the suction of the rubber tires - which draws out the binding material and causes the surface to disintegrate."[63]

In areas where the roads will be used heavily, however, the use of a dust palliative or retardant could be considered. Retardants such as calcium and sodium chloride should not be used--they are soil mobile salts which absorb moisture, and are harmful to both plants and stone bridges. There are also some fears that they contaminate both surface and groundwater and their use has been greatly curtailed. Some dust retardants,

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[62]Baker, 250.

[63]Paul D. Simpson to John D. Rockefeller, Jr., June 11, 1927, personal collection, Mr. and Mrs. Charles P. Simpson.

though, are environmentally safe if they are designed to be non-leaching. In other words, after dilution with either fresh or salt water, they are non-toxic upon application (Appendix IV).

Such retardants work by binding together the fine particles of the road surface to prevent them from saltating, or being put in motion by the action of the wind relatively close to the ground surface. It is saltation and mechanical disturbances such as traffic which suspend the soil particles or, in other words, make a road dusty. The balance of fine and coarse particles provides the cohesiveness necessary to resist saltation and the effects of wheels. Generally, two applications of a dust retardant will compact road surfaces so that traffic can move at normal speeds without stirring up dust.

Application rates and procedures vary from site to site. For example, steep grades or tight curves would require several light applications. Once the area to be treated is studied to determine the correct rate and procedure, equipment needs are assessed. Generally, a water truck, with minor modifications, can be used to apply the retardant. Additional equipment will be necessary to prepare the surface before the application of the retardant and to compact it afterwards. The top 2 inches of the road need to be in a loose, moist condition. The loosening is usually accomplished by blade-grading and shaping the road; a water wagon could supply the moisture necessary to hold the dust

retardant and encourage compaction. The use of a vibratory roller would then be employed to compact the surface.

Under normal circumstances, manufacturers indicate that the first treatment will be effective for 6 to 10 months, and every treatment thereafter for approximately one year. If undisturbed by traffic, the initial application could last as long as three years.

Vista Maintenance

The first step in establishing a program for vista clearing and maintenance is determining the important vistas which need to be maintained and/or enhanced. As outlined in the second section of this report, the plan for the carriage roads is a good place to start. Rockefeller and both Simpson had a keen understanding of how to align roads with the topography to take advantage of scenic views; and they applied their knowledge as the carriage roads on Mount Desert Island were laid out. Studying the topography and the alignment of the roads gives a clear indication of where vistas were planned. Many of these, as noted, are documented in the correspondence between Rockefeller and the Simpsons, and also with Farrand. The documented vistas discovered in the correspondence are shown on Figure Q; however, it should be stressed that these are not the only planned views or important opportunities for vistas. It is significant that

several of the carriage roads were designed to occupy the shoulders of the mountains so that fine views might be obtained from these heights. If dense vegetation obscures these, the intention of the original location is lost.

That periodic clearing of the vistas was an important maintenance activity to Rockefeller is confirmed in a letter to his superintendent at The Eyrie in 1954:

> . . . [A]long the various of the horse roads, particularly up the Long Pond Valley and over along the Southern slopes of Jordan and Sargent, views of the sea and mountains cut some years ago are gradually being obliterated by new growth. These views originally cut are important additions to the enjoyment of the roads which traverse those areas and should be reopened where necessary.[64]

Once these vistas are re-established, the key to maintaining them is vigilance. An annual inspection would provide the opportunity to note encroaching vegetation and make plans for its removal before it becomes overgrown and therefore more difficult to eliminate. Removal of trees, but retention of sun-loving shrubs which do not obscure the vistas, will retard the invasion of pioneer tree species. Routinely removing underbrush and seedlings from designated vistas would thus prove efficient in the expenditure of both manpower and money. In several instances the location selected for the carriage roads has aided in vista maintenance. Some roads were designed to pass the up-hill side

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[64]John D. Rockefeller, Jr., to Robert DeRevere, October 21, 1954.

of large flat outcrops on which very little vegetation grows (e.g., Asticou-Jordan Pond Road on south side of Faint Hill). In these locations, very little additional vista clearing is necessary to maintain important views.

While much of the maintenance work needed on the carriage roads must be done in a relatively warm time of the year, vista clearing and maintenance can be effectively accomplished in the winter. When the leaves are off of the trees it is easier to see the opportunities for vistas. In addition, the noise of the necessary chain saws and chippers will disturb the solitude of fewer visitors at that time of the year. All brush and small limbs should be chipped and left as mulch.

Roadside Cleaning

One of the issues of road construction which particularly interested John D. Rockefeller, Jr., was that of roadside cleaning. He thought that the typical way in which roadsides were left after construction was an eyesore. He funded a demonstration project at Yellowstone National Park in roadside cleanup which was so successful that it became the standard for National Park Service road work. Figure V. shows the condition of the roadsides adjacent to the Eagle Lake bridge shortly after it was constructed, showing how carefully the roadsides were groomed.



Figure V. Roadside Cleaning at Eagle Lake Bridge

Charles E. Peterson, in a 1988 interview, discussed Rockefeller's attitude toward fallen trees and branches adjacent to the roadside:

> He was a very neat person. They said he had a whole team of German foresters, and that after a storm they would rush out and pick up every stick. It offended him to see it.[65]

Rockefeller wrote to Dorr in 1919 concerning the cost of construction of the carriage roads. He said, of the roadside cleaning:

> . . . I am paying . . . the very substantial cost of the extensive forestry work and clearing of dead timber, down and standing, which I always to, not only along both sides of a road but as far back as the eye can see into the woods. . . .[66]

Nearly thirty-five years later, he expressed his feeling about the margins along scenic roadways in a letter to Horace Albright, former Director of the National Park Service:

> As you know, the present trend among park men seems to be to leave nature alone. If a tree is dead, let it stand; if it blows over, let it lie--on the theory that nature should be undisturbed. While this policy is one thing if pursued in the interior of a dense forest where only the hunter goes, to pursue it in any area of a park like Acadia, . . . is to present a roadside aspect of standing and down dead timber . . . .[67]

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[65]Charles E. Peterson, interview with the author, April 15, 1988.

[66]John D. Rockefeller, Jr., to George Dorr, November 19, 1919.

[67]John D. Rockefeller, Jr. to Horace M. Albright, May 8, 1953.

The roadside, like the roadway itself, must be recognized, as Rockefeller suggested, to represent a cultural element in the landscape, with both artistic and natural components. While the hand of man should be employed with restraint and sensitivity to the natural setting, a roadside aspect of "standing and down dead timber" gives the visitor the impression of neglect more than of pristine nature. Dead timber should be cut and removed for a distance of at least 100 feet (or "as far back as the eye can see into the woods") from the edge of the roads. In addition these historical and aesthetic reasons for roadside clean-up, this maintenance activity will also serve to act as an important fire-break for fires in the understory.

Work Force

Maintenance of the carriage roads is a highly specialized area of preservation. It requires a knowledge of the construction of broken-stone roads, including proper crown, depths of the layers of stone, surface compaction and appearance, drainage system design and function, as well as skill in techniques of their upkeep . One person on a motor grader who does not understand the proper cross-section of a broken stone road can do untold damage in a very short time. It is important for the work force to know the locations of the stone lined ditches and the culverts. They should also have a knowledge of

the vista locations and extent. For all these reasons, there should be a specially qualified crew who must demonstrate a knowledge of the unique maintenance and conservation issues regarding the carriage roads prior to assignment on them. Personnel who gain experience in the restoration of some of the roads would have an excellent background to continue with their care.

Cost

The cost of maintenance may vary widely based on the level of maintenance attained. The Park is now faced with the consequences of many years of deferred maintenance on the carriage roads, and is in a position of either restoring the carriage roads, at substantial expense, or watching this remarkable resource fall further into disrepair, at a time when its attraction could greatly help ease the crowding in the Park. Once restored, it is critical that the National Park Service make the kind of financial commitment necessary to maintain and preserve this important record of our road-building history and potentially vital recreational resource.

An "order of magnitude" estimate for a proper level maintenance on the carriage roads may be projected from the records of cost of upkeep during the early years of the carriage roads, before Rockefeller established his own construction and

maintenance crews. As Appendix V. illustrates, Rockefeller spent $3,291.32 from January, 1914, to July, 1919, on "upkeep of the roads". If we presume that the cost of road maintenance rose at the same rate as road construction, and that the amount of maintenance increased directly with the amount of roadway, then this amounted to about $27,500 in 1988 dollars, or about $800 per mile, per year. At the time of Mr. Rockefeller's death a crew of 80 to 100 men were employed who ". . . felled trees and cleaned along Park roads." The would indicate a far greater cost; however, this work included more than maintenance of the carriage roads within the Park.[68]

This may be compared with estimates of average cost for yearly grading, top-dressing, rolling, ditch-line and culvert cleaning, and vista maintenance per mile of carriage road:

Motor grader w/operator	4 hr. @ $50/hr.	200.00
Vibratory roller w/operator	4 hr. @ $50/hr.	200.00
Hand work	16 hr. @ $15/hr.	240.00
Sprinkler truck	2 hr. @ $30/hr.	60.00
Dump truck	2 hr. @ $30/hr.	60.00
Top dressing (stone dust)	30 cy. @ $3/c.y.	90.00
Total		$850.00

This is virtually the same amount, when adjusted for inflation, as was spent by Rockefeller during the early years of

[68]Memorandum from Harold A. Hubler, Superintendent Acadia National Park, to Regional Director, Region Five, National Park Service, September 30, 1960, Acadia National Park Files.

the carriage roads. Until experience with a sustainable level of maintenance can provide more accurate figures, $40,000.00 to $50,000.00 per year for the carriage road system may be used as a planning budget for carriage road maintenance (above figure times 51 miles of roads). It is important to stress that this is the estimate for a proper level of maintenance after the carriage road system has been restored.

Maintenance Cost Allocation

A concessionnaire offers wagon and buckboard rides to Park visitors, leaving from Wildwood Stables. The participation of the concessionnaire in the maintenance of the sections of the roads over which the wagons and buckboards drive is of interest to the Park as future concession agreements are negotiated. As previously stated in this report, a good deal of the difficulty with the condition of the carriage roads is the result of deferred maintenance.

In the case of the area used by the concessionnaire, much of the roadway has become too rough for bicyclists or to use. This effectively dedicates an important section of the carriage roads to one use, by one concessionnaire. As previously mentioned, the proper restoration of the carriage roads will alleviate this conflict to a very great extent. A recent project was undertaken to "recondition" a section of the carriage roads used by the

concessionnaire under a Federal Highway Administration contract which included several road projects in the Park. This contract specified incorrect cross-slope, incorrect depth and material for surfacing, and incorrect ditch section. This area must be restored according to proper broken-stone road specifications before it will be serviceable for both horse-drawn vehicles and other users of the carriage roads.

It is beyond the scope of a concessionnaire's responsibility to restore deteriorated roads which have fallen into disrepair by deferred maintenance, or incorrect "reconditioning". Because of the appropriate use of the carriage roads for horse-drawn vehicles, and the desirability that these roads also be usable for bicyclists, pedestrians, and other users of the Park, it is recommended that restoration of the carriage roads in this section be given a high priority.

Once the carriage roads have been brought up to a correct condition through restoration, some of the cost of annual maintenance on the sections intensively used by the concession, should be borne by the concessionnaire. Routine maintenance, that required to keep the majority of the mileage of the roads in good condition, should be borne by the Park. This includes annual re-crowning, filling depressions as necessary, topping with screenings, rolling, ditch-line and culvert cleaning, roadside cleaning, and vista maintenance. The concessionnaire

would be responsible for maintenance to keep the road in that condition between annual repairs. The concessionnaire would have responsibility to remove manure from the road surface, repair depressions and ruts caused by his operations, and control dust. The concessionnaire could run his own water/dust-retardant truck on the roads with the permission of, and under guidelines established by the Park. The concessionnaire could be required to supply, for his own use, a small vibratory compactor to repair small areas of the road damaged by his operations.

All major maintenance work on the roads should be accomplished by Park maintenance staff specially qualified to work on the carriage roads, as discussed above under Work Force. This includes all grading, rolling, and vista clearing. When the operations of the concessionnaire necessitate additional grading or rolling on the sections used by him, above that normal for the other carriage roads, the work should be done by trained Park personnel, and the cost passed on to the concessionaire through his concession or permit agreement with the Park.

USE

Carriages

When Rockefeller built the carriage road system, he envisioned its use by those who enjoyed both the social and the sporting aspects of carriage driving. At the turn of the century, technological advances resulted in the development of carriages which were easier and fun to drive. The sport of pleasure driving was an outgrowth of this phenomenon. Many chose to spend their leisure time taking a drive through the countryside or in the park. Carriage driving was also considered a form of outdoor exercise. It took great skill and strength to maneuver a horse and carriage, particularly a four-in-hand which was a team of four horses pulling a large coach or carriage. Rockefeller was said to be better than his coachman at driving either a pair or four-in-hand. He was an excellent horseman who loved the out-of-doors. He also anticipated that the sport of carriage driving would increase in popularity. Therefore, he took great care to ensure that the carriage roads were designed to accommodate both large and small carriages. For example, the roads themselves were the proper width, and the bridges were sufficiently high to allow for the passage of a coach.

Every summer, Rockefeller transported his fleet of carriages from his estate in New York's Hudson River Valley to his estate in Seal Harbor. Carriage-driving, however, never developed the

popularity Rockefeller and others expected. Even the buckboards used by Bar Harbor hotels to take people for rides ceased operation. Nevertheless, carriage clubs still exist. Many continue to enjoy the sport and would relish the opportunity to take advantage of an uninterrupted, 51-mile system of carriage roads. The popularity of the current carriage concession is an indication that many visitors enjoy the opportunity to experience the carriage roads by carriage. Since the roads were specifically designed for this purpose, accommodating and encouraging this use seems wise.

Before Rockefeller's roads were built, buckboards were already popular on Mount Desert Island. Many enjoyed open-air rides to popular Island spots. Their approach was more rustic, however. They preferred a less convenient trip and a more "natural" experience of the wilderness. Rockefeller aimed for a more refined use of the roads. They were planned and engineered and did not have the character of a rustic path through the woods. Those who preferred the Island's original setting lobbied hard against the roads and lost. If the carriage roads are properly restored and maintained, the large buckboards of this era would not damage the roads. (Haywagons with rubber tires should not be allowed. Their inappropriate appearance, coupled with the destructive nature of rubber tires on broken-stone roads, make them undesirable.) If the carriage roads were

to be used as Rockefeller intended, however, the vehicles used most on them would range in size from single horse buggies to small buckboards (2 to 4 benches instead of 6). With such usage on properly restored and maintained roads, there need be no limit on the length, duration or sequence of carriage rides.

The current concession includes daily buckboard trips, one hour in duration on the carriage roads, as well as two hour trips with buckboards and haywagons to the summit of Day Mountain for the sunset. In addition, park naturalists accompany two hour trips on the carriage roads as part of an interpretive program. Controlling the dust on these excursions is one of the primary difficulties. With large vehicles, one behind the other, even with dust control measures, those visitors in the second and third conveyances would be uncomfortable. Such large groups also present problems for the Park naturalist trying to speak as the carriage ride progresses. With the interpreter in the first buckboard, communication in the last haywagon is limited. Again, this is also not the way the carriage roads were meant to be experienced.

A better approach would be to hold an interpretive session at Wildwood Farm before the carriage rides leave. The Park naturalist could explain briefly the history of the roads and the nature of their development, and describe the bridges, gate lodges and other points of interest to be seen along the way.

With this introduction and perhaps a pamphlet including additional information, visitors would be well-informed about the experience ahead. In addition, carriage drivers, if properly trained, could answer questions and highlight each of the important stops. A Park naturalist could also be stationed at one or both gate lodges to answer questions.

Horseback riding is available from Wildwood stables. Particularly if carriage clubs are to be encouraged to use the carriage road system, accommodations could also be provided to those who would be interested in using their own horses and carriages on the roads.

Bicycling

In 1949, John D. Rockefeller, Jr., observing that the roads were little used for their original purpose, wrote to Newton B. Drury, the Director of the National Park Service, about the possibility of using the carriage roads at Acadia for bicycling. Drury replied that Park Landscape Architect Benjamin Breeze had made a study nine years earlier of the adaptability of the carriage roads to bicycle use.[69] Breeze had observed that the roads were, indeed, quite suitable for bicycles. He noted that, while the conditions of the roads were quite good (the

[69]Director of the National Park Service to John D. Rockefeller, Jr., January 12, 1949, National Park Service Files.

roads were still being maintained by Rockefeller at the time), he suggested that additional compaction would make them even more useful (Appendix VII).

In the early days of the bicycle the type of construction of the carriage roads--broken-stone--was considered the best road surface for bicycles. Baker states that:

> The best cycle ways are constructed much the same as first-class broken-stone roads, except that the layers do not need to be as thick and do not need as much rolling. The surface should be finished with a layer of stone screenings 1/4 to 1/2 inch thick, the size ranging from 1/4 inch to dust.[70]

This is virtually the same as the surface recommended for the carriage road restoration.

George Dorr had considered the advantage of bicycling in the area before the turn of the century. He recounted his construction of a bicycle path and its dual use for a buckboard:

> Around the pool and winding among the ancient forest trees, I had built . . . for my friends' and the public's use, a broad bicycle path, at a time when a new development of geared machines and rubber-tubed tires had given new popularity to the bicycle, and everyone who could was riding. My path found instant favor, and people came down from the hotels and cottages in throngs to enjoy it, riding round and round, but not, as I had hoped they might, building others like it elsewhere to widen the opportunity and interest.
>
> The Bicycle Path, just wide enough for my mother to pass through in her little one-horse buckboard, became a favorite drive for her in days of mellow autumn sunshine, where she could quietly watch the

[70]Baker, 626.

yellow birch leaves change and fall.[71]

Since that time, and even since Ben Breeze made his report in 1940, bicycling has dramatically increased as a recreational activity. Bicycle technology has greatly advanced since that time. Shops in Bar Harbor rent ten-speed bicycles. The most popular of the types of bicycles used on the carriage roads are "trail" bikes (the L. L. Bean Co. markets such a bike named the "Acadia"). While bikes with extremely knobby tires can damage the road surface, bikes outfitted with only slightly knobby tires, as are currently used on rental bikes, seem to do little damage to the road surface. As has been previously mentioned, fast-moving, rubber-tired vehicles are anathema to broken-stone roads. The relatively narrow width of bicycle tires, however, make them much less of a threat to the road surface than automobile or truck tires. The hardest and smoothest tires will do the least damage to the road surface.

Another great advantage of touring the carriage roads by bicycle is that of rate of travel. Because of the width of the road, the sequence of views and relatively long distances of the loops, walking the carriage roads strikes some as tedious. The speed of a bicycle, however, is much more like that of a carriage behind a jogging horse. The scale and sequence of vistas and

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[71]George B. Dorr, *Acadia National Park: Its Origins and Background*, 12-13.

features is ideally suited to this rate of movement. The width of the roads allow bicyclists to ride side by side, and to pass other bicyclists, pedestrians, equestrians, or carriages without discomfort or danger.

Consideration could be given to leasing of the garages at the Jordan Pond Gate Lodge and the Brown Mountain Gate Lodge to bicycle rental concessions. Parking areas would have to be developed at these areas to accommodate this, but it would make access to the carriage roads by bicycle much easier, and would transform the gate lodges into the major entry points to the carriage roads they were intended to be.

Bicycling represents the most harmonious, accessible, and cost-effective use of the carriage roads today. While the economics of scale limit the routes and flexibility of carriage and buckboard passengers, bicyclists may choose their route, and explore the carriage roads at their own pace. While the Park automobile roads become choked with visitors each season, the carriage roads remain relatively deserted. If properly restored and actively promoted, the use of these roads by bicyclists could help to relieve the pressure on the automobile roads and greatly enhance the visitors' experience.

Wheelchairs

The carriage roads, if properly restored, offer an exceptional opportunity for people confined to wheelchairs to experience the extensive and varied scenery of the interior of Acadia National Park. Most of the carriage roads were designed at a gradient of less than 5%, which is comfortably negotiated by most wheelchair users. Some sections as steep as 7% may be appealing to those looking for a more challenging route. The width of the carriage roads make possible the safe use of them by wheelchair users in conjunction with bicyclists, equestrians, pedestrians and carriages. The beautiful scenery, great extent, diverse users, and historic significance combine to make the carriage road system a wonderful recreational possibility for those confined to wheelchairs. This use is predicated, however, upon the restoration of the surface of the roads to a smooth, hard condition which is suitable for wheelchairs.

Snowmobiles

A short section of the carriage roads along the east side of Eagle Lake is now open to snowmobiles for access to the Park Loop Road. This is a reasonable variance to the general prohibition of motorized vehicles on the carriage roads, but should not be extended to any other sections of the carriage roads.

Cross-country Skiing

Cross-country skiing offers the most appealing winter activity on the carriage roads (Figure W.). These roads are considered ideal for this use by many cross-country skiers. The width of the roads, beautiful views--especially striking in the winter, absence of motor vehicles and gentle gradients make a cross-country skiing outing on the carriage roads particularly delightful. This activity is wholly appropriate for the carriage roads, and it encourages use of the Park during a season in which visitors may enjoy the grandeur of the island without the crowds encountered during the summer. The only deterrent to use of the carriage roads by large numbers of cross-county skiers is a somewhat unpredictable snow cover condition during the winter months. In spite of this, the winter use of the Park and cross-country skiing on the carriage roads, in particular, is growing.

Walking/Hiking

As mentioned above, the scale and distances of the carriage roads do not make them the most appealing routes for many walkers. For many, however, these broad, smooth surfaces, free of motor vehicles, offer a fine alternative to the more arduous hiking trails in the Park. These roads have great appeal for older people, for groups of children who require supervision, for handicapped people, or anyone for whom a leisurely stroll has



Figure W. Cross-country Skiing on Carriage Roads

more attraction than a challenging hike. In addition, some visitors find the carriage roads a wonderful setting for running or jogging. The multiple use of these roads by bicyclists, carriages, equestrians and pedestrians should cause little conflict (if the road surface is restored and maintained), and may even be perceived as an attraction because of the variety and animation which does not occur on the walking trails.

Dog Sleds

The carriage roads have been used in the winter and summer (using sleds on wheels) for dogs sleds. Considering the low use of the carriage roads in the winter, the fact that the activity is non-motorized, and the general compatibility with other winter users, this use seems reasonable and acceptable. The summer use of the carriage roads for "wheeled" dog sled teams could cause conflicts with other users in the summer. As the carriage road use increases, the compatibility of dog sled teams with bicycling, carriages, and pedestrians should be carefully monitored. If conflicts arise, deference must be given to carriage and bicycle users which represent the most appropriate and numerous users of this resource.

CONCLUSION

The carriage roads at Acadia National Park are a remarkable asset. They are a significant remnant of our road building history. They also offer an enormous opportunity to Park visitors to experience the beauties of Mount Desert on quiet, motor-free roads, and, in the process, relieve congestion on the motor road system. Finally, they are the most tangible expression of the personal creative impact of the man who has been called "the greatest ally the National Park Service ever had," John D. Rockefeller, Jr.[72]

The carriage roads are in desperate need of restoration. With the exception of an initiative undertaken with the assistance of a CETA work force in the late 1970s, the carriage roads have fallen farther into disrepair each year since John D. Rockefeller died in 1960. The situation is now critical. The roads will deteriorate at an increasing rate now that binder has been lost from the surface and drainage systems are beginning to fail. At a time when the Park is in great need of finding ways to disperse the visitors to relieve the motor roads, the carriage roads are difficult to traverse in many locations, and the sensational views which were planned have been allowed to grow in.

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[72]John Ensor Harr and Peter J. Johnson, *The Rockefeller Century* (New York: Charles Scribner's Sons, 1988), 198.

This critical situation cannot be addressed with modest increase in maintenance activity on the carriage roads. A major restoration program must be undertaken, followed by a realistic and comprehensive maintenance program. It will not be cheap, but the benefit to the public of the proper restoration, maintenance and use of this wonderful resource is incalculable. To fail to act to preserve this beautiful system of sylvan roads, bridges and gate lodges would be to abdicate our responsibility to the American public. The National Park Service has the remarkable opportunity to at once restore an important historic resource, effectively enhance the visitors' experience, and honor the vision of the man who gave more to the National Park Service and Acadia National Park than any private citizen in history.

APPENDIX

APPENDIX I

SPECIFICATIONS

for

a road at Seal Harbor to be built according to survey and plans made by C. P. Simpson, C.E., who is referred to hereinafter as the engineer and wherever the word "engineer" is used it refers to the chief engineer or his authorized assistants by whom all explanations and directions necessary for the satisfactory prosecution and completion of the work described in these specifications will be given.

INTERPRETATION OF SPECIFICATIONS

In case of ambiguity of expression in the specifications, or doubt as to the correct interpretation of the same, the matter shall be submitted to the engineer, whose decision shall be final.

OMISSIONS IN SPECIFICATIONS

Any work or materials that may have been accidantly omitted in the description of the work, but which is clearly implied, shall be furnished by the contractor the same as if it had been specifically stated.

CONTRACTOR DEFINED

Wherever the word "contractor" is used it refers to and means the party or parties who shall have duly entered into contract with the owner to perform the work; his duly authorized agents or legal representatives.

NOTICE TO CONTRACTOR

Any written notice to the contractor which may be requisite under these specifications may be served on said contractor either personally or by mail, or by leaving the same at his last known place of residence.

PRESERVATION OF ENGINEER'S MARKS

All engineer's marks and stakes after location shall be carefully preserved without disturbance until permission for their removal or erasure shall be given, and every facility must be furnished for the staking out, etc., of all the work to be done under these specifications.

DISMISSAL OF INCOMPETENT PERSONS

Any incompetent person or persons who may be employed on the work shall be removed on the requisition of the owner or engineer; and no person so removed shall thereafter be employed upon any portion of the work.

SPIRITUOUS LIQUORS

Contractors are not to give or sell or suffer any one to give or sell or keep any ardent spirits on any part of the work or in any boarding house or building under his control.

QUALITY OF MATERIALS

All materials furnished and used under these specifications must be of the best quality of their respective kinds, free from any and all defects which in the judgment of the engineer may render them unfit for use. Rejected material must be at once removed from the works or conspicuously marked "condemned". If condemned material is used in any part of the work, the same shall be removed and replaced with materials of the quality required by these specifications.

RIGHT RESERVED TO ALTER DETAILS

The engineer, during the progress of the work, may, by giving written notice to the contractor, alter any of the details of construction in any manner that may be found expedient or suitable; such alterations shall not invalidate the contract, and the contractor must adopt and execute the same as if they were a part of the original contract, and at the completion of the work an allowance will be made for such alterations, etc., either for or against the contractor as the case may be, and the value of such alterations will be estimated by the engineer from the schedule of prices attached to the contract, or should it not apply, the equitable amount will be estimated by the engineer whose figures the contractor hereby accepts as final.

From Station	1850 to 2200	350 ft.
" "	4500 to 5800	1300 ft.
" "	1400 to 1600	200 ft.
" "	3000 to 4500	1500 ft.
" "	5800 to 7000	1200 ft.
" "	7150 to 7650	500 ft.
" "	8150 to 8600	450 ft.
" "	8900 to 9850	950 ft.
" "	10200 to 10550	350 ft.
" "	9850 to 10200	350 ft.
" "	11360 to 11675	315 ft.
" "	11765 to 12050	285 ft.
		7750 ft.

the road to be built shall be what is known locally as a rock filled road with a top surface of clay and bank gravel such as may be found in the vicinity of the work or the finer grades of crushed rock may be substituted for gravel. In general the road is to be of the same character as the Sea Cliff Drive and the Barr Hill Road to which reference is made as a standard for road bed, retaining wall, gutters, etc. The road shall be built true to line and grade as established on the ground by the engineer or as shown on plans with no humps, hollows, yanks or crooks, and the lines, particularly on curves, shall be true and even.

From Station	2200 to 5000	800 ft.
" "	7000 to 7150	150 ft.
" "	7650 to 8150	500 ft.
" "	8600 to 8900	300 ft.
" "	10550 to 11275	725 ft.
" "	12050 to 13350	1300 ft.
" "	1600 to 1850	250 ft.
		4025 ft.

the road shall be what is known as a good gravel road 18 ft. in width between the centers of the gutters, and a full 16 ft. in width of traveled road. All wet and low places shall be filled with rock and the road crowned a full eight inches. The road shall be built true to line and grade as established on the ground by the engineer or as shown on plans with no humps, hollows, yanks or crooks.

WIDTH AND CROWN

The road shall be 16 ft. in traveled width inside the gutters, fences, or walls except where a greater width is shown on plans, and will be crowned so as to be 8 inches higher in the center than at the edges. This crowning to be even and to be made in the rock fill

and verified before the top surface is put on. In placing the rock fill due allowance must be made for settling during construction so that the crown of the road when finished shall be 8 inches. Where a greater width than 16 ft. is shown on plans the crown shall be increased proportionately.

CLEARING

The land will be cleared to the width of 12 feet on each side of the center line, and on each section must be entirely completed before grading is commenced. All stumps shall be grubbed out.

Brushwood, stumps, tree limbs, etc., must not be cast upon the adjacent land, but shall be formed into piles and burned; stumps and other material that will not burn, must be removed from the work and disposed of by the contractor to the satisfaction of the owner. All brush or trees accidentally or otherwise thrown upon the adjacent lands must be taken off and disposed of as above described. All blasting where necessary shall be properly protected by dunnage.

CARE IN BURNING

Particular care must be taken in the burning of all brush and stumps so as not to scorch or injure growing trees. Any tree so scorched or injured must be taken down at the contractors' expense and disposed of

FOUNDATION

The foundation shall be of broken rock finished with at least 4 inches of small rock and to be crowned 8 inches from edge to center of road. Upon this will be put a light coating of fine screenings or coarse gravel sufficient to fill up the spaces between the stones so that the top dressing will not sift through.

FINISH SURFACE

Finish with 2 inches of gravel that will pass through a sieve of 1-1/2 inch mesh and one inch of clay as a binder; all to be rolled upon completion when wet with a roller not less than 2 tons in weight.

GUTTERS

Gutters shall be built on each side of the road at least 2 ft in width and of sufficient depth to carry off water. Reference being made in this as in other respects to the gutters on the Sea Cliff Drive and the Bar Hill Road.

DRAINS AND CULVERTS

Culverts formed of stone, or Acme or Sterling iron pipe at least 8 inches in diameter will be laid wherever directed by the engineer and will be protected at each end by retaining walls of stone or concrete at least five feet in length built up to a level of the surface of the road. The contract price will include the building of forty-four culverts in all, as follows:

Station	1,400	1-8"	culvert	30 ft.	long
"	1,600	1-8"	"	18 "	"
"	1,800	1-8"	"	18 "	"
"	2,100	1-8"	"	18 "	"
"	2,400	1-8"	"	18 "	"
"	2,600	1-8"	"	18 "	"
"	2,800	1-8"	"	18 "	"
"	3,150	1-8"	"	18 "	"
"	3,475	1-8"	"	18 "	"
"	3,700	1-8"	"	18 "	"
"	4,100	1-8"	"	18 "	"
"	4,350	1-8"	"	18 "	"
"	4,650	1-8"	"	18 "	"
"	5,100	1-8"	"	18 "	"
"	5,400	1-8"	"	18 "	"
"	5,750	1-8"	"	18 "	"
"	6,050	1-10"	"	18 "	"
"	6,400	1-10"	"	20 "	"
"	6,800	1-8"	"	18 "	"
"	7,150	1-10"	"	18 "	"
"	7,250	1-10"	"	20 "	"
"	7,525	1-8"	"	18 "	"
"	7,650	1-8"	"	18 "	"
"	7,800	1-8"	"	18 "	"
"	8,200	1-8"	"	18 "	"
"	8,500	1-8"	"	18 "	"
"	8,750	1-8"	"	18 "	"
"	8,925	1-8"	"	18 "	"
"	9,350	1-8"	"	18 "	"
"	9,600	1-8"	"	18 "	"
"	9,825	1-8"	"	18 "	"
"	9,950	1-8"	"	18 "	"
"	10,250	1-8"	"	18 "	"
"	10,400	1-8"	"	18 "	"
"	10,700	1-8"	"	18 "	"
"	10,950	1-8"	"	18 "	"
"	11,100	1-8"	"	18 "	"
"	11,250	1-8"	"	18 "	"
"	11,650	1-8"	"	18 "	"
"	12,000	1-8"	"	18 "	"
"	12,350	1-10"	"	18 "	"

Station	12,575.	1-8" culvert	18 ft. long
"	13,150.	1-8" "	18 ft. "
"	13,250.	1-8" "	18 ft. "

Extra culverts if any to be paid for as follows: 8-inch pipe, 85¢ per foot; 10-inch pipe, $1.05 per foot; 12-inch pipe $1.20 per foot.

RETAINING WALLS

Retaining, slope, parapet and breast walls of dry stone will be constructed where directed. The stones for this kind of work must be sound, flat, bedded stones. No round or cobble stones will be allowed. Not more than one-third of the stones shall be less than one foot thick, and nostone shall be less than six inches thick or have a bed area of less than four feet. The stones shall be set horizontally on their largest bed and no bond shall be less than ten inches. Large stones of sufficient weight to hold fence posts shall be placed in the coping of these walls every 10 ft. The walls shall be built with a batter of 1-1/2 inches to one foot in height and shall be eighteen inches thick at the top. They shall be firmly bedded at the bottom and where set on sloping ledge, it shall be blasted out to make a footing and the bed stones secured in place by iron bolts if directed by the engineer.

BATTER

Care must be taken in the building of the retaining walls to allow for batter so that the top of the wall may align with the edge of the road as planned.

TIME OF COMPLETION

The work shall be prosecuted in such a manner as to complete it in accordance with the plans and specifications on or before June 1, 1917.

PAYMENTS

Monthly estimates shall be made during the progress of the work and payments to the amount of 85% thereof will be made, the retained percentage not being due or payable until the final completion of the work. The contractor shall, if required,, exhibit signed pay rolls, evidencing that all labor, teams and material used or employed on the work has been paid for in full.

BOND FOR FAITHFUL PERFORMANCE OF THE WORK

The contractor, if required by the owner, shall execute with his sufficient securities a bond in the sum of $_____ for the faithful performance of the work in accordance with the requirements of the specifications.

PERSONAL ATTENTION

The contractor shall give his personal attention to the faithful prosecution of the work, shall not sublet the same or any part thereof without the consent of the owner, nor will he assign by power of attorney or otherwise any of the moneys payable under these specifications.

LIABILITY INSURANCE

It is distinctly agreed that the Contractor shall carry Accident Liability Insurance in some good reliable Company, the premium on such insurance to form a part of the costs under this contract. The Contractor shall save the Owner from and hold him harmless against all claims and suits based upon any real or alleged injury to persons (whether employees or otherwise) or property which may occur or which are alleged to have occurred by or on account of any act or omission on the part of the Contractor, sub-contractors or their servants or agents, or which may occur or which are alleged to have occurred in connection with the work covered by this contract, from any cause whatsoever other than the act or omission of an employee of the Owner who is not an agent, servant, workman, or employee of the Contractor or sub-contractors engaged in the performance of work in or about said road under this contract. And the Contractor agrees to defend all such actions at his own expense, to pay all charges of attorneys, and all court or other expenses, and in the event of judgment being rendered against the Owner in any such action, the Contractor agrees to satisfy the same.

This agreement made the 9th day of June in the year one thousand nine hundred and sixteen by and between Alanson E. Clement

and Chauncey D. Joy of Mt. Desert in the State of Maine, parties of the first part, hereinafter designated the contractors and John D. Rockefeller, Jr. of New York in the State of New York, party of the second part hereinafter designated the owner.

WITNESSETH: That the contractors in consideration of the agreements herein made by the owner agree with the said owner as follows:

Contractors shall and will provide all materials and perform all the work for the construction of a road at Seal Harbor Maine, as surveyed by C. P. Simpson, C.E., and known as the extension of the Gardiner Road and shown on profiles marked stations 1400 to 13350, prepared by C. P. Simpson, C.E. and described in the specifications hereinabove recited which are hereby made a part of this contract.

It is hereby mutually agreed between the parties hereto that the sum to be paid by the owner to the contractors for such work and materials shall be twenty-nine thousand four hundred and thirty- seven dollars and fifty cents ($29437.50) subject to additions and deductions as hereinabove provided and that such sum shall be paid by the owner to the contractors in current funds upon certificates of the engineer as hereinbefore provided.

It is further mutually agreed between the parties hereto that in case it is necessary to erect a labor camp on any property adjacent to the work, it shall only be done with the consent of the owner and in such manner as may be approved by him and that immediately upon completion of the work all traces of the camp shall be removed and the property left in as good condition as it was found.

IN WITNESS WHEREOF, the parties to these presents have hereunto set their hands and seals the day and year first above written.

A E Kilpatrick

C D Joy

John D Rockefeller Jr

In Presence of

Appendix 1-A

SPECIFICATIONS

for

a road at Seal Harbor to be built according to survey and plans made by C. P. Simpson, C.E., who is referred to hereinafter as the engineer and wherever the word "engineer" is used it refers to the chief engineer or his authorized assistants by whom all explanations and directions necessary for the satisfactory prosecution and completion of the work described in these specifications will be given.

INTERPRETATION OF SPECIFICATIONS

In case of ambiguity of expression in the specifications, or doubt as to the correct interpretation of the same, the matter shall be submitted to the engineer, whose decision shall be final.

OMISSIONS IN SPECIFICATIONS

Any work or materials that may have been accidently omitted in the description of the work, but which is clearly implied, shall be furnished by the contractor the same as if it had been specifically stated.

CONTRACTOR DEFINED

Wherever the word "contractor" is used it refers to and means the party or parties who shall have duly entered into contract with the owner to perform the work; his duly authorized agents or legal representatives.

NOTICE TO CONTRACTOR

Any written notice to the contractor which may be requisite under these specifications may be served on said contractor either personally or by mail, or by leaving the same at his last known place of residence.

PRESERVATION OF ENGINEER'S MARKS

All engineer's marks and stakes after location shall be carefully preserved without disturbance until permission for their removal or erasure shall be given, and every facility must be furnished for the staking out, etc. of all the work to be done under these specifications.

DISMISSAL OF INCOMPETENT PERSONS

Any incompetent person or persons who may be employed on the work shall be removed on the requisition of the owner or engineer; and no person so removed shall thereafter be employed upon any portion of the work.

SPIRITUOUS LIQUORS

Contractors are not to give or sell or suffer any one to give or sell or keep any ardent spirits on any part of the work or in any boarding house or building under his control.

QUALITY OF MATERIALS

All materials furnished and used under these specifications must be of the best quality of their respective kinds, free from any and all defects which in the judgment of the engineer may render them unfit for use. Rejected material must be at once removed from the works or conspicuously marked "condemned". If condemned material is used in any part of the work, the same shall be removed and replaced with materials of the quality required by these specifications.

RIGHT RESERVED TO ALTER DETAILS

The engineer, during the progress of the work, may, by giving written notice to the contractor, alter any of the details of construction in any manner that may be found expedient or suitable; such alterations shall not invalidate the contract, and the contractor must adopt and execute the same as if they were a part of the original contract, and at the completion of the work an allowance will be made for such alterations, etc., either for or against the contractor as the case may be, and the value of such alterations will be estimated by the engineer from the schedule of prices attached to the contract, or, should it not apply, the equitable amount will be estimated by the engineer whose figures the contractor hereby accepts as final.

CHARACTER OF ROAD

The road to be built shall be what is known locally as a rock filled road, with a top surface of clay and bank gravel, such as may be found in the vicinity of the work or the finer grades of crushed rock

may be substituted for gravel. In general the road is to be of the same character as the Sea Cliff Drive and the Gardiner-Mitchell Hill-Jordan Stream Road, to which reference is made as a standard for road bed, retaining wall, gutters, etc. The road shall be built true to line and grade as established on the ground by the engineer or as shown on plans, with no humps, hollows, yanks or crocks, and the lines, particularly on curves, shall be true and even. All wet and low places shall be filled with rock.

WIDTH AND CROWN

The road shall be 16 feet in traveled width inside the gutters, fences or walls except where a greater or lesser width is specified, and will be crowned so as to be 8 inches higher in the centre than at the edges. This crowning to be even and to be made in the rock fill and verified before the top surface is put on. In placing the rock fill due allowance must be made for settling and wear during construction so that the crown of the road when finished shall be 8 inches. Where a greater width than 16 feet is shown on plans the crown shall be increased proportionately.

CLEARING

The land will be cleared to the width of 12 feet on each side of the center line where the road is a traveled widthof 16 feet, and each section must be entirely completed before grading is commenced. All stumps shall be pulled or grubbed out.

Brushwood, stumps, tree limbs, etc. must not be cast upon the adjacent land, but shall be formed into piles and burned; stumps and other material that will not burn, must be removed from the work and disposed of by the contractor to the satisfaction of the owner. All brush or trees accidently or otherwise thrown upon the adjacent lands must be taken off and disposed of as above described. All blasting where necessary shall be properly protected by dunnage.

CARE IN BURNING

Particular care must be taken in the burning of all brush and stumps so as not to scorch or injure growing trees. Any tree so scorched or injured must be taken down at the contractor's expense and disposed of.

FOUNDATION

The foundation shall be of broken rock finished with at least 4 inches of small rock and to be crowned 8 inches from edge to center of road. Upon this will be put a light coating of fine screenings or coarse gravel sufficient to fill up the spaces between the stones so that the top dressing will not sift through.

FINISH SURFACE

Finish with 2 inches of gravel that will pass through a sieve of 1-1/2 inch mesh and one inch of clay as a binder; all to be rolled upon completion when wet with a roller not less than 2 tons in weight.

GUTTERS

Gutters should be built on each side of the road at least 2 feet in width and of sufficient depth to carry off water. Reference being made in this as in other respects to the gutters on the Sea Cliff Drive and the Bar Hill Road.

DRAINS AND CULVERTS

Culverts formed of stone or Acme or Sterling iron pipe at least 10 inches in diameter will be laid wherever directed by the engineer and will be protected at each end by retaining walls of stones or concrete built up to the level of the road. Wherever possible stone culverts of ample dimensions shall be used. If there is not sufficimnt depth, the iron pipe culverts shall be used and always of as large dimensions as possible. It is the purpose of this clause to assure ample drainage with openings so large as to reduce to a minimum the danger of stoppage with leaves, dirt or debris. A catch basin not less than 18 inches in the three dimensions shall be formed of flat rock, at the entrance to each culvert with its bottom at least a foot below the bottom of the culvert so as to form a receptacle for leaves and debris and prevent the stopping up of the culvert.

RETAINING WALLS

Retaining, slope, parapet and breast walls of dry stones will be constructed where directed. The stones for this kind of work must be sound, flat, bedded stones. No round or cobble stones will be allowed.

Not more than one-third of the stones shall be one foot thick, and no stone shall be less than six inches thick or have a bed area of less than four feet. The stones shall be set horizontially on their largest bed and no bond shall be less than ten inches. Large stones of sufficient weight to hold fence posts shall be placed in the coping of these walls every 10 feet. The walls shall be built with a batter of 1-1/2 inches to one foot in height and shall be eighteen inches thick at the top. They shall be firmly bedded at the bottom and where set on sloping ledge, it shall be blasted out to make a footing and the bed stones secured in place by iron bolts if directed by the engineer.

BATTER

Care much be taken in the building of the retaining walls to allow for batter so that the top of the wall may align with the edge of the road as planned.

PAYMENTS

Monthly estimates shall be made during the progress of the work and payments to the amount of 85% thereof will be made, the retained percentage not being due or payable until the final completion of the work. The contractor shall, if required, exhibit signed pay rolls evidencing that all labor, teams and material used or employed on the work has been paid for in full.

PERSONAL ATTENTION

The contractor shall give his personal attention to the faithful prosecution of the work, shall not sublet the same or any part thereof without the consent of the owner, nor will he assign by power of attorney or otherwise any of the moneys payable under these specifications.

LIABILITY INSURANCE

It is distinctly agreed that the contractor shall carry Accident Liability Insurance in some good reliable company, the premium on such insurance to form a part of the costs under this contract. The contractor shall save the owner from and hold him harmless against all claims and suits based upon any real or alleged injury to persons (whether employes or otherwise)

or property which may occur or which are alleged to have occurred by or on account of any act or omission on the part of the contractor, sub-contractors or their servants or agents, or which may occur or which are alleged to have occurred in connection with the work covered by this contract, from any cause whatsoever other than the act or omission of an employe of the owner who is not an agent, servant, workman or employe of the contractor or sub-contractors engaged in the performance of work in or about said road under this contract. And the contractor agrees to defend all such actions at his own expense, to pay all charges of attorneys, and all court or other expenses, and in the event of judgment being rendered against the owner in any such action, the contractor agrees to satisfy the same.

This agreement made the 25th day of September in the year one thousand nine hundred and eighteen by and between A. E. Clement of Mount Desert in the State of Maine, party of the first part, hereinafter designated the contractor, and John D. Rockefeller, Junior, of New York in the State of New York, party of the second part, hereinafter designated the owner,

WITNESSETH: That the contractor in consideration of the agreement herein made by the owner agrees with the said owner as follows:

Contractor shall and will provide all materials and perform all work for the construction of a road at Seal Harbor, Maine, as surveyed by C. P. Simpson, C.E., beginning at the Gardiner Road, running along the West side of Mitchell Hill, crossing the Little Harbor Brook and to a point on the West side of the brook where the road makes a turn to go South and around Bear Hill. The road to be as described in the specifications hereinabove recited, which are hereby made a part of this contract. It is understood that the bridge across the Little Harbor Brook is not included in this contract but will be made the subject of a separate contract.

It is hereby mutually agreed between the parties hereto that the sum to be paid by the owner to the contractor for such work and materials as will be necessary to fully complete the road shall be at the average of $3. a running foot, and that such sum shall be paid by the owner to the con-

tractor in current funds upon certificates of the engineer as hereinbefore provided.

It is further agreed that a letter dated September 24th, 1918, from the owner to the contractor, herewith attached, shall become a part of this contract, with the following additions to the second clause of said letter; namely that the 16 feet road shall end at Station No. 11, from which point the bridle path will continue to Station 24 on the West side of Harbor Brook; and the balance of the clause shall stand as it reads.

It is further mutually agreed between the parties hereto that in case it is necessary to erect a labor camp on any property adjacent to the work, it shall only be done with the consent of the owner and in such manner as may be approved by him, and that immediately upon completion of the work all traces of the camp shall be removed, and the property left in as good condition as it was found.

IN WITNESS WHEREOF, the parties to these presents have hereunto set their hands and seals the day and year first above written.

A. E. Clement

Materials & Research Division
Hancock Plant

Harold MacQuinn, Inc.
Ellsworth, Maine

SIEVE ANALYSIS DATA SHEET

TIME _____ DATE 7-30-87 (SAMPLED)

SAMPLE NO. _____ TEST NO. _____ MATERIAL SAMPLED 3/8" Crusher Dust PROJ. NO. _____
PROCESS CONTROL ☐ ACCEPTANCE ☐ INDEPENDENT ASSURANCE ☐ TOWN _____
SAMPLED BY D. Focc BRIDGE NAME or NO. _____ PROJECT PHONE _____
PROJECT RESIDENT _____ MAILING ADDRESS _____
CONTRACTOR _____ SUB-CONTRACTOR _____ SUPPLIER _____
SOURCE: PLANT MacQuinn LOC. Hancock PIT _____ LOC. _____
SAMPLE TAKEN FROM: ROADWAY ☐ STATION _____ (OFFSET-FT) LT. ☐ ℄ ☐ RT. ☐ DEPTH B.F.G. or ELEV. _____ LANE ___
PIT ☐ TRUCK ☐ TRUCK NO. _____ STOCKPILE ☐ CRUSHER BELT ☐ PLANT ☐ RR CAR ☐ DISTRIBUTOR ☐
CONCRETE AGGREGATE ☐ BITUMINOUS AGGREGATE ☐ OTHER _____

COARSE SERIES — CLASS Concrete

SIEVE SIZE	C.A.1 TEST NO. _____ WEIGHT RETAINED	WT. PASS. % RET.	% PASSING	C.A.2 TEST NO. _____ WEIGHT RETAINED	WT. PASS. % RET.	% PASSING	BLEND C.A.1 %	C.A.2 %	C.A.3 %	TOTAL % PASS	SPECS.
6"											
4"											
3"											
2"											
1 1/2"											
1 1/4"											
1"											
3/4"											
5/8"											
1/2"											
3/8"											
1/4"											
NO. 4											
NO. 8											
PAN DRY		CONVERSION FACTOR _____			=PAN						
PAN WET											

TARE NO. _____ WET TOTAL WEIGHT _____
WET INITIAL WEIGHT _____
LOSS-GAIN OF WEIGHT _____

WATER CONTENT (FINE SERIES)

TARE & WET SOIL _____
TARE & DRY SOIL _____
WEIGHT OF WATER _____
TARE WEIGHT _____
WEIGHT OF DRY SOIL _____

TARE + DRY SOIL UNWASHED	
TARE + DRY SOIL WASHED	
DIFFERENCE	
+ PAN	
TOTAL	

WEIGHT of WATER / WEIGHT of DRY SOIL = _____ = _____ WATER CONTENT

COARSE FRACTION CORRECTION-WATER

WEIGHT OF PAN (WET) _____
WEIGHT OF PAN (DRY) = PAN WET / 1+W.C. = _____ = _____
WEIGHT OF WATER IN PAN _____
TOTAL WEIGHT OF SAMPLE WET _____
WEIGHT OF WATER IN PAN _____
CORRECTED TOTAL WEIGHT _____

MEETS SPECIFICATIONS YES ☐ NO ☐

TESTED BY D-Focc COMPUTED BY D Focc
CHECKED BY _____ DATE TESTED 7-30-87

FINE SERIES — TEST NO. _____

SIEVE SIZE	WEIGHT RETAINED	WT. PASS. % RET.	% FINER BY WEIGHT FINE	% FINER BY WEIGHT TOTAL	SPECS. % PASS.
3/8"*				100	
1/4"				81	
NO. 4 *				64	
8 *				42	
10				39	
16 *				30	
20				26	
30 *				23	
40				20	
50 *				18	
60				16	
100 *				13	
200				9.6	
				COLOR PLATE NO. ___	
PAN					

700 - SUM * / 100 = F.M. * _____ (2.3 to 3.1)

_____ DRY TOTAL WEIGHT
_____ DRY INITIAL WEIGHT

SET NO. ___

ACADIA NATIONAL PARK

Estimate for One-Mile Typical Section of Carriage Road Reconstruction

Task	Unit	No.	Unit Cost	Amount
Preliminary pruning				
Truck and driver	hr.	40	25	1,000
5 man crew with pole saws, chain saws, and chipper	hr.	40	140	5,600
Repair foundation				
Material (ledge rock)	c.y.	100	5	500
Backhoe	hr.	40	40	1,600
6 Laborers	hr.	40	90	3,600
Pull outside edge w/ grader	hr.	8	50	400
Shape and roll	hr.	8	50	400
Repair or replace middle layer				
Material (1" minus, 2" thick)	c.y.	500	8	4,000
Dump truck (6 yard)	hr.	40	30	1,200
Water truck	hr.	40	30	1,200
Grader	hr.	40	50	2,000
Roller (3-5 ton vibratory)	hr.	40	50	2,000
Repair or replace surface layer				
Material (3/8" minus, 2" thick)	c.y.	500	12	6,000
Dump truck (6 yard)	hr.	80	30	2,400
Water truck	hr.	80	30	2,400
Grader	hr.	80	50	4,000
Roller (3-5 ton vibratory)	hr.	80	50	4,000
Repair stone ditch-lines, culverts breast walls and retaining walls				
Backhoe	hr.	80	40	3,200
Compactor	hr.	80	25	2,000
2 Masons	hr.	160	60	9,600
Re-set coping stones				
Small crane	hr.	80	50	4,000
Flat-bed truck	hr.	80	30	2,400
2 Laborers	hr.	80	30	2,400
Supervisor	hr.	20	30	600

Field engineering 2 men w/ transit	hr.	60	80	4,800
	Sum			71,300
	15% Contingency			10,695
	Total			81,995
Research, design and construction inspection		0.07		5,740
	Total			87,735
	Say			90,000
	Cost per lineal foot			17.05

Reprinted from:

Grounds Maintenance October 1986

Dust retardant benefits campground

For Rainbow Campground in Arizona's Apache-Sitgreaves National Forest, summertime means an increase in the number of visitors to its 139-unit campsite. It also has traditionally meant an increase in the amount of dust kicked up by recreational vehicles.

To alleviate the dust problem, the Springerville Ranger District of the National Forest Service began using Coherex® dust retardant on roadways throughout the campsite. Coherex, manufactured by Witco Corporation's Golden Bear Division, is a cold-water emulsion of petroleum resins.

Cinder problems

The soil composition of the 20-ft.-wide roadways within the campground presented a unique problem. The roadbed contained mostly fine-grained silty clay to which cinders had been added to strengthen the surface. The combination of materials had proved worthy as a surfacing material, although it was a dusty one. Due to the nature of the soil's composition, it was questionable as to whether or not the roadways could take the addition of a dust palliative.

The first step was to evaluate roadway conditions and soil types. Gary Christensen, maintenance foreman at the 1.2-million-acre Apache Engineering Zone (which includes the Springerville Ranger District), and Ron Pruett of Golden Bear examined the soils to determine preparatory work techniques, application and dilution rates, and the degree of final compaction.

Preparation

Under Christensen's supervision, Forest Service personnel bladed and shaped the top 2 inches of the 3 miles of roadway. The crew then used a water wagon to moisten the road prior to applying the dust retardant. This facilitated the penetration of the dust retardant, and it helped to compact the entire loosened depth.

Application, dilution rates

The action of the Coherex depends on its ability to agglomerate the fine particles of the road surface. Therefore, it was important that the mat effect be the right surface composition for the type of vehicular traffic the road received.

Tests showed a dilution rate of 1:4 (agent to water) to be most effective. Determining application rates required several tests due to the convoluted pattern of the roadway.

The general application rate was 1 gallon of Coherex per square yard in two applications. Loops received two applications of Coherex at a rate of 0.6 to 0.75 gsy. Road junctions received two applications of Coherex at a rate of 1.5 gsy due to the heavy traffic.

Using a standard distribution truck, a contractor applied a total of 35,000 gallons of diluted material at the previously established application rates.

After the final Coherex application, Forest Service personnel used an end-dump truck loaded with approximately 15 tons of gravel to compact the roadway.

Technical credit: Apache Engineering Zone, Ariz., Springerville Ranger District, Ariz.



Intricate roadway curves made it necessary to adjust the application rates of the dust retardant.



A distribution truck makes a second application of Coherex dust retardant to the main roadway at the campsite. The material will be absorbed by the bladed and moistened surface within 10 minutes after application.

For further information please contact:

Golden Bear Division
Witco Corporation
P.O. Box 456
Chandler, AZ 85244-0161
(602) 963-2267

Witco

Reprinted from
January, 1986 ROADS & BRIDGES

Forest Service gets drop on dust with suppressant

Dusty Arizona roads were heavily used by public; surface treatment retards dust during most arid period of year



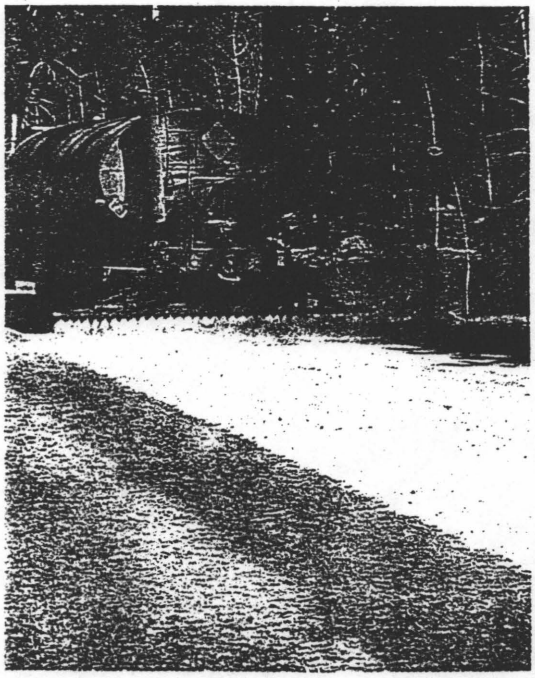
Prep work involved blading to shape and crown.

The Apache-Sitgreaves unit of the National Forest Service in Arizona recently quelled a dust problem on some of its most heavily traveled public roads by using a dust suppressant.

Application required regrading and final compaction by Forest Service forces, and distribution by truck by the contractor, Arizona Refining Co. of Phoenix.

The project involved three miles of intertwining dirt roads serving a heavily used campground in the forest service unit. The campground draws campers from as far as Los Angeles (750 miles); its 139 sites are 90% filled during season and are overused on holidays.

Harold Ward, director of operations and maintenance, Springerville Ranger District, consulted with Gary Christensen, maintenance foreman of the 1.2-million-acre Apache Engineering Zone, which includes Ward's district. They chose to use a dust retardant, a cold water emulsion of petroleum resins that is used to hold down dust on



Moistened surface absorbs suppressant.



Compaction is achieved with loaded gravel truck.

highway shoulders, playgrounds and other environmental sites.

However, the soil composition of the 20-ft-wide roadways within the campground presented a special problem. It contained mostly fine-grained silty clay to which cinders had been added to strengthen the surface. This combination of materials had proved its worth as a surfacing material, although a dusty one. But would it take to the addition of a dust palliative?

First step was an evaluation of roadway conditions and soil types. Christensen examined the soils with an eye to determining preparatory work technique, application and dilution rates, and degree of final compaction.

Preparation work by the Forest Service District involved crowning the roads to provide drainage and extend performance life. In doing this work, Christensen took care to make sure that the top 2 in. would be left in a loosened, moist condition.

During the blading operation, a water wagon applied moisture to the roads in order to facilitate penetration by the dust retardant and ultimate compaction of the entire loosened depth.

Next step was to determine dilution and application rates. The first was important because the action of the dust suppressant depends on its ability to agglomerate the fine particles of road surfaces. It was important that the "mat" effect thus achieved be the right surface composition for the type of vehicular traffic that the road would sustain.

Tests showed that a dilution rate of 1:4 (agent to water) would achieve this result. Determining application rates would require a number of tests due to the convoluted pattern of the roadways.

More testing followed. Three applications were involved, unusual for three miles of roadway.

Application rates were determined as follows:

- *General rate*, 1 gsy in two applications.
- *Loops*, rate cut back to 0.6 to 0.75 gsy, also in two applications.
- *Road junctions*, 1.5 gsy because of the tendency for traffic to be heavier in these spots. Again the material was applied twice.

Under Christensen's supervision, Forest Service personnel bladed and shaped the top 2 in. of the three miles of roads, then moistened them, as planned, prior to application of the dust retardant by the contractor.

Using a standard distributor truck, the contractor applied the agent, diluted 1:4, at the previously established application rates.

At the end of the work, a ¼-mile section leading to the entrance of the campground received an application at the regular rate, 1 gsy in two passes. In all, 35,000 gal of diluted material were applied.

After the final application, the Forest Service crew wheel-rolled the treated roadways in order to compact the soils. Compaction was performed with an end-dump truck loaded with approximately 15 tons of gravel.

The dust retardant performed, according to Ward, especially during the driest period, the month of June—which had previously been the dustiest. □

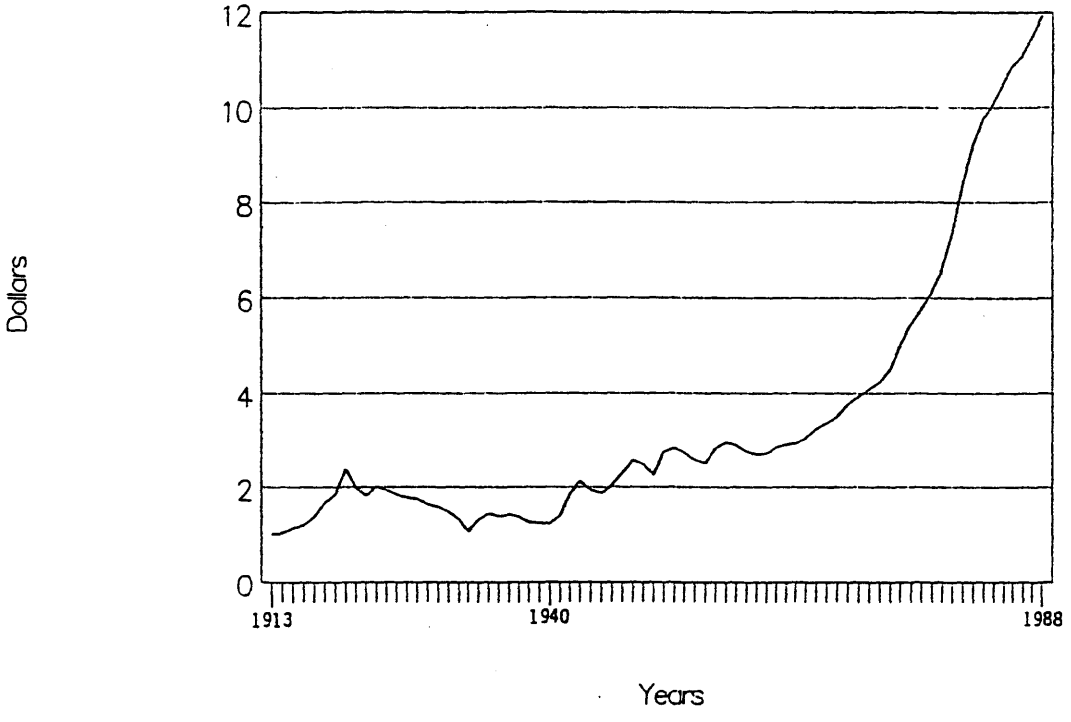
Acadia National Park — Carriage Roads

Maintenance Costs—January, 1914 to July, 1919, Adjusted for Inflation:

Year	Est. % Comp.	Est. $/yr.	Est. Miles	Infla. Factor	1913 =1.00	1988 =1.00	1988 per mi.	1988 mi./yr.	1988 x 51 mi.
1914	10	109.08	0.63	1.020	106.94	1,275.85			
1915	30	327.25	1.88	1.130	289.60	3,454.96			
1916	50	545.42	3.13	1.197	455.65	5,435.96			
1917	70	763.59	4.38	1.373	556.14	6,634.80			
1918	90	981.75	5.63	1.660	591.42	7,055.62			
½ 1919	100	564.23	6.25	1.838	306.98	3,662.25			
		$3291.32	6.25 mi.		$2,306.74	$27,519.45	$4,403.11	$800.57	$40,828.85

Road Construction Cost Index

1913 = 1.00



Sources: Bureau of Labor Statistics
1913 -- 1915 Average of Contractor Indexes
1915 -- 1988 Federal Highway Administration

ROAD CONSTRUCTION COST INFLATION 1913 -- 1988

Year	1967= 100.0	1913= 1.000	Year	1967= 100.0	1913= 1.000
1913	29.6	1.000	1951	81.7	2.756
1914	30.2	1.020	1952	84.1	2.837
1915	33.5	1.130	1953	81.0	2.732
1916	35.5	1.197	1954	76.4	2.577
1917	40.7	1.373	1955	74.2	2.503
1918	49.2	1.660	1956	84.0	2.833
1919	54.5	1.838	1957	87.7	2.958
1920	70.8	2.388	1958	85.5	2.884
1921	58.7	1.980	1959	82.0	2.766
1922	53.5	1.805	1960	80.0	2.699
1923	59.6	2.010	1961	80.7	2.722
1924	57.1	1.926	1962	84.3	2.844
1925	54.3	1.832	1963	86.4	2.914
1926	52.2	1.761	1964	86.9	2.931
1927	51.5	1.737	1965	90.3	3.046
1928	48.1	1.622	1966	96.1	3.242
1929	46.6	1.572	1967	100.0	3.373
1930	43.3	1.461	1968	103.4	3.488
1931	38.8	1.309	1969	111.8	3.771
1932	30.9	1.042	1970	116.3	3.923
1933	38.8	1.309	1971	121.3	4.092
1934	42.4	1.430	1972	125.3	4.227
1935	40.7	1.373	1973	133.1	4.490
1936	41.9	1.413	1974	147.7	4.982
1937	40.1	1.353	1975	161.2	5.437
1938	36.8	1.241	1976	170.5	5.751
1939	36.6	1.235	1977	181.5	6.122
1940	36.1	1.218	1978	195.4	6.591
1941	41.1	1.386	1979	217.4	7.333
1942	55.0	1.855	1980	246.8	8.325
1943	63.1	2.128	1981	272.4	9.188
1944	57.1	1.926	1982	289.1	9.752
1945	55.1	1.859	1983	298.4	10.065
1946	60.1	2.027	1984	311.1	10.494
1947	68.3	2.304	1985	322.2	10.868
1948	76.4	2.577	1986	328.4	11.077
1949	73.7	2.486	1987	340.4	11.482
1950	66.6	2.247	1988	353.7	11.930

Sources: Bureau of Labor Statistics
1913 -- 1915 Average of Contractor Indexes
1915 -- 1988 Federal Highway Administration

APPENDIX VII

ACADIA NATIONAL PARK
Bar Harbor, Maine

Bicycling at Acadia

In studying the possibilities of bicycling in Acadia National Park, let us assume for the moment that there is a sufficiently large group that would cycle and get down to the vital task of creating the actual trails and routes. Later we can discuss the possibilties of patronage of the cycle trails, the costs of cycling and the results of 40 miles of wheeling which I participated in.

I entered into the experiment with the vague knowledge that there was extensive bicycling in Europe, especially in the English countryside, and in other areas such as Bermuda, also that there were such things as bicycle trains in this country, and recent efforts at creation of bicycle trails in large municipal parks, especially in New York, and considerable cycling on college grounds. But my most personal tie with the sport goes back to pictures of my parents in cycling habits and their stories of Sunday bicycle parties before the days of New Departure Brakes and two-speed bicycles. Those parties were large gatherings and bicycling was "the thing to do".

Those parties couldn't have taken place on other than country roads. Probably an occasional gravel surface was encountered, but more often dirt or clay. The picture must have been one of small country roads on one-cart width with two well-packed wheel tracks. There were plenty of hills that had to be pushed over, thick dust to plow through and horse-drawn traffic to contend with. In all, a duplication of similar circumstances found in England and Bermuda today, and more to the point, a duplication of circumstances existing at Acadia in the form of our present carriage road system. Adaptation of this system to present day use seems as simple as getting the carriage road wheel tracks packed down.

The packing is a problem of devising a method of carriage road maintenance that would artificially accomplish the smoothed wheel tracks which were naturally a part of the old country road. Those roads were traveled daily by horse and buggy or team and wagon. What tended to keep the roads smooth for bicycles was the fact that in the case of horse and buggy the horse used the center of the road and in the case of a team, the horses walked slowly in the wheel tracks and the accumulative rolling of the buggy and wagon wheels kept the two wheel tracks smooth.

In present usage, there are few buggies on the carriage roads to make wheel tracks and no teams with wagons. And then there is the more predominant usage of certain portions of the system by horsemen who in no case improve the roads for bicycles. The only compensations are that fast-moving horsemen who are the ones most apt to dig up a road are inclined to travel single file. This is only a meager compensation and of course the more predominant amateurs traveling in groups wander all over the road.

But with all this apparent source of roughening the roads with resultant inconvenience to the cyclist, I found through the coincidence of traveling the roads in the fall when dual-tired repair trucks were using certain sections of the system that only a few trips by such a truck smoothed the wheel tracks so that cycling surfaces were available. In very few portions of the system did I find loose gravel or sand that was devoid of binding material. Actually, one could not ask for better binding gravel with which to work on in order to create satisfactory tracks for a bicycle. I admit that I ran onto very rough sections of road in traveling around Eagle Lake and the Witch Hole Pond section, but of course two stables send riders out on this part of the system and from appearances I doubt if any grading or dragging of these roads had been done since last spring. The material is there, however, and a brush drag and an occasional rolling by a dual-wheeled truck would make excellent cycling. On another loop which I started on from Bubble Pond and followed in a southerly direction around Pemetic Mountain, there had apparently been little usage by horsemen and in addition fall travel by trucks and here I found no discouragement whatsoever to hamper the cyclist. Portions on the east side of the Long Pond loop were very smooth and enjoyable due to the smooth wheel tracks, and in other areas such as the loop around Sargent Mountain where apparently neither trucks or horses had frequented the roads, I found particularly good cycling. I rode over about five miles of the truck trail system on the west side of the Island where only trucks are used and found some very good wheeling. The difference on the truck trails, however, is that they are not surfaced with as great a depth of screened gravel and encountered some large stones in the wheel tracks as well as some pock marks and corduroy. The carriage roads are remarkably devoid of any stones larger than would pass through one-inch screen and these are so well bound together by finer material as not to be noticeable.

I believe it is evident from the approach that I made towards a solution of accomplishing cycle trails on the Island that I regarded the carriage roads as being only a step removed from cycle trails. Another point to mention is that I felt no appeal for the idea of actually paving a portion, i.e., three or four feet on one side of the carriage roads or for the idea of constructing a cycle trail system in addition to the existing motor roads, truck trails, foot trails and carriage road system already existent.

Do you not agree that a solution which allows the carriage road system to develop into the small country roads that it was apparently intended to do, is worth striving for and is more apt to meet with the approval of the individuals closely associated with accomplishment of the system.

Would not the tar surfacing of three or four feet on one side of the carriage road system give the road section a lop-sided appearance and in addition lay us open to the suggestion of tarring the whole surface?

Moreover, if the maintenance of the carriage roads with the purpose of reverting to the old country road for the benefit of both cyclists and horsement proves workable on one section of the system, would we not have accomplished a simple means of expanding on the idea? Or vice versa, if the experiement did not prove worth while could we not rightly say that we had in no way destroyed or disrupted the system?

As to creating a cycle trail system separately from the other travel ways in the Park, I feel that the costs would be out of proportion to the recreational value created, having in mind (1) that about six miles of trail means only an hour's cycle travel; (2) that the cycle system would have to parallel, cross and recross the other systems; (3) that the best views and alignment possibilities are already taken, and (4) that in many cases, while attempting to secure cycle trails of questionable value, we would no doubt detract in many ways from carriage roads and foot trails of proven value.

Surfaces for the cyclist to travel on are not the only problem to be considered, although I can well imagine that they are the greatest factor in limiting bicycle travel on the Island. The matter of road grades logically follows consideration of road surfaces. My personal experience allows me to say that I do not regard the grades encountered on the carriage road system to be in any degree detrimental to their usage by cyclists if one uses a light-weight bike that is low geared. If you will look at your Montgomery Ward catalog you will notice that the nicest looking bicycle models, i.e., the "Torpedo Class" with all the trimmings, including lights, double bars where only one is necessary, baggage carriers and big round juicy balloon tires, weigh from 54 to 68 pounds. That's the kind I used the first day, but being 35 years old, weight 195, and not having used my second wind more than twice a year for the last ten, I perused the catalog a little closer and found that there was such a thing as a light-weight English type two-gear bike that weighted from 24 to 30 pounds, no balloon tires, a good springy seat, and generally minus every unnecessary contraption. Equipped with this knowledge, I was able to rent on the following day a 30-pound bike without the two gears but at any rate with two more cogs in the rear cog wheel.

Consequently, having a bike that was meant for the road and not the show window, I was able to keep my pushing time on the 8.6 mile trip shown as route D on the enclosed map to one hour thirty minutes, and on the 11.3 mile trip shown as E to two hourse twenty-five minutes. I believe that with a two-gear bike and adequate road surfaces, there are but very few and short stretches of the carriage road system that could not be navigated by wheel. However, that is only one side of the question, since we must consider that a mixed party of various ages and cycling abilities would probably adapt their efforts to keeping the party together. This would tend to increase the amount of bike pushing. But no harm done - a slower party helps relieve the strain of continuous cycling, helps take the kinks out of one's muscles and gives the group plenty of opportunity to look around. These probable capabilities of travel by groups leads me to suggest that ten or twelve mile trips which could actually be negotiated in two hours is about the maximum that should be attempted by a group in the course of a full afternoon's schedule.

Actually, I was surprised that as much park territory could be visited by cycle in such short spaces of time. The questions of road surface and grade somehow took all my attention. Then it dawned on me that I was actually covering by wheel in the space of a few hours the same distances that had required a day's travel when I had visited them on foot. One of the most gratifying thoughts is that the carriage road country is more or less a world in itself, one that an individual is apt to visit only once or twice

in a lifetime if he traveled by foot, (this is no mistatement because there are many natives who have never been on the carriage road system) and here, by means of cycling, was a means of visiting in the system at will.

It is this apparent ease with which I could traverse a large part of the system which substantiated my belief that no idea of building separate cycle trails should be harbored, nor, as well, any idea of paving a portion of the existing road system.

One of the principle conclusions to be drawn from this data on timing is that cyclists who wanted to see the carriage road country would not relish confinement to one loop of five or six miles as represented in the Witch Hole Pond or Eagle Lake loops. My first though was that such might be the solution but I soon became imbued with the idea of exploring more and more of the carriage roads.

The 11.64 miles represented in the combined Witch Hole Pond and Eagle Lake loops, the 8.61 miles in the Pemetic Mountain - Jordan Pond loop and the 11.36 miles in the Sargent Mountain - Jordan Mountain loop thus assumed in my mind the status of typical half-day trips that the cyclist could take in normal doses.

A day's wheeling would cost the individual $.75 for bicycle rental, and a party of 20 could rent bicycles at the rate of $.50 per day. A horseman would have to pay from $1.00 to $1.50 an hour and if he had the horse eight hours his costs for rental would be from $8.00 to $10.00. Even if we granted the horseman the benefit of the doubt and conceded rental at the rate of $.75 an hour, his costs are still $8.00 per day.

My own limited experience with horses and bicycles prompts me to hazard the guess that the amateur cyclist, as compared with the amateur horseman, would in two days' travel, cover twice the distance at one-twelfth the cost, feel 50% better and 100% more satisfied than the horseman, but the proof of the pudding is in the eating and you are encouraged to censor my estimates.

I can not resist making three confessions - two regarding horses and the other, bycyles, which may help to clarify the reason for my opinions. I spent several summers working on a farm and had occasion many times to travel by sulky, buggy and spring wagon. The equine object of my affection on such occasions was a gib long-legged black mare named "Lady", and a headstrong thing with callouses at the bit as big as knuckles. She was full of spirit and managed to keep the reins taut and traces hanging. Finally, one day after being a party to pulling the buggy over about a mile of country road by means of my arms, the reins and her calloused mouth, the situation became in my mind a question of whether I was man or mouse. To give myself the benefit of the doubt, I began seesawing on the reins and with good results until I made the belated discovery that I had brought the front of the buggy up against her legs. Well, she proceeded to kick the front out of the buggy and I beat a hasty retreat up and over the back of the seat. Eventually I got her stopped so I always considered the event a draw. This is confession number one by the amateur horseman.

A year later, same amateur, same farm and same horse, found me preparing to carry out the mission of traveling twelve miles to learn when the thrashers would arrive at our farm. This time, I chose the saddle and started off. I couldn't seem to jibe with her trotting so I had to let her out occasionally. At that, everything went well on the way over although I had had enough of "wild west" by the time I arrived. I completed my task. On the way back I wasn't having much success holding her in to a walk with the result that for several miles either on the trot, on the canter or in the gallop, I was slowly and joltingly coming to the conclusion that I'd be better off walking when one of the stirrup straps broke and I ended up with one leg and both arms twined around the mare's neck and she headed, as it were, for the rhubarb. This is confession number two by the amateur horseman.

As to the other side of the picture, which I was at first prompted to cover up, I had an experience with my bike which perhaps in the relating will relieve horsemanship of some of the shadow of doubt which i have thrown upon it. At least it gives horseman an opportunity to say "I told you so".

I refer to the fact that after two days' successful wheeling and an encouraging start of five miles on my third day's plan for cycling eleven miles around Sargent Mountain, I was brought up short with the discovery that I had sheared the rear cog wheel of my bike off the axle by stripping the threads that held the two together. I was six miles from my car, on the top of Sargent Mountain with a supposedly useless bicycle by virtue of the loss of means to peddle forward or brake on the down slopes.

Even so, as you may note from my log, I made the trip in the average time of five miles per hour. The grades ahead of me were, for the most part, all down hill and after walking and taxiing my bike about a quarter of a mile down grade in a state verging on embarrassment, I devised a brake for the crippled bike. A three-pronged brushy birch sapling with one prong out short and hung over the left peddle which I used as a drag served to make the return trip only a matter of coasting and guessing as to the grade and distance that lay hidden beyond each succeeding bend in the road. So much for the confessions of the amateur cyclist.

Regarding the classes and numbers of people who would use the carriage roads for bicycling, I will have to indulge in pure guesswork but I will include the statistics from which I draw my conclusions so that you can form your own opinions from them as well.

Generally speaking a sport like cycling is meant only for those who know the exhilaration and gratification resulting from struggling on to their second wind. The people who will struggle on to this point are akin to those who enjoy cold showers and I think we are most apt to find them in the organized groups made up in park campgrounds and municipal outing clubs. These are the people who may have to struggle to pull down their roll top desks but who will then jump in their cars to join a group that is headed for an all-day trip up and down some mountain side. There is something in the psychology of group activities that seems to bring out all that is actually in the most of us. As part of a group individual are apt to plunge in first and then ask the questions of how and why afterwards.

A year later, same amateur, same farm and same horse, found me preparing to carry out the mission of traveling twelve miles to learn when the thrashers would arrive at our farm. This time, I chose the saddle and started off. I couldn't seem to jibe with her trotting so I had to let her out occasionally. At that, everything went well on the way over although I had had enough of "wild west" by the time I arrived. I completed my task. On the way back I wasn't having much success holding her in to a walk with the result that for several miles either on the trot, on the canter or in the gallop, I was slowly and joltingly coming to the conclusion that I'd be better off walking when one of the stirrup straps broke and I ended up with one leg and both arms twined around the mare's neck and she headed, as it were, for the rhubarb. This is confession number two by the amateur horseman.

As to the other side of the picture, which I was at first prompted to cover up, I had an experience with my bike which perhaps in the relating will relieve horsemanship of some of the shadow of doubt which i have thrown upon it. At least it gives horseman an opportunity to say "I told you so".

I refer to the fact that after two days' successful wheeling and an encouraging start of five miles on my third day's plan for cycling eleven miles around Sargent Mountain, I was brought up short with the discovery that I had sheared the rear cog wheel of my bike off the axle by stripping the threads that held the two together. I was six miles from my car, on the top of Sargent Mountain with a supposedly useless bicycle by virtue of the loss of means to peddle forward or brake on the down slopes.

Even so, as you may note from my log, I made the trip in the average time of five miles per hour. The grades ahead of me were, for the most part, all down hill and after walking and taxiing my bike about a quarter of a mile down grade in a state verging on embarrassment, I devised a brake for the crippled bike. A three-pronged brushy birch sapling with one prong out short and hung over the left peddle which I used as a drag served to make the return trip only a matter of coasting and guessing as to the grade and distance that lay hidden beyond each succeeding bend in the road. So much for the confessions of the amateur cyclist.

Regarding the classes and numbers of people who would use the carriage roads for bicycling, I will have to indulge in pure guesswork but I will include the statistics from which I draw my conclusions so that you can form your own opinions from them as well.

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Using this latter figure in relation to Acadian attendances, i.e., (.005 X 380,000) 1900 cyclists per year become a possibility. Therefore, we have the two estimates of 400 to 500 cyclists as against 1900 cyclists.

Recreations enjoyed with indication of preferences by percentages:

		First	Second	Third
1.	Camping	37.32	12.70	9.93
2.	Motoring	13.58	19.53	6.39
3.	Swimming	10.41*	19.49	14.87
4.	Boating	2.29*	4.63	4.40
5.	Fishing	6.74	12.28	6.22
6.	Hunting	3.24	8.08	4.18
7.	Hiking	6.31*	6.32	8.58
8.	Pack trips	1.00*	0.36	1.34
9.	Horse back	1.22*	1.85	1.93
10.	Winter sports	3.64	3.64	7.49
11.	Nature study	0.90*	1.07	3.23
12.	Picnicking	3.14	5.55	9.68
13.	Rest and relax	1.73	2.16	7.61
14.	Playground	0.72*	0.59	1.14
15.	Campfire entertainment	0.85	7.02	3.41
16.	Other recreations	7.01	0.73	9.60

We find that the activities of users are as follows (using travel figure of 3,710,037):

		New Hampshire	Maine	
1.	Passing through	662,645	75,491	
2.	Sight seeing	2,488,428	98,157	
3.	Boating	2,594*	0	.0007
4.	Camping	36,528	378	
5.	Fishing	6,661	726	
6.	Hiking	76,872*	1,751	.02
7.	Hunting	652	476	
8.	Nature studies	4,792*	45	.0013
9.	Pack trips	0*	0	.0000
10.	Picnicking	44,692	531	
11.	Riding	100*	0	.00003
12.	Swimming	40,523*	762	.011
13.	Sports games	533*	0	.00014
14.	Winter sports	62,317	151	
15.	Other	100,865	0	
				.03319

Another group which would be expected to contribute some cyclists would be the Outing Club of Mt. Desort Island. It has a membership of about 100 people. The average number of members in attendance at scheduled parties such as roller skating, ice skating, hikes, skiing, etc., is about 30. It is safe to estimate that three such parties might be scheduled during a summer season, totalling 90 people. In addition to this, casual cyclists

of the native population might average in time 20 a week or 180 for July and August. Native use of the trails is therefore estimated at 200 to 300 individual trips as a possible contribution. There are 8000 natives on the island so the total cyclist group over the summer amounts to three per cent, i.e. (250 to 8,000).

The summer colony swells the population to about 24,000 people. The additional 16,000 might be figured to contribute three per cent as cyclists and thus a figure of 480 individual trips is added to the estimate.

The following in a summary of potential use of bicycle trails on a minimum, maximum basis.

Tourists	400 to 1900
Natives	200 to 300
Summer Colony	300 to 500
Totals	900 to 2700

The following leg of my travels on the carriage road system concluded the data which I have gathered with the purpose of helping to determine the policy that is to be established in relation to cycling at Acadia. I advocate a policy of permitting joint use of the carriage roads by cyclists and horsemen by means of a program of progressive adaptation to bicycle travel of sections of this system in direct relation to the popularity attained, beginning with one carraige road circuit approximately ten miles in length.

A. Witch Hole Pond Loop:

Distance, 5.90 miles. Time, 1 hour, 10 minutes.

A.M.	
9:20	Start. Firm but rough surface due to horses.
9:40) 9:43)	Pushed bike on account of grade. The footing was firm and fairly smooth in the tracks.
9:50) 9:55)	Pushed bike on account of grade and some degree of loose gravel.
10:00) 10:10)	Rest period.
10:20) 10:22)	Rest after pumping up grade.
10:32	Return.

In general, travel surface was firm to hard and quite consistently rough. Very few loose gravel areas were encountered.

Scenery is ideal, and ranges from distant mountain and ocean views to intimate vistas of woods, ponds and small heaths amidst an entirely wooded setting. The wheeling could be made excellent with proper maintenance. Equipped with a light two-speed English type bike, this section could be peddled from one end to the other.

B. Eagle Lake Loop:

Distance, 5.68 miles. Time, 1 hour, 10 minutes.

P.M.

1:15	Start - road extremely rough.
1:30) 1:40)	Pushed bike, due to loose gravel, roughness and grade. Travel surface changed to an ideal smoothness where repair trucks had traveled over the roads and made wheeling a pleasure.
1:55) 2:00)	Rest at the halfway mark. Down grade since 1:40.
2:00) 2:02)	Pushed bike due to loose gravel, general roughness and grade.
2:10) 2:12)	Rest - wheeling rough and tiresome due to hoof marks. Grade practically zero.
2:25	Return. Last stretch extremely rough due to proximity to riding stables.

This route could be peddled all the way with proper vehicle and good road surface.

The scenery varied from lake and mountain views to the seclusion of deep woods. Five deer were encountered.

C. Long Pond Loop

Distance, 3.7 miles. Time, 40 minutes.

P.M.

3:00	Start. Ideal wheeling along east side of pond due to road smoothing by work trucks.
3:02	Chased a red fox up the road.
3:05) 3:10)	Pushed bike due to grade. Surface good.
3:15) 3:17)	Push and rest. Fine view down Long Pond.
3:40	Return.

D. Pemetic Mountain - Jordan Pond Route.

Distance, 8.61 miles. Time, 1 hour, 30 minutes.

A.M.

9:35 Start. Surface fine due to work trucks.

9:40) Push. Surface good.
9:42)

9:57) Rest at point overlooking Wild Wood Fram.
10:00)

10:05) Watched three deer 100 to 150 feet off road. An
10:10) approaching work truck scared them back into woods.

10:20) Pushing bike along Jordan Pond. This section could be wheeled
10:25) if smooth. However, the trucks had successively smoothed the the road surface and then worked it into corduroy. Enjoyed the opportunity to work the kinks out of my legs and view the scenery at a walk.

10:30) Discovered a red fox hunting the road shoulder for rodents. He
10:35) was less than 100 feet away as I later paced the distance and apparently did not see me or get my scent because I watched him until I got tired of waiting to be discovered.

10:40) Pushed bike due to roughness and losseness of surface. However,
10:41) the lighter bike that I used enabled me to cut the pushing distance in half.

10:45 Stirred up four deer.

11:05 Return.

This was the best trip so far due to good road surfaces and improved type of bicycle used. The scenery was great and included distant mountain and sea views, the large expanse of Jordan Pond, the overhanging Jordan Cliffs and deep woods.

E. Sargent Mountain - Jordan Pond Loop.

Distance, 11.36 miles, Time, 2 hours, 25 minutes.

A.M.

8:50 Start.

8:55) Pushed bike. The surface is loose and rough due to repeated
9:00) churning by horses from nearby stables.

9:05) Pushed bike. The surface was loose and rough.
9:08)

9:20) Rest. Great seaward view. Long Pond in the central distance
9:22) and many islands off shore.

9:24) Rest. Was surprised what grades could be pumped.
9:26)

9:48) Rest. Now at north end of Upper Hadlock Pond. Road surface
9:50) now smooth because horses do not appear to frequent this section of road.

10:10) Have attained top of rise and am looking over Somes Sound.
10:12)

10:13 I discover I have sheared the rear cog wheel off the axel. This means no gears and no brakes.

10:25 Would hate to be caught pushing a bike down hill.

10:30 Have now devised a brake from bushy birch sapling which I use as a drag to regulate speed down hill. Clear sailing ahead.

11:15 Return.

B. L. Breeze,
Resident Landscape Architect.

BLB:NEA