HAWAII VOLCANOES NATIONAL PARK ROADS
Hawaii Volcanoes National Park
Volcano vicinity
Hawaii County
Hawaii

HAER No. HI-47

HAER
HI-47

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C St. NW
Washington, DC 20240

HISTORIC AMERICAN ENGINEERING RECORD

HAWAII VOLCANO NATIONAL PARK ROADS
HAER No. HI-47

LOCATION:	Hawaii Volcanoes National Park, Volcano vicinity, Hawaii County, Hawaii
DATES OF CONSTRUCTION:	1880s-1979
DESIGNERS:	Nineteenth-century entrepreneurs, County, Territory, and State of Hawaii, National Park Service, Bureau of Public Roads
CONTRACTORS:	Various
STRUCTURE TYPE:	Park road system
OWNER:	National Park Service, Hawaii Volcanoes National Park; State Highway 11 within the park is maintained by the Hawaii Department of Transportation
SIGNIFICANCE:	The Hawaii Volcanoes National Park road system provides access to active volcanoes and related landscapes along with varied ecosystems and archeological sites. It represents the traditional NPS approach to road design and development with unique features created by local volcanic and seismic activity.
PROJECT INFORMATION:	Documentation of the Hawaii Volcanoes National Park road system was conducted in 1999 by the Historic American Engineering Record (HAER), Eric DeLony, Chief, a long-range program to document historically significant engineering, industrial, and maritime works in the United States. The HAER program is part of the Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) Division of the National Park Service, Department of the Interior, E. Blaine Cliver, Chief. Funding

was provided by the Federal Lands Highway Office, Arthur E. Hamilton, Program Manager, through the NPS Park Roads and Parkways Program. This recording project was cosponsored by HAER and Hawaii Volcanoes National Park, Jim Martin, Superintendent; Laura Schuster, Branch Chief, Cultural Resources. The summer project also included documentation of Haleakala Highway on the island of Maui, a component of Hawaii National Park from 1916 until 1961.

The documentation was prepared under the direction of HAER architect Todd Croteau and NPS historian Timothy Davis. Large format photography produced by Jet Lowe. The report detailing the history of the park road system was written by project historian Dawn Duensing and edited by NPS historians Timothy Davis and Kelly Young.

PROJECT HISTORIAN: Dawn E. Duensing

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PREFACE

The Historic American Engineering Record (HAER) program of the National Park Service (NPS) has been engaged in a long-term program to document America's national park roads and parkways. Roads are important aspects of the cultural heritage of the national park system. The HAER Park Roads Program has created a detailed visual and textual record of historically significant roads, bridges, ancillary structures, and related landscapes in a broad range of national parks and parkways. Teams of historians, photographers, architects, and landscape architects have documented existing landscape conditions, NPS road-building practices, highway engineering technology, design strategies, and related historical processes.

During the summer of 1999, HAER documented the roads of the former Hawaii National Park, now Haleakala National Park and Hawaii Volcanoes National Park. The project was completed under a Memorandum of Agreement between HAER, Haleakala National Park, and Hawaii Volcanoes National Park. Project Historian Dawn Duensing produced reports detailing the history of each park road system. Historic photographs from the park archives were reproduced to accompany the reports and photographs were taken to document the roads' current conditions. HAER project leaders were Todd Croteau and historian Tim Davis.

Many individuals helped make this project a success. The project historian would like to thank Superintendent Don Reeser and Resource Management Specialist Ron Nagata of Haleakala National Park for their assistance. Thanks also to Superintendent Jim Martin of Hawaii Volcanoes National Park. Laura Schuster, Branch Chief, Cultural Resource at Hawaii Volcanoes National Park, made that park's library and archives available. Volunteer librarian Helen Bevins was extremely helpful in locating materials relating to this project. Helen also provided encouragement and companionship during the months of research at Hawaii Volcanoes National Park. I am grateful to my husband, Mark Waterson, for his assistance in understanding engineering and construction terminology and techniques. This project could not have been successfully completed without the guidance of HAER historian Tim Davis.

This study presents a history of the construction and development of the road system at Hawaii Volcanoes National Park (HAVO). It covers early travel to Kilauea Crater and the growth of HAVO as more park features became accessible to the public.

The history of the park's road system shows that road construction followed the patterns of National Park Service road development and history. National Park Service-Bureau of Public Roads cooperation played an important role in developing the park road system. As with many other national parks, local input was crucial in getting new roads and improved access. Many of the Hawaii Volcanoes National Park roads were the result of local citizens' initiatives as they lobbied for improved access to scenic attractions to encourage tourism. The roads in this national park are locally significant, but they also reflect broader historical currents. Improvements in transportation mirror the growth of the National Park system, the increasing popularity of outdoor tourism, and the institution of federal relief programs during the Great Depression. The report concludes with a discussion of future plans for the park's road system.

A glossary of native Hawaiian terms is provided at the end of this document. Since many of the diacritical marks essential for proper representation of the Hawaiian language are not commonly available on standard word-processing systems, there may be some discrepancies between this report's spelling of Hawaiian terms and place names and the most preferable current practice. While Hawaii Volcanoes National Park was known as Hawaii National Park from its authorization in 1916 until its redesignation in 1961 following the establishment of a separate Haleakala National Park on Maui, for the sake of consistency the official Park Service acronym HAVO will be used throughout this report to refer to both the original national park and the current unit on the island of Hawaii.

HAWAII VOLCANOES NATIONAL PARK

Hawaii National Park was established by Congress in 1916 to protect the outstanding natural features of Haleakala Crater on the island of Maui and the Kilauea and Mauna Loa volcanoes on the island of Hawaii (also referred to as the "Big Island"). Kilauea is the earth's most active volcano, providing visitors with views of dramatic volcanic landscapes and awe-inspiring spectacles of nature. Kilauea also provides scientists with opportunities to study volcanoes and learn about the formation of the Hawaiian Islands. Mauna Loa, an active shield volcano, rises to 13,677' above sea level and is the earth's largest mountain mass, occupying a volume of approximately 18,000 cubic miles. From its base on the ocean floor to its summit, Mauna Loa rises nearly 32,000'. Though located on another island, Haleakala Crater was included as the third section in Hawaii National Park. It is one of the world's largest volcanic craters.

Hawaii National Park became Hawaii Volcanoes National Park in 1961 when the Haleakala section was designated as a separate national park. Today, Hawaii Volcanoes National Park encompasses 230,000 acres and ranges from the summit of Mauna Loa to the sea, following in the tradition of the Hawaiian land division pattern known as the *ahupuaa*. Over half of the park is designated as wilderness.[1] New land is almost continuously being added to the park as a result of volcanic activity.

HAVO is located on the "Big Island" of Hawaii, twenty-nine miles from the island's principal town of Hilo and ninety-six miles from the resort area of Kailua-Kona on the island's leeward coast. The park attracts approximately 2.5 million visitors annually, most of whom stay in the park for less than four hours. The park's primary attraction is currently the eruption of Puu Oo, located on the flank of Kilauea east of Kilaeuaiki and Halemaumau craters. Volcanic activity is unpredictable and many visitors leave the park without viewing an active eruption. The majority of visitors make a tour of the eleven-mile Crater Rim Drive, stopping at major scenic attractions along the way. Many visitors also drive the twenty-mile Chain of Craters Road

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[1] Hawaii Volcanoes National Park Home Page, http://www.nps.gov/havo/, accessed September 25, 1999.

from Crater Rim Drive to the coast.[2] Two secondary roads, Hilina Pali and Mauna Loa, are traveled by few visitors and serve primarily as access for backcountry excursions. Only a small percentage of HAVO visitors leave the comfort of their cars for a hike over a portion of the park's 150 miles of hiking trails. Many visitors are active or retired military personnel visiting Kilauea Military Camp, which provides rooms, meals, and other amenities and is located in the park about one mile from headquarters. A park concessionaire operates the historic Volcano House hotel and restaurant on the crater rim as well as cabins at Namakani Paio Campground.

Hawaii Volcanoes National Park has been designated an International Biosphere Reserve and a World Heritage Site. In addition to its unique volcanic features, the park protects remnants of a Hawaiian ecosystem that has been greatly reduced and damaged by human activity over the centuries. The park preserves tree ferns, *koa*, *ohia lehua*, *ohelo*, and other native plants, as well as native fauna that includes tree snails, happyface spiders, damselflies, and butterflies. Many endemic bird species are threatened or endangered, including the *nene* (Hawaiian goose), *Opeapea* (hoary bat), *io* (hawk), *pueo* (owl), *apapane* (honeycreeper), and *iiwi* (honeycreeper). Archeological features in the park serve as a reminder that this area was important to Hawaiians. Native Hawaiians consider Halemaumau, for which one translation from the Hawaiian is "fern house," the home of the volcano goddess Pele, the creator and destroyer of land. Also known as the "fire pit," Halemaumau is within Kilauea Crater, an active volcano on the flank of Mauna Loa. As the purported home of Pele, the crater and its environs are sacred to Hawaiians. From the earliest days of tourist travel on the island of Hawaii, Halemaumau was also the premier attraction at Kilauea.

THE ROAD SYSTEM OF HAWAII VOLCANOES NATIONAL PARK

The road system of Hawaii Volcanoes National Park provides access to the world's most active volcanoes, along with a diverse array of native ecosystems and archaeological sites. In 1920 National Park Service (NPS) Director Horace Albright asserted that Kilauea Crater was among the most wonderful

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[2] HAVO Home Page; Jim Martin, Superintendent, Hawaii Volcanoes National Park, interview by author, 19 August 1999, Hawaii Volcanoes National Park.

features in the national park system, surpassing the natural wonders of Yosemite, Yellowstone, and Sequoia. Albright recommended acquiring additional land so that roads and trails could be built to make the parks features accessible.[3]

Sections of Crater Rim Drive predate the establishment of the national park, but in 1920 the park had only 16 miles of road. There were few roads within the park when the NPS began active administration in 1922. Of those few roads, some were in poor condition and others, like Crater Road, were damaged by lava. Thus, road construction was an immediate priority.

Over the next few decades, the park acquired additional land and built approximately sixty-five miles of roads that offered access to a variety of natural and cultural features. Crater Rim Drive was extended into a loop that allowed visitors to enjoy the fern forest and active volcanoes. The Uwekahuna-Bird Park Road, eventually extended to become the Mauna Loa Road, made the endemic forest accessible and allowed opportunities to view native birds. The Chain of Craters Road opened up a tremendous area of the national park, providing access to additional scenes of volcanic activity. With the Kalapana Road extension, visitors could enjoy another circuit tour of the park. The road opened opportunities to experience the coast and Hawaiian archeological sites. Hilina Pali Road and Mauna Loa Road were built as utilitarian truck trails, although each road was also used as a scenic road for tourists. In addition, the Mauna Loa Road provided scientists with improved access to the then active summit of Mauna Loa. The Mamalahoa Highway (State Highway 11) became the park's approach road as well as the major route between the island of Hawaii's two major towns, Hilo and Kona.

NPS Road Development and Hawaii Volcanoes National Park

The history of roads in Hawaii Volcanoes National Park followed classic NPS road development policies. Since the early twentieth century, the National Park Service had a dual mission in providing roads for the public. The first part of the mission was to provide access to scenic views and natural features. The second goal was to build roads in a manner that would minimize disturbances to existing landscapes. The philosophy of landscape preservation also meant that construction was intended to harmonize with nature. This dual

[3] Horace Albright, Field Assistant to the Director, National Park Service, "Annual Report," 1920, 1-4, pamphlet files, HAVO library.

mission often caused a balancing act, since increased access and heavier visitation could threaten the protection of parks' scenic landscapes.[4]

Most of the HAVO road system was built between the 1920s and the 1970s to provide park visitors with improved automobile access to volcanic eruptions and their associated landscape features. Many of the park roads were designed and constructed following standard National Park Service road-building policies developed in the early twentieth century. The NPS implemented many of these policies under a 1926 memorandum of agreement between the Park Service and the Bureau of Public Roads (BPR). Under this agreement, park superintendents and NPS landscape architects determined the location and character of park roads. The interagency agreement allowed the NPS to use the BPR's expertise and organization to conduct surveys, determine contract specifications, and manage the construction projects. NPS cooperation with the BPR ensured that park roads were built to the highest engineering standards while also protecting the landscape and park values. This cooperation made it possible to build roads on a standardized system throughout the NPS system. The Park Service retained control in deciding where, when, and how park roads would be built. NPS landscape architects reviewed surveys and contract specifications to assure that construction met strict NPS standards for landscape preservation, while also ensuring that BPR engineering standards were maintained. The 1926 agreement provided the framework for decades of cooperation between the NPS and BPR, including the design and construction of Chain of Craters Road, sections of Crater Rim Drive, and the Mauna Loa Trail.[5]

Early park administrators followed many of the classic road-building policies that were used in national parks throughout the nation. Borrow pits were located out of sight of the roads to preserve scenery. Construction crews worked in the rights-of-way to avoid unnecessary scarring of the landscape. The needless cutting of trees was avoided and in one case, on Crater Rim Drive, a new alignment was rejected because the proposed

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[4] Linda McClelland, *Presenting Nature: The Historic Landscape Design of the National Park Service, 1916 to 1942* (Washington DC: Interagency Resources Division, National Register of Historic Places, National Park Service, U.S. Department of the Interior, 1993), 80.

[5] Ethan Carr, *Wilderness by Design: Landscape Architecture and the National Park Service* (Lincoln, NE: University of Nebraska Press, 1998), 98, 174-175.

project would destroy too many large tree ferns. Trees, however, could be thinned to open vistas and improve scenic features. Roadways were located so that they curved and flowed with the natural contours of the land. Roads were designed with radial curves rather than sharp switchbacks. Gentle grades of no more than 5 percent were another goal, although in some cases, steeper grades were unavoidable. Shoulders were sloped to prevent erosion and present a more natural appearance. A classic park design strategy, the circuit road, was employed twice to facilitate more pleasurable travel, including Crater Rim Road and Chain of Craters-Kalapana Road. The use of native stone for walls, curbs, and drainage systems was prevalent throughout the park.[6]

Road projects at HAVO involved some of the most prominent names in the National Park Service. Assistant to the Director (later Director) Horace Albright helped conceptualize the Mauna Loa Road and asserted that HAVO needed roads to fulfill its mission. BPR engineer Frank Kittredge, who became the NPS chief engineer in 1927, investigated HAVO roads and advised the park on surveys and development. Landscape architect Merel Sager was assigned to HAVO during a prolific era of road development projects during the Great Depression. Landscape architect Thomas Vint was involved in a number of park road projects, most notably the Chain of Craters-Kalapana Road. Vint had a forty-year career with the NPS and was appointed chief landscape engineer in 1927. According to historian Ethan Carr, "No individual influenced Park Service planning process and design details in the late 1920s and 1930s more than Thomas Chalmers Vint."[7] Another prominent NPS landscape architect, John Wosky, was heavily involved in HAVO road development and also served as superintendent during the 1950s.

Unique Conditions in Hawaii Volcanoes National Park

The Hawaii Volcanoes National Park road system has been affected by a combination of natural phenomena that are unique in the National Park System. Lava flows, volcanic ash, earthquakes, heavy rain, and heavy vegetation created unusual conditions for road building and also damaged and destroyed many miles of HAVO roads. Due to these conditions, numerous sections of road have been realigned during the last fifty years.

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[6] McClelland, *Presenting Nature*, 76, 80, 94, 103-104.

[7] Carr, *Wilderness by Design*, 190.

Lava flows are one of the most prominent landscape features in Hawaii Volcanoes National Park. Throughout the park's history, lava has repeatedly destroyed roads and necessitated reconstruction or realignment. Volcanic activity was unpredictable and new roads and realignments were never guaranteed to be unaffected by future eruptions.

Geological features created by lava have created unusual problems for road surveyors and engineers. Roads in HAVO were likely to be constructed over hollow underground lava tubes. It was difficult to ascertain where lava tubes were or how thick the ceiling of the lava tube might be. Therefore, engineers were uncertain whether the lava tube "roof" would withstand the weight of the road and its traffic. Over the years, there have been several ways of dealing with the problem. HAVO's first superintendent, Thomas Boles, thought that he could "sound out" the lava surface by driving a heavy truck over a proposed route. This would assure engineers and contractors that the surface would support a road. Decades later, a geologist asserted that lava tubes could be mapped. He disagreed with Boles' theory of "sounding out" the lava's surface and recommended that roads be built at least 75' from known lava tubes.[8]

The presence of underground lava tubes also made it difficult for engineers to estimate how much fill they could get from road excavations. Due to the hollow nature of the numerous lava tubes, there was sometimes less material to excavate than had been estimated. When this happened, there was not enough material to balance cuts and fills and materials had to be trucked in from other locations.

Earth movement has always been a road maintenance problem in HAVO. Earthquakes often sent the roadway into adjacent volcanic craters. Earthquakes also made pavements heave or crack. Cracking in the road could vary from just a few inches to several feet wide and hundreds of feet deep. Heaved pavement could result in a slight hump in the road or a piece of pavement so large that a car could not drive over or around it.

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[8] Thomas Boles, "Superintendent's Monthly Report," May 1922, HAVO library; and John Aubuchon, Acting Superintendent, HAVO, Memorandum to Superintendent Fred T. Johnston, 22 May 1962, "Kalapana-Chain of Craters Road, Project 2-C1, June 1956-July 1962" folder, File D30, HAVO archives.

Due to the threatening nature of volcanic eruptions and earthquakes, pipe barrier gates were used extensively at HAVO to control access to different sections of the park. Barrier gates could be drawn across the roads at numerous locations throughout the park in order to close them during an emergency. Barrier gates were also useful for prohibiting entry into areas affected by drought and threatened by fire. In recent years, the gates have also closed a road to protect the endangered *nene* during its nesting season.

Climate also caused road problems in HAVO. In both desert and rain forest, the park received heavy rainfall during storms and in the winter rainy season. For example, in 1929, HAVO recorded 74" of rain. In November 1929, 20" of rain fell in one storm, with 7" recorded in only eight hours. Heavy rains could wash out roads or undermine the road surface.[9] Drainage was a concern on many park roads.

With Hawaii's year-round growing season, vegetation also caused unique conditions for roads in the national park. Tree roots frequently undermined the road pavement and forced it to break. Heavy vegetation often obscured road shoulders. Vegetation also blocked vistas created for motorists to view the park's natural beauty.

DESCRIPTIONS OF HAWAII VOLCANOES NATIONAL PARK ROADS

Crater Rim Drive

Crater Rim Drive is a scenic, two-lane, eleven-mile loop road that circles Kilauea's summit caldera and craters. The road passes through rainforest and desert and features numerous scenic stops. The two-way asphalt road varies in width between 19' and 22', depending on the terrain. In the rain forest, between the visitor center and the Chain of Craters Road intersection, the road is no wider than 20', though it has 2' shoulders in some areas. From the Chain of Craters intersection to the Halemaumau parking area, the road is 22' wide. From Halemaumau back to the visitor center, the road is 19' to 20' wide and has no shoulders.

From the Kilauea Visitor Center at Hawaii Volcano National Park, motorists proceed in an easterly direction to a junction located

[9] Thomas J. Allen, "Superintendent's Monthly Report," November 1929.

between the visitor center and the park entrance. Turning right, motorists can continue on Crater Rim Drive. Going straight from the visitor center leads to the park entrance station.

After turning right and proceeding 0.1 mile along Crater Rim Drive, there is a service road on the right that leads to park maintenance facilities. Continuing on, Crater Rim Drive winds through a fern and *ohia* forest for a half-mile, providing the experience of driving through a lush tropical rainforest. At this point, there is a "T" junction and stop sign. To the right is an old portion of Crater Rim Road, part of which was destroyed during the 1983 earthquake and is now used as a hiking trail. Sections of this road that have not collapsed exhibit significant historic design elements including a narrower width and more curvilinear alignment than newer sections, stone-curbed parking areas, and classic NPS "Type No. 2" guardwall. This old roadway follows the crater's edge and ends next to Volcano House. From the old section of Crater Rim Road near the "T" junction there is also a spur road leading to the former Civilian Conservation Corps (CCC) camp, which is now the HAVO research center.

From the "T" junction, drivers turn left to continue on Crater Rim Drive. About 1.4 miles from the visitor center is the Kilauea Iki overlook, which has parking for fifty-five cars and access to the Crater Rim trail. At mile 1.8 is the Thurston Lava Tube, one of the park's most popular visitor attractions. A 15 mph speed limit sign alerts motorists to slow down in this extremely congested area. On the west side of the road is limited parking space for private auto parking; the opposite side of the road is reserved for tour bus parking. There is a crosswalk and access to the Crater Rim Trail as well as the Thurston Lava Tube. Just after this area is a moveable barrier gate, a cattleguard, a 25 mph speed limit sign, and a parapet guardwall of lava rock that dates to the 1930s.

For the next mile, Crater Rim Drive winds through the most extensive stand of remaining fern forest along the road. Fern trees stand up to 30' high in this area, which was called the "fern jungle" during the early twentieth century.

At 2.8 miles from the visitor center, a spur road on the right leads to Puu Puai Overlook. This 0.2-mile road was another section of Crater Rim Drive, some of which was destroyed during the 1959 Kilauea Iki eruption. There is a moveable barrier gate

at the entrance near the main road. Puu Puai Overlook has a large parking area and provides access to the Devastation Trail. The parking area is bordered by lava rock curbs, with a median in the middle of the lot.

The Crater Rim Drive-Chain of Craters Road junction is 3.1 miles from the Kilauea Visitor Center. There are moveable barrier gates on the Chain of Craters Road entrance as well as on each side of the Crater Rim Drive. There is also a short spur road to the Devastation Trail parking area, which has lava rock curbs. This spur road is the other end of the section of Crater Rim Drive that was destroyed by the 1959 Kilauea Iki eruption. The present Crater Rim Drive between the Chain of Craters Road junction and the Puu Puai Overlook spur road is the new road built to replace the section of Crater Rim Drive destroyed after the 1959 eruption.

After the Chain of Craters Road junction, the speed limit on Crater Rim Drive is 35 mph, however 25 mph is recommended for about one mile, as this is habitat for the endangered Hawaiian goose, or *nene*. The effects of the 1959 eruption are still visible, with large piles of cinder 6' to 8' high resembling black sand dunes on both sides of the road. The climate begins to change from rain forest to desert in this vicinity; ferns disappear and the *ohia* forest is less dense. Emerging from the rain forest, the barren landscape of Kilauea Crater comes into view. On a clear day, motorists will see Mauna Loa and the summit of Mauna Kea.

Keanakakoi Crater is 4.7 miles from the visitor center, with turnouts and parking on both sides of the road. The road is at the crater's edge and a lava-rock masonry wall protects visitors. On the opposite (north) side of the road is a short trailhead that leads to an overlook of Kilauea Caldera. This side of the road has iron pipe guardrails to protect visitors and keep them on the walkway. Just past the Keanakakoi turnouts on the south side of Crater Rim Drive is a hand-laid stone gutter constructed by the Civilian Conservation Corps during the 1930s. On the opposite side of the road is an asphalt drainage ditch. It is likely that the asphalt covers CCC stonework.

Crater Rim Drive runs through a gully and over a rise before descending into the south end of Kilauea Crater. Vegetation is sparse and the barren landscape is dotted with steaming fumaroles. The road then passes through the area covered by the 1982 lava flow. There is a turnout 0.4 mile after Keanakakoi

with asphalt curbs and an interpretive sign explaining the April-May 1982 eruption. The pullout provides views into the huge expanse of Kilauea Caldera. Beyond the turnout is an asphalt drainage diversion; this asphalt may have been laid over old CCC stonework. Another turnout is situated 0.1 mile further down the road. An interpretive sign here explains solfataras and allows for a view of Halemaumau.

The road gradually descends to the Halemaumau parking area located 5.9 miles from the visitor center. There is another moveable barrier gate just before this large parking lot, which accommodates 550 cars. A short interpretive trail leads to the rim of Halemaumau. Steam and sulphur fumes fill the air. A crosswalk from the parking lot provides safe passage over Crater Rim Drive for the Halemaumau Trail.

Leaving the Halemaumau parking lot, the road is built on fill as it crosses another gully. There is no shoulder and the drop-off from the road is approximately 6'. A turnout is lined with large lava boulders that serve as a barrier to prevent cars from driving onto the lava flows.

Next, Crater Rim Drive passes through the September 1974 lava flow. There is a minimal shoulder along this section, which is built on fill as it begins to climb out of the caldera. At the top of a hill, 6.1 miles from the visitor center, is the Southwest Rift, a deep fracture in the earth's surface. At this pullout, there is an interpretive display explaining the site and one can view the rift's colorful layers of volcanic rock deposited over centuries of eruptions. After the Southwest Rift, the road is built on fill and the earth on either side of the road has deflated from volcanic activity. Most of this section has no shoulders. The road passes through another *nene* zone with a lower speed limit and rumble strips to remind drivers to slow down.

About 0.4 mile after the Southwest Rift pullout area is approximately 0.1 mile of shoulder stonework constructed by the CCC during the 1930s. This shoulder work is in very good condition and is the best remaining example of its kind in HAVO. The shoulders were constructed to direct the huge amounts of rain off the road and also to channel water that could wash onto the road from the adjacent terrain. There are several CCC stonework culvert headwalls in this area that have not been modified since construction. There are more sections of

stonework shoulders along the road for the next mile. Grass and weeds are growing in the stonework mortar joints.

Approximately 7.5 miles from Kilauea Visitor Center, the road curves as it ascends out of the caldera. Near mile 8, Crater Rim Trail crosses the road. At this point, motorists on Crater Rim Drive have traversed approximately two-thirds of the distance around Kilauea Crater. The landscape begins to change from desert to rainforest once again and vegetation gradually increases.

The Hawaiian Volcano Observatory (HVO) and Jaggar Museum are 8.7 miles from the origination point. There is a moveable barrier gate across the road just before entering the large parking lot. After leaving the parking lot to continue the loop road, there is a stonework culvert headwall.

Nearly nine miles from the visitor center, there is a spur road on the right that leads to the crater's edge and Kilauea Overlook. There is a parking lot, picnic area, and rest room. Vegetation becomes more abundant, with *ohelo*, *ohia*, and other native plants.

Crater Rim Drive becomes somewhat straighter and relatively level as it passes the Kilauea Military Camp and approaches Steaming Bluff. This area has a parking lot, interpretive information, and hiking trails that provide views of the crater and the steam rising from the bluff. One-half mile further along Crater Rim Drive is a short spur road on the left that leads to Sulphur Banks and interpretive information. From Sulphur Banks, Crater Rim Drive curves as it climbs a short hill with a CCC-era lava rock guardwall before returning to the visitor center. Reflective posts have been installed adjacent to the wall to guide motorists through the frequently foggy conditions in this area. On the right is the entrance to Volcano House and to the left is the entrance to a large parking lot that serves the visitor center and the Volcano Art Center. The Volcano Art Center is housed in the relocated 1877 Volcano House hotel.

Chain of Craters Road

Chain of Craters Road begins at an intersection with Crater Rim Drive just past the Devastation Trail parking area and about three miles from the Kilauea Visitor Center. The two-lane asphalt road averages 22′ wide, with 2′ to 3′ shoulders in some areas. There is a moveable barrier gate at the beginning of the

road. Signs notify drivers of the 35 mph speed limit and remind them that there are no services on this road. The Crater Rim Trail crosses the road at 0.1 mile and there is a turnout for parking. The first part of the road passes through a fern-*ohia* forest. The road is relatively straight with some easy curves. Chain of Craters Road begins at an elevation of approximately 3,800' and after twenty-two miles, terminates at sea level.

Lua Manu crater overlook is on the right side of the road 0.4 mile from the road's start. There is an overlook with a lava rock masonry wall. A sign dates the lava flow in this area to 1974. After the crater, the speed limit increases to 45 mph. Moss grows on the pavement in this wet locale and a sign warns drivers that the road can be slippery when wet.

On the left side of the road at Mile Marker 1 is Puhi Mau crater. A short walk leads to an overlook. A small parking lot is bordered by lava rock curbs.

Continuing along the road, motorists cross a cattleguard and, for more than a mile, the road is largely straight. Near the 1.4-mile point is Kookoolau Crater on the right side of the road. There is an NPS Type 3 parapet masonry wall along the crater's edge. The mortar on this wall is unusual and appears to have been scraped with a stick between the rocks. The vegetation at the overlook is overgrown and the view of the crater is obscured.

Just past Mile Marker 2 is the junction with Hilina Pali Road, which runs to the southwest, and another moveable barrier gate. Although there is still some moss on the road, the vegetation begins to change from that of the wet, windward forest, to that of the dry, leeward side.[10] The *ohia* forest begins to thin and lava flows are a more dominant part of the landscape. At 2.6 miles from the road's start is Hiiaka Crater on the left. A sign indicates that the lava flow dates to 1973. There is a pullout on the right side of the road as the road begins curving to the left.

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[10] Hawaii's weather is dominated by moist maritime tradewinds that blow from the northeast. Tradewinds drop moisture on the northeast or "windward" sides of the islands, creating a wet climate. Mountains and air currents affect the trades as they pass over the islands, resulting in the "leeward" or southwest parts of the islands having a dry climate.

About 0.2 mile after Mile Marker 3, Pauahi Crater is located to the left of the road. A short walkway protected by a post and rail fence leads to a crater overlook. Mauna Ulu, which translates into "growing mountain," was created by the 1960s-1970s eruptions along Chain of Craters Road and is visible from the overlook. This area was covered by a November 1979 lava flow. Another moveable barrier gate is located at this point so that the road can be closed if necessary. Just after Pauahi Crater, the road curves to the right and an old road alignment is visible to the left. The old section of road was abandoned after a 1993 realignment. Vegetation has been planted to obliterate the scar.

After the four-mile point, there is a spur road on the left. This 0.4-mile road segment is the remnant of the old Chain of Craters Road that ended at Makaopuhi Crater prior to the 1973 eruption that obliterated the road. There is a large parking area and a new concrete comfort station built as part of the fee demonstration program implemented in 1997. Interpretive signs provide information about the area and hiking trails provide access to Puu Huluhulu, Makaopuhi Crater, and Napau Crater.

Near Mile Marker 4, there are turnouts on both sides of the road and an interpretive sign that explains the 1969 lava flow. *Ohia* forests are interspersed with the lava flows in this area. The road cuts through rock, which rises approximately 20' high on either side, as it passes the Ainahou Ranch Road (closed to the public). The elevation at this point is 3000'. A sign warns drivers to slow down to 35 mph through *nene* habitat.

The road passes through Kipuka Kalii near Mile Marker 5 and there are long turnouts on each side of the main travel way. An interpretive sign explains the deep layer of cinders that covers the area. The road is relatively straight in this area, with some long easy curves. Near the seven-mile point, there are large turnouts on both sides of the road for the Keauhou Trailhead. The trail provides access to the backcountry and its history is depicted on an interpretive sign. The road curves and steeply descends through huge areas of lava fields. A sign warns that the road is slippery when wet.

One-quarter mile past the Keauhou Trailhead is the Muliwai O Pele lookout. There is a short walk to a platform that overlooks the great expanse of lava, Mauna Ulu, and the ocean. The overlook is a good place to view both types of Hawaiian lava, *aa* and *pahoehoe*. The road then proceeds through cuts in

the lava and across fills. A sign near Mile Marker 8 warns of the road's steep grade.

For the next two miles the road passes through a *kipuka* (oasis) of *ohia*. The road continues to descend and proceeds through many cuts and fills in the lava fields. While there are no shoulders and no guardrails along the road, reflective markers have been placed along the curves. Near the ten-mile point, there is a runaway bus ramp on the right side of the road and a sign instructs bus drivers to check their brakes.

After Mile Marker 10 is Kealakomo, a shelter/picnic area with views of the ocean 2000' below. There is a large parking lot and across the road is the Napau Trailhead. The original Chain of Craters-Kalapana Road passed through this area before being destroyed by lava between 1969-1974. There is a moveable barrier gate just past the parking lot. Portions of the old road are found along the Napau Trail and remnants of a parking lot can be seen south of Chain of Craters Road near Mile Marker 11.

The road proceeds through a cut in a high cliff after mile eleven and there is a pullout at Halona Kahakai. Once again, there is a view of the seascape almost 2000' below. After Mile Marker 12, the road switchbacks through deep cuts in the cliffs. After the switchback, the road descends along the contour of the Holei Pali. There are long lengths of galvanized steel w-beam guardrail supported by wood posts along precipitous drop-offs. The road includes many cuts and fills as it goes down the steep slope.

Alanui Kahiko, which translates as the "old road," is located between Mile Markers 14 and 15, near the bottom of the *pali*. There are a turnout, interpretive sign, and stairs to a short trail, which leads to remnants of the old Chain of Craters-Kalapana Road, obliterated in the 1969-1974 eruption. The road then turns away from Holei Pali and heads across the lava fields towards the coast. Near Mile Marker 15, there are turnouts on both sides of the road with interpretation regarding the lava fields and Holei Pali. The road steeply descends as it curves through the lava fields on its way to the ocean.

The road continues in a straight line before it arrives at the Puu Loa petroglyphs turnout and trailhead after Mile Marker 16. On the opposite side of the road are an emergency phone, an

interpretive sign, and trailhead access to the backcountry coastal areas. There is a moveable barrier gate over the road.

After passing Mile Marker 17, the road curves to the left and parallels the ocean until its terminus. Along the way there are turnouts to provide visitors with coastal access and ocean views. A turnout for the Holei Sea Arch is near Mile Marker 19. A sign warns of the hazardous coastline, steep cliffs, and frequent high winds and waves. One-half mile further along the road is a grove of coconut palms. Near Mile Marker 20 is another moveable barrier gate and drivers are cautioned to limit their speed to 15 mph at the turnaround at the road's end. After twenty miles, the Chain of Craters Road is covered by lava flows that began in 1983 and continue to be active in 2000.

Mauna Loa Road (Mauna Loa Truck Trail)

Mauna Loa Road begins on the north side of Mamalahoa Highway, several miles west of the main entrance to Hawaii National Park. The asphalt road is 13.5 miles long. It generally parallels and sometimes coincides with the historic Mauna Loa Truck Trail. A short section of this original road, with accompanying stone guardrail, escaped the lava flows and can be seen along the trail to the eruption site.

For the first 1.5 miles, Mauna Loa road is a fairly straight, two-lane road that is 20' wide. The speed limit is 35 mph. Just after the start of Mauna Loa Road, there is a spur road on the right that leads to the Tree Molds loop drive. Interpretive plaques explain the tree molds. About one mile along the road is another spur road on the right that leads to a picnic ground.

At the end of what was originally the Uwekahuna-Bird Park Road is Kipuka Puaulu (Bird Park), approximately 1.5 miles from the start of the Mauna Loa Road. At Bird Park, there are a loop turnaround, parking, and an interpretive sign for the Kipuka Puaulu trail. Early stone curbing is buried by soil and vegetation. Bird Park is an oasis of forest growth that was not destroyed by Mauna Loa's lava flows.

At the Kipuka Puaulu loop, lava rock masonry pillars on both sides of the road serve as a type of formal entrance to the Mauna Loa Road from Bird Park. There is a moveable barrier gate at the entrance that can be closed during periods of drought and in case of emergency. A sign notifies visitors that the road is ten miles long. From this point to the road's end, the pavement width is no more than 12'.

The road after Bird Park averages approximately 10′ to 11′ wide. The shoulder width for the last eight miles is no more than 2′ and most of the shoulders have been covered by grass. For the first few miles, drivers traverse an *ohia* forest. There is a large switchback at about the 4000′ elevation. Approaching Kipuka Ki, about 2 miles from Kipuka Puaulu, the speed limit is 25 mph as the road winds uphill. At Kipuka Ki, there is a gravel parking area, a moveable barrier gate, and a cattleguard. The speed limit is reduced to 15 mph.

Midway up the Mauna Loa Road, visitors drive through a dense *koa* forest. The road winds through trees that form an arbor above. For several miles in numerous places, *koa* roots have broken and uplifted the pavement, making for a bumpy drive. After the *koa* forest, the road passes through the Keamoku lava flow. There are numerous large cuts and fills in the road, which was built through the *aa* flows. Many of the filled sections are supported by dry-laid stone masonry.

The road ascends almost to the 7,000′ elevation where it ends at a small parking lot. An eight-sided stone shelter constructed by the CCC in 1937-38 contains a map and *nene* exhibits. There are also views of the park's Kilauea area at the shelter, although the views are partially obscured by trees. There are an emergency phone, pit toilet, and access to the Mauna Loa trailhead.

Hilina Pali Road

The Hilina Pali Road begins at an intersection near the Chain of Craters Road Mile Marker 2. At the road's entrance there is a moveable barrier gate that is used to close the road to traffic during the summer fire season. A road sign at the entrance informs drivers that the distance to Kulaniokuaiki is three miles and that Hilina Pali, at the road's end, is nine miles away. Hilina Pali Road provides access to Hawaii Volcanoes National Park backcountry areas and also serves as a scenic route, providing expansive vistas of the Kau coast and Mauna Loa. The road allows viewing of one of the finest examples of geological faulting in the Hawaiian Islands.[11]

The speed limit on this one-lane asphalt road is 25 mph. The road averages 12′ in width and, for most of its length, has

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[11] Richard W. Hazlett and Donald W. Hyndman, *Roadside Geology of Hawaii* (Missoula, Mont: Mountain Press, 1996), 97.

limited shoulders. The pavement is frequently broken or cracked by grass and tree roots.

The first five miles of Hilina Pali Road is relatively straight, with a slight grade and some easy curves as it passes through *ohia* forests with fine views of the Koae geological faults. The road begins to cross *pahoehoe* at mile 3.6, sometimes crossing the lava and other times cutting through the flow. The Mauna Iki trailhead is at mile 3.7, where there is another moveable barrier gate. For the next seven miles, drivers are warned to be cautious as they traverse a "*nene* crossing" area.

Opened in 1999, Kulanaokuaiki Campground is located on a spur road to the north at mile 3.5 and affords views of Mauna Loa. The former Kipuka Nene campground is located at mile five. The campground was closed in 1999 to protect *nene* nesting areas.

Between mile 5.5 and 6 are *pahoehoe* lava flows. A ford just after Kipuka Nene dates to around 1929 and was reconstructed by the CCC in the 1930s. It is now paved with asphalt. The road continues to pass through old lava flows, sometimes cutting through the flows and, in several places, going over the lava and limiting the driver's sight distance. There are some areas of fill over the uneven lava flows.

Dry riverbeds in this area indicate the desert area is subject to severe flooding. There are four fords on the road; one at mile 6.5 has several stones still visible from the CCC construction era. Originally constructed of rock, most of the ford is now overlaid with concrete and asphalt. Another ford, at mile 7.3 also shows some stonework and has been covered with concrete.

From mile 5.9 to the end of Hilina Pali Road, the vegetation begins to change with grassland becoming the predominant feature. The landscape includes shrubs and sparse *ohia*. At this point, the road descends and winds to its end at the Hilina Pali overlook at mile 8.5. The grades towards the end of the road are steeper and probably average at least 5 percent. There is a shelter designed by noted NPS landscape engineer Thomas Vint at the end of the road, along with trailhead information, a hitching post, and a directional finder that indicates points of interest. The overlook provides a sweeping vista of the Big Island's south coast, the Kau Desert, and Mauna Loa. The view stretches forty miles on a clear day. Looking in the opposite

direction, one can often see the volcanic steam rising from the ocean as lava from Puu Oo enters the water.

Highway 11, Mamalahoa Highway

Mamalahoa Highway (Highway 11) is part of the "belt road" system that circles the island of Hawaii. The road is an approach road for visitors, but also a major route for traffic between the east and west sides of the Big Island. The highway bisects Hawaii Volcanoes National Park, following along the park's western boundary before cutting through the narrow strip of land that connects the Kilauea and Mauna Loa sections of the park. Approximately 12.5 miles of Highway 11 traverse NPS land, known as the park "bypass."

The roadbed is 24' wide with 6' shoulders in most sections. The speed limit varies between 45 and 55 mph. Most of the road is straight with wide curves where necessary. With its wide pavement and miles of modern steel guardrails, the highway poses a stark contrast to roads in the park that were designed to blend into the landscape.

Beginning at the west side of the park boundary, about 11 miles from the park entrance station, a Hawaii Volcanoes National Park sign notifies motorists that they are passing through a national park. Other signs inform drivers that the elevation is 2840' and that this is a "U.S. fee area." Just over 1.5 miles from the park's western boundary is the Kau Desert Trailhead. There is a small parking area off the road with interpretive information. The trailhead provides access to the "Footprints" area and the backcountry of the Kau Desert.

For the first five miles of road, drivers pass through sparse dry-land vegetation. There are excellent views of Mauna Loa. Five miles from the park boundary, the road is at a 3500' elevation and begins to enter a dry *ohia* forest. At about 6.5 miles, there is a long, straight uphill climb, with guardrails located along the outer shoulder for much of the distance.

Namakani Paio Campground is situated on the north side of the road eight miles from the park's western boundary. There is a spur road that leads to the campground and cabin area. There is a sign on the highway to alert drivers that they are passing through a fault area and to tune into the park radio for information on current volcano conditions. The road begins to enter the rain forest and the vegetation is denser. Another mile down the road is the Mauna Loa Road intersection. The road

to Mauna Loa is on the north side of Highway 11; on the south side is an old connecting road between the Mauna Loa Road and Crater Rim Drive. The connecting road is closed by a moveable barrier gate.

After the Mauna Loa Road entrance is Piimauna Drive, a local road to the Volcano golf course subdivision. On the south side of Mamalahoa Highway drivers can catch glimpses of Kilauea Military Camp and the national park. Drivers leave the fault zone a little more than ten miles from the western park boundary. Another half-mile along the road, on the south side of the route, is a utility road that leads into the park.

The visitor entrance to Hawaii Volcanoes National Park is eleven miles from the western park boundary. The intersection includes a turning lane for traffic approaching from Hilo. Just over a mile past the park entrance is the park's eastern boundary, with another Hawaii Volcanoes National Park sign.

EARLY TRAVEL TO KILAUEA CRATER

Hawaii's volcanoes have long attracted visitors with their striking scenery and romantic allure. In August 1823, English missionary William Ellis was the first non-Hawaiian to document his journey to Kilauea, writing that the volcano, "until visited by us, [was] unknown to the civilized parts of the world." Ellis' response to the landscape was typical of the Romantic Era. His description of the journey exemplified the contemporary tendency to seek out spectacular scenery and interpret natural features as manifestations of the picturesque and the sublime.

Ellis and several American missionaries journeyed around the Big Island to survey potential locations for mission stations. The Ellis party traveled by foot from Kailua (Kona) and was guided by Makoa, a Hawaiian who had served for many years as the king's messenger. The travelers made their way through native forests, rough lava fields, deep chasms, and a sandy desert that Ellis described as "extremely fatiguing." Conditions ranged from the dampness of the rain forest to the heat of the sun on the black lava fields. As the party approached the volcano, the smell of sulphur became more noticeable.[12]

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[12] William Ellis, *Journal of William Ellis: Narrative of a Tour of Hawaii, or Owhyhee; with Remarks on the History, Traditions,*

Arriving at Kilauea, Ellis described the crater rim region as "a great precipice, with a vast plain . . . fifteen or sixteen miles in circumference, and sunk from 200 to 400 feet below its original level." The party descended to the edge of the pit to view the lava lake, which roared from the volcanic crater like a vast furnace. Contemplating the scene, Ellis was filled with wonder at the "overwhelming manifestation of the dread Being who created the world" and would someday destroy it by fire. The travelers explored nearby areas and returned to view the volcano at night, describing the spectacle as "a sight terrible and sublime beyond all we had yet seen." The party watched the volcano shoot up fountains of fire, making very loud detonations as it ejected bright, ignited stones.[13]

Ellis also noted the Hawaiians' respect for Pele and her power. As they approached the Volcano area, the Hawaiians became increasingly agitated by the foreigners' disregard of Hawaiian customs near Pele's abode. During their journey, Ellis and others were hungry and ate *ohelo* berries. The Hawaiians refused to eat *ohelo* berries until they had reached the volcano and could offer berries to Pele first. When the foreign visitors poked into the earth to examine sand samples, the Hawaiians urged them not to disturb the ground so near the volcano as such action would result in an eruption or some other form of Pele's wrath. Ellis noted that for Hawaiians, Pele's awesome power was evident everywhere on the island; the landscape served as a constant reminder. As a Christian missionary, Ellis was disturbed at the natives' religious traditions and reverence for Pele.[14]

By the 1860s, Hawaii's volcanoes had become an established tourist destination. The standard tourist approach to the volcano was made from the port town of Hilo, twenty-eight miles northeast of the crater on Hawaii's north shore. In 1865, tourist traffic was heavy enough that the thatch-roofed hotel on the crater rim known as Volcano House began keeping a guest book. In the early 1870s, several guests noted that travel time from Hilo was seven hours, although bad weather or other

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Manners, Customs and Language of the Inhabitants of the Sandwich Islands (Honolulu: Hawaiian Gazette Co., 1917; reprint, Honolulu: Advertiser Publishing Co., 1963), vi, viii-ix, 157-162, 180 (page citations are to the reprint edition).

[13] Ellis, *Journal of William Ellis*, 163, 165, 170.

[14] Ellis, *Journal of William Ellis*, 162-163.

obstacles could make for a longer trip.[15] While greatly improved since the days of William Ellis, the trip could still be a challenge, as Sidney Sweet noted in 1880, when heavy rains stretched his journey from Hilo to nearly eleven hours. The difficult trip left him badly demoralized. He recounted that rain "fell in torrents so great" that "the road [from Hilo] was completely submerged for miles."[16] Despite such travel difficulties, visitors rarely left disappointed. Many praised the comfortable accommodations and excellent service afforded by the hotel operators, as well as the spectacular show that the volcano often provided. During his fifth visit to the volcano in 1874, F. A. Schaefer noted that the surrounding countryside proved "sufficiently interesting to induce daily excursions on tolerably good roads." [17] He intended to stay at Volcano House for eight days and was surprised that even with the fine accommodations, most excursionists stayed only a day or two.

With this demonstrated interest in tourist travel to the volcano, local entrepreneurs became involved in the commercial development of the area. This led to the opening of an alternative route up the volcano. On June 1, 1885, a Honolulu newspaper featured an advertisement that announced the Wilder Steamship Company's new route to the volcano via Keauhou Landing. Keauhou was located on the coast approximately ten miles south of Kilauea volcano. The Wilder Company built a landing at Keauhou and constructed a fourteen-mile bridle path to convey tourists from the landing to Volcano House, which had been upgraded to a more commodious wooden structure in 1877. When the company inaugurated service, the steamer *Kinau* brought tourists from Honolulu for $50.00, which included a twenty-four hour stay at the Volcano House. The advertisement described the new approach as "only fourteen miles from the steamer to the Volcano, over a good road," and emphasized that bridle path was "less than half the distance of any other route."[18]

The Wilder Company's route was touted as a great improvement over the difficult approach route from Hilo, which was described

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[15] Darcy Bevens, ed., *On the Rim of Kilauea: Excerpts from the Volcano House Register, 1865-1955* (Hawaii National Park, Hawaii: Hawaii Natural History Association, 1992), 9, 16.

[16] Bevens, *On the Rim of Kilauea*, 20-21.

[17] Bevens, *On the Rim of Kilauea*, 16-17.

[18] Wilder's Steamship Company advertisement, *Honolulu Pacific Commercial Advertiser*, June 16, 1885.

as eight to ten hours of the "hardest possible kind of travel." A Honolulu newspaper claimed that the Keauhou Road passed through "charming country" and could be easily traveled on horseback in two to three hours. The first part of the trip was a challenge, as passengers had to ride the trail from the coast up the steep *pali* (cliff). The article included a report from a recent traveler who described the trail as broad enough for six horsemen to ride abreast and make the trip at a gallop. Even though the trail was good, the tourist noted that his party did not push their horses, as they preferred "to travel slow and take in the glorious scene." With the new route a success, the steamship company revised their schedule so that tourists could remain at the volcano an extra day. In addition, the company announced plans to construct a wagon road so that tourists could travel most of the way at their own discretion.[19]

The Wilder Company took over the Volcano House and tourists were apparently pleased with the accommodations and travel arrangements. J. B. McChesney of Oakland, California, reported that the trip from Honolulu was as easy and comfortable as possible under the circumstances. The trip from Keauhou Landing was just as pleasant. Extolling the experience in the hotel guest register he observed:

> Nearly all the way a well graded road runs through a tropical forest, the beauties and rarities of which are a source of constant surprise and enjoyment. In fact the three or four hours occupied in the ride is only too brief for the pleasure offered, and we arrive at the Volcano House, not jaded and worn as is too often the case in seeking the rare and wonderful in nature, but actually refreshed by the ride. With the present arrangements for transporting passengers from the landing to the volcano no one need hesitate about undertaking the journey.[20]

The road passed through luxuriant growths of ferns, shrubs, and *ohia*. Another visitor from California asserted that the last eight miles of the road were as good as, if not superior to,

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[19] "The Volcano. The New Route Described-A Delightful Trip-Ever-Changing Scenery and Terrestrial Fire Works," *Honolulu Pacific Commercial Advertiser*, October 1, 1885.

[20] Volcano House register entry of J. B. McChesney, in Bevens, *On the Rim of Kilauea*, June 17, 1886, 60-61.

some roads in Honolulu. A two-seat horse cart transported tourists on the upper part of the road.[21]

By 1888, there was a third approach route to the volcano, a carriage road constructed by Peter Lee, the proprietor of several other area hotels. Lee's road approached from Pahala, a community approximately twenty miles west of the volcano. In 1888, H. S. Tregloan reported that he was the first visitor to travel by means of a wheeled conveyance the entire way from an ocean port to the volcano. He described Lee's new road as:

> . . . a fine one, over which the carriage rolled with the greatest ease. The going was good, the grade low, and the landscapes grand. Failing to get an even grade by the zigzag course always thought necessary for that route, Mr. Lee had struck a line directly across the five miles of rugged lava. To effect this bold plan he had to do a good deal of rock cutting, filling in the frequent depressions with fine pumice stone from ancient eruptions. The result is an even thoroughfare of about twenty-five feet in width, as safe and easy for a carriage as the road through Kapiolani Park [in Honolulu].[22]

The Honolulu newspaper printed the news of Tregloan's travels and praised Lee for his enterprise, pointing out that he constructed the road on his own initiative with no promise of public compensation. Although Lee had built the road to increase the patronage at his Punaluu hotel, the newspaper maintained that the public was also the beneficiary of this successful enterprise.

In 1888, the *Pacific Commercial Advertiser* reviewed the approach roads to the volcano in an article titled "What They Are and What They Should Be." The Peter Lee Road was obviously what the newspaper believed an approach road to the volcano should be. It had nothing but praise for the twenty-mile road. Although

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[21] Volcano House register entries of 'Geo.' Bixby, September 28, 1887 and N. H. Davis, Brigadier General, U.S. Army retired, February 18, 1887, in Bevens, *On the Rim of Kilauea*, 61-62;.

[22] "Great Consummation. Carriage Road to the Volcano--First Trip on October 28th--The Pioneer Passenger on Wheels," *Honolulu Pacific Commercial Advertiser*, *November* 7, 1888; and Volcano House register entry of H. S. Tregloan, in Bevens, *On the Rim of Kilauea*, October 28, 1888, 62.

Tregloan had stated the road was 25' wide, the paper reported that it was 10' to 12' wide, with an easy grade and no steep hills or gulches. The newspaper denounced the old route as one of the "worst roads assigned to pleasure-seekers." It had nothing complimentary to say for the "tedious old trail" that traversed lava flows and even disparaged those earlier travelers who had used it, deriding them as the "savages of a century ago, who cared little whether they progressed more or less than one mile a day." Continuing to elaborate on what a road should not be, the *Advertiser* criticized the original approach road as a "rough bridle path" that took five to six hours in good weather and up to ten hours in the frequently rainy weather. Lee's surveying skills and building techniques were cast as a considerable improvement over those of the government. Lee's route was praised as significantly better than its predecessor, since it afforded an excursion that was much more pleasant than the trip along the hot old trail over the lava. The newspaper bragged that a loaded brake drawn by one horse could travel the Peter Lee Road in just over three hours, with the horse arriving at the end of its journey just as fresh as it had started.[23]

After the construction of the Keauhou and Peter Lee routes, the Hawaii Territorial Legislature appropriated $30,000 in 1888 to reconstruct the original approach road from Hilo.[24] By 1890, the trip from Hilo could be made by stage over the government road for the first two hours, but visitors still had to travel by horse or mule for another four and a half hours. The experience was pleasant when the weather was fine, but one Canadian visitor noted that the Volcano Road could not be completed too soon "for the good of the country." As Darcy Bevens explained in her compilation of entries from the Volcano House Register, "As more roads were built, expanded, and improved, visitors were delighted, but also wished for further improvements." Work on the government road from Hilo continued in the early 1890s, usually with prison labor at an expenditure of about $1000 per month. By 1893, nearly twenty-two miles of the road from Hilo were completed, leaving only nine and one half miles of horseback riding. In August 1894, Volcano House visitor S. E. Bishop advised that the new Hilo road was "excellent" and reported that it was finished to within a quarter mile of the

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[23] "The Approaches to the Volcano. What They Are and What They Should Be," *Honolulu Pacific Commercial Advertiser*, November 7, 1888; and *Honolulu Pacific Commercial Advertiser*, December 11, 1888.

[24] "The Approaches to the Volcano."

Volcano House. An anonymous entry in the Volcano House register noted that the carriage road from Hilo to Volcano was completed on September 13, 1894. Apparently by this time, the area was being referred to as "Volcano."[25]

By early 1897, the Inter-Island Steamship Company controlled the Keauhou Route and was considering whether to improve the trail built by Wilder's Steamship Company. The new company wanted a road in "fit condition" for carriages or stages and believed that the trail in its current condition was of no use, as tourists had to be taken by horseback to the top of the *pali* to board a carriage for the rest of the trip to Volcano House. The Inter-Island Steamship Company wanted to transport passengers by carriage the entire length of the trip, from the landing to the hotel. Without such a road, they believed it was useless to run the steamer to Keauhou. The Keauhou Route was still the shortest route from the coast to the volcano, so the company planned to investigate whether a road could be cut through the steep *pali* at a reasonable cost.[26] Two months later, the steamship company dropped plans to improve the road and the Keauhou Route to the volcano was abandoned.[27] The newly completed carriage road from Hilo had rendered the Keauhou Road obsolete.

The government road was well suited to carriage traffic, but a new factor soon entered the equation, initiating another round of complaints and eventually leading to calls for more improvements. After making the first automobile trip from Hilo to Volcano House in July 1902, an A. James noted that the journey from Hilo had taken three hours "over some of the worst roads anywhere." James blamed the bad conditions on the Hawaiian legislature. Although the first automobile trip had been completed, auto travel did not immediately replace the stage. Sometime before 1905, a rail line began transporting passengers from Hilo to Glenwood, where they would board a stage to

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[25] Bevens, *On the Rim of Kilauea*, 62-65, including Volcano House register entries of V.M., of Toronto, Canada, August 14-16, 1891 and S. E. Bishop, August 28, 1894. Today, Volcano village is located just outside HAVO boundaries.

[26] *Honolulu Pacific Commercial Advertiser*, March 18, 1897.

[27] "Keauhou Route. Inter-Island Company Considering New Volcano Road," *Honolulu Pacific Commercial Advertiser*, January 16, 1897; and "New Road to Kilauea," *Honolulu Pacific Commercial Advertiser*, January 28, 1897. Remnants of the old Keauhou Road still exist and are used by backcountry hikers. Keauhou Landing is now a backcountry campsite.

Volcano. Volcano House visitor Chase S. Osborn of Michigan described his journey of twenty-two miles by rail and nine miles by stage: "The rail ride was through an attractive country forming a panorama of sugar plantations and fields of bananas and coffee. But the particularly enchanting ride was that by stage over a very good basaltic mountain road, walled with tropical vegetation." Many travelers still complained about the trip to Volcano, one claiming that the area roads "would make a better sea bottom than anything else." H. C. Bruns grumbled about his stage ride, claiming that it felt like he had traveled a thousand miles instead of nine by the time he reached the Volcano House. He noted that his trip was not conducive to acceptable Christian behavior, but instead produced the opposite effect. Bruns confessed that "What little chance I did have for a harp and a crown in the hereafter is surely lost to me now, owing to the method by which I silently expressed my feelings during that stage ride." Not everyone was disappointed by the travel conditions, however. One repeat visitor exclaimed on the great improvements since 1872, when he and his wife were forced to take the stage all the way from Hilo. In 1909, they traveled by train to Glenwood, and then switched to stagecoach for the final stretch to the Volcano House. He was pleased that the agony of a stage trip was thus reduced by 72 percent, "What a change! . . . What comforts now, compared with the simple necessities of those days."[28]

Trips from the Volcano House to Kilauea Crater were made by horseback or foot during the nineteenth century. With the approach roads to the volcano area established, suggestions began to crop up about building a road to the crater itself. In 1907, Acting Territorial Governor Jack Atkinson supported the construction of an automobile road to Halemaumau Crater. He recommended that the road enter Kilauea Crater where the cliffs were low and suggested that prison labor do the work. Atkinson wanted a road that enabled older people (like himself) to have an easier and more comfortable journey. He also believed that a new road would make the volcanic spectacle a regular trip rather than a once in a lifetime experience. Atkinson asked the County of Hawaii Board of Supervisors for their cooperation and suggested that a survey and an estimate of construction costs be made.[29] The Hawaii Board of Supervisors approved Atkinson's road

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[28] Bevens, *On the Rim of Kilauea*, 65-66, 69-70.

[29] "Automobile Road to the Crater's Edge," *Honolulu Pacific Commercial Advertiser*, July 28, 1907.

proposal, stressing that it would be an incentive for more people to come and stay on the Big Island.[30]

Atkinson's proposed route approached the crater from the Kau (west) side. Within a month, however, a different route that followed the Hawaiians' old Hilo-Kau trail on the Hilo (east) side of the crater was proposed. The latter route was more favorable as it could follow a better grade and would be easier to survey. One benefit of the original "Atkinson" route, however, was that it went over government land rather than on lands owned by the Bishop Estate.[31]

Territorial Governor Frear added his support to the crater road project in September 1907. Frear believed that the road would benefit both the territory and county. He supported the route on the Hilo side, declaring "This would seem to be of easier construction and, having the craters of Kilauea-Iki and Keanakakoi along the way, would add to the interest of the route."[32] He also warned that, since the route passed through Bishop Estate land, it would be necessary to obtain their support for a permanent right-of-way.

Territorial Surveyor W. E. Wall sent a survey team to Volcano in 1907. Engineer Charles E. Smith began surveying the road that would become the predecessor of Crater Rim Drive on September 2, 1907. He worked in rain, fog, and "other difficulties."[33] Smith located both routes and reported that the line by way of Kilauea Iki (the Hilo side) was "incomparably better both from a scenic and an engineering standpoint." From the scenic standpoint, Smith asserted, there was "nothing to compare with it in the islands." The decision was made to follow the Hilo-Kau trail and Bishop Estate trustees agreed to give a right-of-way for the line Smith surveyed. The *Pacific Commercial Advertiser* declared that the new road would be infinitely easier than the old route by horseback or foot, permitting visitors to "ride right to the

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[30] "Atkinson Road to Halemaumau," *Honolulu Pacific Commercial Advertiser*, August 16, 1907.

[31] "Change of Plan For Crater Road," *Honolulu Pacific Commercial Advertiser*, August 27, 1907.

[32] "Proposed Road into Kilauea," *Honolulu Pacific Commercial Advertiser*, September 7, 1907.

[33] Bevens, *On the Rim of Kilauea*, 68.

brink of Halemaumau in a buggy or automobile or any other kind of conveyance."[34]

Smith wrote about his survey in the *Pacific Commercial Advertiser*. According to Smith, the new route, formally christened the Halemaumau Road, would be the most scenic drive in the Territory of Hawaii, the beauty of which was "indescribable." The views along the road were not just spectacular but engagingly diverse: lush forests with towering tree ferns 25' to 30' high gave way to desolate lava craters and glimpses of the sea were attractively interspersed. From the Volcano House, Smith's line entered the fern forest near the old trail to Kilauea Iki. It then ran along the edge of the bluff for about a mile, into the forest again, and along the edge of the "extinct" crater, Kilauea Iki. The route then passed through magnificent *ohia* and giant tree ferns and proceeded southwest for a mile and a half through the forest before Kilauea Crater came into view. One-half mile further, Keanakakoi Crater was visible. From there, the road curved with easy grades to the south side of Halemaumau and ended at the corral, from whence it was a ten-minute walk to the edge of the pit. Explaining the route's appeal from a technical standpoint, he noted that the 8-mile road would have an average grade of 2.5 to 3 percent, with a maximum grade of 8 percent in three locations. The road would be 16' wide, which would allow for carriages to pass, and would have a good crown and wide drains on each side. Smith noted that available gravel and clay would make good road material. His grade line was established and he expected the survey to be completed within two weeks. Prison labor was already working on clearing the right-of-way.[35]

Smith did not finish his survey in two weeks and found his work to be much more difficult than expected. He experienced problems due to the dense forest and the difficulty in securing a safe road across the crater. The survey was completed, however, on October 2, 1907. Smith's line was 7.5 miles long and he had reduced the steepest grades from the previously expected 8 percent to 6 percent, with an average grade of 3 percent. Construction on the new road began on September 23,

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[34] "Atkinson Road to Halemaumau," *Honolulu Pacific Commercial Advertiser*, September 17, 1907.

[35] Charles E. Smith, "Enthusiast Describes the Atkinson Road," *Honolulu Pacific Commercial Advertiser*, September 23, 1907. Smith's article made note of the "present trail to Kilauea Iki," which was probably a horse trail to the crater area.

1907, and one mile was expected to be completed by the end of October.[36]

High Sheriff William Henry soon reported that he was pleased with the convicts' "splendid" progress on the crater road construction. He maintained that they made no trouble to speak of, as only prisoners with the best records were chosen for the work and they appreciated the change.[37] Engineer Smith similarly observed the convicts' work was "going merrily on" and suggested that they came to Volcano to "improve their health and enjoy the climate found here, and incidentally to build the Halemaumau Road."[38] Although satisfied with the progress, the sheriff wanted the work to proceed faster. By March 1908, 2.5 miles were completed, meaning that the prisoners had to walk five miles to and from the work site each day, losing nearly two hours of work. This problem would increase as the work progressed. Henry requested that the Hawaii Board of Supervisors furnish transportation for the laborers so that the work could be completed as soon as possible. He argued that the faster the work was completed, the sooner steamer travel would increase to Hilo, since visitors would want to take advantage of the easy access to the volcano.[39]

By the end of summer, drought had slowed the progress on the so-called "Atkinson Road." A new group of prison laborers was due to replace those whose terms had expired and Henry planned to add more men to the project. If it did not rain soon and improve the water situation, however, Henry would be forced to withdraw the entire force from the project and suspend work.[40]

In 1910, *The Sunday Advertiser* updated its readers on the road-building project. While it jokingly referred to the project as the "Road to Hell," the "Jack Atkinson" or Halemaumau Road was cast as having tremendous importance in terms of attracting more

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[36] "New Carriage Road to Kilauea Crater," *Honolulu Pacific Commercial Advertiser*, October 28, 1907; and Bevens, *On the Rim of Kilauea*, 68.

[37] "Volcano Road Progressing," *Hilo (Hawaii) Tribune-Herald*, January 21, 1908.

[38] Bevens, *On the Rim of Kilauea*, 68.

[39] "The Crater Road," *Honolulu Pacific Commercial Advertiser*, March 30, 1908.

[40] "Dry Spell Affects Volcano Road Work," *Honolulu Pacific Commercial Advertiser*, August 11, 1908.

visitors to the volcano area and thereby boosting the local tourism industry. The newspaper praised Atkinson as one of the road's primary supporters and as the man responsible for convincing the government to grant the use of convict labor. Volcano House proprietor George Lycurgus was commended for paying for the workers' transportation and providing housing in one of the prettiest spots along the road. By January 1910, six of the seven miles to the crater was completed. Construction of the first six miles through the fern forest had been relatively easy, the paper noted, but the balance of the work was expected to be slow because the road had to be cut through lava.[41]

The road around the caldera skirted the crater's edge then passed through the thick fern forest near the "extinct" craters of Kilauea Iki and Keanakakoi, where two wide turnouts were provided.[42] A newspaper article noted that one of the fine points of the road was the careful avoidance of any sharp curves or steep grades. Reflecting the automobile's growing influence, the reporter noted that the grades throughout the first six miles could easily be taken in high gear. Four-foot walls constructed of lava rock were strategically placed at dangerous points so motorists could make the entire trip "with a feeling of perfect safety."[43]

Although the Halemaumau Road to Kilauea Crater was officially completed on July 26, 1910, road work in the area was not finished. By September, prisoners were already repairing the "upper end" of the dirt road, which had been badly washed in some places by heavy rains. A shortcut from the Hilo-Volcano Road was also expected to be completed soon.[44] Peter Lee began work on a shortcut to connect his establishment with the new road. County surveyors laid out this cut-off, but neither the county nor the territory had the money to construct the new road, so Lee built the shortcut himself, completing the task during the winter of 1910/11. While Lee's road was only 1200' long, it would save five miles of travel.[45]

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[41] "Better Material than Good Intentions Paves Kilauea's Automobile Roadbed," *Honolulu Sunday Advertiser*, January 16, 1910.

[42] While Kilauea Iki was labeled as "extinct" in many early twentieth-century documents, it erupted in 1959.

[43] "Better Material than Good Intentions."

[44] *Honolulu Pacific Commercial Advertiser*, September 26, 1910.

[45] *Honolulu Pacific Commercial Advertiser*, December 1, 1910.

Visitors appreciated the scenic new road through the fern forest that provided easy access to the Halemaumau's "lake of fire." In 1911, Philip Henry Dodge expressed his thoughts on the road in the Volcano House register:

> When twenty years ago, through toil and flood
> We reached the crater's glare
> How little did we dream that large-eyed
> Motor cars would rush and stare![46]

EARLY YEARS OF HAWAII NATIONAL PARK

Although established as a national park in 1916, Hawaii National Park was not dedicated until 1921. Active administration of Hawaii National Park began in 1922 with the appointment of Thomas R. Boles as superintendent.[47] HAVO was a small national park in its early days and the park's main goal was acquisition of private lands.[48] Without additional land acquisition, it was unlikely that more roads could be built within the park.

In 1920, Horace Albright, Field Assistant to the Director of the National Park Service, provided an overview of Hawaii National Park. Characterizing Kilauea as the "most awe-inspiring thing" he had ever observed, Albright maintained that it was one of the greatest features in the National Park System. He was impressed with other sites within the park, including steaming and dead craters; great forests of primeval tree ferns; *ohia* and *koa* forests; and the lava trees and tree molds in Bird Park. Albright reported that the park had sixteen miles of roads, of which seven miles were the 1910 Halemaumau Road leading from the main highway near the park boundary to the floor of Kilauea Crater. The remaining mileage included the cross-park road.[49]

Albright reported on NPS efforts to work with the Bishop Estate and the territorial government in acquiring private lands in the Kilauea section. The Park Service wanted land along the main approach road in order to protect the forest. Albright feared

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[46] Bevens, *On the Rim of Kilauea*, 72.

[47] Nash Castro, "Important and Interesting Dates (1778-1953), The Land of Pele," timelines compiled by the former Assistant Superintendent at HAVO, circa 1959, 3, pamphlet files, HAVO library.

[48] Albright, "Annual Report," 1-4.

[49] Albright, "Annual Report," 6-7.

that the land would be sold for summer homes and then the highway would be in danger of losing its "sylvan beauty." Once this private property was obtained, HAVO would be able to appropriate money to protect the park and build roads, trails, camp facilities, and other visitor amenities. Albright supported improvements in "this great national resort area," emphasizing that HAVO featured "wonders not equaled in any other park."[50] His desire to improve visitor facilities was based on the commonly held opinion that Hawaii's volcanoes were "safe" and accessible and should be enjoyed by all. With the assumption that the necessary land would be acquired, Albright also recommended constructing a road to the summit of Mauna Loa in the near future.[51]

Thomas Boles began writing HAVO superintendent's reports in 1922. In one of his earliest reports, he noted that tourist travel to the park was intermittent and depended entirely on the twice-weekly steamer trips between Honolulu and Hilo. From the steamer, visitors traveled to Glenwood by train and generally went the rest of the way in organized automobile tours. Individual motorists were the exception to the rule at this time. Boles described the typical tourist's visit to the park:

> Three auto lines, operating heavy cars, handle the visitors from Hilo to the Park and return, over the 30 mile highway. All boats reach Hilo at 8 AM and the tourists take a six hour ride along the east coast of the Island over the Railroad, and then drive to the Park, reaching here about 5 PM. The volcano is first visited after supper, and again by daylight next morning; other nearby points of interest are then visited, and the return trip is made just after dinner, reaching Hilo in time for the 4PM departure of the boats.

Boles reported that the Hilo approach road consisted of eleven miles of "first class" reinforced concrete pavement; the balance being macadam with an oiled surface. There were a few short stretches of asphalt through particularly wet sections. He also noted that a temporary detour through the sugar cane fields,

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[50] Albright, "Annual Report," 9-10.

[51] Albright, "Annual Report," 16-19.

where the last two miles of concrete was being laid, "added somewhat to the discomfort and saturation of the passengers."[52]

During the 1920s, the county of Hawaii was laying concrete pavement from Hilo, as funds were available. By 1923, twelve miles of the road from Hilo were concrete and a contract had been awarded to extend the concrete pavement another four miles. Reinforced concrete pavement was relatively advanced technology in the early 1920s. Boles commented that it was "a far higher type of roadway [than] the immediate or future traffic warrants." Perhaps as a result of these roadway improvements, the Hilo Railroad Company discontinued service to Glenwood in 1926.[53]

THE CRATER ROAD (CRATER RIM DRIVE)

In 1918 Boles reported that a section of road, probably the crater road, had been destroyed by lava.[54] He noted that repairs had been started on the "Volcano House road to the pit trail" and also on the "road from the Volcano House around past Waldron's Ledge and Kilauea Iki." This road past Waldron's Ledge, which Boles called the "Crater" road, was part of the old wagon road to the crater, which had been abandoned for several years. The other road was most likely an alternate road that had been used after the 1918 eruption. Boles noted that rain was preventing needed repairs and routine oiling of the road. This would become a common complaint. Heavy and frequent rain not only hampered roadwork in HAVO, it was also a significant source of damage to park roads.[55]

As the park's initial superintendent, Boles was dedicated to making HAVO as popular as Yosemite or Yellowstone National Parks.[56] Repairing and improving the road around Waldron's Ledge would foster this goal by exposing visitors to impressive views of the crater from the top of a 600' cliff. Three viewpoints were selected, cleared of brush, leveled off, and provided with

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[52] Boles, "Superintendent's Monthly Report," April 1922.

[53] Castro, "Important and Interesting Dates," 2.

[54] Thomas Boles, "Superintendent's Annual Report," 1922, HAVO library.

[55] Boles, "Superintendent's Monthly Report," March 1922.

[56] Boles, "Superintendent's Monthly Report," September 1922.

railings. One of the turnouts, Pali Aloha, was finished by April of 1922 and, according to Boles, received "considerable favorable comment."[57]

Improvements to Crater Road were nearly completed by September 1922. Sharp curves were lengthened and widened and "parapets of lava" were built along the outside shoulder. Soft places were filled with cinders and packed by a seven-ton roller. This work was considered necessary both for safety purposes and to put the road in shape for the coming wet winter. After the packing, 2000 gallons of crude oil were applied in order to make the surface shed water quickly and retard growth of weeds and grass.[58] By midwinter, road-related work included ditching along the roadsides to protect against anticipated rains and placing a row of whitewashed lava boulders at the road's end.[59]

Boles planned and supervised other improvements as well. Seeing that many elderly visitors had trouble walking the existing one-half mile path to view the lava, he ordered a road survey and discovered it would be possible to get cars from the "crater road" to within 100' of the crater. He wanted the new road to be temporary and quite narrow, with a fair surface and alignment and ample turning and parking at its end. Boles was anxious to finish this road for an anticipated June visit by a large group of Shriners.[60]

During Boles' first years as superintendent, the HAVO budget for roads and maintenance was minimal. HAVO received appropriations for work and county road crews were sometimes hired to do the work. County crews built Boles' road across the lava of Kilauea to a parking area that brought cars to within 150' of the south rim of the fire pit. The new road was 1800' long. It was built of broken lava and had a sand surface that was not rolled or oiled. The parking area accommodated fifty cars and could be expanded if traffic warranted. In accordance with the NPS goals of providing scenic vistas, viewpoints along Kilauea and Kilauea

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[57] Boles, "Superintendent's Monthly Report," April 1922.

[58] Boles, "Superintendent's Monthly Report," September 1922.

[59] Boles, "Superintendent's Monthly Report," December 1922.

[60] Boles, "Superintendent's Monthly Report," April 1922. Boles stressed the temporary nature of the new road, but did not explain why. Since the road would be so close to the crater, one can infer that he thought a permanent or expensive road might be damaged or destroyed.

Iki rims were cleared and rustic fences erected. After the road was built, Boles commented about the special concerns encountered when building near the volcano:

> This side of the crater seems firm, and I do not think we will lose any of the road, or be endangered by further widening of the crater. [T]he county was dubious about allowing their roller to work on this road on account of the possibility of the lava crust breaking, but I have 'sounded' all the road and have sledged down the weak places, and have tested the entire road and parking space with a loaded truck giving a total weigh of seven tons, insuring the safety of auto traffic.[61]

While Halemaumau was the park's most popular destination, Crater Road had other attractions that captured the imagination of visitors and park personnel. The thoroughfare passed through the "fern jungle," where ferns, 30' high with fronds as long as 25', arched gracefully over the road. As part of his effort to make HAVO as popular as Yosemite, Boles sent photographs of the scenic drive to NPS Director Stephen Mather, requesting that he use his influence to have them placed in the *Saturday Evening Post*.[62] Period photographs showing a very narrow path covered by an arch of tree ferns confirm how spectacular this drive was. Today's wide road and cleared shoulders do not provide the same tunnel effect of the early twentieth-century fern forest drive.

In 1924, a volcanic eruption obliterated one-half mile of the road to the crater. The park built a new parking lot and trail 1000' from the new crater rim. While lava flows were spectacular, the superintendent remarked that the most dangerous roads during eruptions were those covered by "skiddy" ashes, which were a menace to driving and had to be removed by hand.[63]

Boles was also concerned with more permanent safety improvements, expressing his determination to continue widening and "safetying" the road to the volcano. In March 1925, crews

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[61] Boles, "Superintendent's Monthly Report," May 1922; and McClelland, *Presenting Nature*, 84.

[62] Boles, "Superintendent's Annual Report," 1922 and 1925; and Boles to Stephen Mather, letter, attached to "Superintendent's Annual Report," 1925.

[63] Boles, "Superintendent's Annual Report," 1924.

improved the road by widening the roadbed around sharp curves. Waste material was used to widen embankments from 12' to 20' on curves and 18' on tangents.[64]

As was the case with most national parks, appropriations lagged behind projected needs. In 1923, Mather complained that the most urgent need in the parks was for new roads.[65] In HAVO, road equipment was rented, borrowed, and difficult to come by. Regular road equipment in 1924 consisted of two wheelbarrows, some picks, and shovels.[66] Boles often lamented that crews lacked construction equipment and noted that a roller was badly needed, especially in light of the fact that heavy rain often washed out the roads.[67] Nevertheless, he claimed to have eliminated 90 percent of existing accident hazards on the main park roads during 1925.[68]

Despite these limitations, Superintendent Boles worked diligently to improve the park. In February 1923, a ten-acre public campsite above Byron Ledge on the east rim of the crater was set aside to encourage auto tourists to travel to HAVO.[69] One month later, Boles reported that ledges on the Mauna Loa trail had been "wedged off" so light autos could drive to the edge of Bird Park.[70] Next, a temporary road to Bird Park was built to bypass private property that included a golf course over which park visitors had been driving. The road connected to an old road that traversed the *koa* grove and led to Bird Park. Because the new road protected the hotel's golf links, the Volcano House shared the cost of building it. The parking lot at "Koa Grove" was expanded to hold 126 cars.[71] A few men worked on the old Keauhou Road's "worst places" so that light cars could pass.[72] Other improvements included an arch of *ohia* and *koa* logs constructed over the park's entrance road to

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[64] Boles, "Superintendent's Monthly Report," March 1925.

[65] Carr, *Wilderness by Design*, 90, 149.

[66] Boles, "Superintendent's Monthly Report," March 1924.

[67] Boles, "Superintendent's Monthly Report," March 1925.

[68] Boles, "Superintendent's Annual Report," 1925.

[69] Boles, "Superintendent's Monthly Report," February 1923.

[70] Boles, "Superintendent's Monthly Report," March 1923.

[71] Boles, "Superintendent's Monthly Report," April 1923 and July 1923.

[72] Boles, "Superintendent's Monthly Report," September 1923.

identify Hawaii National Park and to "invite the public to enjoy it as their own property."[73] Gateways that harmonized with nature were constructed throughout the park system, providing visitors, Mather claimed, "with a thrill of pride in our great national playgrounds."[74]

Improvements to Crater Road continued throughout the 1920s. In 1925, the NPS released $15,000 for roadwork in preparation for a three-month U.S. Navy fleet visit to Hawaii. BPR engineer F. A. Kittredge commended the park for spending the money wisely to reduce grades, ease curves, and improve the surface, which was now graded to a width of 16' to 18'. Kittredge was considered one of the Bureau of Public Road's best locating engineers and had extensive experience in building park roads. Despite Boles' improvements, Kittredge noted that many curves were still dangerously sharp and that there were still a few "excessive" grades. He recommended that this important road receive further improvements in alignment and grade prior to paving.[75] In keeping with NPS standards, no trees were cut to facilitate these road improvements unless absolutely necessary. The parking lot near Halemaumau was to be expanded to accommodate 150 automobiles.[76] In April 1927, the Sulphur Banks Road, northeast of Volcano House on the north rim of Kilauea crater, was finished. The road provided easy access to another park attraction; an area where gases and steam seeped from the ground and the land had been stained by sulfuric gases.[77]

Volcanic eruptions influenced many aspects of road planning in HAVO. In 1929, plans were being made to expand the parking lot at Halemaumau to accommodate 250 cars. In July 1929, the spectacular eruption of Halemaumau drew huge crowds to the park, so that park crews rushed to clear parking space for an additional 250 cars, bringing Halemaumau's parking capacity to 500. The eruption set records for park visitation; from July 25

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[73] Boles, "Superintendent's Monthly Report," May 1923.

[74] McClelland, *Presenting Nature*, 74.

[75] Frank A. Kittredge, *Report on Hawaii National Park Road Program*, U.S. Department of Agriculture, Bureau of Public Roads, (Honolulu, 1925), 2-3, NARA; and McClelland, *Presenting Nature*, 109. Kittredge became the chief engineer of the National Park Service in 1927.

[76] *Hilo (Hawaii) Daily Tribune*, February 4, 1925; and McClelland, *Presenting Nature*, 104.

[77] Boles, "Superintendent's Monthly Report," April 1927.

through 28, 25,000 people visited the park. The heavy traffic made for more road problems and the natural dirt surface on Crater Road was ruined, forcing the park to do a "thorough overhaul." One month later, the road was in "very good shape."[78] In 1929, heavy rains created another natural disaster for HAVO roads. A total of 74" of rain was recorded that year, of which 20" fell in November. On one day, 7" of rain fell in only eight hours. The rainfall necessitated unusual amounts of road repairs and exhausted the annual budget for road maintenance.[79]

In 1930, Crater Road was surveyed for improvements and reconstruction. In 1930-31, the road was graded and surfaced with emulsified asphaltic macadam. The road length was 6.094 miles and the width was 16', the 1929 NPS standard, with 3' shoulders.[80] Superintendent Leavitt was disappointed with Bitulithic Concrete and Paving Company of Honolulu, which won the bid to reconstruct the road. The company failed to get the project started on time, then used an inexperienced crew. The company's superintendent was also sick on Maui most of the time. The contractor asked to open a new quarry site rather than use the existing quarry as specified in the contract. Leavitt denied this request based on his view that the new quarry would not provide a higher quality rock as the contractor insisted. The superintendent's policy was consistent with NPS standards, as he believed that a new quarry would damage plant life and the surrounding landscape.[81] Since the early 1920s, NPS standards dictated that borrow pits be located in areas where they could be screened from the road. Furthermore, one of the fundamental philosophies of NPS development was that the landscape be preserved as much as possible.[82]

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[78] Allen, "Superintendent's Monthly Report," July 1929 and August 1929.

[79] Allen, "Superintendent's Monthly Report," November 1929.

[80] Department of the Interior, National Park Service, "Plans for Proposed Project No. 4 (Grading and Surfacing) Route No. 4, Uwekahuna-Bird Park, Hawaii National Park, Territory of Hawaii," field copy [1932], title sheet, HAVO Maintenance Division files; Department of Agriculture, Bureau of Public Roads, "Location Survey Report, Uwekahuna-Bird Park Project No. 4, Hawaii National Park, August 1932," credited to H. L. Handley (Hawaii National Park, August 1932), 1, NARA; and *Hilo (Hawaii) Tribune-Herald*, August 14, 1930.

[81] Ernest P. Leavitt, "Superintendent's Monthly Report," June 1931.

[82] McClelland, *Presenting Nature*, 80, 82.

Although not specified in the contract, part of the Crater Road reconstruction included widening the road from headquarters to Halemaumau to provide greater safety in an area with numerous curves. The widening required more excavation so that the contract had to be revised to accommodate the additional expense.[83] With the onset of the winter rainy season, the contractor's performance went from bad to worse as frequent rains made road conditions poor and the crew failed to do proper maintenance and drainage. Much of the road through the fern forest was washed out or blocked by roadwork. Without the new road that had been constructed around the other side of the crater, the fern jungle would have been inaccessible.[84]

The Bitulithic Paving Company work was so unsatisfactory that heavy post-construction maintenance was necessary. The road surface cracked and the NPS determined that the job was a failure even before the contractor finished. The company did not make required repairs and mixed fern roots and debris into the concrete in violation of contract specifications. Between Thurston Lava Tube and the Chain of Craters Road, bitumuls manufactured by the Standard Oil Company were deemed inferior, and 162 seal coat patches had to be made. Despite all the problems, the paving company kept their equipment near the national park hoping to win the bid on the upcoming Uwekahuna-Bird Park project. When that project was cancelled, the company finally removed its equipment.[85]

UWEKAHUNA-BIRD PARK ROAD

In 1931, at the suggestion of the NPS landscape division, Superintendent Leavitt ordered that an auto trail of approximately 3.5 miles be graded between Halemaumau and Uwekahuna Bluff to allow visitors to approach the crater from two sides. The trail ran from the eastern rim of the crater, around the southern rim, and up over the *pali* to Uwekahuna Bluff where the observatory and museum were located.[86] Leavitt's road

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[83] Leavitt, "Superintendent's Monthly Report," July 1931.

[84] Leavitt, "Superintendent's Monthly Report," October 1931.

[85] Leavitt, "Superintendent's Monthly Report," February 1933.

[86] Leavitt, "Superintendent's Monthly Report," March 1931; and USDA, "Location Survey Report," 1.

was built at a cost of only $500.[87] The superintendent reported that the work was easy and took only about a week to complete.

Thirty to forty visitors used the new thoroughfare each day, many of whom were soldiers who used it to make the somewhat dangerous hike from Kilauea Military Camp to the observatory. The new road was a bit longer than the old path, but it provided easier walking and afforded fine views, while also opening up an interesting area of the park. Leavitt anticipated increasing traffic over the new road and realized that it would be necessary to bring it up to standards. At this point, he formulated his idea for a loop road around the crater. The primary attraction of this configuration was that it would allow visitors to approach the crater without having to back track along the same road they came in on. Such circuit roads had long been held desirable for park development for this reason.[88] Leavitt also pointed out that when eruptions brought increased traffic to the park, the road could become one-way, which would increase safety, especially at night.[89] Superintendent Leavitt did not specifically mention the other compelling justification for loop road development at HAVO, which was that a loop road could provide an escape route should lava block the road in an emergency.

In July 1932, Leavitt discussed his plans to complete the Kilauea section road system with BPR District Engineer Frank Wheeler. Wheeler approved the superintendent's proposal to make a loop road by improving the auto trail from Kilauea Military Camp to Halemaumau via Uwekahuna. The engineer wanted the road to be entirely rebuilt so the grades and alignment would be up to current NPS standards.[90] Landscape architect Thomas Vint, who took charge of the NPS landscape Division in 1927, agreed that Leavitt's plans were a logical addition to the park's road system. Vint's suggested improvements included widening the roadway, adding drainage ditches and wooden culverts, and improving grades.[91]

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[87] *Hilo (Hawaii) Tribune-Herald*, April 28, 1931.

[88] McClelland, *Presenting Nature*, 104.

[89] Leavitt, "Superintendent's Monthly Report," March 1931.

[90] Leavitt, "Superintendent's Monthly Report," July 1931.

[91] Leavitt, "Superintendent's Monthly Report," August 1931; and McClelland, *Presenting Nature*, 94.

While the Uwekahuna road plans were being discussed, Wheeler also advised the park on road modifications on the other side of the proposed loop road, the old Crater Road in the vicinity of the fern jungle. Wheeler studied this section of road, with its numerous tight 40° curves combined with 7 percent grades. His goal was to reduce the sharpness and number of curves so drivers would not feel a need to speed in order to make the relatively steep grade in high gear. Wheeler also believed that the sharp curves increased the risk of drivers crossing the center line and causing accidents. Although Leavitt appreciated Wheeler's assessment, he noted that the suggestions would require relocating the road, which would necessitate the removal of many large and attractive tree ferns. Leavitt's arguments followed the NPS philosophy on preserving landscapes and he ultimately rejected the proposed realignment. "I believe we should build the road on the line as laid out," Leavitt concluded, "and if it should develop through actual use, that the road is dangerous, the question of a change to make the necessary improvements should then be given consideration, but not at this time."[92]

The auto trail to Halemaumau was heavily traveled with up to 1000 cars a day during eruptions. Bird Park was a popular picnic area that was then approached by means of a "very poor road." In 1932, BPR Senior Engineering Inspector H. L. Handley made a location survey for the Uwekahuna-Bird Park Road. Handley determined what improvements were needed to bring the road from Halemaumau to Uwekahuna up to contemporary standards and also planned the extension of this road to connect with the main road and thence to Bird Park.[93]

The road began at Halemaumau in an arid, barren desert and ended at Bird Park in a grassy, forested area. The topography included *pahoehoe* (smooth, ropey lava), ash deposits, soil, loose rock, and solid rock. There would be no clearing necessary for the first two miles of roadway and the remainder would entail light clearing. The road would run over comparatively flat country for most of its distance, except for side cuts at three locations. Handley estimated that at least 75 percent of the work could be done with tractors and scrapers.[94]

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[92] Leavitt, "Superintendent's Monthly Report," May 1931.

[93] USDA, "Location Survey Report," 2.

[94] USDA, "Location Survey Report," 2-3.

After a careful study of the types of material through which the road would be constructed, the climatic conditions, and the conditions of vegetation along the line, Handley felt it was unwise to follow NPS standards for the rounding of cut slopes. It was a common practice in NPS road construction to sculpt the sides of cuts and fills to form gently sloping banks that could be reseeded, thus reducing erosion and blending the roadbed more harmoniously into the natural landscape. In this case, however, Handley believed that steeper slopes were better from a maintenance perspective, as no vegetation suitable for protecting the slopes would grow in the arid region. More gentle slopes would scour, rut, and deposit debris in the side ditches until they became more unsightly than the steep slopes he proposed. Handley also anticipated problems from sulphur, a common atmospheric condition in the area. To avoid corrosion, he recommended that all drains between Station 0+00 and Station 100+00 be built of concrete. After Station 100+00, it was unlikely that the sulphur would affect metal pipes.[95]

Handley's line followed the old road very closely. At Station 43+00, the old road climbed the first bluff on an 11 percent grade. At this point, Handley's line left the old trail in order to climb the bluff at a more permissible 7 percent grade. At the bottom of this grade was the road's shortest radius curve at 25°. There would be several 20° curves and the maximum grade of 7 percent was permitted for short distances. Although NPS policy called for roads to have "very light grades" and not exceed 5 percent, road builders in HAVO frequently had to make exceptions. Handley believed his new line would reduce the drainage problems the park had experienced on the desert side, resulting in reduced construction and maintenance costs.[96]

After the road passed the Uwekahuna Museum, Handley outlined two alternative alignments. Line "A" followed the shortest route to the main road and would be cheaper to construct. The alternate line "B" would be more scenic as it skirted the top of the bluff at the edge of Kilauea Crater and connected with the main road near Steaming Bluff. Handley liked the alternate route for its excellent views as well as for the fact that it passed an area of steam cracks. "These steam cracks are a constant attraction

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[95] USDA, "Location Survey Report," 2-3; and McClelland, *Presenting Nature*, 94.

[96] USDA, "Location Survey Report," 3-4; and McClelland, *Presenting Nature*, 76.

to tourists," he noted, "and it is to be recommended that parking space close to the edge of the cracks be provided so that the effect of automobile exhausts on the condensation of steam from the cracks can be demonstrated to visitors." Handley also favored this proposal because motorists were making their own routes to the steam vents, which scarred the surrounding landscape.[97]

The Uwekahuna-Bird Park plans were approved in late 1932. Despite the second route's greater attractions, Handley's Route "A" was selected because it was $13,000 cheaper. A few months later, with the United States sliding deeper into the Great Depression, the Bureau of the Budget in Washington D.C. ordered that no new road construction begin. This would allow money to be used to meet payments on the previous year's projects.[98] The Uwekahuna-Bird Park project was postponed; the estimated costs at that time were $100,000.[99] Island leaders lobbied for the superintendent to start the project as a way to provide relief for the unemployed, but the best he could do was have the existing road regraded.[100]

In June 1933 Hawaii National Park issued a press release that President Franklin Roosevelt's budget might include significant funds to help build Hawaii National Park roads and help provide unemployment relief. Press reports indicated that a public works bill in Congress was being considered and speculated that it might provide HAVO between $500,000 and $1,000,000. In July, National Park Service Director Albright announced appropriations of $16 million for park roads, which included $101,000 for the Uwekahuna-Bird Park Road and $400,000 for Haleakala Highway.[101] Funding for these projects came through the National Recovery Act of 1933.[102]

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[97] USDA, "Location Survey Report," 3-4.

[98] Leavitt, "Superintendent's Monthly Report," March 1933; and Leavitt, "Memorandum for the Press," March 15, 1933, attached to "Superintendent's Monthly Report," March 1933.

[99] Leavitt, "Superintendent's Monthly Report," December 1932 and February 1933.

[100] Leavitt, "Superintendent's Monthly Report," March 1933 and April 1933.

[101] Leavitt, "Superintendent's Monthly Report," May 1933 and July 1933.

[102] *Hilo (Hawaii) Tribune-Herald*, October 23, 1933.

Contractor E. E. Black submitted the low bid of $93,855.31 for the Uwekahuna-Bird Park Road project.[103] One hundred unemployed men were hired to work on the four-mile project, which would eventually be extended to the summit of Mauna Loa.[104] The crews worked a thirty-hour workweek at $.45 per hour for the Civil Works Administration.[105] The November 1933 superintendent's report noted that roadwork "progressed marvelously with the good weather."[106]

The Uwekahuna-Bird Park Road was 4.672 miles in length with a macadam surface 18' wide and 2' shoulders. The road included several 6 percent grades with the steepest grade being 7 percent near Station 95+75. Hand-laid riprap between Stations 44+00 and 48+00 was constructed using 175 cubic yards of material. The Halemaumau Parking area at Station 4+00 included space for 550 cars and was landscaped with stone curbs.[107]

By February 1934 the road was 78 percent complete.[108] The next month, the project was 98 percent finished and the contractor began moving his equipment off the job. BPR engineer Wheeler made the final inspection of the new road completing the crater circuit. Landscape architect Merel S. Sager inspected the project for the NPS. Sager had trained under NPS chief landscape architect Thomas Vint and had helped draft the job description and examination for NPS landscape architects.[109] He was assigned to HAVO in 1933 to supervise construction contracts, including the park's other major road project at the time, the Haleakala Highway on Maui. The Hilo Chamber of Commerce conducted an elaborate opening celebration for April 14-15, 1934. The new road was opened with the cutting of a 25' *maile-ohia lei* draped across the road, which had been made by Peter Lee's widow. The celebration was a community affair with

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[103] *Hilo (Hawaii) Tribune-Herald*, September 7, 1933.

[104] *Hilo (Hawaii) Tribune-Herald*, October 23, 1933.

[105] *Hilo (Hawaii) Tribune-Herald*, December 15, 1933.

[106] Edward G. Wingate, "Superintendent's Monthly Report," November 1933.

[107] USDOI, "Plans for Proposed Project No. 4."

[108] Wingate, "Superintendent's Monthly Report," February 1934.

[109] Carr, *Wilderness by Design*, 193, 254.

numerous activities, including a goodwill tour of Maui that expressed the desire for inter-island cooperation.[110] The following month, the superintendent reported that maintenance was already needed on the new Uwekahuna-Bird Park road due to severe damage done by less than 2" of rain. Photographs from the "Desert Hill" area showed the extent of erosion. A photograph of a man standing in the gully showed the pavement's edge was broken and the gully erosion was waist deep. A ditch was cut through the old road where it had acted as a dam, forcing rainwater to run over the new road. Fortunately for HAVO, repairs and improvements were accomplished with the help of the Civilian Conservation Corps (CCC) enrollees and park funds. CCC crews built stone drainage gutters to control the erosion. They also obliterated the old road in accordance with NPS standards that required that road scars be removed from the landscape and the area restored. By June, however, the new road had cracks in it from earth movement.[111] Earth movement would be a perennial maintenance problem in HAVO. Road cracks varied from minor cracks of a few inches to huge cracks several feet wide and hundreds of feet deep caused by major earthquakes.

FINISHING TOUCHES AND KEEPING THE ROAD OPEN

With the loop road completed, Hawaii National Park prepared to host its most notable visitor to date, President Franklin Delano Roosevelt, who was scheduled to tour the park in July 1934. Like all visitors, the president wanted to learn about volcanoes and view Halemaumau. In order to facilitate the tour, a 500' temporary road was constructed to the crater rim so that the polio-afflicted president would be able to view Halemaumau without leaving his car. Walls at Uwekahuna lookout were torn down, a driveway was constructed around and in front of the museum, and a ramp was placed at the crater's rim. The visit generated a great deal of excitement. The public road from Hilo was cleaned up so that, in the words of Superintendent Wingate, it "presented a neat and pleasing appearance." After the

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[110] Wingate, "Superintendent's Monthly Report," April 1934. A photograph of the opening day celebration is included with this report.

[111] Wingate, "Superintendent's Monthly Report," April 1934, May 1934, and June 1934; photographs attached to "Superintendent's Monthly Report," April 1934 and June 1934; "Press Release," May 15, 1934, attached to "Superintendent's Monthly Report," May 1934; and McClelland, *Presenting Nature*, 82.

president's departure, the temporary measures were obliterated and the landscape restored to its former appearance.[112]

Numerous improvements to Crater Road continued with the assistance of the CCC, which was a great asset in HAVO during the 1930s. Sager served as the technical supervisor for CCC projects. One of the earliest public works projects in the park was the construction of parapet guardwalls and lookouts at Thurston Lava Tube, Waldron Ledge, Kilauea Iki, and other places along Crater Rim Drive. The parapet walls throughout the park were a variation on the standard NPS design used throughout the system, employing local volcanic rock to blend in with the surrounding terrain.[113] Sager instructed crews to slope and seed road shoulders where appropriate. In HAVO, sloped banks were employed not only for aesthetic purposes, but also as another way to help control erosion, an important concern in a park prone to heavy rainfall. Superintendent Wingate praised Sager for using his role in bringing standard National Park Service practices to Hawaii.

Another important CCC contribution was the removal of dead and exotic plants from the roadsides. Crews removed morning glory at Bird Park and spruced up the park entrance by clearing the main road of dead fern fronds and exotics. Removing alien species gave native vegetation an opportunity to stabilize. The removal of alien ferns and vegetative residue along the roads also helped reduce fire hazards. These landscaping practices, typical throughout the NPS, were drawing such favorable attention from the public that Superintendent Wingate expressed confidence that they would become standard for all road-building projects in the territory. He also credited the Park Service with establishing the standard for stone masonry construction on Hawaii road projects.[114] CCC crews continued to build stonework ditches, shoulders, and riprap along the Uwekahuna-Bird Park Road to control erosion.[115] In 1935, the CCC built a road to a picnic area in Bird Park.[116] CCC crews would continue to slope

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[112] Wingate, "Superintendent's Monthly Report," July 1934.

[113] Wingate, "Superintendent's Monthly Report," February 1934.

[114] Wingate, "Superintendent's Monthly Report," January 1934; "Press Release," May 15, 1934; and McClelland, *Presenting Nature*, 84.

[115] Wingate, "Superintendent's Monthly Report," December 1934 and May 1935.

[116] Wingate, "Superintendent's Monthly Report," July 1936.

shoulders, landscape, and construct rockwork along park roads until 1940.[117]

CCC enrollees assisted the park in other ways. During the September 1934 eruption, the crews directed traffic in the parking area. They also served as guards at the edge of the crater and helped handle the enormous crowds of visitors who came to witness the fiery display. Approximately 6000 cars entered the park on the first night of the eruption. When the Uwekahuna-Bird Park Road was completed, the local newspaper had criticized the park for making the parking lot at Halemaumau too big and an affront to professed park policies of preserving the natural landscape. The latest eruption, however, proved that the Park Service had exercised correct judgment, since the new roads and parking areas made it possible for rangers and CCC enrollees to handle the traffic surge without traffic jams or accidents. The loop drive significantly eased traffic problems as the road became one-way at night. The local paper admitted its error and apologized for its criticism.[118]

The flurry of road development in HAVO and concurrent construction at Haleakala prompted Superintendent Wingate to write an article explaining NPS road building philosophy. Wingate stressed that although road improvements were intended to allow the public to enjoy the parks, the fundamental goal of preserving the landscape was never ignored. He explained how BPR engineers worked with NPS landscape architects to preserve park features, referring to the landscape architect as "the guardian of the park policy of unimpaired preservation." Wingate emphasized that NPS roads should be seen as the means by which visitors could have access to park landscapes, not as destinations in their own right. He asserted that the best way to visit a park was to get off the roads and hike the trails.[119]

The U.S. military used portions of Hawaii National Park during World War II. This unexpected chain of events damaged park roads that were not designed for heavy traffic. The military vehicles weighed up to thirty-two tons, which caused the fill

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[117] Wingate, "Superintendent's Monthly Report," November 1939 and January 1940.

[118] Wingate, "Superintendent's Monthly Report," September 1934.

[119] Wingate, "Superintendent's Monthly Report," July 1934; and Wingate, "Hawaii National Park and the National Park Service," n.d., attached to "Superintendent's Monthly Report," July 1934.

over fissures or lava tubes to give way, leaving holes up to 20' deep and 2' to 8' in diameter. Chuckholes developed in the road surface and the edges raveled faster than the small work force could keep up with.[120] Due to the wartime emergency, maintenance often had to be neglected due to inadequate manpower and funding. After the war, it took until November 1948 for most of the necessary repairs to be completed on the primary roads.[121] In 1949, the park removed unsightly sheet metal comfort stations and resurfaced the parking area at Halemaumau, which had been torn up by the military to prevent enemy aircraft from landing.[122]

In 1953, long overdue maintenance was completed on Crater Rim Road. A sealcoat project applied an initial coating of 25 lbs. of #4 aggregate and .25 gallon of 100-200 HX bitumuls per square yard. Where a second application was necessary, crews used 15 lbs. of #5 aggregate and .20 gallon of 10-200 HX bitumuls per square yard.[123] Another improvement was the thinning of vegetation at lookouts along Kilauea Iki Crater.[124] Two sections of guardrails constructed of concrete posts and wood rails were installed along Crater Rim Drive. The guardrails conformed to established standards used elsewhere by the Park Service. These guardrails protected motorists in hazardous areas where only narrow sections of small trees separated the road and a 400' drop into Kilauea Caldera.[125] Along Kilauea Iki, 384' of guardrails were installed as protection from a 640' drop. The park also extended the existing stone wall and planned to add pipe handrails to existing walls.[126] In 1959, the roadway was realigned and the adjacent parking space widened so visitors could get in and out of their vehicles without blocking the road.[127]

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[120] Wingate, "Superintendent's Monthly Report," August 1943.

[121] Francis R. Oberhansley, "Superintendent's Monthly Report," November 1948.

[122] Oberhansley, "Superintendent's Monthly Report," April 1949.

[123] Oberhansley, "Superintendent's Monthly Report," June 1953.

[124] Francis R. Oberhansley, "Maintenance Report to Superintendent," January 1952, HAVO archives.

[125] John Wosky, "Superintendent's Monthly Report," November 1957.

[126] Wosky, "Superintendent's Monthly Report," March 1958.

[127] Fred T. Johnston, "Superintendent's Monthly Report," September 1959.

Prior to 1959, Crater Rim Drive ran along the southern rim of Kilauea Iki. In November 1959, Kilauea Iki erupted and covered the road with ash, forcing an emergency closure of Crater Rim Road. Travel for the month soared as 198,605 visitors came to witness the event. Although HAVO was prepared to handle such crowds at Halemaumau, Kilauea Iki had limited access and almost no parking. The December visitor numbers recorded an increase of 330 percent over the previous December. Seven park employees from mainland national parks were brought in to assist HAVO staff. In addition, the park hired Hilo policemen and state park employees.[128] Three additional parking lots were added to help handle the crowds.[129] Photographs in the HAVO Superintendent's Reports indicate that the heavy traffic seriously deteriorated road shoulders in the area.[130]

NPS Director Conrad Wirth visited HAVO in December to help formulate plans for a bypass that would re-establish the loop road. In January 1960, the "Cinder Cone" pioneer road was ready for emergency use and a field survey was completed for another new, half-mile route. Other sections of Crater Rim Road were cleared of ash and the Byron Ledge Road was relocated.[131]

By March 1960 approximately 8,000 cubic yards of a jagged, rocky type of lava, known locally as *aa*, had been hauled and laid on the cinder cone connecting road. The rock cost about $1.50 per cubic yard, which was low considering the haul was long and slow. HAVO received an emergency allotment of $136,000 to reconstruct the roads and parking areas.[132] The road was surfaced in June and parking areas were completed at Puu Puai, Kilauea Iki, and Thurston Lava Tube.[133] The destroyed section of Crater Rim Road was turned into a footpath, known as Devastation Trail, which continues to provide an interpretive experience of the 1959 eruption.

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[128] Johnston, "Superintendent's Monthly Report," November 1959.

[129] Johnston, "Superintendent's Monthly Report," December 1959.

[130] Johnston, "Superintendent's Monthly Report," February 1960.

[131] Johnston, "Superintendent's Monthly Report," December 1959, January 1960, and February 1960.

[132] Johnston, "Superintendent's Monthly Report," March 1960; and "Form 10-771 Monthly Progress Report," attached to "Superintendent's Monthly Report".

[133] Johnston, "Superintendent's Monthly Report," June 1961.

Although volcanic ash was responsible for obliterating the road near Kilauea Iki in 1959, roads in Hawaii Volcanoes National Park have more often been destroyed by lava flows. In 1971, 1974, and 1984, lava flowed over Crater Rim Drive in the vicinity of Halemaumau and Keanakakoi Craters.[134] Volcanoes in Hawaii produce two types of lava, *pahoehoe* and *aa*. *Pahoehoe* has a smooth, ropey surface, which in some cases, can be easy to build roads on. The 1970s and 1980s flows that covered Crater Rim Drive were *pahoehoe* and the park was able to rebuild these sections of road relatively easily. Reconstruction after the September 1971 lava flow involved sub-excavation of the 2' to 5' thick *pahoehoe* to the previous roadway grade and over the same road alignment. The road base was 6" crushed aggregate with a prime coat of 2" hot bituminous concrete. The contract protected the landscape by requiring that no equipment be allowed outside the roadway except as designated by the NPS engineer. The road surface was 22' wide. Jas. W. Glover, Ltd., completed the work in twenty-nine days rather than the fifty days granted in the contract. Work was completed by February 1973 and the circuit road was reopened with three new pullouts at a cost of $86,000. The project was accomplished with funds provided by a program known as Emergency Reconstruction of Federally Owned Highways (ERFO).[135]

Numerous sections of Crater Rim Drive were destroyed by lava flows and earthquakes during the early 1980s. In April 1981 large earth cracks undermined a 0.1-mile section of Crater Rim Drive, forcing Superintendent David Ames to close the road between the Waldron Ledge overlook and the research center. Traffic was diverted to an existing bypass. Hawaiian Volcano Observatory scientists had been monitoring the cracks for a year and believed that the weight and vibration of traffic had enlarged the cracks and increased the likelihood that the roadbed next to a 400' *pali* would collapse. Visitors were still allowed to drive the portion of the road from Volcano House to the Waldron Ledge parking area.[136]

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[134] Department of the Interior, National Park Service, Hawaii Volcanoes National Park, brochure/map, 1999.

[135] "Final Construction Report, Hawaii Volcanoes National Park, Route 4 ERFO (4)1, Crater Rim Road, Hawaii County, Hawaii, 1972-1973," HAVO archives; and "Plans for Route #4-Crater Rim Road Uwekahuna-Bird Park Road, HAVO Highway System, Hawaii" (1972), microfiche #41903, HAVO Maintenance Division files.

[136] "Detour on Park Road," *Hawaii Tribune-Herald*, April 5, 1981.

The September 1982 Kilauea eruption destroyed 800' of Crater Rim Drive between Halemaumau and Keanakakoi Craters. The earthquake that accompanied the eruption forced the park to repair and realign the road at Keanakakoi. Another earthquake in November severely damaged roads throughout the park and forced another closure of Crater Rim Drive. One section along Crater Rim Drive near Kilauea Military Camp had cracks 8' wide and 200' deep. More sections of the old road between Waldron Ledge and the research center slumped into the crater and the road to park housing was closed and converted into an earthquake trail.[137]

In November 1983 an earthquake shook large sections of the road into the caldera below, forcing the complete closure of the road near Waldron Ledge and diverting traffic to the bypass.[138] The earthquake also destroyed part of the Crater Rim Trail. Today, pieces of the remaining road are used as part of Crater Rim Trail. In August 1999 the Waldron Ledge overlook was reopened and rededicated and park visitors can hike to this scenic view from Volcano House. The road formerly known as a "bypass" is now a section of the Crater Rim Drive.

BUILDING THE FIRST CHAIN OF CRATERS ROAD

In April 1922 Superintendent Boles noted that, while Halemaumau was the premier attraction for park visitors, there were other promising opportunities for scenic road development within the park. With only fourteen miles of good road within the park, Boles pointed out that visitors could see all the park's attractions in a day. Those staying longer left their autos behind and used the parks' trails. He was convinced that the popularity of the Six Crater Trail made it imperative that a new road be constructed in this area. Boles described the Six Crater Trail as a ten-mile loop that passed Thurston Lava Tube and ten steaming craters.[139] Seven craters were located along a path known as Cockett's Trail, four of which were steaming.[140] A month later, Makaopuhi Crater, which was seven miles from Crater

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[137] David Ames, "Superintendent's Annual Report," 1983.

[138] Department of the Interior, National Park Service, Hawaii Volcanoes National Park, interpretive sign at Crater Rim Trail, Waldron Ledge section, near Volcano House.

[139] Boles, "Superintendent's Annual Report," September 1, 1923.

[140] Boles, "Superintendent's Monthly Report," April 1922.

Road, erupted and generated an increased number of local visitors to the park.[141]

Boles increased his efforts to develop what he was calling the "Chain Crater" or "Pit Crater" Road during 1924 when Kilauea was inactive and park visitors had to hike to other craters if they wanted to view volcanic activity. Boles reiterated that the limited roads made it difficult for the park to offer attractions other than Kilauea. He argued that a road to the pit craters could be built quickly and cheaply. He maintained that it would be more popular than the proposed Mauna Loa summit road, another candidate for road development within park.[142] The superintendent was convinced that nothing would make HAVO more popular among Hawaii residents than a road through the pit crater district with its steaming craters and molten lava.[143]

When BPR engineer Frank A. Kittredge reported on the Hawaii National Park road program in 1925, he recommended that the "Chain of Craters Highway" be considered a construction priority. Kittredge based his opinion on the fact that a new area of the park would be opened to tourists. He also noted that the county intended to build a road from the Puna Coast to the Chain of Craters Highway, which would make a circuit route possible from Hilo to Volcano.[144]

Kittredge's proposed line proceeded in a southerly direction along a chain of eight craters from a junction with Crater Road five miles west of park headquarters. The road would end at Makaopuhi Crater. The landscape through which the proposed route passed was gently rolling lava fields covered by trees and brush. Kittredge described the craters as "gigantic" holes in the ground as deep as 1000'. He pointed out that the road's proposed alignment would be excellent for automobile traffic, with no curves sharper than 14° and a maximum grade of 6.5 percent. The new road was to be seven miles long, 16' wide, and surfaced with 3/4" crushed rock or screened material. The park estimated that there would not be enough traffic to warrant a

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[141] Boles, "Superintendent's Monthly Report," May 1922.

[142] Boles, "Superintendent's Monthly Report," April 1924 and July 1924.

[143] Boles, "Superintendent's Annual Report," 1924; and Boles, "Summary of Conditions," September 1, 1924, attached to "Superintendent's Annual Report," 1924.

[144] Kittredge, *Report on Road Program*, 2.

paved surface. Kittredge noted that drainage would not be a problem (as it was along the Crater Road), since the area had "been shattered by volcanic and earthquake action to such an extent that it is rendered thoroughly porous." The estimated cost for the project was $155,254, with a targeted completion date of May 1927. At the time, the park had $250,000 available for highway construction and $10,000 for surveys. The location line for the project was staked and the project was ready to be advertised for bids in 1925.[145]

Park employees started clearing and grubbing for the road in 1926. Construction bids came in under the estimated costs and by December 1925 clearing had progressed as far as the second crater.[146] Clearing involved burning underbrush and treetops and was done during the rainy winter months when the fire risk was minimal. Timber suitable for firewood or building purposes was saved for park use.[147]

Construction of the Chain of Craters Road officially commenced on April 11, 1927. Richard T. Evans, the new superintendent, reported that the road project was the "outstanding development of the year."[148] A contract for $148,000 was awarded to Charles Will. Within a month, however, there were problems between the contractor and superintendent. Evans located a source of gravel for the road's top dressing 1.25 miles southwest of the second crater. The contractor refused to build a service road to access the recommended borrow pit and invoked a clause in the contract that allowed him to haul gravel from a spot near Crater Road. Evans wanted the new borrow pit to be used because its material would not require screening.[149] Another difficulty encountered during construction was a thick core of basalt near Aloi Crater that required the hiring of additional laborers to cut the roadbed.[150]

The BPR engineer inspected the Chain of Craters construction in June, when work had progressed beyond Devil's Throat. He

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[145] Kittredge, *Report on Road Program*, 1-4, 16.

[146] Boles, "Superintendent's Annual Report," 1926.

[147] Boles, "Superintendent's Monthly Report," December 1925.

[148] Richard T. Evans, "Superintendent's Annual Report," 1927.

[149] Evans, "Superintendent's Annual Report," 1927; and Evans, "Superintendent's Monthly Report," May 1927.

[150] Evans, "Superintendent's Monthly Report," October 1927.

reported that progress was satisfactory, but observed that a shortage of workers was slowing the project. Three months later, the crew of eighty-five had only been increased to one hundred men.[151] Grading was completed as far as Pauahi Crater in August. Gravel had been spread for two miles by this time and the lava rock guardwall at Kookoolau Crater was completed. By September 1927, 58 percent of the work was completed. By the end of the year, lava masonry walls 40' to 60' long were finished where the road passed along the rims of each crater.[152]

A February 1928 press release announced that the park expected the new road to be finished by March 1, despite very rainy weather. Rain continued to hamper work during the following month and the completion date was revised several times. Nevertheless, the contractor finished the final guard wall and laid the subgrade and gravel on the loop at the end of the road by February.[153] In March, toilets were installed at the end of the road and trails were built to Makaopuhi Crater and Devil's Throat. The road was completed except for an anticipated four days of rolling. The contractor exceeded the budget by $1500, but the engineering costs had come in $2500 under the original estimate. The road was officially finished on March 24, 1928, though it remained closed to the public for three weeks, during which time "beneficial rains" helped bind the gravel surface.[154]

Chain of Craters Road was inspected on April 14, 1928, by BPR engineers Wheeler and McCracken, contractor Charles Will, and Superintendent Evans. The road opened to the public the next day at 8:30 a.m. Attendance was lower than expected due to what NPS officials referred to as "some garbled publicity." Although a formal dedication of the road was planned for October, it was indefinitely postponed when an anticipated Packard caravan from San Francisco was unable to attend.[155]

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[151] Evans, "Superintendent's Monthly Report," May 1927, June 1927, and August 1927.

[152] Evans, "Superintendent's Monthly Report," August 1927, September 1927, and December 1927.

[153] Evans, "Superintendent's Monthly Report," February 1928.

[154] Evans, "Superintendent's Monthly Report," March 1928.

[155] *Hilo (Hawaii) Tribune-Herald*, April 15, 1928; and Evans, "Superintendent's Monthly Report," April 1928 and September 1928. No information regarding a formal road dedication was located.

Chain of Craters Road demonstrated several standard NPS design practices, including the provision of scenic vistas to exhibit impressive natural features. Clearing vegetation to improve or expose vistas was an important design and maintenance practice, which had been advocated by the first NPS landscape engineer, Charles P. Punchard, as early as 1919.[156] The road incorporated another classic park road design principle in that it was arranged, at least for half its length, so that interesting views were presented on alternate sides of the road.[157] The first four craters are viewed in an alternating sequence on the right and left sides of the road. Presumably, the road passed along the south side of the remaining craters due to the need to construct the road on stable land. Early park photographs depict visitors enjoying views of the craters and adjacent scenery from the crater's lava parapet walls.[158] In the 1950s, it was standard practice for maintenance crews to trim or remove trees that blocked views at the overlooks.[159] By the 1990s, however, the planned views at a number of craters were blocked by trees, many of which were alien species. With these crater overlooks obscured by trees, visitors might wonder why the road was named "Chain of Craters."

As with many roads in wilderness areas, maintenance was a constant challenge on many levels. Before the road was completed, BPR engineers forewarned Superintendent Evans that the day after construction ended, maintenance issues would begin.[160] Only one year after Chain of Craters Road opened, a three-mile section of the road was in such bad repair that newspaper editorials described it as a "multitude of deep chuck holes in a heavy oiled crust." Repairs were often unsuccessful due to the heavy rain and travel on the road. The park pledged to maintain the road as long as maintenance money was available, but also noted that money would be needed to rebuild the highway.[161] Although the BPR survey for the Chain of Craters

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[156] McClelland, *Presenting Nature*, 106.

[157] McClelland, *Presenting Nature*, 106.

[158] An example of one of these photographs is attached to Oberhansley, "Superintendent's Monthly Report," October 1947.

[159] Wosky, "Superintendent's Monthly Report," March 1956; and McClelland, *Presenting Nature*, 85.

[160] Evans, "Superintendent's Monthly Report," September 1928.

[161] Allen, "Superintendent's Monthly Report," April 1929.

Road claimed the drainage was good, rain damaged the road considerably in 1931, washing it out in several places.[162]

Chain of Craters Road was paved with emulsified asphaltic macadam in 1930-31.[163] Even after the paving project, natural forces continued to affect the road. In addition to the earlier damage caused by rain, vegetation grew and broke the pavement in 1932. Park personnel killed the grass alongside the road with arsenic so seeds would not be carried into future paving projects.[164]

Earthquake activity was a major factor in the rapid deterioration of the road. In 1935, a 30' crack in the ground near Aloi Crater made the road collapse. To repair the problem, park crews excavated the damage, bridged the crack with a concrete slab, resting it on solid rock, and then filled the crack and resurfaced the road.[165] This system of repairing cracks and gaping holes caused by earthquakes occurred repeatedly over the years. Earthquakes also caused roads to "hump," sometimes so severely that cars could not pass over the heaved pavement.[166] It was not always obvious when the road was undermined by earth movement. Once, a ranger drove over the road near Pauahi Crater and the pavement beneath his wheel collapsed into a hole.[167] In May 1938, earthquakes caused such extensive damage to Chain of Craters Road that the road had to be closed between Makaopuhi and Pauahi Craters. Permanent repairs were postponed until the park could be reasonably certain that the earth movements had stopped. On August 28, 1938, about 323 tremors were registered in the park. In March 1939, there was still ground movement in the area and the park had not yet decided to fix the road.[168] The Civilian

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[162] Leavitt, "Superintendent's Monthly Report," September 1931.

[163] USDOI, "Plans for Proposed Project No. 4."

[164] Leavitt, "Superintendent's Monthly Report," May 1932.

[165] Wingate, "Superintendent's Monthly Report," June 1935.

[166] Wingate, "Superintendent's Monthly Report," August 1938; and photograph, attached to "Superintendent's Monthly Report," August 1938.

[167] Wingate, "Superintendent's Monthly Report," September 1938; and photograph, attached to "Superintendent's Monthly Report," September 1938.

[168] Wingate, "Superintendent's Monthly Report," May 1938, August 1938, and March 1939.

Conservation Corps made temporary repairs to the road in 1939, although for a two-mile stretch near Pauahi Crater, motorists had to "negotiate with care" as they passed numerous humps in the road.[169]

MAUNA LOA ROAD (MAUNA LOA TRUCK TRAIL)

The 1916 bill that established HAVO included plans for a "strip of land of sufficient width for a road" to connect the Kilauea and Mauna Loa sections of the park.[170] When Horace Albright visited Hawaii National Park in 1920, he reiterated the necessity of acquiring a tract of land to connect the two sections. Albright described three trails that led to the summit of Mauna Loa, including the most traveled trail, Puu Ulaula (Red Hill), which had been constructed in 1915 by the 25th Infantry Division (Colored) to connect the Kilauea section to Mauna Loa. Albright remarked that the trail was on a good grade, but noted that it should be improved for horse travel between the Puu Ulaula rest house and the summit.[171]

Albright advised that a road to Mauna Loa's summit be built in the near future and recommended that a survey and cost projection for the route be conducted as soon as possible. He believed that a road could be built through *aa* flows, which were composed of natural road materials that would require only heavy rolling and shaping. In addition to providing access to the spectacle of Mauna Loa, a road would also make Bird Park and the *koa* forest accessible. Albright inspected nearby roads constructed through lava flows and was impressed that they had been built at very reasonable costs. Based on those costs, he estimated that a Mauna Loa road could be constructed for no more than $10,000 per mile, or a total cost of $300,000.[172]

In 1921, prominent Honolulu businessman and HAVO promoter Lorrin A. Thurston supported the concept of a road to the summit of Mauna Loa. He estimated that a good, semi-macadamized, thirty-mile road would cost approximately $6,000 per mile and could be

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[169] Wingate, "Superintendent's Annual Report," 1939.

[170] Frances Jackson, *An Administrative History of Hawaii Volcanoes National Park, Haleakala National Park,* U.S. Department of the Interior, National Park Service (Honolulu, 1972), 222, HAVO library.

[171] Albright, "Annual Report," 1-2, 15-16.

[172] Albright, "Annual Report," 17-19.

built on a grade of approximately 6 percent. He noted that the road would "revolutionize" volcanic observation at the summit and enhance tourist travel.[173]

After taking over as HAVO's first on-site administrator in 1922, Superintendent Boles visited all areas of the park, including the Mauna Loa summit. Accompanied by territorial forester Charles Judd, Boles investigated the possibilities for building a road to the rest house and, from there, constructing a trail to the summit.[174] In February 1923 Boles and Hawaiian Volcano Observatory scientist Thomas Jaggar surveyed a possible route to the summit. No road funds were available, but a horse trail was constructed. Boles felt that this solution was adequate for the time being as there was very limited travel to the summit and the Kilauea area remained HAVO's premier attraction.[175]

BPR Engineer Kittredge made several observations about a potential Mauna Loa summit road in his 1925 investigation of HAVO roads. Because of the volcano's relatively constant and undifferentiated topographic configuration, he noted, there were an indefinite number of possible routes to the summit. One possible route would be for a road to start from the summit and descend on the maximum grade by spiraling around the mountain. This route would allow for views in all directions. A second followed the general line of a rift and used numerous easy switchback curves. The curves would have radii of 100' to 300'. Kittredge preferred his second alternative since it was in the vicinity of an existing trail. This route would allow visitors to pass a number of volcanic cones without exceeding a grade of 5 or 6 percent. The route included more curvature than Kittredge would have liked, but he believed that the ability to provide access to attractive scenic features was more important than the frequency of curves. Kittredge also mentioned the possibility of extending the Mauna Loa Road into a loop road that would connect Hilo and Volcano. In addition to providing scenic opportunities, a loop route would have commercial value. A potential problem with these plans was that only one of Kittredge's three summit routes was entirely within park boundaries.[176]

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[173] Lorrin A. Thurston, "The Story of a Volcano," *Mid-Pacific Magazine*, January 1921, 32-33.

[174] Boles, "Superintendent's Monthly Report," July 1922.

[175] Jackson, *Administrative History*, 223.

[176] Kittredge, *Report on Road Program*, 5-8.

In 1925 the Bureau of Public Roads completed a survey for the proposed Mauna Loa truck trail. The line was 11.5 miles long and had an average grade of 5 percent. The proposed width was 8', much narrower than contemporary standards for NPS roads. The BPR line ran very close to the park boundary, and in a few places, the proposed alignment went outside the park.[177] Superintendent Boles noted that it was important to avoid private grazing lands, making it necessary to run one or two additional survey lines.[178] Kittredge returned to the Big Island and revised the location of the lower end of the proposed road to avoid privately owned land. A party of congressmen visited HAVO and hinted that construction funds would be difficult to appropriate unless the government gained title to a strip of land at least one mile wide on each side of the proposed road. The right-of-way through private property that HAVO had assumed would be sufficient was no longer considered acceptable. The BPR surveys for a Mauna Loa road were completed in October 1925 and the new line was located almost entirely on territorial land.[179] The survey was furnished to the territorial governor so he could work on the necessary land exchanges for the proposed road.[180]

By May 1927 HAVO owned the land on which to build a connecting road between the Kilauea and Mauna Loa sections.[181] Residents continued to push for the road. According to Superintendent Leavitt, Lorrin Thurston, the *Honolulu Advertiser* publisher, was busily printing "propaganda" in support of the road.[182] In July 1931 the superintendent had an "information only" discussion about the proposed road's costs and possibilities with BPR District Engineer Frank Wheeler. Governor Judd met with Leavitt later that year to encourage the park to start the road as soon as the planned Haleakala Highway on Maui was finished. By the

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[177] Department of Agriculture, Bureau of Public Roads, "Preliminary Mauna Loa Truck Trail Location, Proposed ECW Project," traced from a 1925 Bureau of Public Roads Survey (June 28, 1935), microfiche #3041, HAVO Maintenance Division files. The BPR survey was probably made by Kittredge.

[178] Boles, "Superintendent's Monthly Report," September 1925.

[179] Boles, "Superintendent's Monthly Report," October 1925.

[180] Boles, "Superintendent's Monthly Report," December 1925.

[181] Jackson, *Administrative History*, 226.

[182] Allen, "Superintendent's Monthly Report," November 1930.

end of the year, the Mauna Loa trail had been improved and the superintendent ascended to the summit with three of his employees. Leavitt subsequently issued a press release stating that Mauna Loa's summit had more interesting and scenic attractions than Kilauea, and since the latter was inactive, he strongly recommended that a road be built to accommodate park visitors.[183]

In February 1933, with no road to Mauna Loa started, Thurston spoke to area residents and urged them to continue lobbying for a road. He emphasized that if the Haleakala Highway on Maui were constructed before a Mauna Loa road, it would draw tourists away from the Big Island. A bill was introduced by the territorial legislature to allow the use of prison labor to construct the Mauna Loa road.[184] The next month, with the Great Depression deepening its impact, federal authorities ordered that no new road construction be initiated.[185] Big Island residents did not lose hope, however, especially after National Park Service Director Horace Albright announced the allocation of $16 million for park road construction, including $400,000 in National Recovery Act (NRA) funding for the Haleakala road.[186] Thurston's newspaper again urged support for a Mauna Loa road project. In August 1933, Dr. Jaggar of the Hawaiian Volcano Observatory demonstrated his ardent advocacy of the road in an *Advertiser* editorial. He asserted that the road was extremely important for scenic purposes, but also emphasized that it was vital for its scientific value, which would make possible discoveries "such as the world has never dreamed of."[187]

In late 1933 and early 1934, Mauna Loa erupted, further increasing the demand for the long-proposed summit road. This time, Thomas Sakakihara of Hilo led the campaign and introduced a resolution in the Territorial Legislature that called for the National Recovery Act to allot a million dollars for the road. Similar resolutions were passed by the county government and

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[183] Leavitt, "Superintendent's Monthly Report," July 1931, September 1931, and November 1931.

[184] Wingate, "Superintendent's Monthly Report," February 1933.

[185] Leavitt, "Superintendent's Monthly Report," March 1933; and Leavitt, "Memorandum for the Press," attached to "Superintendent's Monthly Report," March 1933.

[186] Leavitt, "Superintendent's Monthly Report," July 1933.

[187] Leavitt, "Superintendent's Monthly Report," August 1933, and September 1933.

numerous community organizations. Jaggar predicted more eruptions and again urged the NPS to consider the road's scientific value. He emphasized the great advantage such a road, even a "very rough one," would provide to vulcanologists. Despite the lack of funding at the time, Jaggar insisted that if enough "steam" was put into a campaign, eventually the money for a road would become available.[188] Despite having the CCC in HAVO and the allocation of NRA money for roadwork, other park projects took precedence over the Mauna Loa road, including Haleakala Highway on Maui and the Uwekahuna-Bird Park Road. The NPS considered the Haleakala Highway a higher priority as the Maui portion of the Hawaii National Park still had no modern roadway leading to its impressive volcanic summit.

With no major funding for a Mauna Loa summit road, HAVO planned an alternative project. HAVO Associate Engineer A. H. Wong made a location survey for a proposed truck trail for the Emergency Conservation Work (ECW) in August 1935. Truck trails in the national parks were designed as separate road networks intended for use for administrative and protection purposes rather than as tour routes for the motoring public.[189] The Mauna Loa truck trail would theoretically be used primarily for general patrol purposes, fire fighting, and eruption emergencies. It began at the end of the Uwekahuna Bird Park Road from the park's Kilauea section. Wong restaked the 1925 BPR survey and located the road entirely within HAVO. The unsurfaced road would be 8' wide, approximately 10.5 miles long, and end near the 7,000' elevation.[190]

On September 3, CCC enrollees started work on the Mauna Loa truck trail. By November, the CCC camp director reported that his crew had made progress for 3 miles and that their work was already helping those going to the summit to view eruptions. The director reported that more work would have been completed, except that the enrollees were also erecting fences to keep

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[188] Wingate, "Superintendent's Monthly Report," November 1933, January 1934, and February 1934.

[189] McClelland, *Presenting Nature*, 105-106.

[190] Wingate, "Superintendent's Monthly Report," August 1935; and "Press Release," attached to "Superintendent's Monthly Report," August 1935.

goats out of the park.[191] In November, Wingate emphasized that the new truck trail was important for safety reasons and suggested the road end at a higher elevation than originally planned. Elaborating on this issue in his November 1935 monthly report, Wingate observed:

> The eruption again emphasized the need of some sort of road on Mauna Loa as far as the resthouse at 10,000 feet. If a passable road had been available at the time of the outbreak it would have been possible within a very few hours to have correctly determined the position of the eruption and the probable direction the resulting flows would take. Such a determination would have allayed the apprehensions of various ranchers in different parts of the island. As it was, it was necessary to wait 14 hours before a report could be obtained from the Army pilot who had set out at dawn.[192]

Work on the truck trail progressed rapidly in early 1936. A powder magazine was erected about two miles up the Mauna Loa trail, out of sight of the road. Dynamite was necessary when building the road through *pahoehoe* lava fields and the blasting crew moved along nicely with the help of a new electric detonator. A compressor and a portable rock crusher were also used on the project.[193] At times, however, the major portion of man-days was expended on making cuts and fills by hand through the *pahoehoe*. At one point, laborers made two eleven-foot cuts totaling 210' and laid 8' to 14' of fill for 180'. Excavation in this area had to be done using hand drills and wheelbarrows because it was impossible to detour a truck around the *aa*. Another problem in getting the work done was the need to keep water in drought-stricken areas threatened by fire.[194] A long spell of dry weather, combined with heavy construction traffic

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[191] Wingate, "Superintendent's Monthly Report," September 1935 and October 1935; and "Report of the Camp Director," attached to "Superintendent's Monthly Report," October 1935.

[192] Wingate, "Superintendent's Monthly Report," November 1935.

[193] Wingate, "Superintendent's Monthly Report," January 1936 and February 1936; and photographs, attached to "Superintendent's Monthly Report," January 1936 and February 1936.

[194] Wingate, "Superintendent's Monthly Report," March 1936; and W. J. Stephens, "Project Superintendent's Report," attached to "Superintendent's Monthly Report," March 1936.

on the new trail, made the gravel surface unravel, so that a new layer of fine material had to be laid. The new materials combined with several days of damp weather allowed the surface gravel to bind.[195] Superintendent's reports indicate that excessively dry weather continued to hamper the project.

In order to speed progress in the difficult areas of *pahoehoe*, a side camp for the CCC enrollees was maintained along the Mauna Loa trail near the 9.5 mile point at an elevation of about 6,500'. About thirty enrollees, a cook, and a foreman lived at the camp in June 1936. Men worked in two shifts of six hours each and spent much of their time drilling and blasting. The camp director reported that much better progress could be made once the drillers were far enough ahead of the construction gangs that a minimum of time was lost running for cover during blasting operations. Blasting was done during the late afternoon after the other laborers returned to the main camp. The director also pointed out that subsistence costs at the side camp were a bit higher than at the main camp. By August, work had progressed enough that the side camp was no longer needed. Excavation was almost finished and all but 0.2 mile of subgrade had been laid. Once again, project superintendent Stephens noted that the lack of rain hampered progress. Without rain, the trail surface had no opportunity to bond into the subbase. Lack of adequate binding material was also a problem and sand had to be hauled a considerable distance to the project site.[196]

The Mauna Loa truck trail was finished on September 30, 1936.[197] Stephens reported that the road was 9.8 miles long and surfaced with loose gravel mixed with sand and dirt filler. He predicted that the road surface would ravel until weather and traffic would bind it, thus requiring future maintenance and repairs. A fire cache was built alongside the road and Ranger Harry Doust requested that a corral and small building be constructed at the end of the road to facilitate work during an eruption. Since the road was planned to eventually extend to 10,000', Doust noted that a temporary building would suffice.[198]

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[195] Wingate, "Superintendent's Monthly Report," April 1936.

[196] Wingate, "Superintendent's Monthly Report," July 1936 and August 1936.

[197] Wingate, "Superintendent's Annual Report," August 1937.

[198] Wingate, "Superintendent's Monthly Report," September 1936 and December 1936. The September 1936 report includes a photograph of fire cache.

In addition to providing a practical transportation route, the Mauna Loa Truck Trail benefited HAVO in other ways. Conservation benefited from goat fences erected to protect native forests. After the road was built, grazing was no longer permitted in the park. The regrowth of *koa* was noticeable after only three months. ECW work also included removing exotic plants up to the 7000' elevation.[199] Even though the road was intended for administrative use, visitors also enjoyed the new road. The CCC built a trailside museum at the end of the road in 1937-1938 and, between 1939 and 1945, park rangers offered auto tours on the truck trail.[200]

The CCC made repairs in early 1937 to correct drainage problems. By 1939, Park Ranger John Minter reported that the light binder on the truck trail was blowing away and that rain and traffic had made the last mile quite rough. Where the road had been built with fine crushed rock, Minter noted that it was holding up "exceedingly well."[201]

Although the Mauna Loa Road was never extended to 10,000', the Territory of Hawaii did not give up on its dream of a summit road. Over the years, the NPS policy and position on the summit road shifted. The idea of a summit road for Mauna Loa lost favor with the NPS, as park managers decided that Mauna Loa should be a place to experience nature in relative solitude, not a tourist highway.[202] The territory, however, refused to give up on a summit road and decided to build a road on the other side of the volcano using prison labor. Superintendent Francis Oberhansley considered this an "undesirable development" as far as the park was concerned and released what he termed "counter publicity" against the road in 1949.[203] The territory eventually completed a rough jeep road to a scientific observatory near the 11,000' elevation. Approximately 4.5 miles of the road was within the national park and was authorized by a revocable special use permit because the road was for scientific purposes.

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[199] Wingate, "Superintendent's Monthly Report," December 1940 and February 1937; and photographs, attached to "Superintendent's Monthly Report," December 1940.

[200] Wingate, "Superintendent's Monthly Report," September 1937, February 1938, March 1939, and January 1945.

[201] Wingate, "Superintendent's Monthly Report," April 1937 and June 1939.

[202] Jackson, *Administrative History*, 227-228.

[203] Oberhansley, "Superintendent's Monthly Report," February 1949.

A proposal to extend the Mauna Loa Road into a loop road circulated again.[204]

In 1955, $18,100 was allotted to improve the lower portion of the Mauna Loa truck trail. The average width of the existing road was 10' and there was no surfacing other than gravel. About thirty trees were cleared and two short pieces of lava drilled and shot to widen the road to a full 16' along the lower 2.6 miles. Two *aa* pits had to be opened to provide surface material after the first was found to have no suitable binder. The road was laid with 6" of *aa* base course and oiled at a rate of 1/2 gallon per square yard. By 1956, the last three miles of road were widened and graded to allow tourists to travel to the road's end. The road was subsequently referred to as a scenic road and included on maps of HAVO.[205]

AN AUTO TRAIL FOR HILINA PALI

The earliest mention of a possible road at Hilina Pali appeared in a March 1927 report in which Superintendent Evans mentioned his visit to the Kau Desert. Evans, accompanied by Dr. Jaggar, traveled by automobile as far as the "Cone-and-Pit Craters" and then hiked three miles south to Hilina Pali. Evans suggested that the bluff would be a fine objective for an auto trail.[206] Although the Hilina Pali auto trail was not yet constructed, a HAVO "friends" group, Hui O Pele, built an overnight shelter at Hilina Pali in 1930 and donated it to the park. The structure was built of native stone and overlooked the seacoast. NPS landscape architect Thomas Vint chose the site for the shelter and also approved the building plans. Vint may have played a role in the design itself.[207]

A 1932 park circular described HAVO's auto trails as roads fit for "venturesome motorists." In February 1931, Superintendent

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[204] Oberhansley, "Superintendent's Monthly Report," August 1951, October 1951, and June 1951.

[205] Wosky, "Superintendent's Monthly Report," December 1955, May 1956, and June 1956; and "Project Completion Report, Construction of Bird Park-Mauna Loa Road (R-32-2), Hawaii National Park, 1956 Fiscal Year," 1956, HAVO archives.

[206] Evans, "Superintendent's Monthly Report," March 1927.

[207] Allen, "Superintendent's Monthly Report," June 1930 and July 1930. The shelter cost $825.

Leavitt reported on his trip over the Hilina Pali auto trail, which wound its way for nine miles over the lava flows. The park had made improvements by building toilet facilities at the site.[208] In May, Leavitt reported that the trail to Hilina Pali was improved, although it was only accessible to lightweight cars. He wanted additional improvements so that motorists with larger vehicles could use it without damaging their cars or tires. Leavitt considered his improvements a "worthwhile addition" to the park's secondary road system and emphasized that the road was primarily for patrolling to prevent for illegal hunting and fishing. The park also planned to use the road for goat drives.[209]

In late 1936, the CCC began filling holes, breaking up lava, and leveling the Hilina Pali Road. The enrollees also placed an orientation disk at the end of the road, which identified cardinal directions and natural features.[210] By 1939 the road was being called a truck trail and Superintendent Wingate noted that the CCC repairs were unsatisfactory. The road was frequently damaged by rain and Wingate wanted the road improved to a "passable state" so cars could patrol it without being damaged. In July, a camp was established at the shelter and the CCC began a realignment and reconstruction project of the Hilina Pali Road. The project made satisfactory progress and by December approximately 1.75 miles of subgrade was completed. The next month, however, work came to a virtual halt while the park waited for compressor parts to arrive from the mainland. Work resumed in March 1940, and by April was 39 percent completed. After the compressor was repaired, CCC enrollees worked two shifts to make up for lost time.[211]

The superintendent ascertained that rain and erosion were creating major problems on the Hilina Pali Road. To address this issue, enrollees constructed fords of native rock across dry washes. Fills were laid across low areas. Field plans from 1937 showed that the roadbed was to be 12' wide. The average

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[208] Department of the Interior, National Park Service, "Circular of General Information" (Hawaii National Park, 1932), 4, HAVO library; and Leavitt, "Superintendent's Monthly Report," February 1931.

[209] Leavitt, "Superintendent's Monthly Report," May 1931.

[210] Wingate, "Superintendent's Monthly Report," January 1936 and December 1936.

[211] Wingate, "Superintendent's Monthly Report," March 1939, July 1939, December 1939, January 1940, March 1940, and April 1940.

grade was 2 to 3 percent, although there were several grades of 5 to 6 percent.[212] Earthquakes cracked the roadbed in 1938 while construction was still underway.[213]

Progress on the Hilina Pali Road was hampered by a shortage of men when enrollees and potential recruits moved to Oahu for better jobs. In March 1941, the superintendent complained that the Hilina Pali Road project had come to a complete standstill due to low CCC enrollment. He lamented that only eighty-three man-days were spent on the road in March, which was unfortunate as the park needed the road for fire protection and reforestry projects. Work on the truck trail did not resume as enrollees were diverted from the road project to "priority projects" that included the new hotel and a new volcano observatory.[214] CCC work was curtailed after the December 7, 1941 attack on Pearl Harbor when many enrollees were transferred into defense-related jobs.[215]

The U.S. Army had been using land below Hilina Pali for bombing practice as early as 1940. After the war started, Hilina Pali became an observation post. Heavy military traffic took its toll on roads throughout the park, resulting in additional maintenance demands at a time when park staff was reduced due to several employees joining the service. In June 1942, Superintendent Wingate expressed his great disappointment that the U.S. Congress took action to abolish the Civilian Conservation Corps. Since December 7, the CCC crews had been engaged almost exclusively on military-related projects. Wingate believed these projects were important because they gave enrollees useful "organized" training and allowed them to feel that they were contributing to the war effort. He concluded

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[212] Wingate, "Superintendent's Monthly Report," October 1939, December 1939, and February 1941; photographs, attached to "Superintendent's Monthly Report," October 1939, December 1939, and February 1941; "Hilina Pali Truck Trail" (1937), microfiche #5301, HAVO Maintenance Division files; and Wosky, "Superintendent's Monthly Report," April 1953. Wosky discussed a project to widen the road to 10' in some areas.

[213] Wingate, "Superintendent's Monthly Report," August 1938. These earthquakes were the same that caused great damage to Chain of Craters Road.

[214] Wingate, "Superintendent's Monthly Report," July 1941. The Volcano House had burned to the ground in 1940.

[215] Wingate, "Superintendent's Monthly Report," December 1941.

that the cost of park projects would increase significantly and that park operations would be "severely handicapped." In addition to loss of the CCC, about half the rangers' work time was spent on guard duty.[216]

After the war, road repairs throughout HAVO were a priority. Patches were laid on most roads, although a shortage of bitumuls forced work to stop by mid-November 1946. In June 1948 the park completed the Hilina Pali project started by the CCC prior to the war. Rubble drainages were repaired and grouted so that travel could resume on the road, eliminating a 3000' detour. About 1200' of roadbed was "roughed in" and "brought to grade." The next month, an additional 2000' of the road was realigned and surfaced.[217] In 1949 grading began on the lower three miles of the road, but was suspended when a territorial dockworkers' strike prevented shipments of oil from being delivered. Grading and oiling were finally completed and the road opened to traffic on November 10, 1949. Superintendent Oberhansley reported that the Hilina Pali overlook, with its magnificent panoramic views of the coast, was quickly becoming a "must" for HAVO visitors. By the end of the year, the park naturalist was conducting organized tours or "auto caravans" along the road.[218]

A storm in January 1950 flooded several sections of the Hilina Pali Road, including culverts, retaining walls, and fills. The storm washed out the gravel on the road's steeper portions and made the route impassable. The park allotted $3000 for minimal repairs and requested $5000 to complete the repair project. Most of the storm damage was repaired by April, with the help of an additional $5000 that came from reserve funds. Steep sections of roadway were paved to prevent future washouts, the upper 5.5 miles was "dustcoated," and some repair work remained to be done along the lower 3.5 miles.[219] In November, torrential rains caused extensive damage to the road again, washing out and

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[216] Wingate, "Superintendent's Annual Report," 1940; and Wingate, "Superintendent's Monthly Report," June 1942 and July 1942.

[217] Oberhansley, "Superintendent's Monthly Report," October 1946, June 1948, and July 1948.

[218] Oberhansley, "Superintendent's Monthly Report," August 1949, November 1949, and December 1949; and park naturalist's "Memorandum to the Superintendent," attached to "Superintendent's Monthly Report," December 1949.

[219] Oberhansley, "Superintendent's Monthly Report," January 1950, February 1950, and April 1950.

undermining the oil surface over almost the entire length of road. This time, the park allotted $9,365 for repairs that included grading and re-treating the road surface. Work on the Hilina Pali Road was completed using surplus asphalt from the Army.[220] By February 1951, the rehabilitation project on this "heavy visitor use road" was finished. A ten-car parking area was provided at the Kipuka Nene picnic area. Speed limit signs were posted along the road, allowing 25 mph from the road's entrance to Kipuka Nene, and 15 mph beyond that point.[221]

Routine maintenance on the Hilina Pali Road during 1953 included patching and sealing, as well as widening the road to 10' for 5.2 miles from the Chain of Craters junction. The sealcoat consisted of 0.25 gallon of 100-200 bitumuls and 20 lbs. of field aggregate per square yard of surface. Another 2.3 miles of road was widened and sealcoated five months later. Nine hundred cubic yards of *aa* cinders were used to level high points and explosives were used to straighten the roadway.[222] By 1957, the lower 5 miles of road were badly deteriorated and required extensive patching to make the surface smooth. Road shoulders were cleaned to improve appearance and to prevent ravelling. Grass along the roadsides was treated with herbicides to prevent further damage to the road.[223]

Volcanic activity in the 1960s cracked and pitted the road, making it necessary to close the road for repairs.[224] Over the years, sections of the road have been closed for other reasons as well, including periodic droughts and the summer dry season. During the summer of 1999, the road was closed near Kipuka Nene to protect a sensitive *nene* nesting area.

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[220] Oberhansley, "Superintendent's Monthly Report," November 1950 and February 1951. Numerous postwar shipping strikes, including a six month strike that ended in October 1950, made asphalt scarce and slowed many road projects in HAVO.

[221] Oberhansley, "Superintendent's Monthly Report," February 1951 and March 1951.

[222] Wosky, "Superintendent's Monthly Report," May 1953 and September 1953.

[223] Wosky, "Superintendent's Monthly Report," February 1957 and March 1957.

[224] Jackson, *Administrative History*, 124.

EXTENDING THE CHAIN OF CRATERS ROAD TO KALAPANA

When work began in 1926 on the Chain of Craters Road, HAVO and the County of Hawaii discussed extending the road to connect with a county road in the village of Kalapana south of the park. The proposal would create a ninety-mile circuit route between Hilo and the national park by having the county extend the road from Kalapana (south of the park) and the NPS extend the Chain of Craters Road to Kalapana. The road would eliminate approximately 45 miles of backtracking. The county authorized surveys for this proposal in 1926. Superintendent Boles emphasized that the NPS road would be designed to current BPR standards.[225] The Kalapana extension was deferred for decades while the county, territory, and NPS debated issues of land acquisition and financing for the project.

In mid-1927, the territorial legislature rejected a proposal to fund a road to Kalapana. In December 1928, visitors to the park included the Hawaii County Board of Supervisors and territorial Senate President R. W. Shingle, all of whom expressed interest in extending the Chain of Craters Road.[226] In 1929, the territorial legislature granted the county permission to sell $30,000 worth of road bonds. The bonds were never sold and authority was granted again in 1931. Projected road costs of $400,000 far exceeded the $30,000 bond approval.[227]

In 1931, BPR Senior Engineering Inspector H. L. Handley inspected the proposed Kalapana road, which was projected to follow the old Kalapana trail. Superintendent Leavitt recommended that park funds be used on other projects, however, as the county had done nothing to support the road's construction and it appeared unlikely that anything would happen in the immediate future.[228] In July, Leavitt discussed the Chain of Craters-Kalapana Road project with BPR District Engineer Wheeler. He reported that the county had appropriated $25,000 for the project, but estimated that the amount would only complete one mile of the proposed fifteen-mile road. Wheeler and Leavitt recommended that the county do surveys and

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[225] Boles, "Superintendent's Annual Report," 1926.

[226] Evans, "Superintendent's Monthly Report," May 1927 and December 1928.

[227] Jackson, *Administrative History*, 133.

[228] Leavitt, "Superintendent's Monthly Report," May 1931.

preliminary work.[229] Several months later, the Hawaii Board of Supervisors adopted a plan to cover the cost of the Kalapana road with matching funds from the federal government. The Hawaii Tourist Bureau, former territorial Governor Farrington, and other prominent Hawaii citizens supported the idea. Governor Judd, however, believed the money would be better spent building new bridges along the island's rugged Hamakua Coast, and a controversy ensued over how to spend the federal aid. Governor Judd pledged his cooperation in improving roads to the park, including the road to Kalapana, although he was more interested in constructing the proposed Mauna Loa road.[230]

When Superintendent Wingate assumed duties in HAVO in 1933, he also supported the proposed road to the village of Kalapana. Wingate was concerned, however, that this project might adversely impact Hawaiian interests in the area. He believed that non-Hawaiians would economically exploit native communities rendered more easily accessible by modern roads. Wingate feared that Hawaiians would suffer at the hands of developers, lose their land and lifestyle, and then be condemned to living in tenements. In order to prevent this course of events, Wingate proposed a park expansion that included Kalapana. By incorporating Kalapana into the park, the NPS would protect one of Hawaii's last remaining traditional villages. Wingate, assisted by the park naturalist, also selected a route for the proposed road. In December 1936, a newspaper reported that Secretary of the Interior Harold Ickes agreed with Wingate and recommended that Kalapana be included in HAVO in order to preserve one of the few remaining unspoiled Hawaiian communities and to provide shoreline access.[231] Three months later, Territorial Delegate Sam King introduced a bill to Congress to add Kalapana to HAVO. In June 1938, the bill for the Kalapana addition was passed by Congress. The bill became law in 1941.[232]

Building the Kalapana extension of the Chain of Craters Road depended on the NPS acquiring title to the land on which to

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[229] Leavitt, "Superintendent's Monthly Report," July 1931.

[230] Leavitt, "Superintendent's Monthly Report," August 1931 and September 1931.

[231] Wingate, "Superintendent's Monthly Report," January 1935 and December 1935. From 1900 to 1959, Hawaii was a territory and was represented by a delegate to the U.S. Congress.

[232] Wingate, "Superintendent's Monthly Report," March 1936 and June 1938; and Jackson, *Administrative History*, 134.

build the road. The 1916 legislation that established HAVO prohibited the appropriation of federal funds for development until the United States acquired title to or easements over private property. This policy was standard throughout the National Park Service.[233] In HAVO, the territory was responsible for acquiring new park land and the NPS was then responsible for the costs of new road development.

The history of land acquisition in HAVO has always been complicated and obtaining the necessary land for the Chain of Craters-Kalapana Road was no different. Contested transactions delayed construction for decades. As early as 1943, the territorial legislature appropriated money to purchase land at Kamoamoa near Kalapana. The next mention of the territory's quest for land did not come until 1948, when Governor Stainbeck assured the superintendent that no further legislation was needed for the Kalapana extension and that funding for land acquisition was available.[234]

In 1949 the territorial attorney general's office filed a condemnation suit to obtain parcels in the area. The attorney general then filed an order of possession in early 1950. One year later, Governor Long signed an executive order that transferred control of eighteen parcels. In response, seven landowners filed demands for a jury trial in the matter. Long used another executive order for more land acquisition at Kalapana. While the condemnation suits were pending, HAVO assumed protective custody of the land.[235] Matters were not settled until about 1960, when plans were finalized to build the road.[236]

The long history of land disputes soured relations between Hawaii island residents and the National Park Service. In 1951, Superintendent Oberhansley noted that local people did not trust

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[233] Albright, "Annual Report," 2; Dudley C. Bayliss, "Planning Our National Park Roads and Our National Parkways," *Traffic Quarterly* 11 (July 1957): 426.

[234] Wingate, "Superintendent's Monthly Report," February 1943; and Oberhansley, "Superintendent's Monthly Report," August 1948.

[235] Oberhansley, "Superintendent's Monthly Report," August 1949, February 1950, February 1951, and July 1951.

[236] Wosky, "Superintendent's Monthly Report," April 1953. The Superintendent's reports did not mention when title to land was acquired.

the NPS because the agency had condemned land at Kalapana in order to acquire it. The superintendent placed the blame elsewhere by asserting that the territorial government had actually condemned the land, not the Park Service. He claimed that the territory was supposed to have exchanged the land on terms agreeable to the residents, not acquired it by condemnation.[237]

NPS Director Conrad Wirth visited HAVO in 1960 and decided that the best approach to building the Kalapana extension would be to divide the contract work into two units. The first contract would cover grading and structures for the entire length of the road during fiscal year 1962. The second contract would include the base course and surfacing for the road during fiscal year 1963. The NPS wanted the BPR to begin surveys as soon as possible, anticipating that their work would require between nine and ten months to complete. The estimated cost for the two contracts was $1,250,000.[238]

HAVO staff and experts from the NPS Western Office of Design and Construction (WDOC) in San Francisco conducted a preliminary reconnaissance survey in 1960. The surveyors walked the route for several miles and flew over the area in a small plane. NPS officials also met with BPR Division Engineer Frank Carlson and archeologist Kenneth Emory of the Bishop Museum in Honolulu.[239] Because the Kalapana coastal area was rich in archeological features, the Bishop Museum was contracted to prepare a report on the area's archeological remains and plant life.[240]

The reconnaissance survey's upper terminus ran through a forest of *ohia* and staghorn fern on a slightly descending grade to the *pali*, a distance of about four miles. The surveyors recommended that the road descend as directly as possible from the end of the Chain of Craters Road to the *pali*. At the top of the *pali*, visitors would enjoy a spectacular view of the seacoast. From

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[237] Oberhansley, "Superintendent's Monthly Report," August 1951.

[238] Johnston, "Superintendent's Monthly Report," February 1960.

[239] P.E. Smith, Supervisory Engineer, and C. E. Krueger, Supervising Landscape Architect, "Memorandum of March 17, 1960," 1-3, "Kalapana-Chain of Craters Road, Project 2-C1, June 1956-July 1962" folder, File D30, HAVO archives.

[240] Kenneth Emory et. al., "Puna Survey, Preliminary Report Undertaken for the Hawaii National Park Service" (Honolulu: Bernice P. Bishop Museum, 1959), 1.

the *pali*, the road would descend along a natural break in the cliff and require two or more long switchbacks. The alignment from the base of the *pali* would be determined by a variety of archaeological, geological, and scenic considerations. The survey recommended that the road go directly from the bottom of the *pali* to the seacoast to avoid a long traverse over the monotonous coastal plain. The location team pointed out that this would provide the only coastal access in the park and recommended that the road follow the shoreline as closely as possible to allow visitors to enjoy the "fascinating and ever-changing" ocean.[241]

After decades of delay, the Kalapana extension project finally began in earnest in June 1961 when the BPR contracted with Harland Bartholomew and Associates to complete a detailed engineering survey of the new road.[242] Wirth explained that the private engineering firm was hired to do the Kalapana survey because the Honolulu BPR office did not have sufficient staff to do a project of this size. Harland Bartholomew and Associates was a national, renowned firm with extensive experience in park development. Wirth observed that the project landscape architect, Don W. Wolbrink, was a "very capable individual" who had experience with the NPS and was familiar with NPS goals.[243] Bartholomew and Associates' duties included photogrammetric surveys, route surveys, soil surveys, boring and sampling, soil testing, and design. The firm was to analyze all feasible alignments, prepare construction plans, and compile cost estimates. The contract was awarded for $182,287.[244]

As segments of the survey were completed, the superintendent, park engineer, landscape architect, archeologist, and others associated with the project inspected the route. U.S. Geological Survey geologist James G. Moore also inspected the alignment. The park wanted Moore to address concerns about lava

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[241] Smith and Krueger, "Memorandum," 2-3.

[242] Johnston, "Superintendent's Monthly Report," June 1961.

[243] Conrad Wirth, Memorandum to Paul F. Royster, BPR Assistant Commissioner for Operations, February 16, 1960, "Kalapana-Chain of Craters Road, Project 2-C1, June 1956-July 1962" folder, File D30, HAVO archives; and Wirth to Royster, June 14, 1960, "Kalapana-Chain of Craters Road, Project 2-C1, June 1956-July 1962" folder, File D30, HAVO archives.

[244] Miscellaneous documents, "Kalapana-Chain of Craters Road, Project 2-C1, June 1956-July 1962" folder, File D30, HAVO archives.

tubes, the stability of the seacoast, and the probability of earth movements in fault areas. He advised that fault cracks could not be studied to predict hazards and recommended that the road be located at least 75' from the known ends of lava tubes. In several locations, Moore recommended keeping the road at least 140' from the ocean cliffs.[245]

While Bartholomew and Associates prepared the route, WDOC made plans for a campground, picnic sites, and a parking lot at Wahaula Heiau along the coast. The superintendent reviewed and approved preliminary plans and alignments, and also made suggestions on pullout locations and other features. Archeological investigations continued as part of the overall design plan. Tom Vint, the NPS's senior landscape architect, collaborated with the superintendent in reviewing the Kalapana road project. Vint was assigned to Hawaii to supervise construction projects, including the new Kalapana Road.[246]

By January 1963, Harlan Bartholomew and Associates completed plans and specifications for the lower half of the Kalapana route. The survey crew went back into the field to work on the road's upper section.[247] The first of three increments of the project went out for bid in January. Five bids were received for a project that engineers estimated to cost $513,223.90. The BPR recommended awarding the project to the low bidder, the Construction Equipment Company, at a cost of $347,187.59.[248]

A pre-construction conference was called in March to discuss landscaping matters. Vint was the project supervisor and instructed the contractor in how to protect the park landscape. NPS landscape architects were in charge of landscape protection during road construction and Vint's recommendations followed Park Service standards. He specified that equipment was to stay within the road right-of-way to avoid scars on the landscape. Trucks were to use designated turnouts, and, if trucks could not turn around within these areas, the contractor had to get

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[245] Johnston, "Superintendent's Monthly Report," April 1962; and Aubuchon, "Memorandum to Superintendent Johnston."

[246] Johnston, "Superintendent's Monthly Report," July 1962, August 1962, and November 1962; McClelland, *Presenting Nature*, 94; and *Hawaii Herald-Tribune*, June 28, 1962.

[247] Johnston, "Superintendent's Monthly Report," January 1963.

[248] Miscellaneous documents, "Kalapana-Chain of Craters Road" folder.

approval from Vint regarding where and how this should be done. Vint required any controlled burns employed to clear the right-of-way be carefully restricted to the designated area. The construction office was to be set up at the borrow pit until another site inside the park was accessible. Vint would only permit limited blasting on the project. The NPS also required the contractor to stop work and notify the park when burial sites were encountered.[249] Over the course of the Kalapana project, several burials were found along the project site and reburied by park crews in other locations.[250]

The contract with Construction Equipment, Inc. included clearing, grading, drainage, and laying the base course on 9.82 miles of roadbed. By June, the company began rough grading, crushing rock, and applying *aa* as base material. The project was 20 percent complete although 34 percent of the time had elapsed. The project continued to run behind schedule and, by September, BPR Engineer Frank Clavert observed that the contractor would need a "terrific speed up in progress" to complete the project on time. Clavert estimated that the contractor would need sixty extra days to complete the project and would be fined $100 per day for the delays. The Kamoamoa Campground Loop Road and a residential road had been included in the original contract, but were instead completed by day labor. The project was completed, inspected, and accepted in January 1964.[251] The total calendar days allowed for the project were 225; twenty-six extensions added to the project brought the total days to 276.[252]

The second increment of the project went to bid in November 1963. Construction Equipment, Inc. again submitted the low bid of $388,565.11 and was awarded the contract. The project budget was $774,700, prompting Superintendent Johnston to request that

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[249] Miscellaneous documents, "Kalapana-Chain of Craters Road" folder; McClelland, *Presenting Nature*, 109-110.

[250] Johnston, "Superintendent's Monthly Report," February 1964 and March 1964.

[251] Johnston, "Superintendent's Monthly Report," March 1963, June 1963, September 1963, October 1963, and January 1964. Records did not indicate why the project was behind schedule.

[252] "Final Construction Report, Hawaii Volcanoes National Park 2-C1, Chain of Craters-Kalapana Road, Hawaii County, Hawaii, Grading, 26 ft. roadbed" [1964], "Kalapana-Chain of Craters Road, Project 2-C1, August 1962-March 21, 1966" folder, File D30, HAVO archives.

the money saved be applied to improving the existing Chain of Craters Road. Johnston's request was refused by the regional director, who stated that the savings could only be applied to deficits on other projects.[253]

Grading the pioneer road for the upper portion of the Kalapana road project got off to a good start in January, but the project was already behind schedule by February. The superintendent blamed the slow-down on the fact that the contractor had to bury cleared timber in the borrow pit (rather than burn it) and the company did not have enough heavy equipment on the job. In response to BPR and NPS pressure, the contractor added several pieces of heavy equipment to the project. BPR Division Engineer W. C. Peterson inspected the project in March and was "favorably impressed" with the progress.[254]

Even with the additional heavy equipment, work continued to progress slowly due to equipment breakdowns and a shortage of excavated materials. The borrow pits for the project were located outside the park in the Royal Gardens subdivision. The park had purchased ten lots for a borrow pit, but the contractor ran out of fill. Work was delayed waiting for the owner, Norman Inaba, to assign additional lots.[255] The project was also short of fill material from road excavation. Due to the numerous (hollow) lava tubes, there was less material to excavate and as a consequence, a shortage of materials to balance cuts and fills.[256] Additionally, construction crews had to excavate and fill about fifteen steam cracks to a depth of about five or ten feet in order to proceed with the project.[257]

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[253] Merel S. Sager, Chief Landscape Architect, to BPR Director G. M. Williams, November 7, 1963, "Kalapana-Chain of Craters Road, Project 2-B1, June 1963-March 1966" folder, File D30, HAVO archives; Fred Johnston, Superintendent, HAVO, to Regional Director, October 30, 1963; and Keith P. Neilson, Acting Regional Director, to Johnston, November 7, 1963, "Kalapana-Chain of Craters Road, Project 2-B1, June 1963-March 1966" folder, File D30, HAVO archives.

[254] Johnston, "Superintendent's Monthly Report," February 1964 and March 1964.

[255] *Hawaii Tribune-Herald*, May 14, 1963.

[256] Johnston, "Superintendent's Monthly Report," January 1964, February 1964, April 1964, and May 1964.

[257] *Hawaii Tribune-Herald*, December 17, 1963.

Vint returned to the mainland in June. Superintendent Johnston reported that the Kalapana road progress was satisfactory, although the project was 24 percent behind schedule. By August, the contractor was being fined $100 per day for time overruns and had begun working on Saturdays in an effort to make up time. He had five bulldozers, three traxcavator loaders, and six trucks on the project. The contractor was still paying penalties in September. According to the superintendent, it was clear that it was cheaper for him to pay fines than to work overtime on the project. The contractor finally completed excavation in October. The steep slopes near the Holei Pali near Station 430+00 had to be reworked, however, as the *aa* above the road broke and caused rockslides. The contractor "benched" the cliff above the road to correct the problem. These benches were long flat segments cut into the cliff to catch rockslides. The second phase of the Kalapana road project was completed in December 1964.[258]

The roadbed was 26' wide, which included 3' shoulders. It began at an elevation of 2910' near Makaopuhi Crater and ran 9.148 miles. The subbase was 4" thick. There were to be no tight curves and the maximum grade was about 7 percent in several places, including the descent down the *pali*. One of the most notable features along the road was the switchback at the top of the *pali*. The road cut through vesicular basalt rock 40' high near station 350+00. The switchback radius was 450°. From the top of the switchback, near Station 345+00 at an elevation of 1302', the road descends to an 1140' elevation near Station 368+00 at the end of the switchback. The end of the switchback curve was constructed on fill approximately 25' deep. Shoulders in some areas were widened to 10' to improve sight distance and 966.5' of guardrail was installed between stations 353+96 and 368+50.[259]

The James W. Glover Construction Company of Honolulu was the low bidder on the third increment of the project, which involved paving the Chain of Craters Road-Kalapana extension. The contract price was $729,938 in November 1964. In December, park

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[258] Johnston, "Superintendent's Monthly Report," June 1964, September 1964, October 1964, and December 1964.

[259] Department of the Interior, National Park Service, "Plans for Proposed Project Hawaii V.N.P.R. 2-B1, Route No. 2~Chain of Craters-Kalapana Road, Hawaii Volcanoes National Park Road System, Hawaii" (August-September 1963), title sheet and sheet 15, HAVO Maintenance Division files.

personnel poisoned weeds along the shoulders and in the parking areas and pullouts along the lower section of the road. The contractor was instructed to begin work in January 1965. The paving project covered 18.967 miles and, by May, the base course was being laid, the lava rock walls at Wahaula were completed, and curbs in several areas were placed. Rainstorms slowed the work in April and stop-work orders were issued twice due to adverse weather. The next month, the surfacing was completed except for the parking areas and spur roads. The project was 95 percent finished and the estimated completion date was June 10.[260]

Thomas Vint and John Wosky returned to Hawaii Volcanoes National Park for the Kalapana Road dedication ceremony, which took place on June 19, 1965.[261] Associate NPS Director A. Clark Stratton represented Secretary of the Interior Stewart A. Udall. The ceremony at the Wahaula Heiau parking area drew 2000 visitors. An official opening caravan drove up the Chain of Craters-Kalapana Road to Crater Rim Drive. Superintendent Fred T. Johnston and Hawaii County Board of Supervisors Chairman Shunichi Kimura spoke at the dedication.[262] Slim Holt, a Big Island tour operator, commented that the circuit route would add a new dimension to touring in Hawaii, giving operators much more flexibility and allowing them to add almost a whole day to the trip. Another tour operator called the road the "greatest thing that has happened to Hilo and vicinity in the last fifty years."[263] To assist the increasing number of tours in the national park, the park prepared a "Guide to the Kalapana-Chain of Craters Road" for drivers and other "professional guides."[264]

The opening of the road presented resource management problems, as visitors flooded into the newly opened areas along the coast to camp, hike, picnic, and fish. It appeared that visitors did not understand the park had regulations governing these

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[260] Johnston, "Superintendent's Monthly Report," November 1964, December 1964, January 1965, April 1965, and May 1965.

[261] HAVO became Hawaii Volcanoes National Park in 1961 when the Haleakala unit became an independent national park.

[262] Johnston, "Superintendent's Monthly Report," June 1965.

[263] *Honolulu Advertiser*, January 28, 1965.

[264] Department of the Interior, National Park Service, "Guide to the Kalapana-Chain of Craters Road," credited to Dwight L. Hamilton, Chief Park Naturalist (Hawaii Volcanoes National Park, April 1966), HAVO library.

activities. Fishing was limited to native Hawaiians and their guests, which was not a popular arrangement with non-Hawaiian residents.[265]

6,224 visitors traveled over the road from its opening on June 19 through the end of July. The superintendent noted that 45.7 percent of park visitors traveled the circuit road and he seemed surprised that more drivers chose to go down the road than up it. He attributed this to the fact that the downhill drive presented more spectacular views. Another possible reason was that local residents did not like the steep climb up the *pali*. In 1965, 24,661 cars toured the new road. In August 1967, the Wahaula Visitor Center was completed.[266]

LAVA DESTROYS THE CHAIN OF CRATERS-KALAPANA ROAD

In April 1965, two months before the dedication of the new Kalapana route, Makaopuhi Crater, at the end of the original Chain of Craters Road, erupted, providing an inauspicious omen of future events. The popular new circuit route through the park was to be short-lived. Four years after its dedication, on February 22, 1969, Mauna Ulu erupted and covered three sections of road near Makaopuhi and Alae Craters. Three miles of road were inundated with lava, completely severing the popular new route through the park.[267]

The federal government promised to provide emergency funding for road reconstruction, on the grounds that the damage was caused by a "natural event of unusual magnitude." The Hawaii State House of Representatives passed a resolution urging the NPS and BPR to rebuild the road, citing its importance to the local economy and essential role as a major route in the island's road system.[268] A survey crew studied the layout of a new proposed

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[265] Johnston, "Superintendent's Monthly Report," June 1965; and Jackson, *Administrative History*, 135-136.

[266] Johnston, "Superintendent's Monthly Report," July 1965; Glen Bean, "Superintendent's Monthly Report," December 1965; and Daniel J. Tobin, "Superintendent's Monthly Report," August 1967.

[267] Gene Balaz, Acting Superintendent, to Jack Suwa, Hawaii State Senate, March 24, 1969, "Chain of Craters Road Reconstruction, March 1964-August 1969," folder, File D30, HAVO archives.

[268] John B. Dalhouse, Division Engineer, USDOT, to W. E. Bowen, Regional Director, Western Region, BPR, April 30, 1969, "Chain of Craters Road Reconstruction, March 1964-August 1969" folder, File D30,

route in June. The lava outbreak started again the next day. Successive flows over the next five years inundated nearly half of the 25-mile road. The road was also damaged by severe earthquakes. This continuous volcanic activity prevented the park from reopening the highway.[269]

A new route for the Chain of Craters Road was proposed by 1970 and a survey crew was to begin staking the project's centerline. The project was to be advertised for bids and the expected completion date was March 1971.[270] In August 1970, however, another finger of lava crossed the road, destroying 1.5 miles of pavement. There was also a flow near Holei Pali, further down the road.[271] Despite the continuing destruction of roads, plans for rebuilding continued. M. F. Maloney of the U.S. Department of Transportation (DOT) office in Washington recognized that the volcanic activity was unlikely to subside in the near future, but noted that because the loop road was so extensively used by tour groups and tourists that the heavy demand made it desirable to consider reconstruction. Maloney realized that reconstruction might not even be completed before new damage was done and suggested that a temporary road be built as an alternative. He accepted that there would always be a risk that the road would be destroyed again and concluded that the investment in road reconstruction should be minimal.[272] DOT Division Engineer John B. Dalhouse disagreed and asserted that the federal government should wait to risk construction funds until the U.S. Geological Survey and the Hawaiian Volcano

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HAVO archives; and Hawaii State Legislature, House Resolution, April 28, 1969, "Chain of Craters Road Reconstruction, March 1964-August 1969," folder.

[269] Photographs, 1971, "Chain of Craters Road Reconstruction" folder, File D30, HAVO archives.

[270] John B. Dalhouse to J. W. White, Director, Highway Programs Office, USDOT, San Francisco, May 28, 1970, "Chain of Craters Road Reconstruction, March 1964-August 1969" folder, File D30, HAVO archives.

[271] Gene Balaz, Memorandum to Director, Western Region, NPS, August 17, 1970, "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder, File D30, HAVO archives.

[272] M. F. Maloney, Director, Office of Engineering, USDOT, to J. W. White, Washington, D.C., September 9, 1970, "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder, File D30, HAVO archives.

Observatory provided assurance that the lava threat was minimal.[273]

The specifications for the 1970 survey stated that the road should be similar in standards to other recent HAVO road construction projects, with 10' lanes and shoulders not to exceed 3'. Superintendent Balaz hoped to avoid deep cuts through the lava and wanted to lay the new road on the existing land surface to afford maximum scenic viewing. He also pointed out that experience had demonstrated that deep road cuts tended to channel lava flows along the paved surface, which increased the loss of roads, a situation to be avoided if at all possible.[274]

Another major concern in planning the new road was the problem of building over existing lava tubes. DOT engineers noted that *pahoehoe* was highly variable, with random locations of solid rock, lava tubes, and brittle crust. Balaz wondered how engineers could find lava tubes while constructing roads and then assess their "roof" strength. He requested assistance from the USGS staff, who noted that it was possible to map lava tubes, including the average diameter and the thickness of the basalt "roof" over the tubes. A related problem was that engineers could not calculate how much material could be excavated from the proposed roadbed. Engineers noted that plans would have to include imported borrow, base, and surfacing to complete the road. While engineers and NPS officials spent most of 1970 planning the new road, by early 1971, lava had obliterated other sections of the Chain of Craters Road making 11.8 more miles unusable.[275]

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[273] John B. Dalhouse, Division Engineer, USDOT, to Tetsuo Harano, Chief, Highways Division, State DOT, December 22, 1970, "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder, File D30, HAVO archives.

[274] Gene Balaz, Superintendent, to Garrett Smathers, November 11, 1970, "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder, File D30, HAVO archives. Balaz does not identify who Smathers was, but asks his opinion on the proposed route's relation to the ecology of the area.

[275] John B. Dalhouse, Memorandum to Glenn M. Yasui, Area Engineer, USDOT, Honolulu, March 1970, "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder, File D30, HAVO archives; Gene Balaz to Dr. Gordon P. Eaton, USGS, August 24, 1970 and September 2, 1970, "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder; Eaton to Balaz, August 28, 1970, "Chain of Craters Road

The 1973 HAVO master plan included provisions for rebuilding the Chain of Craters Road. Superintendent G. Bryan Harry emphasized that the Chain of Craters Road was not just a recreational tourist drive but also a safety route for the numerous farms and residences that lay along the rift zone. He pointed out that an eruption could isolate local residents and noted that, in the event that this happened, the government would need to construct a road in the midst of the crisis. He advised anticipating such a crisis and ensuring that an alternate route existed.[276] The safety issue became more pronounced after the Mauna Ulu eruption buried 1/2 mile of the escape road, an old roadbed that served as an alternate route in case the main road became impassable during an emergency.[277]

Volcanic activity in the park during 1974 was remarkable. The eruption of Keanakakoi Crater covered portions of Crater Rim Drive and more of Chain of Craters Road and Mauna Ulu continued its relentless destruction of Chain of Craters Road. As a result, road repair monopolized most of the maintenance time and budget. Portions of the roads were rebuilt over new lava on Crater Rim Road, but the Chain of Craters Road remained impassable.[278]

In February 1975, Superintendent Harry told FHWA officials that he believed it was time to begin reconstructing the Chain of Craters Road. Harry acknowledged that Kilauea was "far from dormant" and admitted that it would undoubtedly obstruct the roadway again. Scientists at the Hawaiian Volcano Observatory (HVO), however, reported that Kilauea was not inflating as it had in the past, which was interpreted as a good sign. Harry wanted to investigate whether the reconstruction project could be financed by the Emergency Reconstruction of Federally Owned Highways (ERFO) program.[279] HVO Scientist-in-Charge Donald W.

Reconstruction, January 1970 to November 1975" folder; and Balaz, Memorandum, March 2, 1971, "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder.

[276] "Craters Road to be Rebuilt," *Honolulu Advertiser*, April 12, 1977; and G. Bryan Harry to H. Kusumoto, Assistant Division Engineer, Federal Highway Administration, July 25, 1973, "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder, File D30, HAVO archives.

[277] G. Bryan Harry, "Superintendent's Annual Report," 1973.

[278] Harry, "Superintendent's Annual Report," 1974.

[279] Harry to Kusumoto, February 27, 1975.

Peterson asserted that the area was still vulnerable to lava inundation, but agreed with Harry that rebuilding the Chain of Craters Road was a good idea as it provided another access road for local residents. The USGS refused to guarantee that eruptions would not destroy roads in the future, but approved the superintendent's proposed route as practical.[280]

In August 1975 the Hawaii Hotel Association and tourism officials called for the park to make reopening the road a priority. The association stressed that the so-called "golden triangle" linking the Hilo, Kalapana, and Volcano areas was an important circuit route for island travelers. Several months later, NPS officials announced plans to rebuild the Chain of Craters Road. Environmental assessments were completed in early 1977 and the park was ready to reconstruct approximately 12 miles of road.[281]

The Chain of Craters Road would be relocated on an entirely new alignment. The road proposed in 1975 began about 3/4 mile west of Alae Crater and ran in a southeasterly direction for 12 miles to about 12 miles east of the village of Kalapana. The new road would be built to the same standards as the existing section of road to Kalapana, 20' wide with 3' shoulders. A "reasonable" number of pullouts would be built and, perhaps, a large scenic overlook. A major point of discussion was whether to reuse the road that descended Holei Pali. With its 7 percent grade, the road down the steep cliff did not fit within NPS guidelines, which stipulated a maximum of 5 percent. In the end, everyone agreed that it would be too difficult to relocate the road over the new lava flow and that no better route could be found. The new section on the Holei Pali would have to be "fully benched" with the possible addition of another bench above the road. Benches were necessary to catch loose material falling from the steep slopes above.[282]

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[280] Donald W. Peterson, Scientist in Charge, Hawaiian Volcano Observatory, to Bryan Harry, July 26, 1975, "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder, File D30, HAVO archives; and Chris D. Cameron, Acting Superintendent, Memorandum of a meeting regarding Chain of Craters Road Reconstruction, July 29-30, 1975, "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder.

[281] *Honolulu Star Bulletin*, November 1, 1975; and "Craters Road to be Rebuilt."

[282] "Federal Aid Program Data, Hawaii Volcanoes National Park, Rt. 2, Chain of Craters Road" [1975], "Chain of Craters Road

Reconstruction was set to begin in midsummer 1977 and to be completed by mid-1978. After consulting with USGS scientists, the NPS requested that the new alignment be relocated in a way that future lava flows would cross the road at right angles, minimizing damage to the road. Past lava flows had demonstrated that the lava used the road like a stream channel. Another factor in relocating the alignment was that the old road was under more than 300' of lava in some places. The DOT and NPS agreed that the one-mile section of road that remained intact at the Holei Pali should be reconnected and reused. The new road would begin 8 miles southwest of Wahaula Visitor Center and continue up the flank of Kilauea to the Ainahou Ranch Road near Pauahi Crater, where the old road was blocked.[283]

Five routes were considered for the new Chain of Craters Road. Alternative Route 2 essentially followed the original Chain of Craters Road and was rejected because it would be subject to future lava flows for most of its length. This alignment would also mar the most impressive geological feature along the route, Mauna Ulu, the lava shield that had erupted in the early 1970s and destroyed part of Chain of Craters Road. Another route, Alternative Route 3, was designed to closely parallel the old road. This would provide interesting interpretive features, but it would also mar the impressive sites. This, too, was rejected on the grounds that future lava flows would impact its upper section. Alternative Route 4 would pass through an area untouched by lava flows, but would also mar geological features. In addition, this route would pass through approximately 5 miles of undisturbed natural areas. Alternative Route 5 attempted to avoid lava inundation by crossing the east rift zone between Makaopuhi Crater and Napau Crater, then skirting a proposed wilderness area. It would cross the historic Kalapana Trail and impact approximately 470 acres of prime native forest and bird habitat. The final alternative considered by the Park Service was to take no action at all and not rebuild the road. The NPS rejected this option as it would not achieve the interpretive and access needs of HAVO. Alternative Route 1 was chosen, as it

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Reconstruction, January 1970 to November 1975" folder, File D30, HAVO archives; and Cameron, Memorandum. The benches are visible above the road as one drives the road descending the *pali*.

[283] "Craters Road to be Rebuilt"; and Department of Transportation, "Inspection Report, Chain of Craters Road, Hawaii Volcanoes National Park," by R. J. Warren (July 29-30, 1975), "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder, File D30, HAVO archives.

was the only proposed route that did not pass through the planned wilderness area. This route would be the least disruptive and destructive path through the unimpaired environments on Kilauea's south flank. It was also one of the shortest proposed routes and one of the paths least likely to be effected by future eruptions.[284]

Although there was considerable community support for rebuilding the road, several environmental issues were raised in opposition to the project. Robert Wenkam, the Pacific Representative of Friends of the Earth, objected to the road project because of its impact on important natural features. Superintendent Harry encouraged Wenkam to resolve this issue with the incoming superintendent and stressed the fact that the new route protected the park's geological, botanical, and archeological features as much as possible. Harry noted that the park naturalist and archeologists had worked with road designers to avoid sensitive areas. Another protest against the new road came from a former HAVO seasonal employee who objected that the road would increase traffic through the rural Kalapana community. No other public testimony was noted against the project.[285]

The reconstruction project was funded through ERFO. NPS officials located ten interpretive and overlook sites, as well as a new parking area at Mauna Ulu. A runaway vehicle escape ramp was included above Holei Pali to prevent a recurrence of an October 1968 incident when the brakes on a tour bus failed, resulting in an accident that killed four and injured thirty-eight. The road profiles and plans were designed to "flow" with the natural contours of the terrain to minimize construction scars and impact on the land. The road surface was an "open-graded friction course," designed to reduce hydroplaning. Safety features also included raised reflectors, white edge striping, and edge delineators along the entire length of the road.[286] The visibility of safety markers was an important

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[284] "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder, File D30, HAVO archives.

[285] Bryan Harry to Robert Wenkam, November 7, 1975, "Chain of Craters Road Reconstruction, January 1970 to November 1975" folder, File D30, HAVO archives; and "Craters Road to be Rebuilt."

[286] Department of Transportation, "Inspection Report, Plan-in-Hand Review, Chain of Craters Road," by Ted V. Fitzgerald, Area Design Engineer (April 26-28, 1977), "Chain of Craters Road Reconstruction, January 26, 1976-1977" folder, File D30, HAVO archives.

factor since the road was subject to heavy fog and rain and was traveled after dark during eruptions. The new highway was one of the first roads in the nation to be constructed using metric measurements.

The M. Sonomura Contracting Company was awarded the $2.04 million contract to reconstruct Chain of Craters Road. The NPS requested that all trees removed within the project area limits be cut into 8' lengths and stockpiled along the road for park crews to pick up and put to use elsewhere. The NPS stipulated that the contractor's offices and equipment had to remain within the project area and agreed to provide an area for such purposes at the Ainahou Ranch. Contractors were not allowed to use the popular Crater Rim Drive section known as the "fern forest" and had to drive the longer (and straighter) section of Crater Rim Drive via Uwekahuna. The project was completed in June 1979, using 399 days of the 415 allotted.[287]

On June 30, 1979, the new Chain of Craters Road was dedicated near the Puuloa Petroglyph field, reopening the ninety-two mile circuit route between Hilo, Volcano, and Kalapana. In attendance was Daniel J. Tobin, Associate Director of Operations in Washington and the former HAVO superintendent who had closed the road in 1969. Governor George Ariyoshi's message praised the new road, characterizing it as the result "of wise planning, of designing, of commitment to excellence, of determination to overcome Nature."[288] The *Hilo Tribune Herald* reported that the well-designed road gave drivers a feeling of actually being on the lava flow. Superintendent Ames noted that visitors complimented the road as the most sensitive construction job they had ever seen, with the road appearing to lie on the landscape as if it had been there for years. Ames commented that people praised the road as "perfect in all respects."[289]

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[287] "Craters Road to be Rebuilt;" USDOT, "Inspection Report, Plan-in-Hand Review;" and Department of Transportation, Federal Highway Administration, "Plans for Proposed ERFO Project 2(2), Length 20.175 Kilometers, Chain of Craters Road, Hawaii Volcanoes National Park, Highway System, Hawaii" (November 15, 1977), title sheet, HAVO Maintenance Division files.

[288] "Dedication-Chain of Craters Road (Including "Tour") January 1979 to July 1979" folder, File A8215, HAVO archives.

[289] *Hilo (Hawaii) Tribune-Herald*, October 14, 1979; and David Ames to Jerry L. Budwig, Director, Federal Highway Projects, Federal Highway Administration, July 10, 1979, "Chain of Craters Road Reconstruction, 1978-1979" folder, File D30, HAVO archives.

Lava would damage the road again, with eruptions from Pauahi Crater in November 1979 and again in 1980. In 1979 the road was reopened after two days. In 1980, the park installed three new moveable barrier gates along the road.[290]

In 1984, four miles of the Chain of Craters Road between Pauahi Crater and the Crater Rim-Chain of Craters junction were resurfaced. The purpose of the project was to bring the section up to the standards of the rest of the Chain of Craters Road. The road needed to be widened to accommodate increased traffic and tour buses. The road was so narrow that buses had to pull over to allow each other to pass and, in many places, there were no shoulders on which to pull over. The project also reconstructed pavement that had deteriorated due to a combination of seismic and volcanic activity. The new roadway followed the original route, with the exception of several minor changes in alignment, including moving the road away from Pauahi Crater. Two cattleguards were installed to help the park control the feral pig population.[291]

Jas. W. Glover, Ltd. of Hilo was the contractor for the 120-day project. The contractor was granted thirty-four extensions to complete the project and used 180 days. The park reported that the contractor was disorganized, experienced excessive equipment failure, and had problems hauling material.[292] In addition to construction delays, some of the contractor's work was not satisfactory. Jerald M. Lorenz, a landscape architect with the NPS Denver Service Center, complained that the stone wall at the Lua Manu parking area was not constructed as detailed. Plans for the wall specified that the mortar color should match the rock and that the mortar was to be recessed so that the walls appeared to be dry-laid masonry. The final construction report did not mention how these problems were rectified.[293]

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[290] *Honolulu Advertiser*, November 20, 1979; and Robert D. Barbee, "Superintendent's Annual Report," 1979 and 1980.

[291] Department of Transportation, Federal Highway Administration, "Final Construction Report on Hawaii Volcanoes N. P. Project 2(4) Chain of Craters Road, Grading, Base Course, and Bituminous Surfacing" (Region 16, December 2, 1986), 1, HAVO archives.

[292] USDOT, "Final Construction Report Project 2(4)," 2, 6.

[293] Jerald M. Lorenz, Landscape Architect, Alaska/Pacific NW/Western Team, Denver Service Center, NPS, "Trip Report," May 25, 1984, "Resurface 4 Miles of Chain of Craters Road" folder, File D30, HAVO archives.

There were also several engineering problems with this project. One problem was that conditions had significantly changed after the location survey was done in 1980. The area was subject to volcanic activity, so when the project was staked in 1983, surveyors discovered that the area had deflated between 3" and 9". Another difficulty was that the shrinkage factor, the amount of additional material allowance needed to fill non-uniformed surface conditions, was figured at 10 percent. During construction, the shrinkage was actually 60 percent. The difference was attributed to lava tubes and numerous sub-surface cracks. As a consequence, additional fill material was needed.

Kilauea erupted from Puu Oo in 1983 and caused new problems for the Chain of Craters Road. In March 1987 the Wahaula entrance station on the coast was closed when lava crossed the highway. Thus, the circuit route was severed again.

In 1997 the park closed 6 miles of road for two weeks between Mile Marker 4 and the Kealakomo Overlook. The closure allowed maintenance crews to apply a "safety friction treatment" that would improve tire traction during rainy weather. The treatment consisted of applying a thin layer of asphalt emulsion to the existing pavement. A half-inch layer of gravel chips was then spread and compacted into the asphalt. Crews swept away any excess chips.[294]

Puu Oo was in its sixteenth year of continuous eruption by 1999 and had covered approximately four miles of Chain of Craters Road. As of 1999, it had not been reconstructed.

AN APPROACH ROAD TO THE PARK

The Mamalahoa Highway, the "belt" or "around the island" road, always served as the main approach road into Hawaii National Park. Until the early 1960s, the belt road was also the main thoroughfare through the park, passing near the headquarters, Kilauea Military Camp, Volcano House and Kilauea. In the park's early history, the main concern with Mamalahoa Highway was

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[294] Department of the Interior, National Park Service, "Chain of Craters Road to Close Temporarily," News Release (June 12, 1997), "1997 8302-2704-MCR, Safety Seal Coat" folder, HAVO Maintenance Division files; and Department of the Interior, National Park Service, "Safety Seal Coat Completion Report, 8304-2704-MCR" (1997), HAVO Maintenance Division files.

getting it built as far as the park and keeping it in good condition so that tourists and local residents would have easy access to the park.

Kittredge addressed the subject of the "around the island road" in his 1925 investigation of the HAVO road system. He noted that the road had been constructed by the county before Hawaii National Park was established. Three miles of the 16'-wide road within the park were surfaced with oil macadam. The other 2.5 miles were graded to a width of about 16', but needed to be surfaced. The remaining 1.5 miles passed through lava flows and were not adequate in width or alignment. Kittredge noted that most tourists did not use the last portion of road, as they did not want to make an extended trip under such conditions. He recommended that the unsurfaced portions of the road be graded, drained, and surfaced with crushed rock. Kittredge concluded that the approach road was not as scenic as other roads in the park, but observed that it was important as the artery from which all other park roads branched. The road was also considered important because the superintendent wanted to extend it to provide access to the Kau Desert area.[295]

In 1928 the road west of the park was reconstructed, surfaced with macadam, and widened to 10', with 3' shoulders. The superintendent reported that 70 miles of the "around the island" road were completed and provided a continuous improved highway from Hilo, across the park, to the village of Waiohinu west of the park.[296] The last links of the belt road were completed in 1933. The belt highway was 231 miles long with a paved surface of 10' and a graded surface of 22'.[297]

In 1947 Public Roads Administration (PRA) highway engineer Frank Carlson inspected the park roads and recommended that Highway 11 from Hilo be reconstructed and widened to a paved surface of 22' with 5' shoulders. He also suggested that the park consider a complete realignment that would run the road along the park boundaries and avoid unsightly developments near the park. Carlson's idea was to build a new approach road into the park with a 500' right-of-way granted to existing development.[298]

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[295] Kittredge, *Report on Road Program*, 4, 16.

[296] Evans, "Superintendent's Monthly Report," January 1928 and May 1928.

[297] Leavitt, "Superintendent's Monthly Report," July 1933.

[298] Oberhansley, "Superintendent's Monthly Report," August 1947.

Superintendent Oberhansley agreed that the fern-*ohia* forests that lined the road adjacent to the Hilo entrance were quickly disappearing as a result of roadside developments. The roadside was an unsightly mess of Quonset huts, old building foundations, and assorted junk piles. Concerned citizens spoke out and asserted that the only solution was the construction of a new approach road and entrance.[299] The bypass road was also an issue because the NPS wanted to reroute commercial traffic away from the park. Sugar companies used the belt road to transport approximately 50,000 tons of raw sugar, 12,000 tons of molasses, and 35,000 tons of supplies every year.[300]

An unusual proposal to "bypass" the main section of the national park came from NPS Regional Landscape Architect Sanford Hill. Hill proposed a "through the park road" that ran from Pahala west of the park along the coast to Kalapana. Hilina Pali Road would provide access to a coastal route from within the park. Hill believed that natural features along the ocean were not as important as those in the central and upper portions of the park, so a coastal route for commercial and through traffic would help protect the Kilauea area and limit development there. Superintendent Oberhansley disagreed with Hill's claim that the coastal area was less important and insisted that commercial traffic should not run through that area any more than it should elsewhere in the park. He also pointed out that Hill's route would be too costly and too long.[301]

In 1953 Assistant Secretary of the Interior Orme Lewis sent a letter to Hawaii Governor Wallace Farrington stating that relocating the Mamalahoa Highway should be HAVO's first priority. He assured the governor that the new road would be mutually advantageous, but noted that it could not be constructed until the territory acquired land for the new

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[299] Oberhansley, "Superintendent's Monthly Report," September 1947 and November 1947.

[300] Charles C. Morris, Division Engineer, Public Roads Administration, to Major O. A. Tomlinson, Regional Director, [October 1946], "Roads, general, 1946" folder, File D30, HAVO archives.

[301] Sanford Hill, Regional Landscape Architect, Memorandum to Regional Director, October 1, 1947, "Roads, Inclusion of Hilo Road in HAVO 1936-1947" folder, File D30, HAVO archives; map, attached to Hill, "Memorandum;" and L. I. Hewes, Chief, Western Headquarters, Public Roads Administration, to Major O. A. Tomlinson, Regional Director, [1948], "Roads, general, 1948" folder, File D30. Hewes's letter concerns Oberhansley's objections.

route.[302] For the rest of the decade, federal and territorial officials debated the road's width and right-of-way, as well as the question of who should be responsible for its construction and maintenance.

The BPR and territory called for a wider road than park officials wanted, stating that the road needed to conform to other reconstructed sections of the belt road. These agencies also noted the need for a wider road to accommodate large trucks. Superintendent Wosky felt that there was not enough commercial traffic in the area to warrant 24' of pavement with 7' shoulders. Several plans were suggested, including NPS Director Wirth's suggestion that the agency that would maintain the road should establish the width. Wosky objected to this because he felt that standards should be determined by traffic needs, not by bureaucratic jurisdictions. Wosky also pointed out that the territory did not maintain its roads to NPS standards and would be unlikely to take on the additional responsibility of the bypass road.[303]

The territory and the NPS hammered out an agreement in 1955. The NPS would construct the new bypass and the territory would assume maintenance. The problem then centered on how to grant the territory the jurisdiction it needed for the road. Vint stated that granting a right-of-way to the territory would require an Act of Congress. A better method, he suggested, would be to grant a permit. Wosky argued strongly against giving the territory any control over the roadway and advised that it was premature to enter into an agreement. He believed the savings for the NPS were not great enough to justify giving up control. The acting chief of the NPS Western Office of Design and Construction agreed with Wosky.[304]

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[302] Orme Lewis, Assistant Secretary of the Interior, to Hawaii governor, Wallace Farrington, 1953, "Roads, general, 1953" folder, File D30, HAVO archives.

[303] John Wosky, Memorandum to Chief, Western Office of Design and Construction (WDOC), December 1, 1954, "Roads & Trails, September 1954-October 1959" folder, File D30, HAVO archives; Robert G. Hall, Acting Chief, WDOC, to Raymond Archibald, Division Engineer, BPR, March 16, 1955, "Roads & Trails, September 1954-October 1959" folder; and Wosky to Chief, WDOC, April 13, 1955, "Roads & Trails, September 1954-October 1959" folder.

[304] Thomas Vint to John Wosky, March 3, 1955, "Roads & Trails, September 1954-October 1959" folder, File D30, HAVO archives; Wosky to

Although a permanent solution to the bypass issue was not agreed upon, in 1956, 2.377 miles of the Mamalahoa Highway near the park's west entrance were realigned. James W. Glover, Ltd. was awarded the contract based on a bid of $162,635.50, which was more than 4 percent below the estimated cost. The project was completed in 162 days, slightly ahead of schedule, on December 4, 1956. Work included grading and widening the roadbed, placing 4" of a crushed base course, and 2.5" of a three-application macadam pavement. The new alignment provided improved sight distance with its minimum radius curve of 22,918' and a maximum grade of 3.35 percent. A related project was the construction of a new park entrance sign. A lava rock wall was constructed and letters were ordered from Spanjer Brothers, Inc., of Chicago, Illinois. When the 8" cast aluminum letters arrived, they spelled "Hawaii National Bank," rather than Hawaii National Park. Correct letters were ordered and cost $150.60.[305]

During NPS Director Conrad Wirth's visit to HAVO in January 1960, park officials made the decision to construct a bypass road behind park headquarters and Kilauea Military Camp in the 1961 fiscal year. The plans and surveys were to be completed by July 1, 1960, so the contract could be awarded shortly thereafter. Frank Carlson, E. R. Morrison of the State Highway Department, WDOC officials, the superintendent, and the park engineer examined the proposed bypass location in February. They agreed to standards, specifications, contracts, and construction. State Highway crews started work on the survey and established a paper location in March. Park personnel assisted by clearing the park boundary and locating and flagging monuments. By May, state highway crews had finished the surveys for the bypass road, headquarters connecting road, loop road on the east side, and Uwekahuna connection. Surveys were underway for the Bird Park connection. The plans and cross sections were almost completed when a tidal wave struck Hilo and two field notebooks and completed paperwork were lost at the highway department office. The work was expected to be delayed by three weeks.[306]

Chief, WDOC; and Lyle E. Bennett, Acting Chief, WDOC, Memorandum, April 12, 1955, "Roads & Trails, September 1954-October 1959" folder.

[305] "Final Construction Report, Hawaii National Park Project 3-C, Mamalahoa Highway" (1956), HAVO archives; and "Project Completion Report, Construction of Mamalahoa Highway, Route 3-C (Portion), (PCP R-1-5), Road Construction and Entrance Sign" (n.d.), HAVO archives.

[306] Johnston, "Superintendent's Monthly Report," January 1960, February 1960, March 1960, and May 1960.

The field surveys and plans for the bypass were completed by the state highway department in July. Carlson, NPS landscape architect Tom Carpenter, Superintendent Johnston, state highway officials, and park engineer George D. Smith inspected the plans. Carlson recommended several minor changes and all agreed that the plan was a good one. A contract for $611,967.91 for the bypass construction was awarded to Kuwaye Brothers and Black, Ltd., a joint venture, and clearing commenced on April 17, 1961.[307]

The bypass roadbed was 36′ wide, with the connecting roads constructed at 26′ and 30′. The road was surfaced with two layers of 6" crushed aggregate base and a 2" bituminous plant-mix surface 24′ wide. The connecting roads had a 4" crushed aggregate base of two layers and a 1.5" bituminous surface of 20′ and 22′.[308]

The contractors made very good progress and were well ahead of schedule by June, having cleared the roadbed and started excavation. Work was 44 percent completed by July with only 41 percent of the time elapsed. Crusher operations were producing 700 cubic yards of material per day and the contractor had ordered a new, 42" jaw crusher to speed up production. The work fell slightly behind schedule in September while the contractor waited for a new heavy crusher. The contractor was back on track the next month with priming and paving scheduled for some sections in November.[309] The road was 83 percent completed in November. The selected material was hauled and compacted, oil was placed on several sections, and paving was underway on the Uwekahuna connection. Work was temporarily suspended at this point, due to poor test results for the asphalt mix. The asphalt would not meet specifications for penetration, so the state inspector shut the job down until corrections were made. Work resumed and good progress was made. Paving was laid on three connecting roads and about half of the main road in

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[307] Johnston, "Superintendent's Monthly Report," July 1960 and April 1961; "Monthly Progress Report," attached to "Superintendent's Monthly Report," April 1961.

[308] Department of the Interior, National Park Service, "Plans for Proposed Project Hawaii N.P.H. 3-A, Headquarters Bypass & Connections, Route No. 3~Mamalahoa Highway, Hawaii National Park Highway System, State of Hawaii" (October 28, 1960), title sheet and signing plan, HAVO Maintenance Division files.

[309] Johnston, "Superintendent's Monthly Report," June 1961, July 1961, September 1961, and October 1961.

December. Shoulder grading and compacting was being done along with some slope treatment. Although the project completion date was December 24, the revised date was January 10, 1962.[310]

The bypass road was officially completed on January 12, 1962. Local dignitaries were in attendance at the dedication ceremony on January 16.[311] John Wosky, then Regional Chief of Operations, authorized the park to commit park personnel to landscaping and planting, using approximately $3000 of remaining funds.[312] Landscape architect A. M. Baclawski inspected the road and reported that it had a clean, well-constructed appearance. There was minimal damage to the surrounding terrain as the contractor's activities were closely confined to construction limits. Baclawski made suggestions for the obliteration of old road sections, signage, additional fill around exposed culverts, and other minor details for roadside cleanup.[313]

Traffic surveys conducted after the bypass opened showed a remarkable drop in park visitor numbers. In February 1961, 46,119 visitors were counted at the park as compared to 33,688 one year later. The superintendent noted that this figure was somewhat misleading, since the higher visitor count for 1961 could be partially attributed to the eruption of Halemaumau, which drew larger crowds to the park. By April, the visitation was down over 25 percent and the superintendent predicted that the bypass would decrease overall travel for the year by 30 percent unless an eruption started. In 1963, the travel count was down more than 45 percent. The superintendent claimed this was due to the new method of counting travel used since the opening of the bypass.[314]

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[310] Johnston, "Superintendent's Monthly Report," November 1961 and December 1961.

[311] Johnston, "Superintendent's Monthly Report," January 1961.

[312] John Wosky, Regional Chief of Operation, Memoorandum to Chief, WDOC, February 2, 1962, "Headquarters Bypass and Subsidiary Roads (Highway 11), July 1956-October 1959" folder, File D30, HAVO archives.

[313] A. M. Baclawski, Supervising Park Landscape Architect, Memorandum to WDOC, January 18, 1962, "Headquarters Bypass and Subsidiary Roads (Highway 11), February 1960-December 1962" folder, File D30, HAVO archives.

[314] Johnston, "Superintendent's Monthly Report," February 1962, March 1962, and December 1963.

In 1964 the State of Hawaii Highway Division assumed responsibility for the maintenance of the bypass, which was officially known as Mamalahoa Highway.[315] The issue of jurisdiction and right-of-way continued to be debated after the bypass opened.[316] In August 1999 Superintendent Jim Martin reported that there were ongoing discussions with the state regarding the jurisdiction on the Mamalahoa Highway through the park. Martin stated that the NPS retained the authority to review all plans and had the final authority on road standards, though he noted that the Park Service had compromised on features that the state wanted in order to meet safety standards, including wider (6') shoulders and more guardrails. The superintendent asserted that the park would neither cede land to the state nor give it any foothold in jurisdiction and pointed out that this would impact resource management. The NPS patrolled the road, but federal and county authorities cooperated in civil defense, fire protection, and police matters. Martin emphasized that the state and Park Service had a cooperative working relationship regarding the bypass road, although it was "important for the future" to take action and rewrite the right-of-way agreement.[317]

THE FUTURE OF HAWAII VOLCANOES NATIONAL PARK ROADS

As of 1999, plans were being finalized to reconstruct two miles of severely deteriorated pavement on Mauna Loa Road. Koa roots beneath the road caused the pavement to crack and lift, creating a bumpy ride for travelers. The rehabilitation project was scheduled for early 2000. The project was intended to remove existing pavement and underlying gravel. The roadbed was to be cleared and grubbed, with all roots and organic materials removed to a depth of 3' below the existing surface and 2' beyond the edge of the pavement. A plastic root barrier that extended two feet below the ground surface would be installed along the length of the two-mile reconstruction. The subgrade

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[315] Johnston, "Superintendent's Monthly Report," November 1964.

[316] Bryan Harry, Letter to Regional Director, Western Region, July 29, 1974, "Headquarters Bypass and Subsidiary Roads (Highway 11), March 1963 to ___" folder, File D30, HAVO archives.

[317] Martin interview.

was to be compacted and pavement would consist of 4" of 1.5" gravel, 2" of 3/4" gravel, and 3" of asphalt.[318]

General transportation planning would play a more prominent role in Hawaii Volcanoes National Park road management. No new construction was planned, but Superintendent Martin acknowledged that the park needed to address how it could manage increasing traffic. As an example, he noted that the Thurston Lava Tube parking area along Crater Rim Drive was already at capacity. The institution of a public shuttle system was under consideration. The park management was also examining its policy regarding bicycling and consideration was being given to the idea of encouraging bicycle travel and constructing a bike trail around the crater rim area.

HAWAII VOLCANOES NATIONAL PARK ROADS: THEIR IMPACT

While the landscape of Hawaii Volcanoes National Park offers a striking combination of scenic views and dramatic natural phenomena, the most unusual aspect of the park's road system from a highway engineering perspective is the manner in which the roadways are subject to a process of continual change and adaptation as sections are lost to lava flows and earthquakes. Over the years, the changes along Crater Rim Drive and the Chain of Craters-Kalapana Road have been remarkable, with major alignments mandated by the park's volatile geologic features. Other major changes to the park system were the result of planning decisions and bureaucratic agreements. The most dramatic example of these factors was the construction of the Mamalahoa Highway, or bypass road, in the 1960s, which enabled the park to remove commercial and through traffic from the main visitor area. With the exception of the Mamalahoa Highway, park roads maintain much of the historic character and quality that BPR engineers and NPS landscape architects and designers intended. The roads feature relatively easy curves and grades, although some exceed the modern standard of 5 percent. In some areas, stonework from the CCC construction era remains. Historic stone parapet walls and other traditional National Park Service features such as lava curbs and stone shelters can also be found in the park.

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[318] HAVO Project Review, Mauna Loa Road Rehabilitation, October 7, 1999.

The road system was a major factor in developing Hawaii Volcanoes National Park and making it one of Hawaii's premier visitor attractions. This road system will no doubt continue to evolve as the earth continues to erupt and quake around the world's most accessible volcanoes.

GLOSSARY OF HAWAIIAN WORDS[319]

aa: One of two types of lava in Hawaii, it is chunky and jagged lava.

ahupuaa: land division usually extending from the uplands to the sea.

apapane: Hawaiian honeycreeper with a crimson body and black wings and tail.

iiwi: scarlet Hawaii honeycreeper.

io: Hawaiian hawk. The bird is endangered and confined to forests on the island of Hawaii.

kipuka: an oasis within a lava bed where there may be vegetation.

koa: the largest of native forest trees, with light-gray bark and crescent-shaped leaves.

maile: a native twining shrub.

nene: endangered Hawaiian goose (*Nesochen sandvicensis*).

ohelo: small native shrub in the cranberry family.

ohia lehua: native tree that grows abundantly in wet areas. The tree is well-known for its bright red flowers, which are an important source of food for honeycreepers.

opeapea: endangered Hawaiian hoary bat.

pahoehoe: One of two types of lava in Hawaii, it is smooth, unbroken type of lava.

pali: cliff or steep hill.

pueo: Hawaiian short-eared owl (A*sio flammeus sandwichensis*).

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[319] Mary Kawena Pukui and Samuel H. Elbert, *Hawaiian Dictionary* (Honolulu: University of Hawaii Press, 1986); and Pukui, Elbert, and Esther T. Mookini, *Place Names of Hawaii*, 2d ed., rev. and enl. (Honolulu: University of Hawaii Press, 1974).

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ADDENDUM TO:
HAWAII VOLCANOES NATIONAL PARK ROADS
Hawaii Volcanoes National Park
Volcano vicinity
Hawaii County
Hawaii

HAER HI-47
HI-47

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HI-47

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FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
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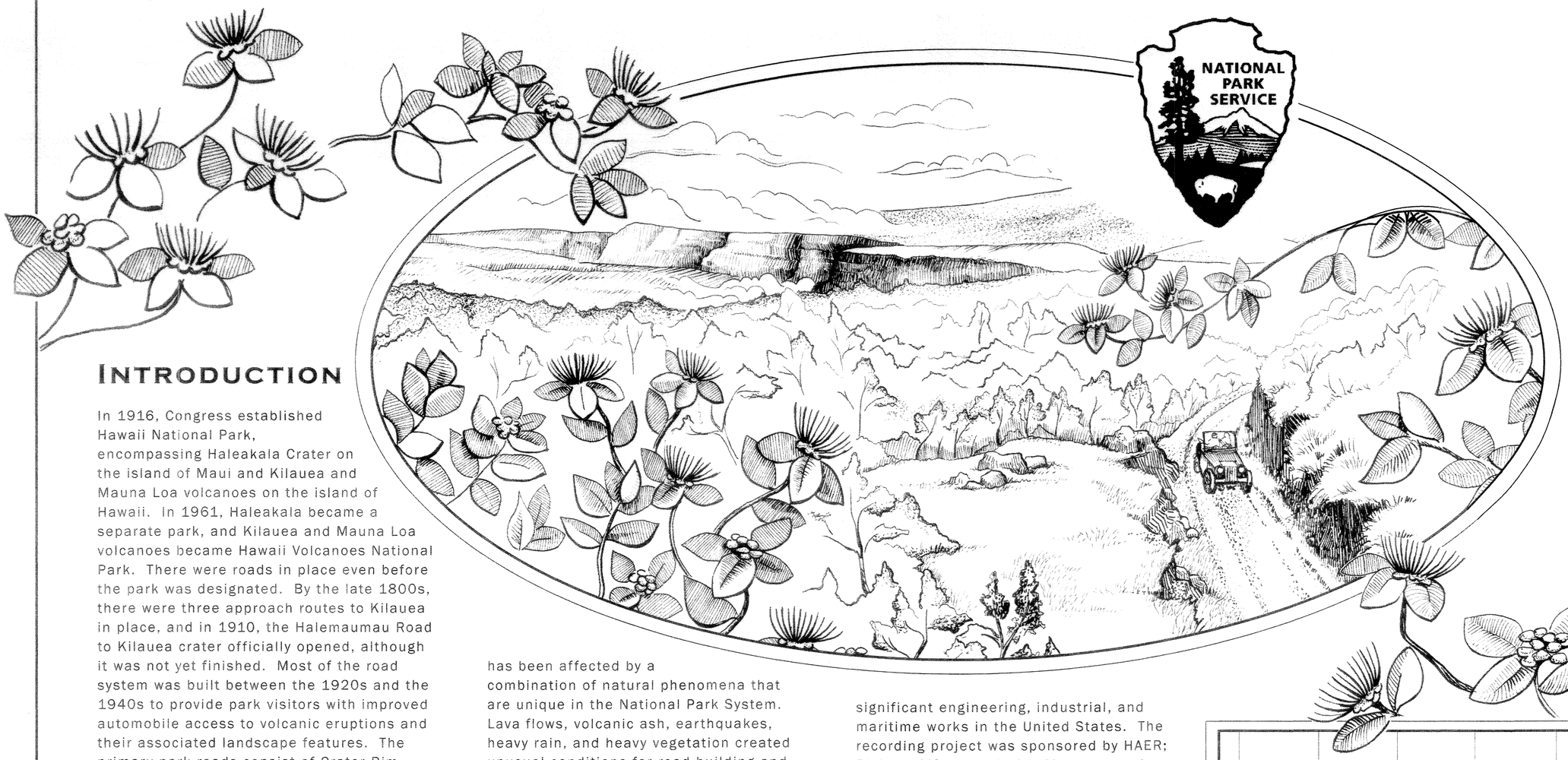
Hawaii Volcanoes National Park Roads

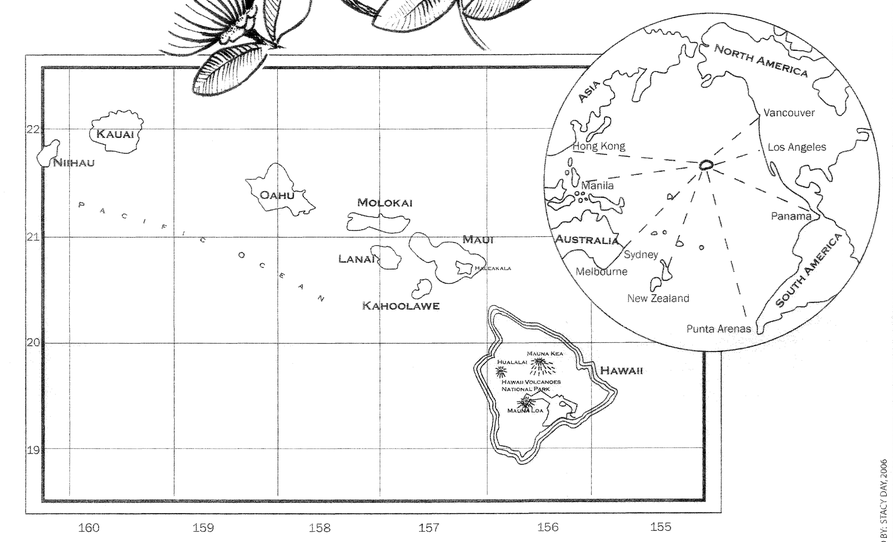


Introduction

In 1916, Congress established Hawaii National Park, encompassing Haleakala Crater on the island of Maui and Kilauea and Mauna Loa volcanoes on the island of Hawaii. In 1961, Haleakala became a separate park, and Kilauea and Mauna Loa volcanoes became Hawaii Volcanoes National Park. There were roads in place even before the park was designated. By the late 1800s, there were three approach routes to Kilauea in place, and in 1910, the Halemaumau Road to Kilauea crater officially opened, although it was not yet finished. Most of the road system was built between the 1920s and the 1940s to provide park visitors with improved automobile access to volcanic eruptions and their associated landscape features. The primary park roads consist of Crater Rim Drive, which circles Kilauea Caldera, and Chain of Craters Road, which travels down to the coast. Secondary roads include Hilina Pali Road, extending from Chain of Craters to Hilina Pali Overlook, and Mauna Loa Road, providing access to Kipuka Puaulu, Mauna Loa Lookout, and the trail to the summit of Mauna Loa Lookout. The history of road development in the park followed classic NPS road development policies. The park roads not only provided access to the natural and cultural features of the park but also harmonized with the landscape.

The Hawaii Volcanoes National Park road system exists on a dynamic landscape and has been affected by a combination of natural phenomena that are unique in the National Park System. Lava flows, volcanic ash, earthquakes, heavy rain, and heavy vegetation created unusual conditions for road building and also damaged and destroyed many miles of the park's roads. Lava flows are one of the most prominent landscape features in the park and have repeatedly destroyed roads and necessitated reconstruction or realignment. Most sections of the park road system, however, retain a high degree of integrity with original alignment, width, and engineered structures, much built by the Civilian Conservation Corps.

Documentation of the Hawaii Volcanoes National Park road system was conducted in 1999 and 2006 by the Historic American Engineering Record (HAER), a long-range program to document historically significant engineering, industrial, and maritime works in the United States. The recording project was sponsored by HAER; Richard O'Connor, Acting Manager, and Hawaii Volcanoes National Park; Cindy Orlando, Superintendent, Laura Schuster, Branch Chief, Cultural Resources. The documentation was prepared under the direction of Todd Croteau, HAER Architect. Stacy Day and Jay Wozniak, ASLA, landscape architects, prepared the measured drawings. Drawing text comes from the 1999 report detailing the history of the park road system by Dawn Duensing, with additional research by Justine Christianson, HAER Historian. Large format photography was done by Jet Lowe, HAER Photographer, in 1999.

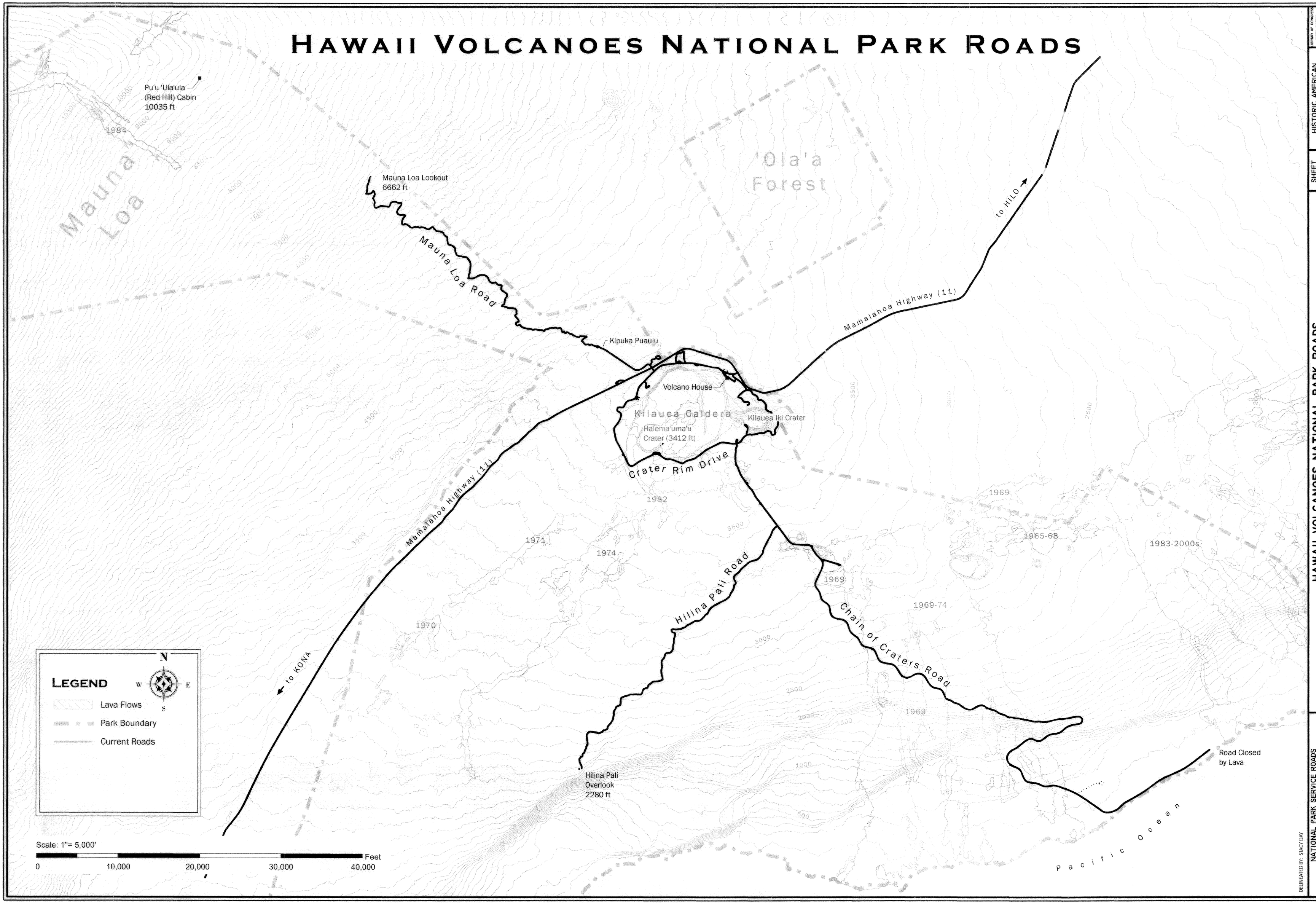


* Based on 1929 map. Not to scale.

HAWAII VOLCANOES NATIONAL PARK ROADS
HAWAII COUNTY
HAWAII
SHEET 1 OF 20
HISTORIC AMERICAN ENGINEERING RECORD HI-47

DELINEATED BY: STACY DAY, 2006
HAWAII VOLCANOES NATIONAL PARK ROADS
RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

Hawaii Volcanoes National Park Roads



DELINEATED BY: STACY DAY

NATIONAL PARK SERVICE ROADS
RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

HAWAII VOLCANOES NATIONAL PARK ROADS
HAWAII VOLCANOES
HAWAII COUNTY
HAWAII

SHEET 2 OF 20

HISTORIC AMERICAN ENGINEERING RECORD
HI-47

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Overview of Hawaii Volcanoes National Park Visitation

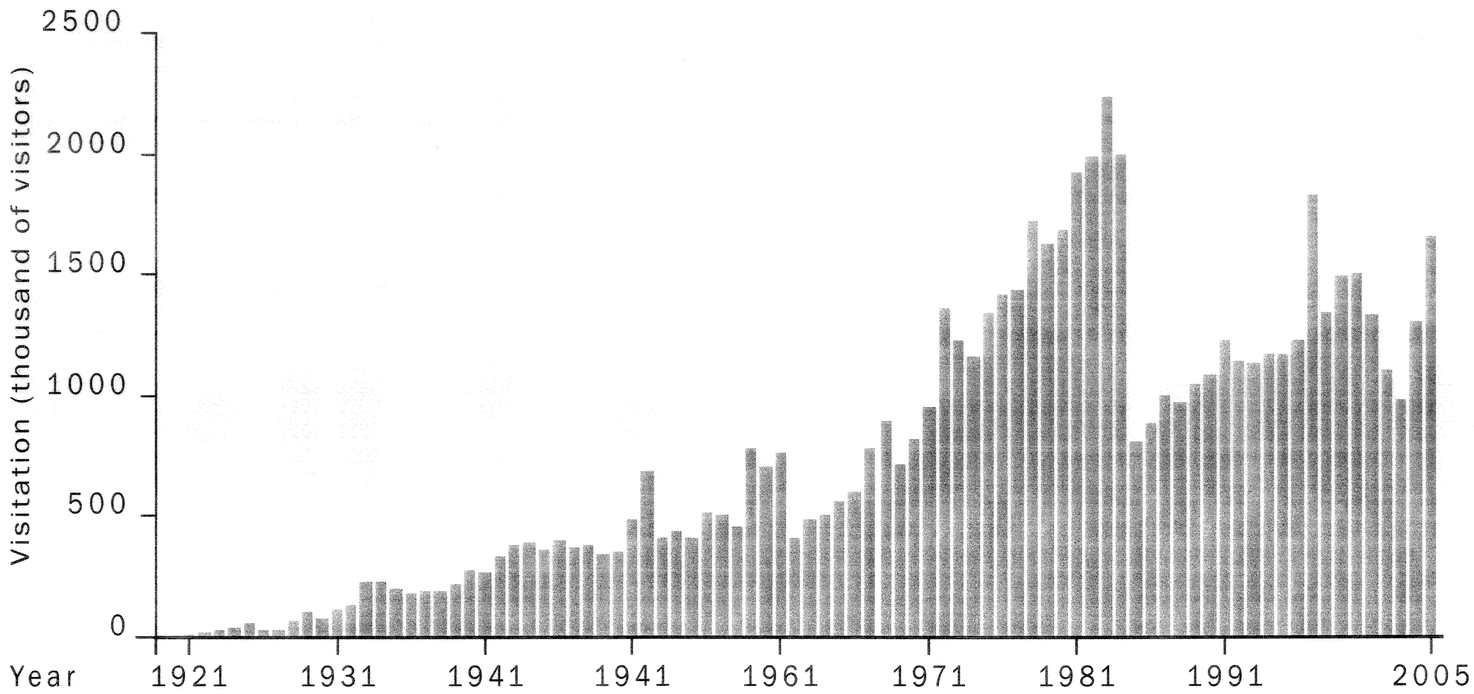
Evolution of Transportation

Early travel to the volcano usually meant a long, arduous journey by foot or horseback on rough roads to reach the Volcano House. During the 1880's, it would take visitors 7 hours to make the trip from Hilo by horseback. By the turn of the century, travelers would make their way up from the coast by not only horse, but by stagecoaches and carriages as well. From 1905-1926 the railroad carried visitors 22 miles from Hilo to Glenwood, where stages carried them the remainder of the distance.

Annual Park Visitation Rates

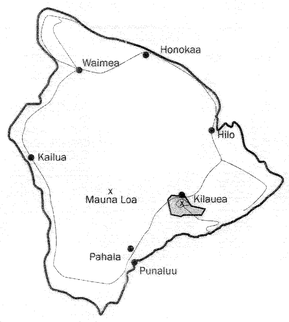
Since it's dedication in 1916, annual visitation rates to Hawaii Volcanoes National Park have greatly increased due to accessibility of the island by steamship, and later, airplanes, and as roads to the park have improved. Historically, visitation spiked during eruptions, and the addition of formal tourist attractions, such as Thurston Lava Tube, Steam Vents, and the Jaggar Museum. The steam eruption of Halemaumau in 1929 drew 25,000 people from July 25-28. The Kilauea Iki eruption of 1959 drew 198,605 visitors in the month of November.

Visitation at Hawaii Volcanoes National Park

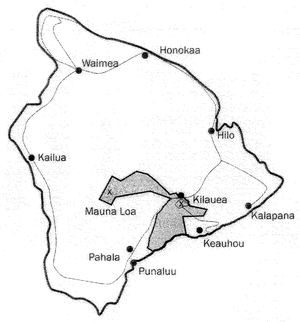


Visitation spikes generally follow eruptive events. 2001 drop due to 9/11Terrorist Attacks.

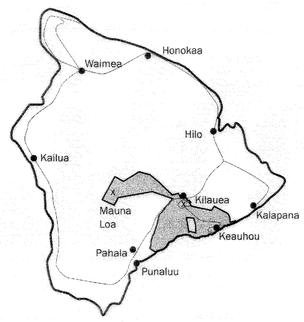
Land Aquisition of Hawaii Volcanoes National Park



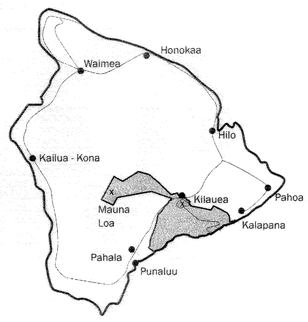
Pre-1920s (Park Proposal)



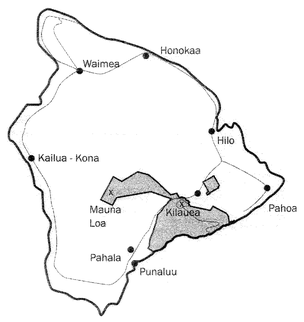
1920s



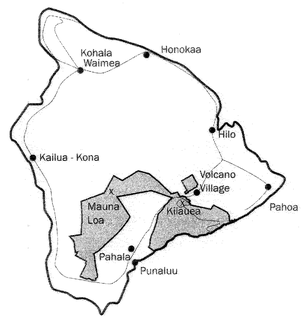
1930s



1970s



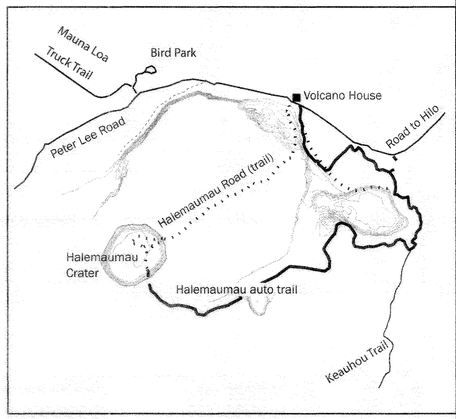
1990s



Current

Crater Rim Drive Evolution & Timeline

PRE - NATIONAL PARK ERA PRIOR TO 1916



1846 First Volcano House; Footpath from Volcano House to Kilauea Caldera

1860s Hilo Route- 28 mile horse/foot trail to Volcano House

1870s Keauhou Trail from coast to Caldera via Ainahou Ranch

1877 Establishment of Volcano House (wooden structure)

1880s Keauhou Wagon Road from steamer pier at Keauhou Landing

1888 Peter Lee Road completed (20-miles from Punalu)

1894 30 miles of Hilo Road was completed

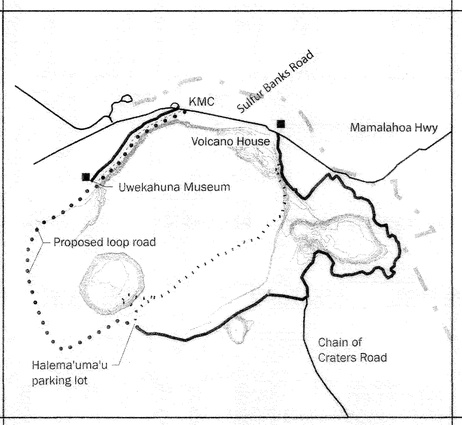
1905-1926 Glenwood rail line: 22 miles from Hilo to Glenwood, 9 miles from Glenwood to Volcano by stagecoach

1908 7 miles of Halemaumau Road from Volcano House to Halema'uma'u Crater via Thurston Lava Tube completed

1912 Auto trail from Volcano House, around Kilauea Iki to Halemaumau Crater was completed

1915 Mauna Loa Truck Trail constructed by Army Corps of Engineers "Buffalo Soldiers"

PARK ESTABLISHMENT & MASTER PLANNING 1916-1931



1916 Kilauea Military Camp opened

1916 HNP was established as a national park

1920s Mamalahoa Road completed around island

1920 16 miles of park roads was completed

1922 Halemaumau Parking lot was constructed accomodating 50 cars

1925 Road was improved to reduce grades, ease curves, & surface was improved with oil macadam
Halema'uma'u parking lot destroyed by lava
New lot was constructed accomodating 150 cars 1000' away from crater rim

1927 Uwekahuna Museum established
Route completed to Museum
Sulfur banks road constructed

1928 Chain of Craters built from Rim Road

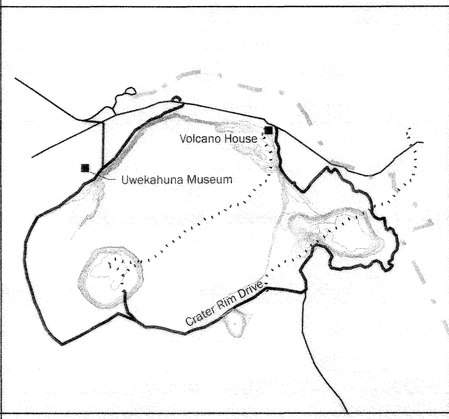
1929 Halemaumau erupted
Halemaumau parking lot increased to accomodate 500 vehicles

1930 Road was graded & resurfaced

1931 A circuit road was proposed
Thurston Lava Tube land was acquired

1932 Thomas Vint suggests adding drainage & culverts to proposed loop road

CCC ERA 1931-1941



1933 CCC began to assist in road repairs & new construction
Gutters, curbing and drainage features from this period

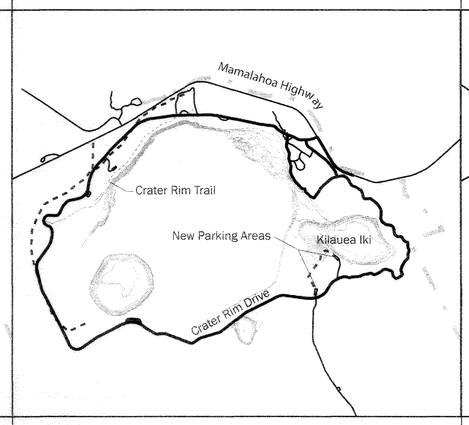
1934 New Crater Rim Road was completed with President Roosevelt visiting

1937 Thurston Lava Tube area improved for visitors

1941 New Volcano House was built at edge of Kilauea Caldera

1942-1949 Roads damaged by military equipment during WWII
Halema'uma'u parking lot removed to prevent enemy aircraft from landing

WAR YEARS & MISSION 66 1941-1966



1956-1966 NPS Mission 66 is initiated (a 10 year building campaign) for park improvements

1959 Kilauea Iki erupted spreading cinder over road

1959 Kilauea Iki eruption closes loop road at Pu'u Pua'i

1960 Crater Rim Drive is relocated around cinder (Devastation Trail area)

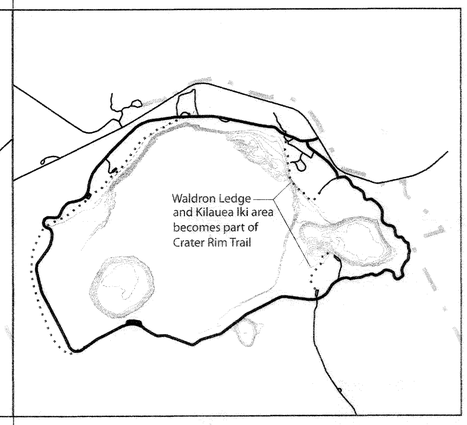
1947-1962 Mamalahoa Highway bypass built, diverting thru-traffic away from park;

1959 Kilauea Iki eruption closes loop road at Pu'u Pua'i

1962 New parking areas developed at Pu'u Pua'i, Kilauea Iki, & Thurston Lava Tube
Loop Road reconnected by realignment between Chain of Craters intersection to Pu'u Pua'i Overlook

1971, 1974 & 1984- Lava flowed over the road near Halema'uma'u Crater, necessitating reconstruction

1967+



1981 Earth cracks closed vehicular access to Waldron Ledge and road abandoned

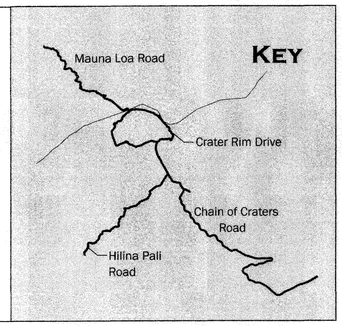
1982 Kilauea erupted and covered south side of caldera road

1983 Abandoned section became part of Crater Rim Trail

1983-current General maintenance period with ongoing repair

LEGEND

- Park Boundary
- Current Roads
- Old Road Alignments
- Trails
- Proposed Roads



DELINEATED BY: STACY DAY, 2006

NATIONAL PARK SERVICE ROADS RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

HAWAII VOLCANOES NATIONAL PARK ROADS
HAWAII VOLCANOES
HAWAII

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HISTORIC AMERICAN ENGINEERING RECORD HI-47

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HAWAII VOLCANOES NATIONAL PARK ROAD EVOLUTION & TIMELINES

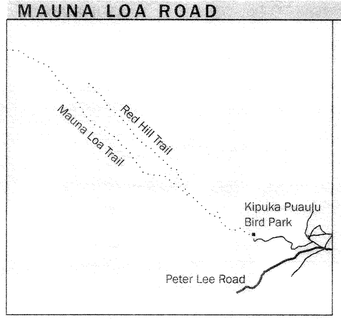
PRE - NATIONAL PARK SERVICE ERA
PRIOR TO 1916

PARK ESTABLISHMENT &
MASTER PLANNING 1916 - 1931

CCC ERA
1931 - 1941

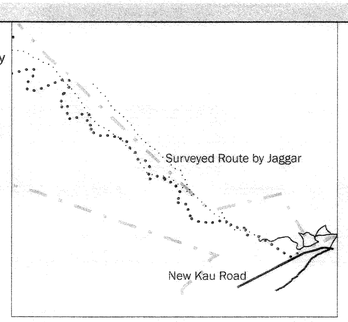
WAR YEARS, MISSION 66, THRU CURRENT
1941 - CURRENT

MAUNA LOA ROAD



1915 Pu'u'Ulaula (Red Hill) trail constructed by the 25th infantry Division to connect Kilauea & Mauna Loa

Known as Mauna Loa Truck Trail

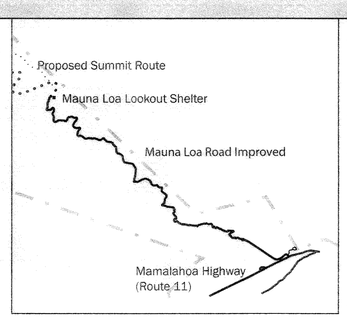


1916 Road is proposed to connect Kilauea & Mauna Loa sections of the park

1921 Businessman Lorrin A. Thurston supported the road concept (semi-macademized, 30-mile road) to "revolutionize volcanic observation at the summit & enhance tourism

1923 Superintendent Boles and volcanologist Jaggar surveyed a route to the summit

1927 HAVO had acquired all the land needed for road construction



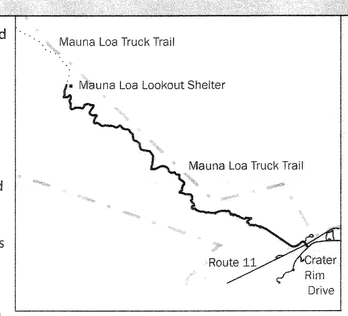
1933 Thurston & Jaggar advocated for the reconstruction of Mauna Loa Road

1933 - 34 Mauna Loa erupted

1935 Road improvement was proposed & construction began from Uwekahuna Bird Park by the CCC.

9.8 miles of construction was completed by September

1937 - 38 CCC constructed stone lookout shelter and repaired the drainage issues



1949 Superintendent released "counter publicity" against the development of a summit road

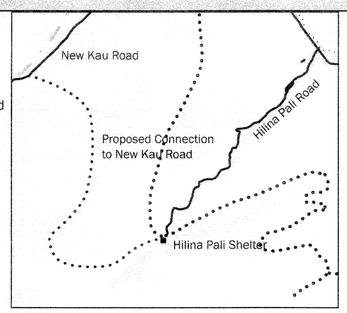
1955 Lower portions of road were improved

1956 Last three miles of road were widened & graded for tourists

HILINA PALI ROAD

1927 Superintendent Evans proposed Hilina Pali Road

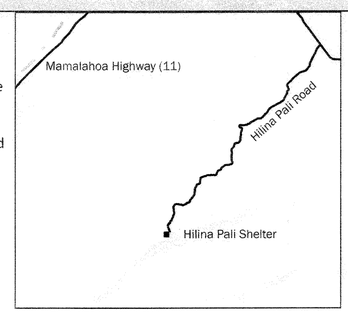
1930 HAVO friends group, Hui O Pele builds a shelter at Hilina Pali and donates it to the park



1936 CCC improved the trail into a road

1937-47 Fords are added to remediate rain damage

1938 Earthquakes cracked the road during construction



1948 Construction was completed

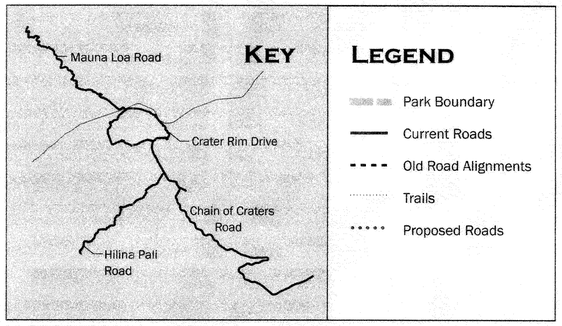
1949 Road was opened to traffic

1950 A flood washed out culverts, retaining walls, & fills
Steep sections are paved
Damage from a second flood required regrading & retreating the entire road

1953 Road widened for 52 miles from Crater Rim junction
Sections of road were leveled & straightened

1951 Rehabilitation completed

1960s Volcanic activity cracked & pitted the road and was closed for repairs



LEGEND

- Park Boundary
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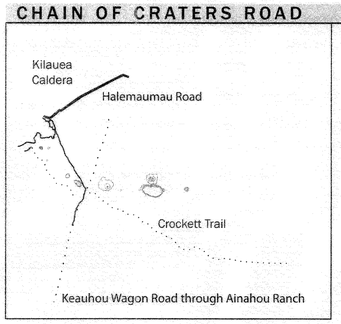
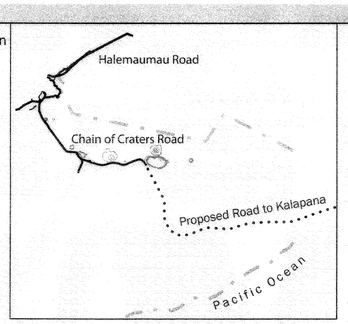
CHAIN OF CRATERS ROAD



1800s Crockett Trail preceded the Chain of Craters Road

Keauhou Trail (later a wagon road)
came from steamer pier through Ainahou Ranch to caldera

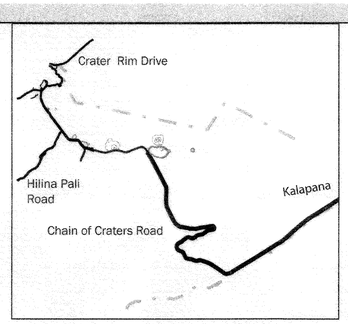


1922 Chain of Craters Road construction became a priority. Led by Kitteredge, the engineer, it was proposed to be 7 miles long, 16' wide & surfaced with 3/4" crushed rock

1926 Clearing for road began and a possible road extension to Kalapana was surveyed

1927 Construction commenced on Chain of Craters Road

1928 Road opened through Napau



1935 30' deep crack was repaired

1938 Earthquakes caused extensive damage

Bill for Kalapana land extension passed

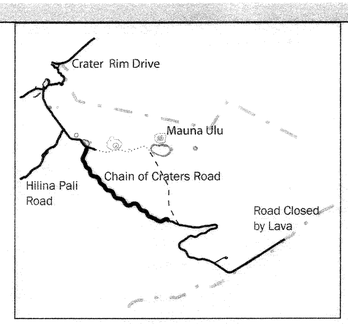
1939 CCC made temporary repairs to Chain of Craters Road

1960 Implementation of Master Plan

1960 Kalapana Route surveyed

1961 Kalapana construction began

1964 First and Second phase of Kalapana Project completed



1965-1969 Multiple eruptions at Makaopuhi Crater and Mauna Ulu covered several miles of road

1975 New route for Chain of Craters Road was proposed

1979 New Chain of Craters Road was dedicated

1983 Pu'u O'o began erupting

1988 Lava crosses Chain of Craters Road, closing it at the ocean section

DELINEATED BY: STACY DAY, 2006

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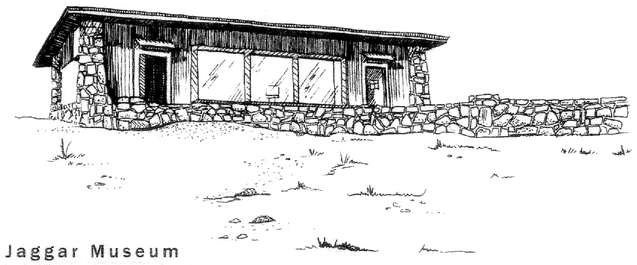
Overview of
Crater Rim Drive



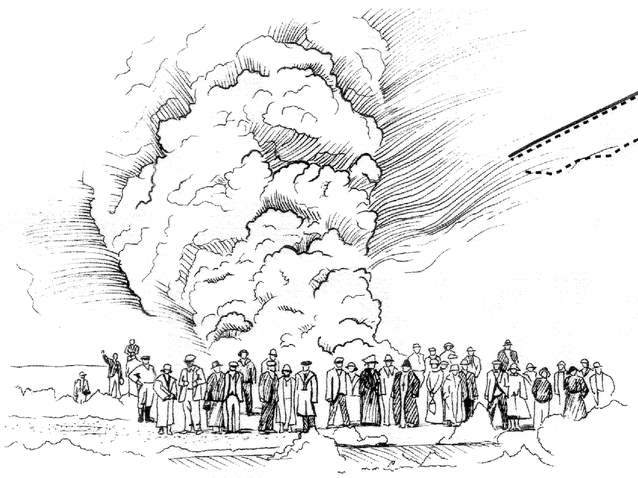
Thomas A. Jaggar Museum
The Hawaii Volcano Observatory and Jaggar Museum sit at a prominent location on Uwekahuna Bluff. Visitors can view Halemaumau crater, witness working seismic equipment, and learn about volcanic activity.

Volcano House
Situated near the brink of Kilauea Caldera, the Volcano House has been a resting place for visitors to the volcano since 1846. Rebuilt & relocated several times since it's origin, it hosted many noteworthy individuals including Mark Twain, Louis Pasteur, and Queen Liliuokalani

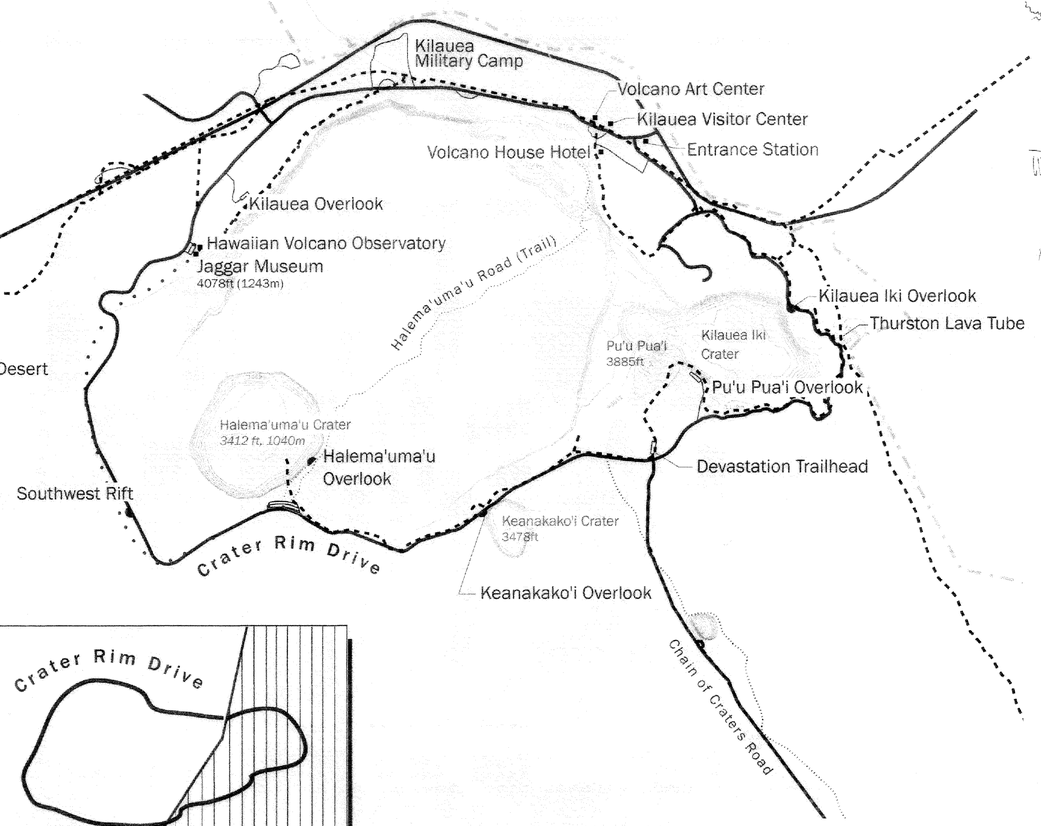
Ohi'a lehua
Metrosideros-polymorpha

THURSTON LAVA TUBE AREA

Rainforest
Crater Rim Drive passes through an area known in the early twentieth century as the "fern jungle", a lush rainforest of tree ferns and o'hia, native plant species found nowhere else on earth.



Halema'ma'u Crater Overlook
Visitors can walk up to the edge of the Halema'uma'u pit crater, where a lava lake boiled for more than 100 years. The natural draining of the lake caused a violent steam eruption in 1924.



LEGEND:
- Park Boundary
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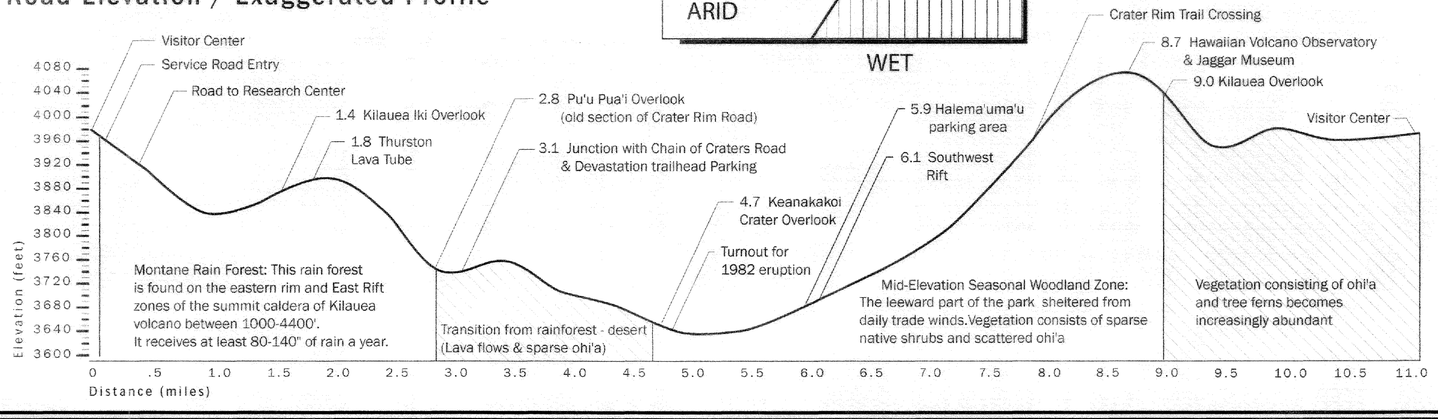
N W E S

Scale: 1"= 2,000'
0 4,000 8,000 feet

Road Elevation / Exaggerated Profile



A STRING OF PEARLS ON AN ASPHALT NECKLACE

The completed Crater Rim Drive loop around the Kilauea Caldera opened in April 1934. It connects various points of interest and provides visitors with the opportunity to see a variety of landscapes. These include those associated with volcanoes, such as the Steam Vents where sulfur dioxide and hydrogen sulfide are released due to an intrusion of magma. Crater Rim Drive also provides access to overlooks, such as the Halema'uma'u and Keanakako'i crater overlooks. Thurston Lava Tube offers lush ferns, Hawaiian rainforest, and a walk through a once active lava tube, providing a very different landscape experience.

Crater Rim Drive also serves a scientific purpose by providing access to scientists working at Hawaiian Volcano Observatory. Established by Dr. Thomas Jaggar in 1912, the observatory now houses the U.S. Geological Survey.

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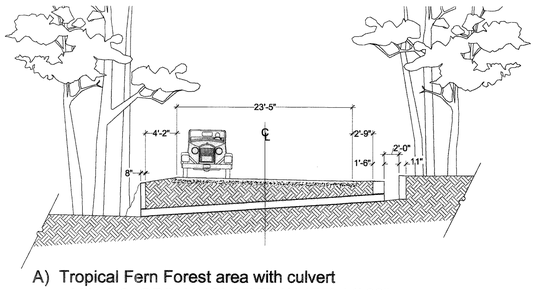
UNITED STATES DEPARTMENT OF THE INTERIOR
DELINEATED BY: STACY DAY, 2006

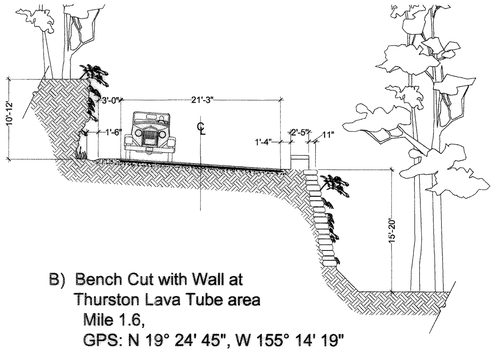
CHARACTER CROSS-SECTIONS OF
CRATER RIM DRIVE

From lush rainforest conditions near the entry of the park to the desert setting around Halemaumau Crater, Crater Rim Drive offers the same diversity of natural scenery for park visitors as it did when the road began to evolve from a footpath in the late 19th century. Different construction methods, following a variety of seismic and volcanic activity, have given Crater Rim Drive the character that intrigues one-time guests and daily users the same. The average existing paved road width is between 19' and 22'.

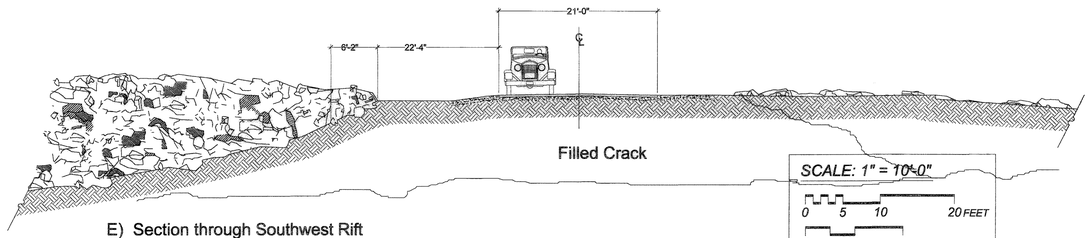
The mileage given for each Crater Rim Drive section is the distance from 0.0 Miles at the first intersection after the entry gates coming into the park. Sections continue clockwise in the historical construction of Crater Rim Drive. Global Positioning System (GPS) coordinates given for each section have been taken from the centerline of the existing road.



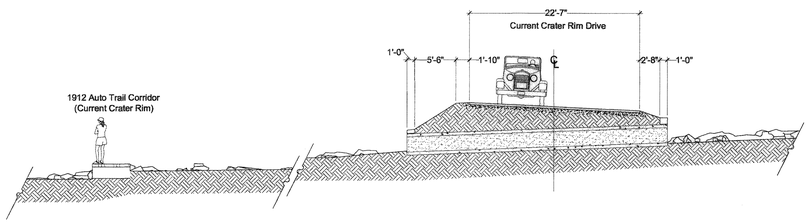
A) Tropical Fern Forest area with culvert
Mile 0.9, GPS: N 19° 25' 7", W 155° 14' 39"



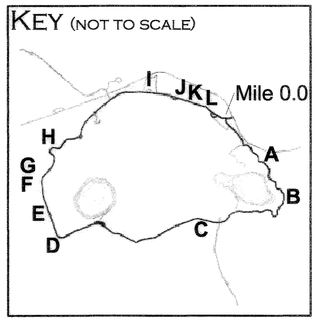
B) Bench Cut with Wall at
Thurston Lava Tube area
Mile 1.6,
GPS: N 19° 24' 45", W 155° 14' 19"

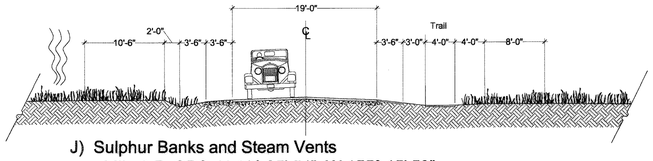


E) Section through Southwest Rift
Mile 6.0, GPS: N 19° 24' 5", W 155° 17' 36"

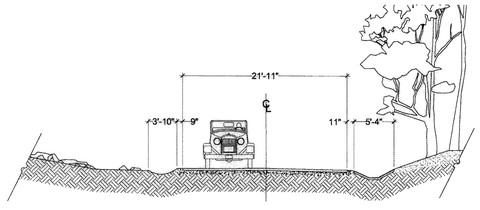


F) Culvert on Existing Crater Rim Drive (& 1912 Auto Trail)
Elevated Causeway type road in Kau Desert
Mile 6.5, GPS: N 19° 24' 49", W 155° 17' 48"

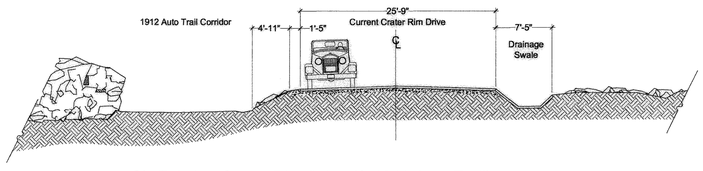




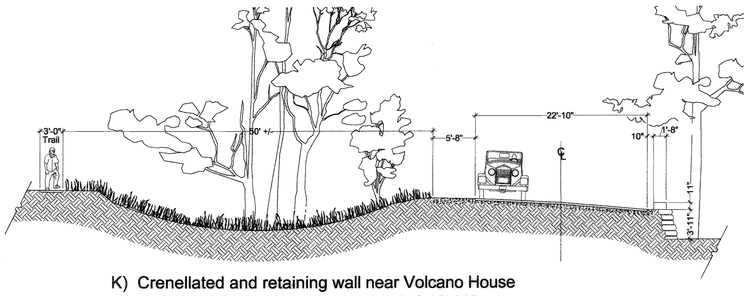
J) Sulphur Banks and Steam Vents
Mile 9.7, GPS: N 19° 25' 54", W 155° 15' 59"



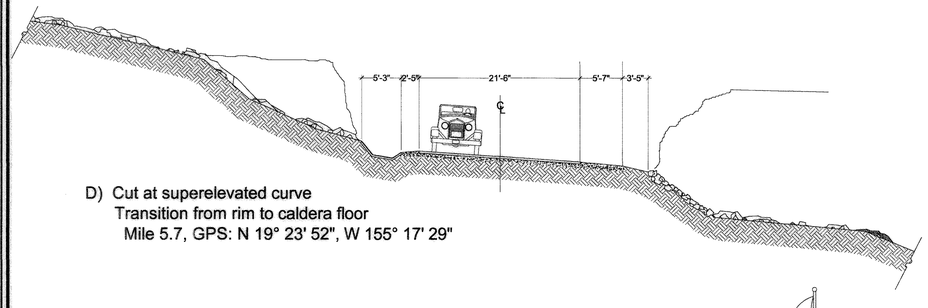
C) Section through cindered shoulders at Pu'u Puai
Mile 3.5, GPS: N 19° 24' 16", W 155° 15' 39"



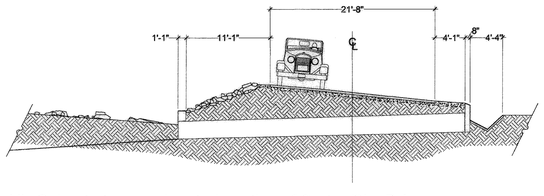
G) Existing Crater Rim Drive (& 1912 Auto Trail)
Mile 6.6, GPS: N 19° 24' 33", W 155° 17' 49"



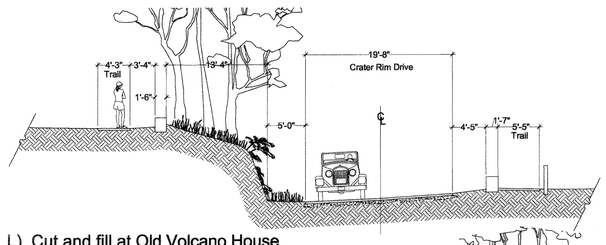
K) Crenellated and retaining wall near Volcano House
Mile 10.1, GPS: N 19° 25' 50", W 155° 15' 36"



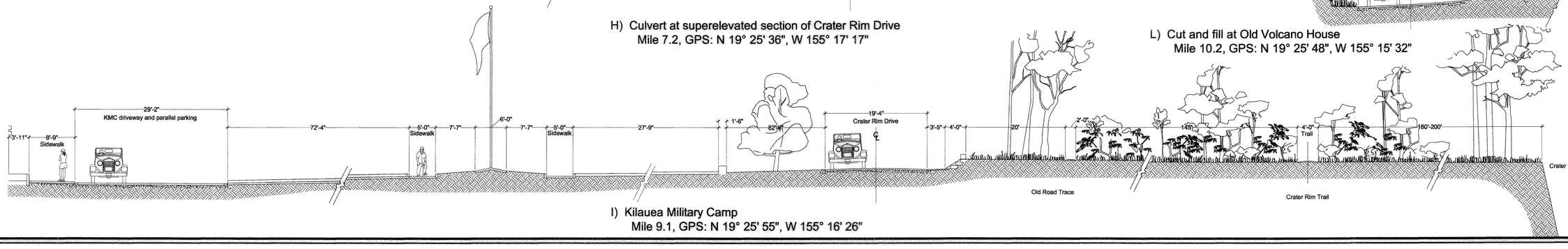
D) Cut at superelevated curve
Transition from rim to caldera floor
Mile 5.7, GPS: N 19° 23' 52", W 155° 17' 29"



H) Culvert at superelevated section of Crater Rim Drive
Mile 7.2, GPS: N 19° 25' 36", W 155° 17' 17"



L) Cut and fill at Old Volcano House
Mile 10.2, GPS: N 19° 25' 48", W 155° 15' 32"



I) Kilauea Military Camp
Mile 9.1, GPS: N 19° 25' 55", W 155° 16' 26"

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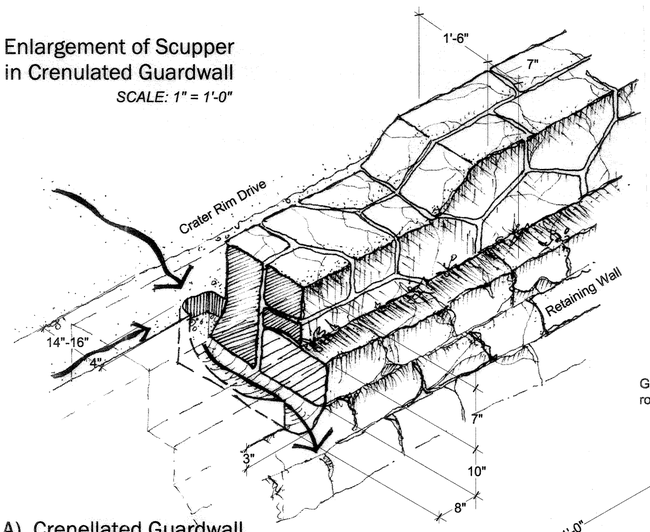
HAWAII VOLCANOES
DELINEATED BY: JAY WOZNIAK, 2006
NATIONAL PARK SERVICE ROADS RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

ROAD-SIDE EDGING ON
CRATER RIM DRIVE

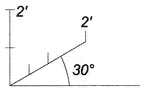
The parapet walls on Crater Rim Drive are a variation on the standard NPS design used throughout the system, employing local volcanic rock to blend in with the surrounding terrain. The crenelations were designed to avoid a monotonous stretch of guardwall. The CCC built the stone guardwalls in the 1930s at lookout points and steep embankments. Additional guardrails were built in the 1950s and 1960s also following NPS guidelines. These were concrete post and wood rail guardrails, as seen near Kilauea Military Camp. The work within the park introduced the state to building techniques used on the mainland. Superintendent Wingate lauded Landscape Architect Merel D. Sager in 1934 for bringing new ideas, noting "plans which have been carried out under his direction are establishing a mark for similar work in the community to aim at."

Enlargement of Scupper in Crenulated Guardwall
SCALE: 1" = 1'-0"

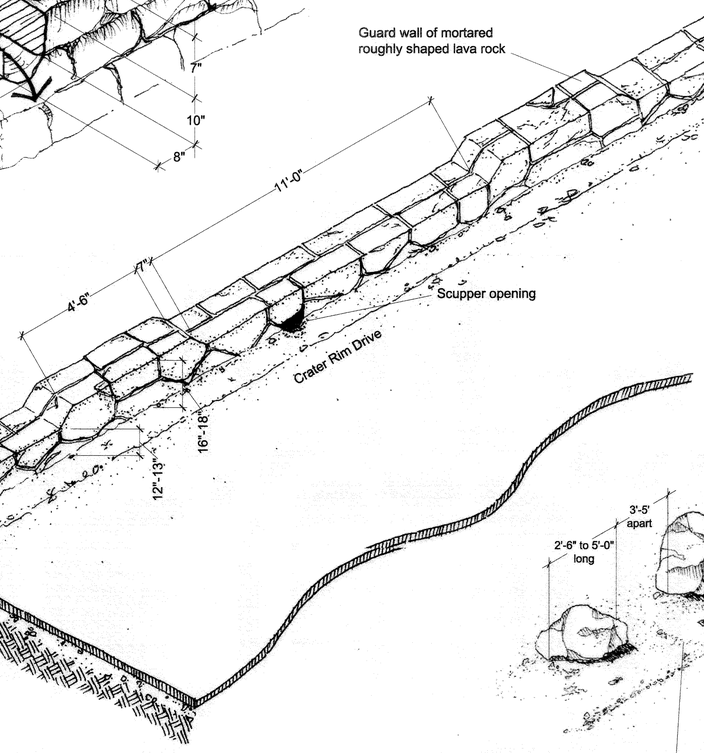


Construction of crenellated wall and retaining wall

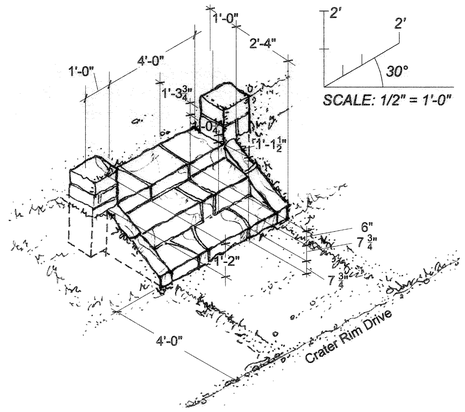
A) Crenellated Guardwall on Retaining Wall



SCALE: 1/2" = 1'-0"



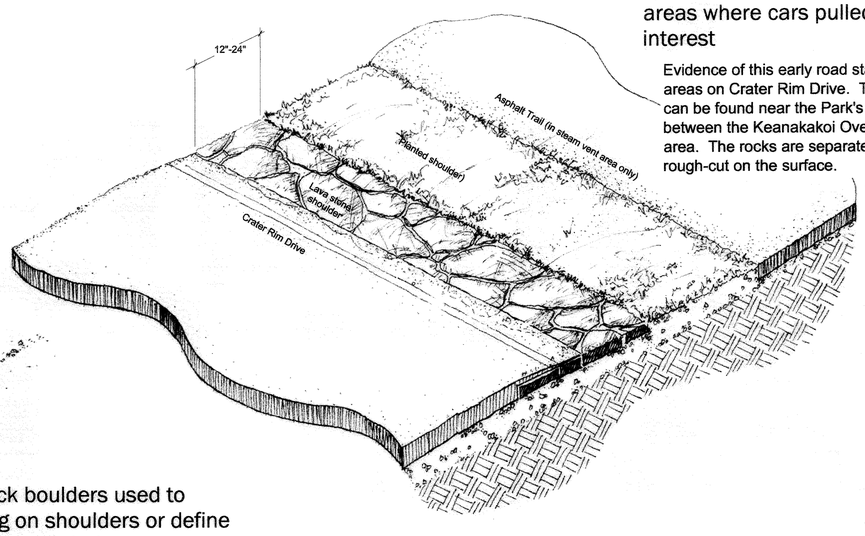
D) Steps at Kilauea Military Camp crosswalk

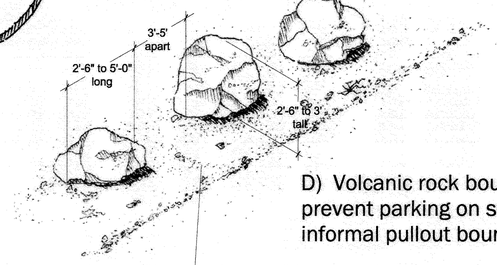


SCALE: 1/2" = 1'-0"

F) Volcanic rock pavers added to road shoulder at areas where cars pulled off to see sights of interest

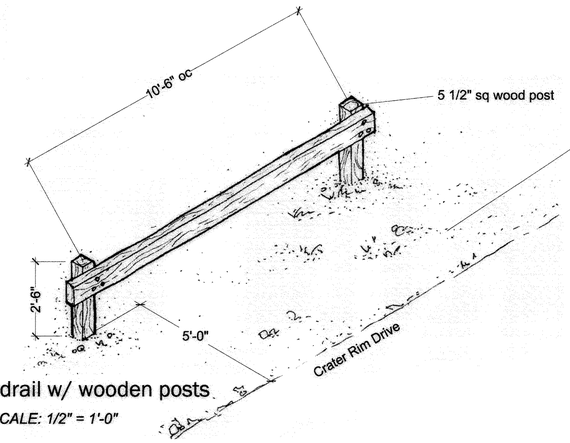
Evidence of this early road stabilization method is apparent in two areas on Crater Rim Drive. The dry laid lava rock road shoulder can be found near the Park's entry in the steam vent area and between the Keanakakoi Overlook and Devastation Trail parking area. The rocks are separated by butt-joints and are flat and rough-cut on the surface.



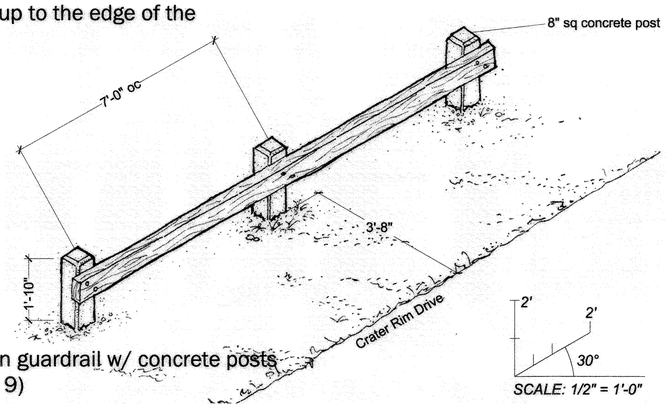


D) Volcanic rock boulders used to prevent parking on shoulders or define informal pullout boundaries

Road Shoulders were mixed with soil and seeded to promote vegetation up to the edge of the pavement

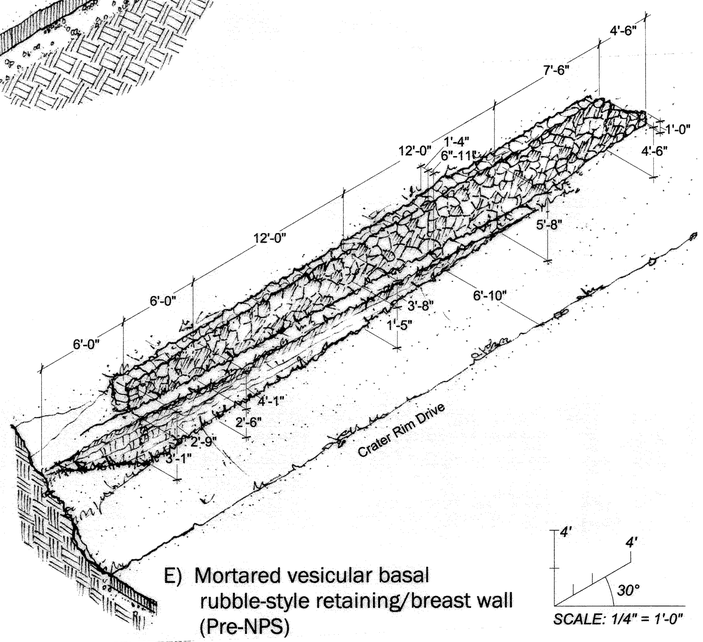


B) Wooden guardrail w/ wooden posts (Type 9) *SCALE: 1/2" = 1'-0"*



C) Wooden guardrail w/ concrete posts (Type 9)

SCALE: 1/2" = 1'-0"



E) Mortared vesicular basal rubble-style retaining/breast wall (Pre-NPS)

SCALE: 1/4" = 1'-0"

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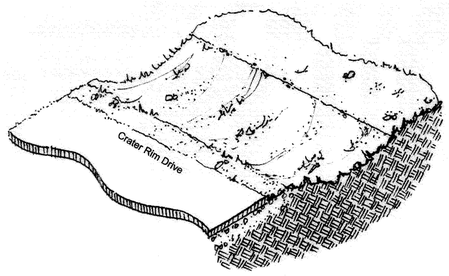
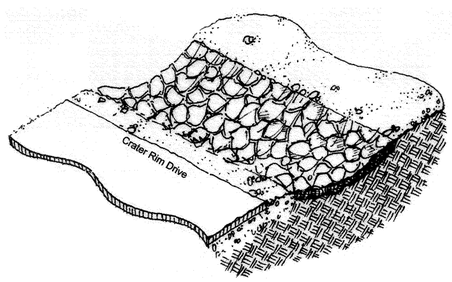
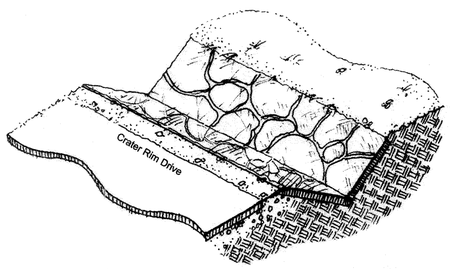


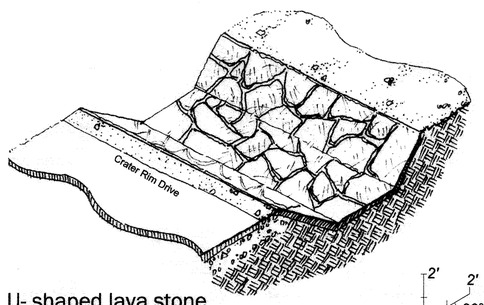
Earthen swale



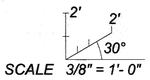
Rubble lava rock gutter



V - shaped lava stone with mortar gutter



U- shaped lava stone with mortar gutter



SCALE 3/8" = 1'- 0"

SCALE 1" = 1'- 0"

Drainage Principles of
Crater Rim Drive

The heavy rains at the park required a drainage system on Crater Rim Road to prevent it from being washed out. During the 1930s the CCC sloped the banks of the road corridor for aesthetic reasons and for diverting water. Erosion control measures include a variety of stone drainage gutters and hand laid riprap.

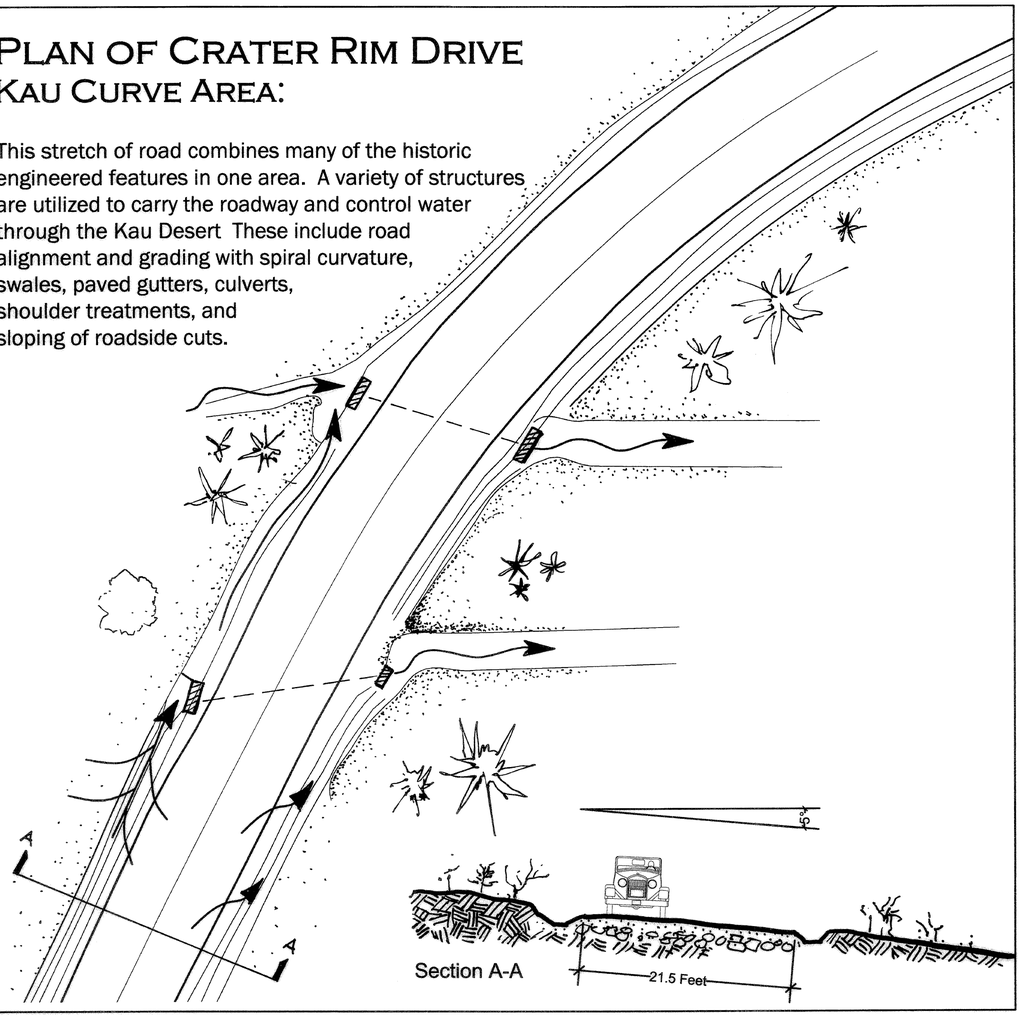
Crater Rim Drive has a number of drainage swales and gutters constructed in a variety of ways. The design and implementation of these structures are based upon the topography, porosity of the soil, and amount of overhead and groundcover plants in the drainage area being served. Gutters, mostly constructed of cut lava rock, catch storm water and channel it into culverts and away from the road.

Construction of a lava stone gutter on Crater Rim Drive

Historically, a variety of different sized and shaped lava rock has been used throughout the construction of all of the Park's roads as a base and stabilizing material. Using native materials in hardscape features is one of the National Park Service's most important construction methods since it integrates the natural landscape into new construction and as a conservation measure since these materials could often be harvested, collected, or quaried from the site itself.

Plan of Crater Rim Drive
Kau Curve Area:

This stretch of road combines many of the historic engineered features in one area. A variety of structures are utilized to carry the roadway and control water through the Kau Desert These include road alignment and grading with spiral curvature, swales, paved gutters, culverts, shoulder treatments, and sloping of roadside cuts.



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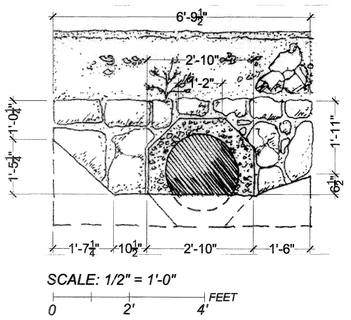
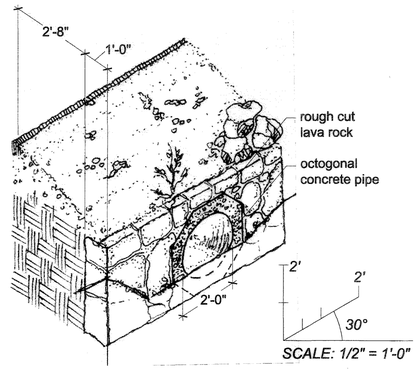
DRAINAGE PRINCIPLES OF
CRATER RIM DRIVE

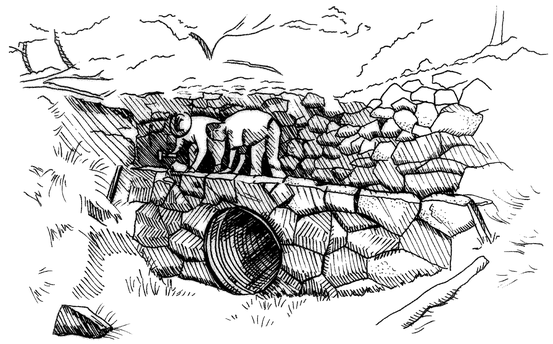
Culverts were another measure implemented. A variety of culvert types drain the historic Crater Rim Drive corridor. Concrete pipes had to be used in certain sections because the sulfur in the air near the craters caused corrugated metal to corrode. Most headwalls were constructed of lava rock to blend with the terrain.

Much like the gutters that lead to these culverts, the design of these structures is also based upon the topography, porosity of the soil, and amount of overhead and groundcover plants in the area. Most of the culverts in the park were built using CCC labor.

A) Coursed rough cut lava headwall with concrete octoganal pipe (Typical)

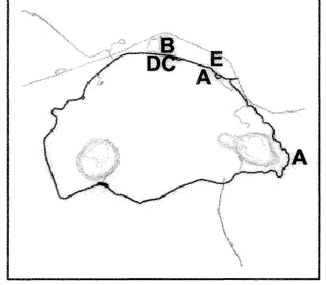




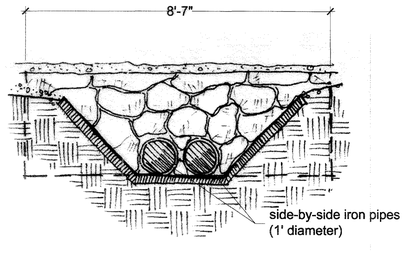


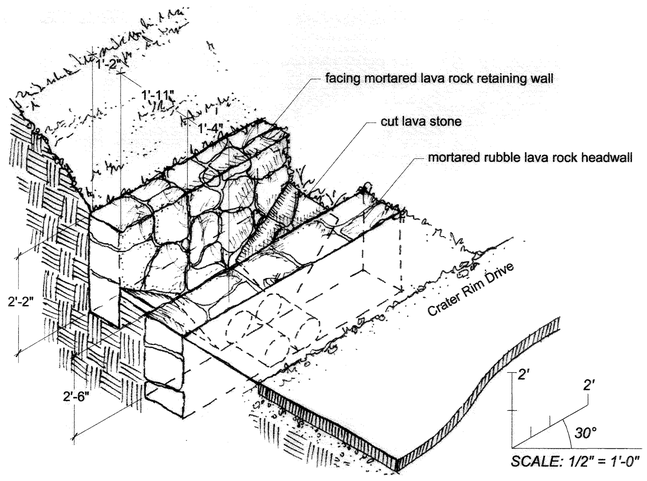
Construction of a culvert headwall on one of Hawaii Volcanoes National Park's roads

KEY (NOT TO SCALE)

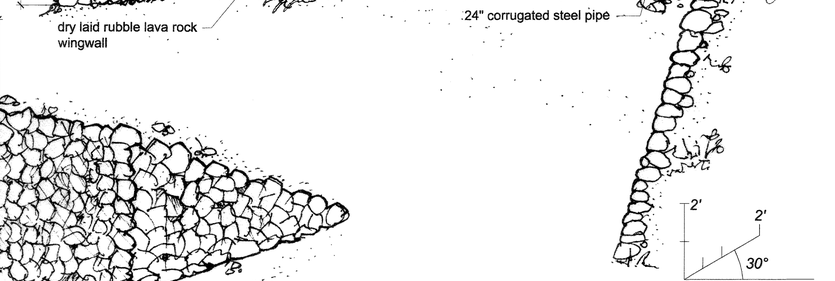


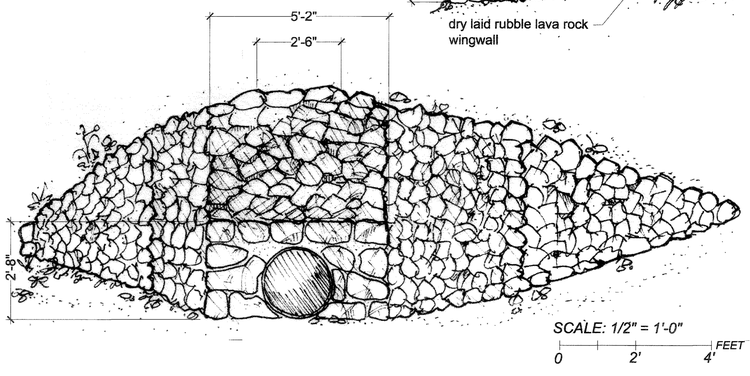
B1) Rectangular mortared rubble lava rock inlet headwall (shown below) with facing retaining wall with side by side pipes (Atypical)



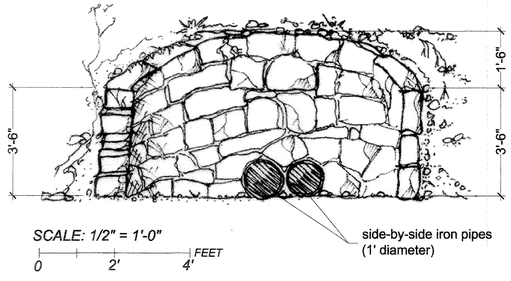


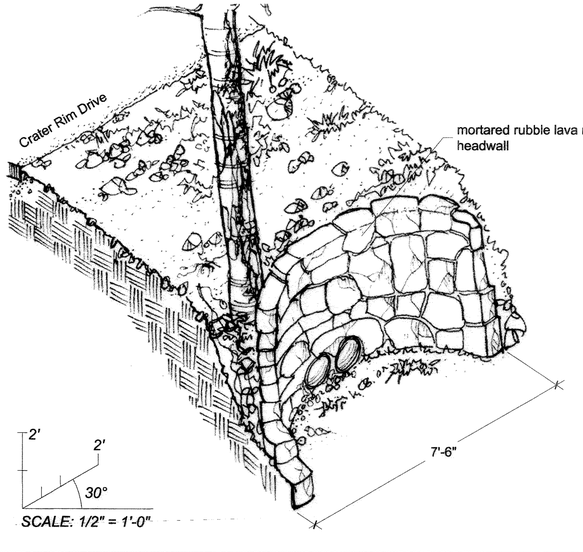
C) Drylaid lava rock winged inlet headwall (Atypical)



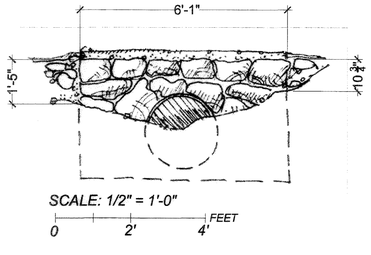


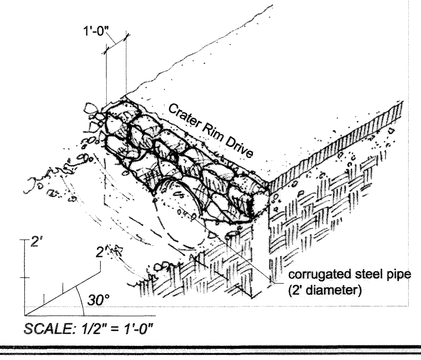
B2) Curved mortared rubble lava rock outlet headwall with side by side pipes (Atypical)





D) Mortared lava rock inlet headwall w/ corrugated steel pipe (Typical)





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Crater Rim Drive

Mauna Loa Road

Mauna Loa Road Connector
(built 1930s/abandoned 1960s

Mamalahoa Highway (11)

to KONA

Peter Lee Road

Kilauea Military Camp

Mamalahoa Highway (11)

Sulfur Banks Trail

Volcano Art Center

Kilauea Visitor Center

Entrance Station

Volcano House Hotel

Crater Rim Trail

Kilauea Overlook

Hawaiian Volcano Observatory

Jaggar Museum
4078ft (1243m)

Lava flows before 1924

Waldron Ledge

Crater Rim Trail

Halema'uma'u Trail

Kilauea Caldera

Escape Road

Old Road to Hilo

Mamalahoa Highway (11)

to HILO

Kilauea Iki Overlook

Kilauea Iki Crater

Kilauea Iki Trail

Pu'u Pua'i
3885ft

Thurston Lava Tube

Pu'u Pua'i Overlook

Lava flows before 1924

Byron Ledge Trail

Halema'uma'u Crater
3412 ft, 1040m

Halema'uma'u Overlook

Devastation Trailhead

Old Kaunou Road

Kau Desert Trail

Crater Rim Drive

Southwest Rift

Lava flows before 1924

Keanakako'i Overlook

Keanakako'i Crater
3478ft

Chain of Craters Road

Crater Rim Trail

1971 1974 1975 1982 1954 1959

1219m 1169m 1119m 1069m

LEGEND

N W E S

- Lava Flows
- Park Boundary
- Current Roads
- Old Road Alignments
- Trails
- Proposed Roads

KEY

Scale: 1"= 1,000'

0 2,000 4,000 6,000 8,000 feet

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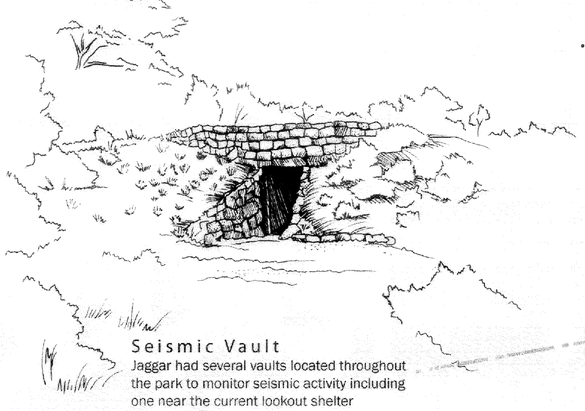
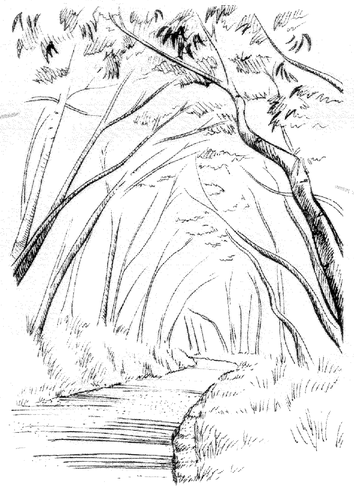
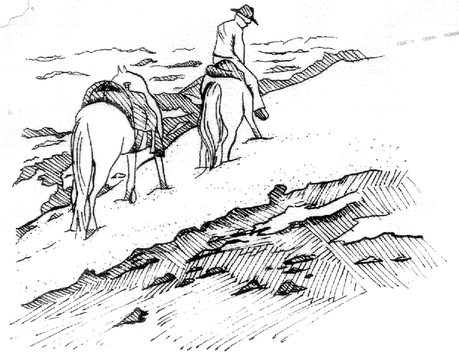
Overview of Mauna Loa Road

Thomas A. Jagger
A pioneer in the field of volcanology, Jaggar established the Hawaiian Volcano Observatory & Museum. He researched volcanic and seismic activity at various locations within the park's boundaries.

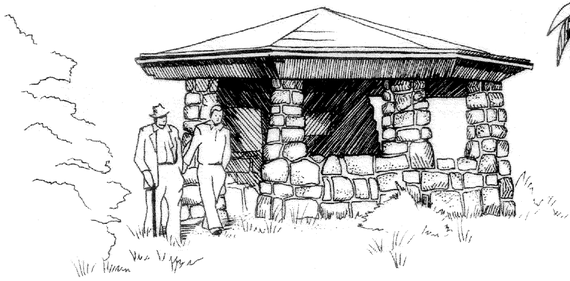


Seismic Vault
Jaggar had several vaults located throughout the park to monitor seismic activity including one near the current lookout shelter





Route to the Summit of Mauna Loa
Originally a footpath, Jaggar established this trail as a route to conduct his scientific research at Moku'aweoweo Caldera. Mauna Loa Road was iitially planned as a route to the summit, but was only constructed to the current location of the shelter near the 7,000 ft. elevation

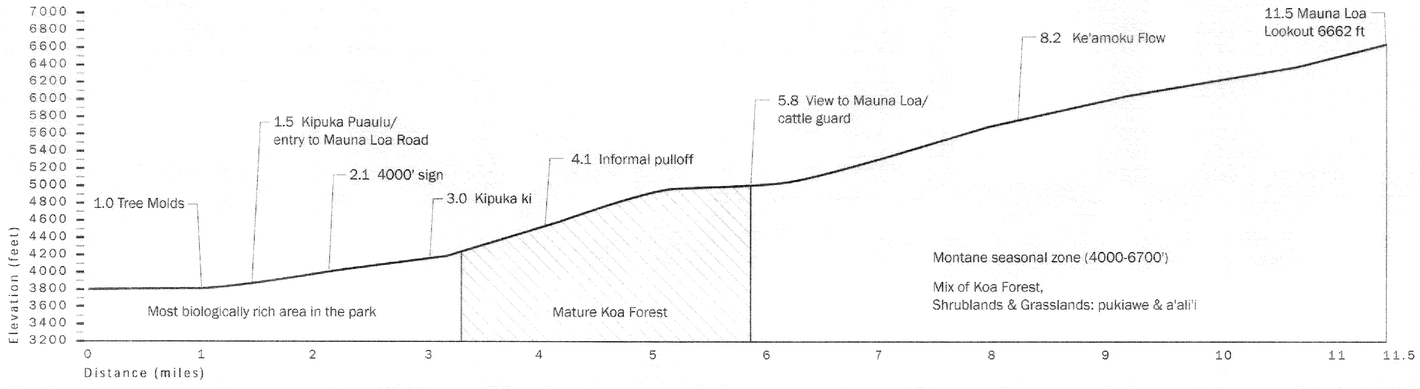


Mauna Loa Lookout:
This shelter was constructed by the CCC from 1937-1938 as a scenic overlook and trailside museum.

Koa
Acacia koa

Koa Forest
A hardwood tree endemic to Hawaii, koa dominates the canopy on the mid elevations on Mauna Loa Road

Road Elevation / Exaggerated Profile



The 1916 act that established the park included plans for a "strip of land of sufficient width for a road" to connect the Kilauea and Mauna Loa sections of the park. In 1920, there were three trails up to the summit, including the most traveled trail, Puu Ulaula (Red Hill). The trail had been constructed in 1915 by the 25th Infantry Division (a Buffalo Soldier regiment) to support Jagger's volcanic research on Mauna Loa. There was much support for constructing a road all the way to the summit, but without funding, the park decided to construct a truck trail using CCC labor. The truck trail was finished to 6,662' elevation in 1936, with a shelter at the end completed by the CCC in 1938. Although the Mauna Loa Road was never extended to 10,000', the Territory of Hawaii did not give up on its dream of a summit road. Over the years, the NPS policy and position on the summit road shifted. The idea of a summit road for Mauna Loa lost favor with the NPS, as park managers decided that Mauna Loa should be a place to experience nature in relative solitude, not a tourist highway. Travelers on the Mauna Loa Road can access the Tree Molds and Kipuka Puaulu (Bird Park), an oasis of forest. The road then travels 10 miles through lava flows and koa forests.

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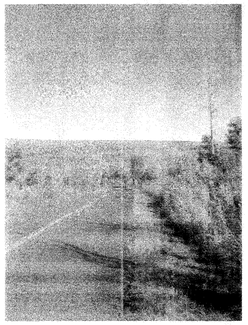
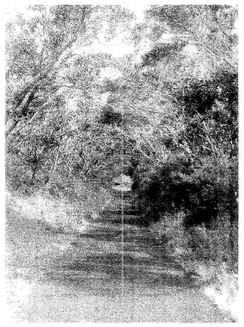
Views / Road Character



The first 1.5 miles of Mauna Loa Road is a fairly straight, two-lane road with grassy shoulders leading to Bird Park.

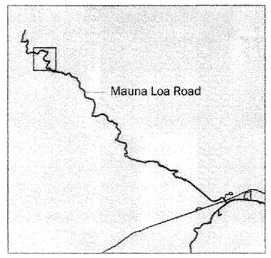


The road, averaging 10-12' wide after Bird Park, passes through a dense koa forest, with grassy shoulders no more than 2' wide.

After the Koa forest, the scenery opens to occasional brushy clearings, with several informal pulloffs along the road.

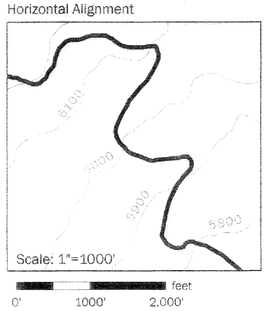
The road traverses the Keamoku Flow, an a'a field that required large cuts and fills during construction as the road wound through it. Mauna Loa Road eventually ends at the Mauna Loa overlook where visitors can venture further on backcountry trails that pass through and over much of the same vegetation and geology they drove by.

Road Alignment

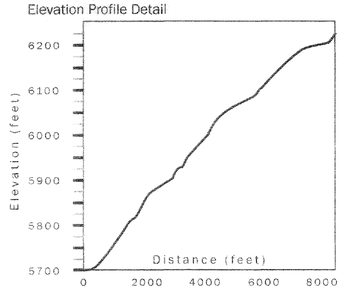


After the first 1.5 miles, Mauna Loa goes from a relatively straight, 20' wide road to a 10'- 11' wide road, with a maximum 6% grade (average of 5%). Curves have a maximum radii of 100' - 200'.

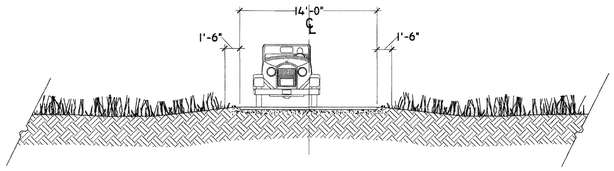
Horizontal Alignment



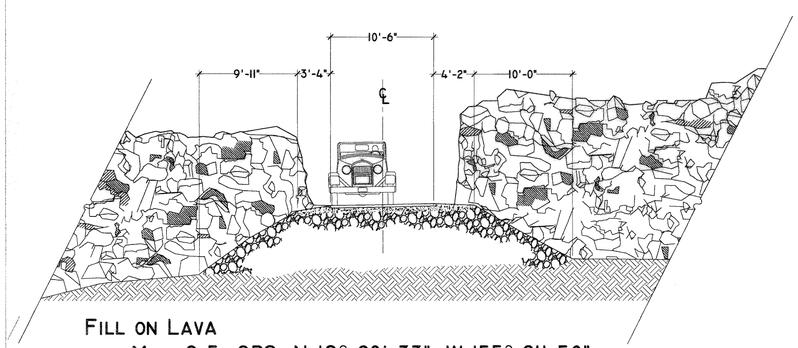
Elevation Profile Detail



Road Section / Elevations

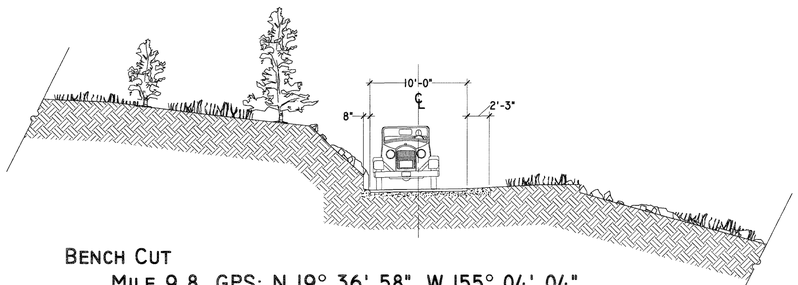


TYPICAL GRASSLANDS SECTION
MILE 1.3, GPS: N 19° 25' 52", W 155° 17' 03"

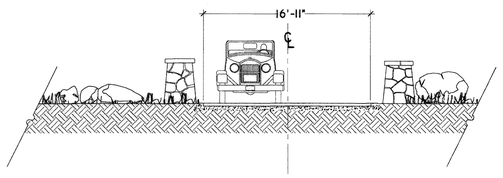


FILL ON LAVA
MILE 9.5, GPS: N 19° 28' 33", W 155° 21' 50"

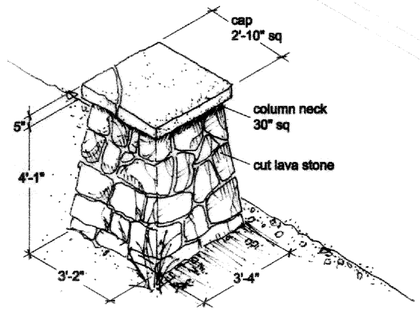
LAVA CUT
MILE 9.5, GPS: N 19° 28' 33", W 155° 21' 49"

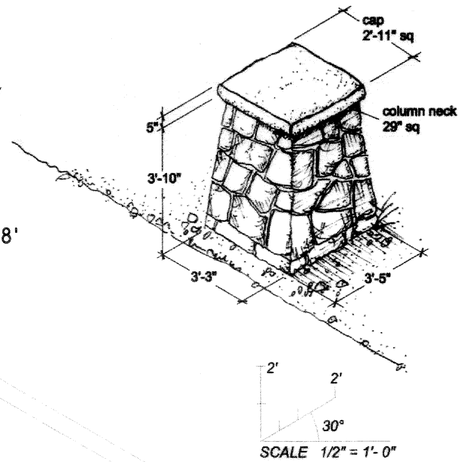


BENCH CUT
MILE 9.8, GPS: N 19° 36' 58", W 155° 04' 04"



ENTRY FEATURE
MILE 0.0, GPS: N 19° 26' 14", W 155° 18'





Mauna Loa Road Entry Pylons
(Located at Bird Park parking area)

CHARACTER OF

MAUNA LOA ROAD

Mauna Loa Road affords visitors an isolated, narrow, rustic drive up the slope of Mauna Loa into the higher altitude landscapes characterized by broomshedge grasses, Koa groves, and lava flows with panaramic views over the caldera and Kau Desert towards the ocean. The journey is completed by a stop at the picturesque shelter with interpretive panels at 6,662' elevation.

CCC crews used dynamite to blast through the pahoehoe lava fields and also made use of a compressor and portable rock crusher during construction of Mauna Loa Road. At times, the CCC crew also had to make cuts and fills by hand. In one section, excavation had to be done using hand drills and wheelbarrows because it was impossible to detour a truck around the a'a. When completed in 1936, the road was surfaced with loose gravel mixed with sand and dirt filler. From 1955 through 1956, the road was widened and graded for improved access.

CCC Construction over a field of a'a, Mauna Loa Road

MAUNA LOA ROAD

Pu'u 'Ula'ula
(Red Hill) Cabin
10035 ft

Mauna Loa Trail

Proposed Road to Summit

Mauna Loa Lookout
6662ft

Old Truck Trail

Keamoku Flow

Mauna Loa Trail

Red Hill Trail

Mauna Loa Road

Kipuka Ki

Kipuka Puaulu

Bird Park

Mauna Loa Trail

Tree Molds

Mamalahoa Highway (11)

Old Peter Lee Road

Crater Rim Drive

Kilauea Caldera

9000
8500
8000
7500
7000
6500
6000
5500
5000
4500
4000

LEGEND

N
W E
S

- Park Boundary
- Current Roads
- Old Road Alignments
- Trails
- Proposed Roads

KEY

Scale: 1"= 2,000'

0 4,000 8,000 16,000 24,000 feet

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HAWAII VOLCANOES NATIONAL PARK ROADS
HAWAII COUNTY
HAWAII

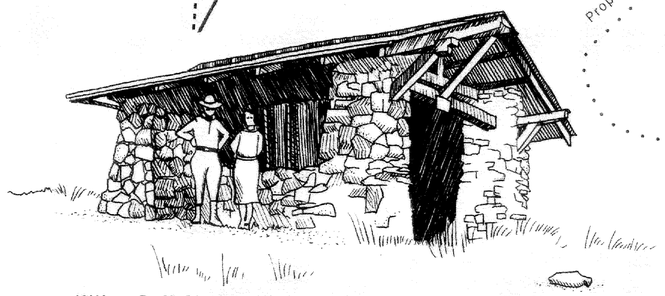
HAWAII VOLCANOES

DELINEATED BY: STACY DAY, 2006

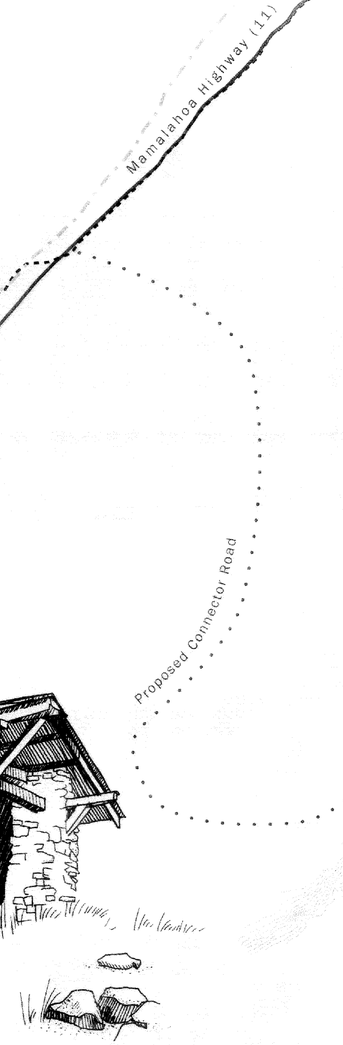
NATIONAL PARK SERVICE ROADS
RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

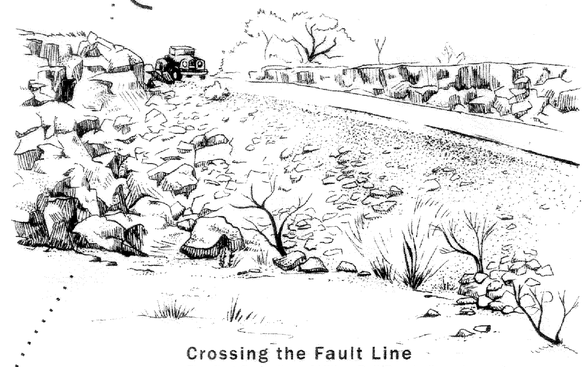
Overview of Hilina Pali Road

Hilina Pali Overlook
With a spectacular view from the top of Hilina Pali out to points along the coast and beyond to the Pacific, the end of the road also offers access to many backcountry trails leading through wilderness areas.



Hilina Pali Shelter
This shelter at the end of Hilina Pali Road was built by a park friends group, Hui O Pele. It was donated to the park in 1930, before the road had been constructed.





Crossing the Fault Line
The first five miles of Hilina Pali Road allow views of one of the finest examples of geological faulting in the Hawaiian Islands. The road crosses the fault line at mile 3.6.

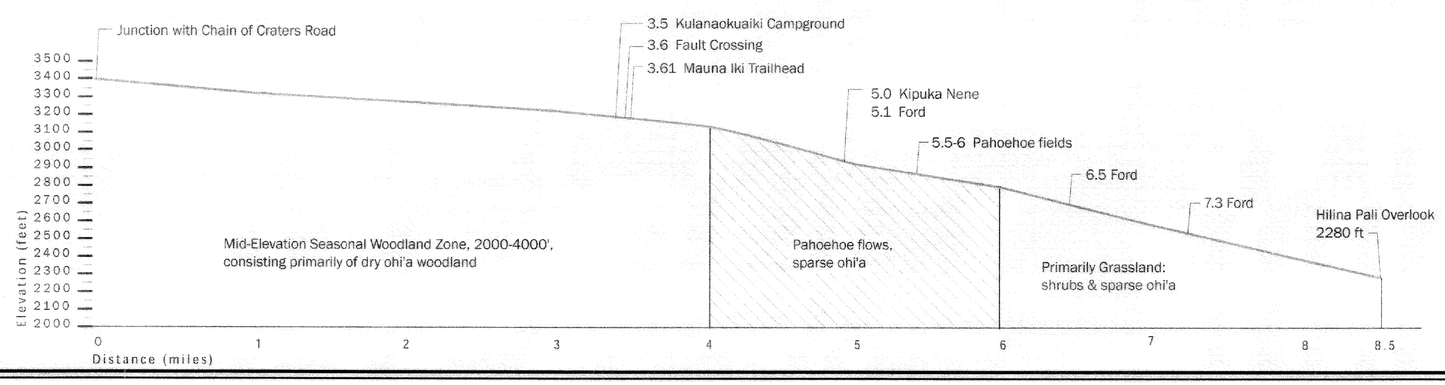
Ohi'a lehua
rosideros-polymorpha

LEGEND
- Park Boundary
- Current Roads
- Old Road Alignments
- Trails
- Proposed Roads

N
W E
S

Scale: 1"= 4,000'
0 8,000 16,000 feet

Road Elevation / Exaggerated Profile



In 1927, Park Superintendent Evans wrote that Hilina Pali "constitutes a fine objective for an auto trail." Even though there was no automobile road to the overlook, Hui o Pele built a lava rock shelter at the edge of the cliff and donated it to the park in 1930. The Park Service made use of a horse trail to the overlook, so improvements were needed to make the road passable for automobiles.

From the 1930s through the 1950s, park funds were expended when available on improving the road, and construction occurred sporadically as a result.

The CCC worked on the road from 1939 to 1942, and the park completed construction in 1949, although work continued into 1953. The completed road afforded travelers views of the Koa'e fault and lava flows as well as grasslands before terminating at the overlook where visitors could see the Pacific Ocean and the expansive Kau coastline.

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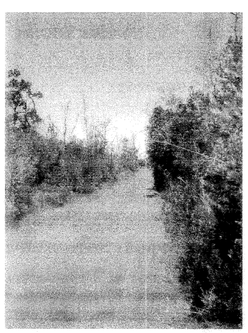
DELINEATED BY: STACY DAY, 2006

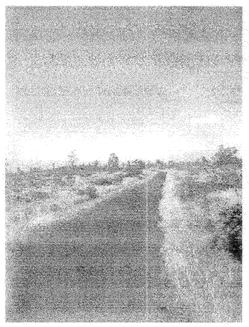
Views / Road Character



The first segment of Hilina Pali Road is relatively straight, with slight grades and easy curves through ohi'a forests.

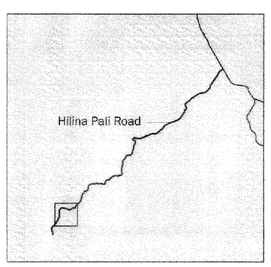
Due to clouds of volcanic smog wafting from the Puu'O'o eruption, many trees have died. A variety of shrubs and ground cover have since taken root on the pahoehoe flows.

The road passes through old lava flows, occasionally cutting through the lava or going over it. It limits the driver's sight distance at times, but it always keeps the drive interesting.



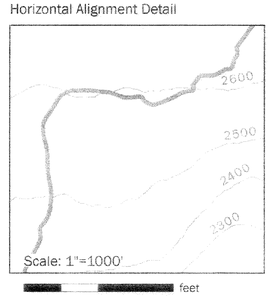
Toward the end of Hilina Pali Road, the vegetation becomes predominantly grassland, and the road descends and winds with average grades of 5% until the end of the road.

Road Alignment



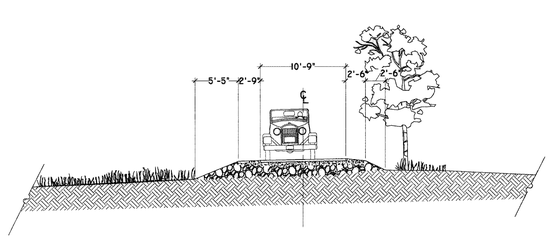
Hilina Pali Road averages 12' in width, with an average grade of 2-3%, though several grades reach 5-6%.

Horizontal Alignment Detail

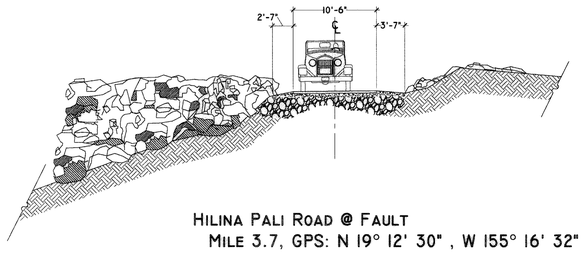


Elevation Profile Detail

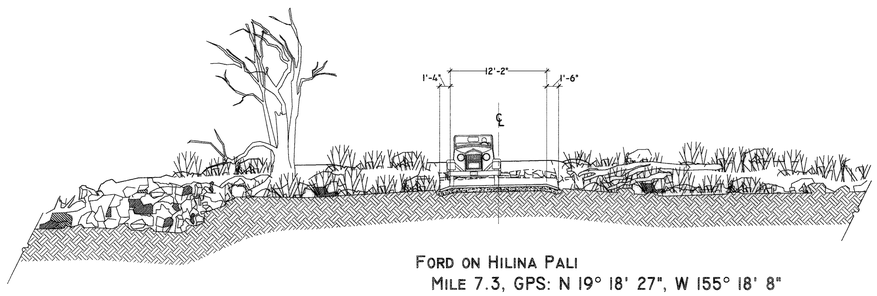
Road Section / Elevations



ROAD ON FILL
MILE 2.6, GPS: N 19° 20' 58", W 155° 15' 10"



HILINA PALI ROAD @ FAULT
MILE 3.7, GPS: N 19° 12' 30" , W 155° 16' 32"

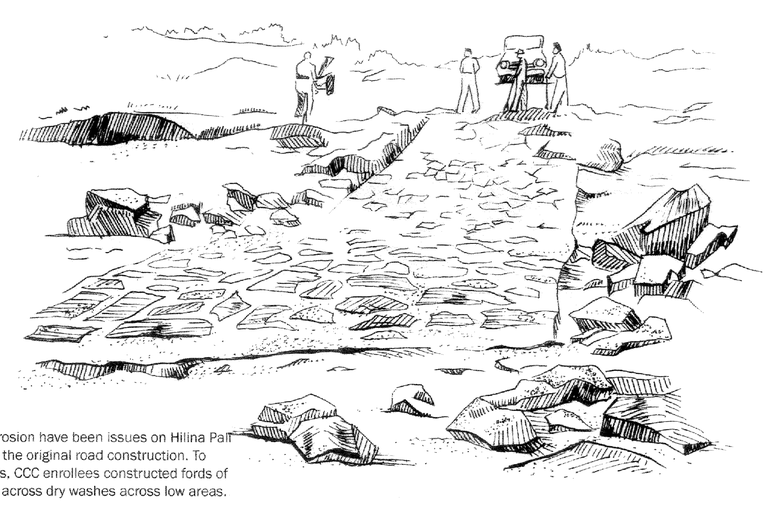


FORD ON HILINA PALI
MILE 7.3, GPS: N 19° 18' 27", W 155° 18' 8"

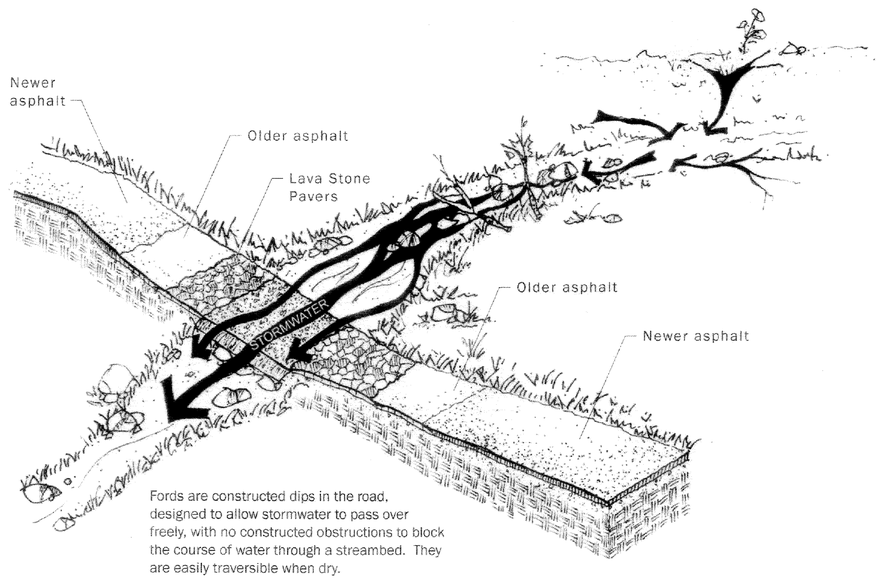
CHARACTER OF

HILINA PALI ROAD

Hilina Pali Road is a 12' wide, one lane road with limited shoulders. Its route essentially follows a survey done in the mid-1930s by the National Park Service's engineering branch. As constructed, the road had a 6" base of crushed a'a lava with a 2" layer of volcanic ash or crushed rock and was surfaced with crude oil. The rock fill came from blasting through the lava flows through which the road travels. In 1950, the steeper grades had to be paved because flooding damaged the oiled surface. Furthermore, culverts constructed by the Civil Conservation Corps in 1934 proved inadequate to handle the heavy flooding in the area that occurred in 1939, 1945, and 1950. A grouted lava rock wash was built in 1941, but it was not until 1950 that three others were added to replace the culverts, check dams, and retaining walls that had been damaged by excessive rains.



Rain and erosion have been issues on Hilina Pali Road since the original road construction. To address this, CCC enrollees constructed fords of native rock across dry washes across low areas.



Fords are constructed dips in the road, designed to allow stormwater to pass over freely, with no constructed obstructions to block the course of water through a streambed. They are easily traversible when dry.

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HAWAII VOLCANOES
DELINEATED BY: JAY WOLVOVSKI, STACY DAY, 2006
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NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR
LIBRARY OF CONGRESS INDEX NUMBER
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HILINA PALI ROAD

Mamalahoa Highway (11)

to KONA

Ka'u Desert Trail

Mauna Iki Trail

Chain of Craters Road

Hilina Pali Road

Kulanaokuaiki Campground

Fault Line

Kipuka Nene

Halape Trail

Hilina Pali Overlook
2280 ft

Proposed Loop Road

Hilina Pali Trail

3500

3000

2500

2000

500

LEGEND

N
W E
S

- Park Boundary
- Current Roads
- Old Road Alignments
- Trails
- Proposed Roads

KEY

Scale: 1"= 2,000'

0 4,000 8,000 16,000 24,000 feet

DELINEATED BY: STACY DAY, 2006

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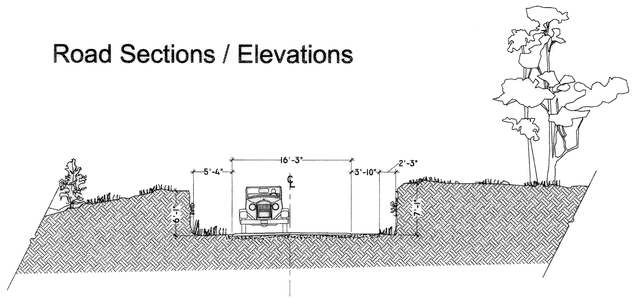
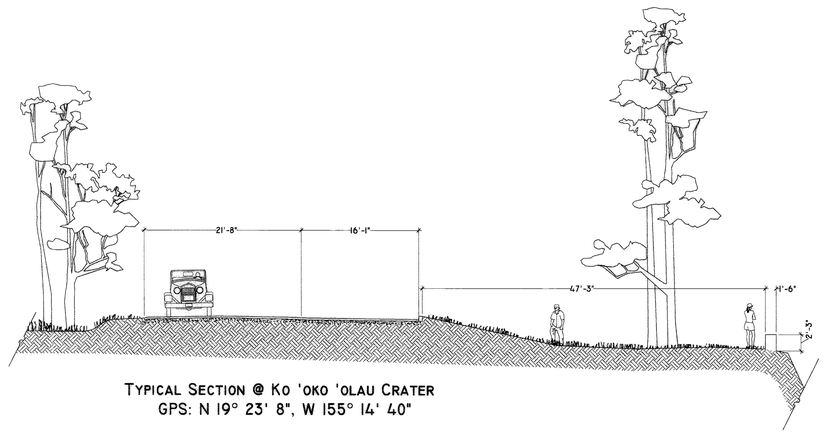
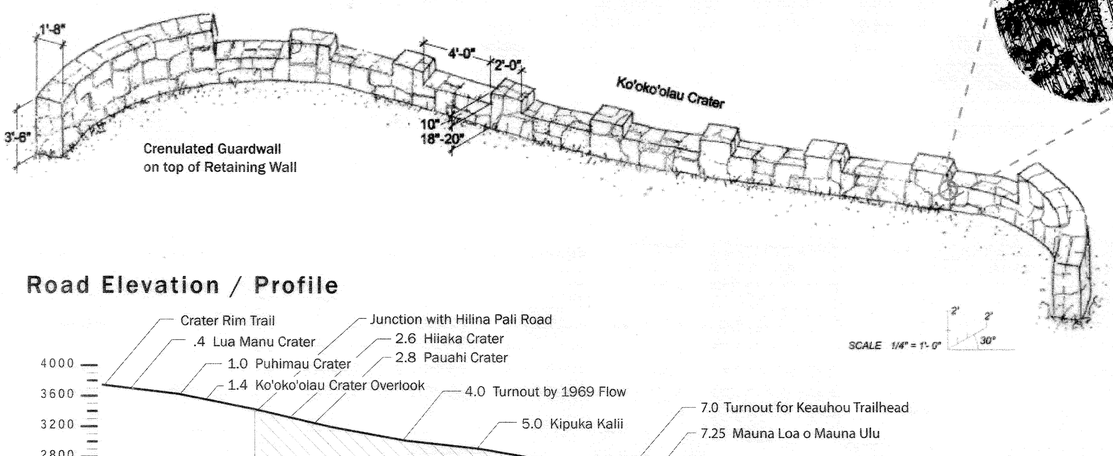
Road Sections / Elevations



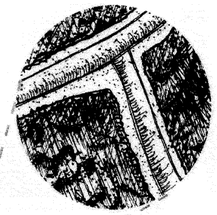
CUT AT MAUNA ULU
GPS: N 19° 21' 57", W 155° 13' 9"



TYPICAL SECTION @ KO 'OKO 'OLAU CRATER
GPS: N 19° 23' 8", W 155° 14' 40"



Crenulated Guardwall
on top of Retaining Wall

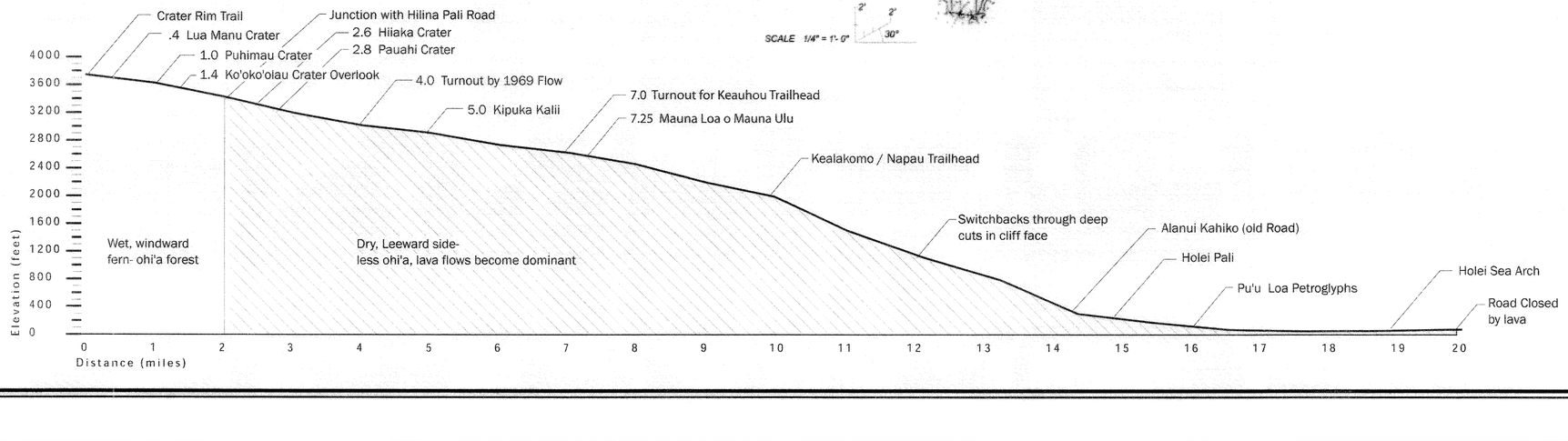


Scale: 1" = 1"

One of the park's more unique examples of masonry can be found at Ko'oko'lau Crater on Chain of Craters road. This is the only wall in the park that has square crenellations and a 'beaded joint.' The beaded joint is centered and consistent throughout the wall's mortar.

SCALE 1/4" = 1'-0"

Road Elevation / Profile



CHARACTER OF CHAIN OF CRATERS

LEGEND:

- Lava Flows
- Park Boundary
- Current Roads
- Old Road Alignments
- Trails
- Proposed Roads

Park Service officials in the early 1920s advocated for the construction of a road through the park's pit crater district to increase the recreational and sightseeing opportunities for visitors. In 1927, work began on the Chain of Craters Road, and it opened in April 1928. The original alignment connected eight craters, ending at Makaopuhi Crater. In 1960, work began on the Kalapana extension of the road after years of discussion and land negotiations. The extension opened in 1965, but just four years later the eruption of Mauna Ulu destroyed a 3-mile section of road. From 1969-1974, lava flows and earthquakes continued damaging the road and preventing its use. The park had the road rebuilt on a new alignment, and it reopened to the public in 1979. When Kilauea erupted at Puu Oo in 1983, however, the last 4 miles of the road were covered. The Chain of Craters Road represents the challenge in transporting visitors through an active volcanic landscape. The alterations to the road have been the result of natural phenomena, which continues to reshape the landscape.

DELINEATED BY: STACY DAY, JAY WOZNIAK, 2006

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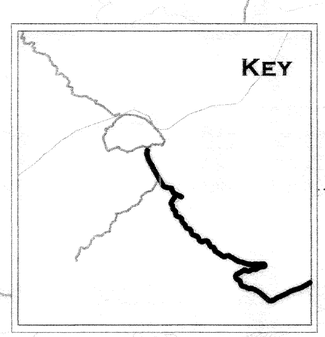
Chain of Craters Road

Kilauea Caldera
Crater Rim Drive
Crater Rim Trail
Lua Manu Crater Overlook
Puhimau Crater Overlook
Ko'oko'olau Crater Overlook
Crockett Trail
Escape Road/ old Keahou Road
Pauahi Crater
Pauahi Crater Overlook
Mauna Ulu
Napau Trail
Napau Crater
Mauna Ulu Parking/Trailhead
Chain of Craters Road
Hilina Pali Road
Kipuka Kahali'i
Mauna Loa o Mauna Ulu (2680 ft)
Muliwai a Pele
Naulu Trail
Kalapana Trail
Proposed Road to Kalapana
Kealakomo
Halona Kahakai
Keauhou Trail
Alanui Kahiko
Holei Pali
Road Closed by Lava
Pu'u Loa Petroglyphs
Holei Sea Arch
Puna Coast Trail
Pacific Ocean

1982
1974
1969
1965-68
1983-2000s
1969-74
1969-74
1969-74
1969

3500
3000
2500
2000
1500
1000
500
2500
2000
1500
1000
500

Key



Legend

N
W E
S

- Lava Flows
- Park Boundary
- Current Roads
- Old Road Alignments
- Trails
- Proposed Roads

Scale: 1"= 3,000'

0 6,000 18,000 24,000 30,000 feet

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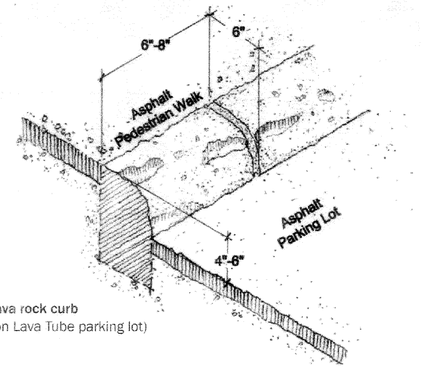
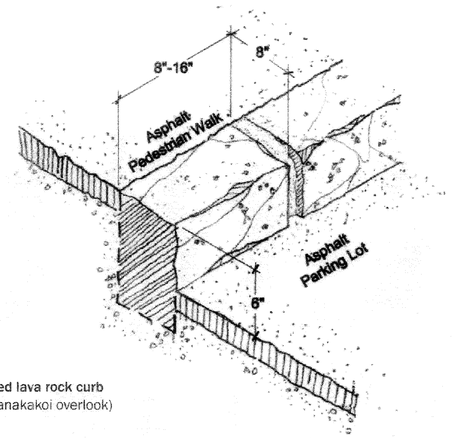
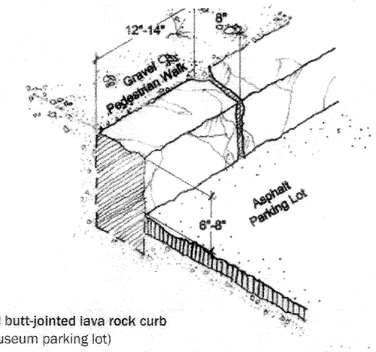
CURBS



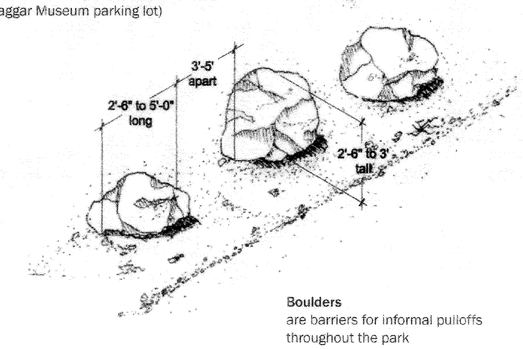
Mortared lava rock curb
(ex. Thurston Lava Tube parking lot)



Mortared lava rock curb
(ex. Keanakakoi overlook)

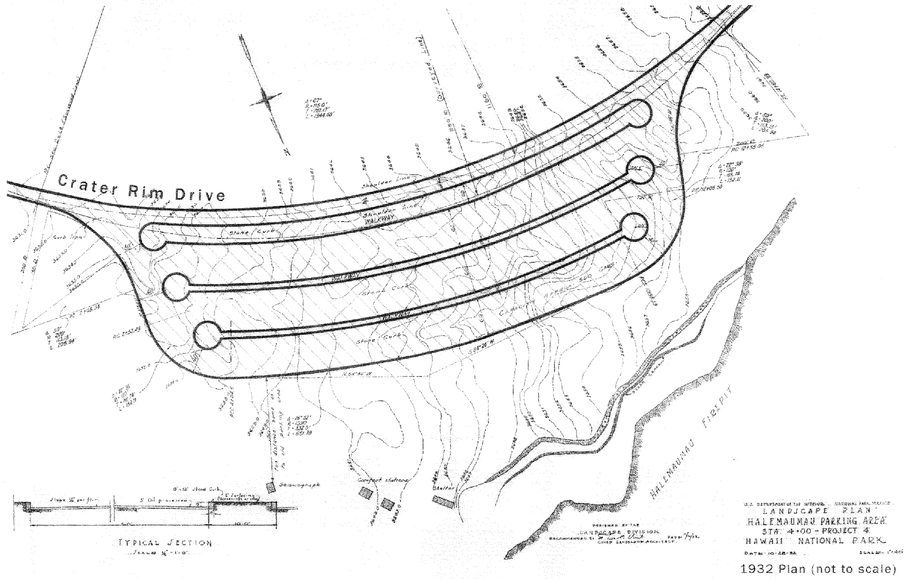


Block cut and butt-jointed lava rock curb
(ex. Jaggar Museum parking lot)



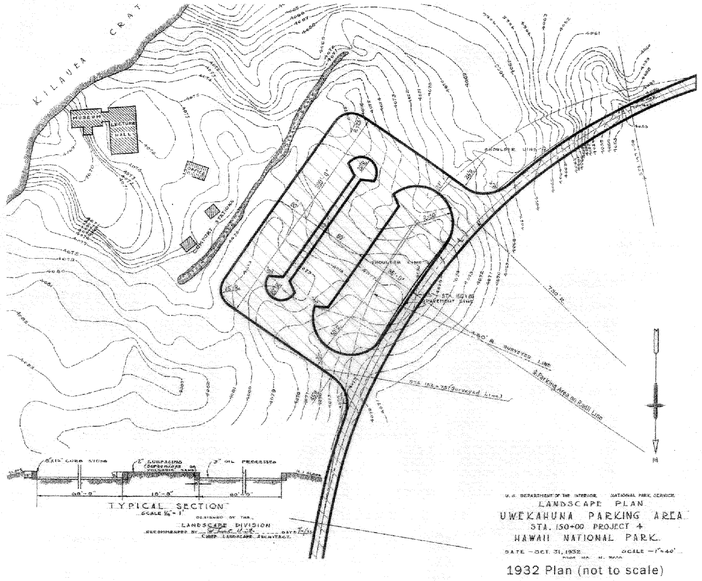
Boulders
are barriers for informal pulloffs throughout the park

PARKING LOTS



1932 Plan (not to scale)

Halemaumau Parking area was first constructed in 1922 to accomodate 50 cars. It has experienced many changes over the years due to volcanic activity and increased visitor attendance. As early as 1929, it was expanded to accommodate 500 cars, and currently remains a popular pulloff for cars and large tour buses to view the smoldering crater.



1932 Plan (not to scale)

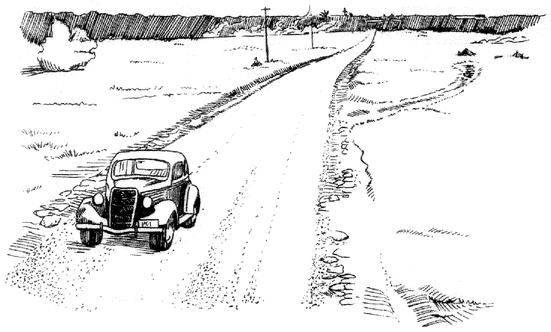
The Jaggar Museum & Hawaii Volcano Observatory Parking lot was originally built in 1932 to serve the museum built in 1927. It has since been expanded to accommodate tour buses.

HAWAII VOLCANOES NATIONAL PARK'S

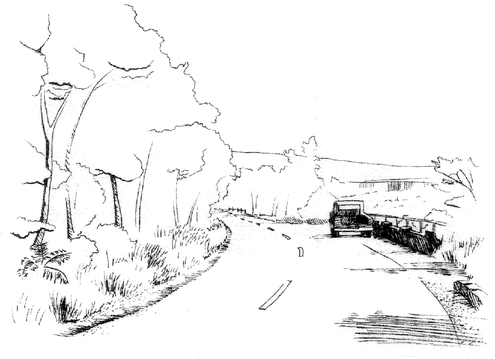
MOTORIST WAYSIDES

Waysides serve many purposes within Hawaii Volcanoes National Park. They provide access to attractions and views, parking for visitor exploration, and function as safety pullouts, allowing other vehicles to pass. There are several types of waysides; including parking lots, formally designed pulloffs, and informal pulloffs. Parking lots and formal pulloffs, such as the Halema'uma'u parking area and the Kilauea Iki pulloff, are spaces developed around particular attractions, designed to accomodate a certain number of vehicles. Informal pulloffs evolve from impromptu use, serving as short-term parking areas, turnaround points, or for maintenance access. In the park, informal pulloffs are generally bounded by lava boulders, formal parking areas are curbed. Due to fluxes in tourist visitation as a response to eruptions and other natural events unique to Hawaii Volcanoes National Park, many pulloffs and small parking areas were developed into larger, formal parking lots to accommodate additional traffic.

PULLOFFS



In 1927, the Sulfur Banks Road, initially served as an informal pulloff on the north rim of Kilauea caldera, provided easy access to an area where gases snd steam seeped from the ground. It has since evolved into a formal parking area.



From the 1930s through the 1950s, the Kilauea Iki Overlook was a scenic pulloff designed with a parapet wall to protect visitors from a 640' dropoff. After the Kilauea Iki eruption in 1959, which attracted 198,605 visitors in one month, the road was expanded and this viewpoint was developed into a parking area.

DELINEATED BY: JAY WOLTMAN, STACY DAY, 2005

NATIONAL PARK SERVICE ROADS
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NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

HAWAII VOLCANOES NATIONAL PARK ROADS
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HAWAII VOLCANOES NATIONAL PARK ROADS — HAER No. HI-47
Hawaii Volcanoes National Park
Volcano Vicinity
Hawaii County
Hawaii

INDEX TO HISTORIC PHOTOGRAPHS

All of the images are photographic copies of historic photographs belonging to Hawaii Volcanoes National Park, housed in the park library. For all of the images, the photographer is unknown.

HI-47-1 ROCK SHOULDER WORK. FROM LOOSE PHOTOGRAPHS COLLECTION. c. 1931-1932.

HI-47-2 CIVILIAN CONSERVATION CORPS ENROLLEES MARCHING IN THE KAMEHAMEHA DAY PARADE IN HILO. FROM "SUPERINTENDENT'S MONTHLY REPORT," JUNE 1934.

HI-47-3 FRANKLIN DELANO ROOSEVELT AT THE RIM OF HALEMAUMAU CRATER. FROM "SUPERINTENDENT'S MONTHLY REPORT," JULY 1934.

HI-47-4 "CONSTRUCTION WORK, ROCK-LINED DITCH, DESERT HILL." FROM "SUPERINTENDENT'S MONTHLY REPORT," JULY 1934.

HI-47-5 MAP OF HAWAII NATIONAL PARK ROADS. FROM "CIRCULAR OF GENERAL INFORMATION," 1932.

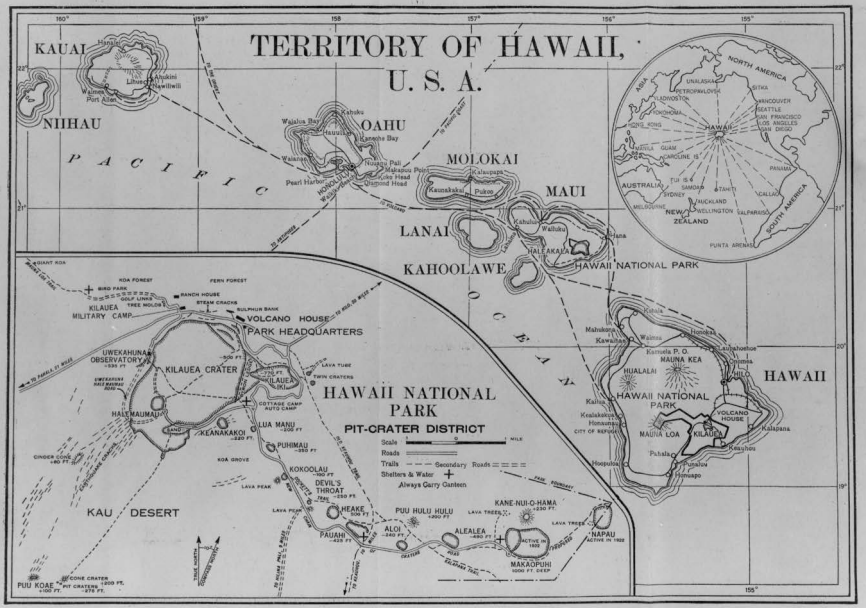
HI-47-6 MAP OF KILAUEA CRATER SECTION ROADS. FROM 1948 HAWAII NATIONAL PARK BROCHURE. TRACED BY JOHN J. BLACK, JANUARY 1948.

HAER No. HI-47-1

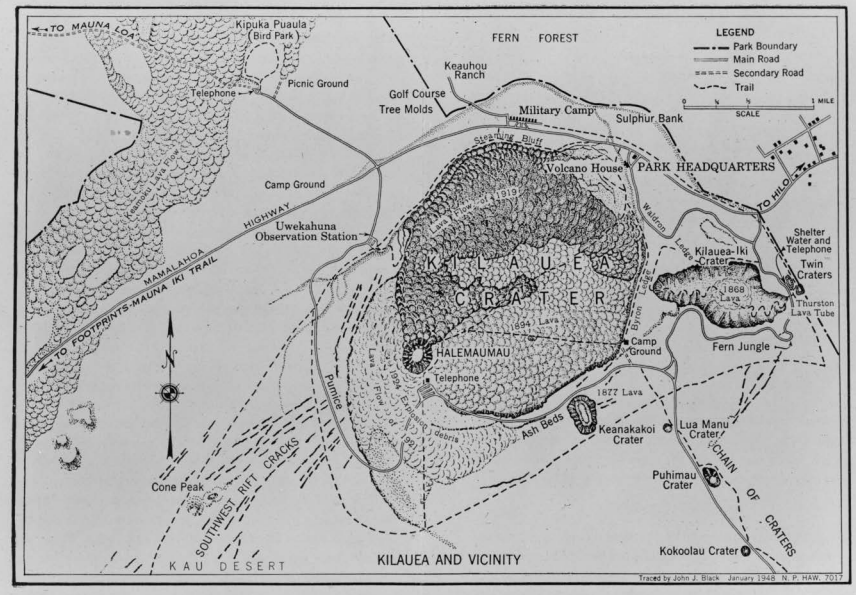
4 x 5

HAER No. HI-47-2.

HAER No. HI-47-3.



88868°—32. (Face p. 10.)



Valleys to the sea. The summit depression includes an area of over 19 square miles, and most of its floor lies more than 2,500 feet below the high western rim. Trade-wind rain