WAIMALU BRIDGE **HAER No. HI-115**
(Waimalu Stream Eastbound Bridge & Waimalu Stream Westbound Bridge)
Kamehameha Highway and Waimalu Stream
Pearl City
Honolulu County
Hawaii

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
U.S. Department of the Interior
National Park Service
Oakland, California

HISTORIC AMERICAN ENGINEERING RECORD

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David Franzen, Photographer May 2012

HI-115-1 OVERVIEW OF WAIMALU BRIDGES, WITH WESTBOUND BRIDGE ON RIGHT. VIEW FACING WEST.

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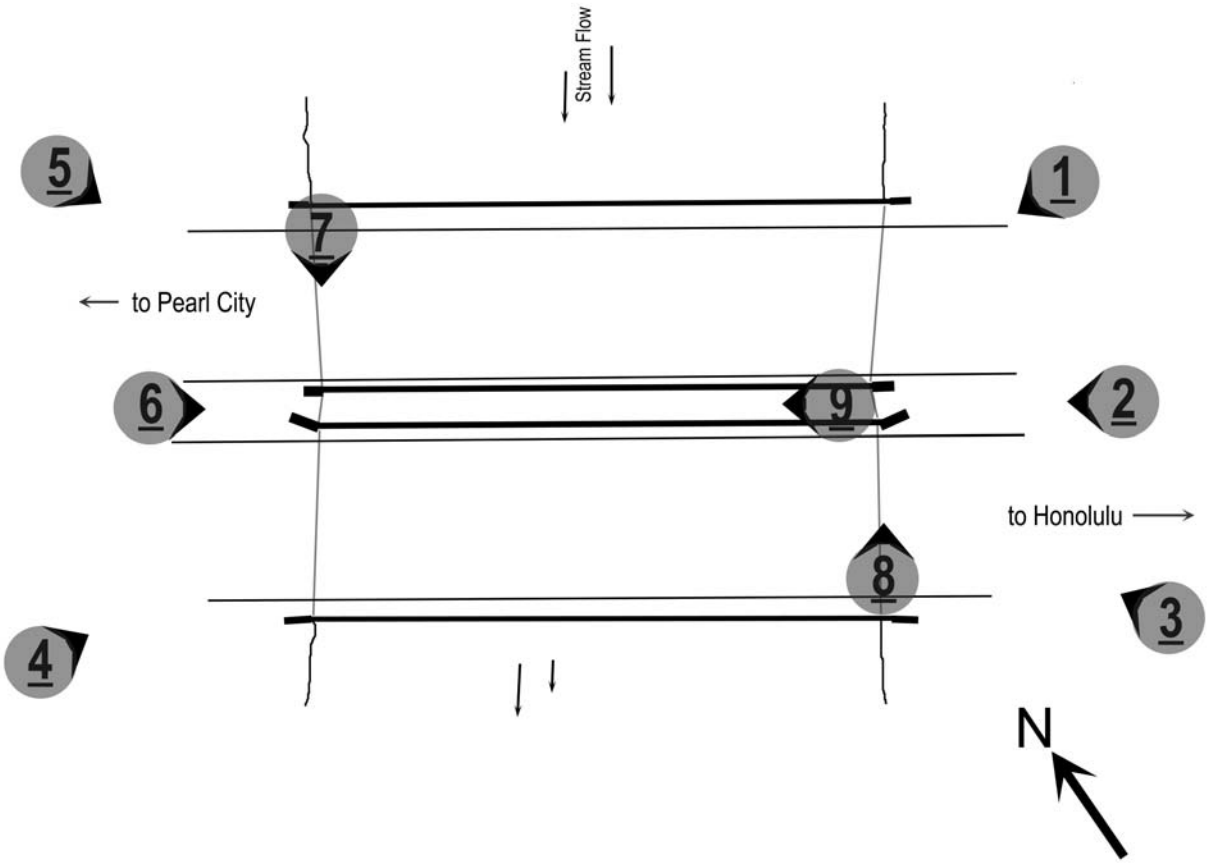
HI-115-10 "WAIMALU BRIDGE" DRAWING DATED JUNE 1945, SHOWING LONGITUDINAL SECTION OF WESTBOUND BRIDGE PLUS LAYOUT PLAN OF BOTH WESTBOUND AND EASTBOUND BRIDGES. *State of Hawaii, Department of Transportation, Highways Division, Design Branch, Project No. DA-WR 10 (3), drawing 5157.12.*

HI-115-11 HISTORIC PHOTOGRAPH TAKEN CA. 1937, SHOWING KAMEHAMEHA HIGHWAY NEAR PEARL CITY. *Superintendent of Public Works,* Report to the Governor, Territory of Hawaii for the Year Ending June 30, 1937*, between pages 28 & 29.*

PHOTO KEY



HISTORIC AMERICAN ENGINEERING RECORD

WAIMALU BRIDGE
(Waimalu Stream Eastbound Bridge & Waimalu Stream Westbound Bridge)

HAER No. HI-115

Location: Kamehameha Highway and Waimalu Stream
Pearl City
City and County of Honolulu, Hawaii

U.S.G.S. Topographic map, Waipahu Quadrangle 1998 (7.5 minute series)
Universal Transverse Mercator Coordinates NAD 83:
04.608600.2365250

Present Owner: State of Hawaii

Present Use: Vehicular Bridge

Significance: The Waimalu Bridge is a significant resource in the history of Oahu's road transportation system. It is significant at the local level for its association with the development of this section of Kamehameha Highway and the adjacent Aiea and Pearl City settlements, which grew into suburbs from their initial establishment as a sugarcane plantation and a train-stop "city," respectively.

Historian: Dee Ruzicka
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Honolulu, HI 96813

Project Information: This report is part of the documentation for properties identified as adversely affected by the Honolulu Rail Transit Project (HRTP) in the City and County of Honolulu. This documentation was required under Stipulation V.C. (1, 2) of the Honolulu High-Capacity Transit Corridor Project (HHCTCP) Programmatic Agreement (PA), which was signed by the U.S. Department of Transportation's Federal Transit Administration, the Hawaii State Historic Preservation Officer, the United States Navy, and the Advisory Council on Historic Preservation. After consultation with the City and County of Honolulu, the National Park Service, Pacific West Regional Office, in a letter dated June 29, 2011, stipulated the details of the required documentation efforts, including HAER documentation for this and other bridges affected by the HRTP. Archival photographs were taken by David Franzen, Franzen Photography, Kailua, HI. The field work was conducted in May 2012, and the report was prepared in June 2012. The report was finalized in December 2012.

Part I. Historical Information:

A. Physical History:

1. **Dates of construction**: 1936, 1945, 1966 (see section A.4. below for sequence of construction.)
2. **Engineers**: 1936, unknown. 1945, William R. Bartels. 1966, C.R.Y. / R.K.

   1936. No plans were located.

   1945. William R. Bartels, bridge engineer for the Hawaii Territorial Highway Department. He received his education and training in Germany and immigrated to Hawaii in 1932 when he commenced working with the Highway Department; he continued his career there until his retirement in 1958.[1] During that period, he was a prolific and versatile designer, responsible for large and sophisticated bridge construction projects in Hawaii, including many tee-beam and rigid-frame concrete bridges. He also designed the reinforced-concrete girder bridges (Waimalu Bridge and Kalauao Springs Bridge) and the steel I-beam bridge (Kalauao Stream Bridge) along the Aiea-Waimalu segment of Kamehameha Highway. Bartels' name appears on original drawings of the 1945 Waimalu Bridge as the designer. These drawings were completed in June 1945, drawn by Paul Yamashita but designed and checked by Bartels. B. F. Rush, the Territorial Highway Engineer in 1945, approved the drawings.[2]

   1966. C.R.Y. & R.K. are the initials appearing after the note "designed by" in the margins of drawings for the 1966 widening of Kamehameha Highway that added an extra lane to both the 1936 and the 1945 bridges. These drawings are dated June 1965.[3]
3. **Builder**: 1936 - Chester R. Clarke.[4] 1945 - E. E. Black, Ltd.[5]
4. **Original plans and construction**: The Waimalu Bridge is comprised of two bridges that both cross Waimalu Stream, each of which carries three lanes of Kamehameha Highway traffic in opposite directions, eastward and westward. The original bridge, built in 1936, had two lanes, one for each direction. This bridge, since 1945, carries the eastbound-traffic lanes. It retains a concrete parapet with cross-shaped voids and curved concrete end stanchions. Those two original end stanchions have stepped corner detailing, along with year built (1936) and bridge name inscriptions.

   In 1945, the original bridge was augmented by the construction of a second two-lane bridge beside it, *mauka* (common Hawaiian term denoting: inland) of the 1936 one. After this construction, each bridge carried two lanes of traffic in opposite directions. The 1945 bridge conveys the westbound traffic. It retains a concrete parapet with cross-shaped voids and rectangular end stanchions. Although not curved like the 1936 end

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[1] "TH Honors 4 Veteran Employees," *Honolulu Advertiser*, July 1, 1958, article at the University of Hawaii, Hamilton Library, Honolulu Newspapers Clippings Morgue, on microfiche in Biographical section under: Bartels.
[2] State of Hawaii, Department of Transportation, Highways Division, Design Branch, Project No. DA-WR 10 (3), Plans of Three Bridges on Kamehameha Highway, Drawing 5157.1. June 18, 1945.
[3] State of Hawaii, Department of Transportation, Highways Division, Design Branch, FAP No. U-090-I (9), Waimalu Stream Bridge Widening, Drawing 73. June 1965.
[4] "Aiea Highway Link Dedicated," *Honolulu Star Bulletin*, August 25, 1937. p. 6.
[5] Superintendent of Public Works. *Report to the Governor, Territory of Hawaii, for the Year Ending June 30, 1946.* [Honolulu: author] [1946]. p. 26.

stanchions, the remaining 1945 stanchions on the second bridge have similar stepped corner detailing, as well as year built (1945) and bridge name inscriptions.

In 1966, the State of Hawaii, Department of Transportation widened both the 1936 and 1945 bridges with a third lane in each direction. The new lanes, replacement walkways, and new parapets required demolition of the outboard walkways and parapets of each bridge. The 1966 parapet design features a concrete lower section, topped with two horizontal cylindrical metal rails. The concrete end stanchions are simple rectangular forms with year built (1966) and bridge name inscriptions.

The *makai* (common Hawaiian term denoting: toward the sea) eastbound bridge retains its original *mauka* parapet and end stanchions, dating from 1936. The westbound bridge retains its original *makai* parapet and end stanchions, dating from 1945. These older parapets are adjacent to each other, on the inboard side of both bridges.

Both the eastbound bridge and the westbound bridge are listed as "stringer/ multi-beam or girder" designs, with prestressed concrete, in the National Bridge Inventory (NBI) Database.[6] However, only the 1966 portion of those bridges used prestressed concrete in the structural design; the 1936 and 1945 original bridges were girder designs with cast-in-place concrete.

5. **Alterations and additions**: The bridges have added steel guardrails. They are located along the eastern approaches to the westbound bridge and attached to the eastern end stanchions. Similarly, a steel guardrail is attached to the western end stanchion of the 1936 (*mauka*) parapet of the eastbound bridge. On the *makai* side of this bridge, a steel guardrail, backed by an added grid of metal, runs along the *mauka* side of the walkway, and extends beyond the bridge on each end to provide protection from the traffic. A similar metal grid is located on the outer side of the upper parapet railing). The 1966 drawings for the Kamehameha Highway widening project do not show these guardrails, so they must have been additions after 1966.

B. Historical Context:

There are two other related bridges along this segment of Kamehameha Highway, built under the same series of project numbers --- see the Historic American Engineering Record (HAER) reports for Kalauao Springs Bridge (HAER No. HI-116) and Kalauao Stream Bridge (HAER No. HI-117). The original Waimalu Bridge, Kalauao Springs Bridge, and Kalauao Stream Bridge were all initially constructed in 1936-1937; Waimalu Bridge was part of Federal Aid Project (FAP) No. 9-F and the Kalauao Springs and Stream bridges were part of National Recovery Highway (NRH) Project No. NRH-9-C.[7] In 1945, under Hawaii Project No. DA-WR 10 (3), three additional two-lane bridges were built parallel to the original ones, and these new bridges all carried the westbound lanes. The 1966 Kamehameha Highway widening, FAP No. U-090-I (9), included an additional lane on the outboard sides of all six bridges.

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[6] National Bridge Inventory Database, Waimalu Bridges, on website nationalbridges.com, accessed May 23, 2012. [The eastbound bridge has NBI Structure Number 003000990401986, and the westbound bridge has NBI Structure number 003000990401987.]

[7] Superintendent of Public Works, *Report to the Governor, Territory of Hawaii, for the Year Ending June 30, 1936* (Honolulu: New Freedom Press) [1936]. pp. 10 & 11.

Kamehameha Highway

Until 1936 Kamehameha Highway was the only road that provided passage across the *ahupuaa* (common Hawaiian term for land divisions that typically extend from the mountains to the sea) of Kalauao, Waimalu, Waiau, and Waimano, between the settlements at Aiea and Pearl City. The pre-1936 alignment of this highway ran east-west along a winding hillside route located on firmer ground, but not as level as the well-watered soils closer to Pearl Harbor. Part of Kamehameha Highway's pre-1936 route between Aiea and Pearl City is the present-day alignment of Moanalua Road. Today's section of Moanalua Road between Kaonohi Street and Moanalua Loop is a new straighter alignment; the pre-1936 Kamehameha Highway route basically followed what are now Kaonohi Street and Moanalua Loop. Before 1936, Kamehameha Highway crossed Waimalu Stream much further *mauka*, about where Moanalua Road now bridges the stream.

Planning for the realignment of Kamehameha Highway, in this area that included the 1936 Waimalu Bridge, had started before 1933, when NRH funds became available; that year, road improvements from Honolulu to Pearl City Junction were on the list for the grants. Within that planned project, the highway section from Honolulu to Aiea had a higher priority, and the remaining section, from Aiea to Pearl City Junction, was to be undertaken "if financially possible."[8] Two years later, this second-priority section, west of Aiea, still awaited funding. In 1935, Louis S. Cain, Superintendent of Public Works, submitted a road plan to the U.S. Bureau of Public Roads that included the construction of an "additional unit of Kamehameha Highway beyond Aiea, approximately one mile" that was expected to cost $148,000.[9] The contract amount reported March 1937 for construction of the highway from "Aiea through Pearl City" was $203,000.[10]

On August 24, 1937, the new alignment of Kamehameha Highway between Aiea and Pearl City was dedicated. This new road passed over the three 1936 bridges, crossing Waimalu Stream, Kalauao Springs, and Kalauao Stream. The two lanes of the 1937 Kamehameha Highway are the present-day two inner lanes of the eastbound half of the highway. At the time of its opening the road was referred to as the "Aiea-Pearl City link of the new Kamehameha" Highway.[11] This new section, measuring 3.16 miles long, was described as "virtually curve free" with "only two flat curves," compared to 23 curves in the pre-1936 alignment.[12] The road project had been under construction since about February 1936, and had cost almost $310,000. Because of swampy ground conditions, when “constructing the highway it was necessary to lay a lumber mat of 265,000 board feet before putting in the rock sub-base.”[13]

The portion of the new alignment of Kamehameha Highway, from Pearl City to what is now the junction at Kaonohi Street, had been open since August 2, 1937. At that junction, traffic was routed onto old Kamehameha Highway, between there and Aiea, while construction was completed on the remaining portion of the new road. Chester R. Clarke built the portion of road that opened on August 2 (including the Waimalu Bridge). Mr. Clarke was a prominent business leader in Honolulu, having moved to Hawaii in 1923, who started many companies, including Clarke Transportation Co., Clarke & Rourke (general insurance business), Honolulu Paving Co.,

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8 "Hawaii Road Building Projects Selected," *Honolulu Star Bulletin*, June 24, 1933. p. 1.
9 "Cain Submits Road Plan to U.S. Officials," *Honolulu Star Bulletin*, May 3, 1935. p. 1.
10 "Cain Reveals Road Scheme for 5 Islands," *Honolulu Star Bulletin*, March 6, 1937. p. 1.
11 "Ceremony Will Open New Road," *Honolulu Star Bulletin*, August 23, 1937. p. 7.
12 "Aiea Highway Link Dedicated," *Honolulu Star Bulletin*, August 25, 1937. p. 6.
13 Ibid.

and Clarke-Halawa Rock Co.[14] The construction firm of Walker & Olund, Ltd. built the remainder of the new Kamehameha Highway segment toward Aiea.[15] A few years later, that firm became Walker-Moody Construction Co., Ltd., a distinguished business still active in Hawaii.[16]

In 1945 Kamehameha Highway between Aiea and Pearl City was improved by the addition of two more traffic lanes, separated by a median from the 1937 two-lane highway. This allowed the 1945 lanes to be dedicated to westbound traffic and the 1937 lanes to carry eastbound vehicles. This improvement included the 1945 portion of the Waimalu Bridge, which was originally built with matching parapets and stanchions on each side of the new roadway. This 1945 construction was carried out under Hawaii Project No. DA-WR 10 (3).[17] According to the Superintendent of Public Works report after World War II:

> During the war years, highway construction activities were limited to the building of new highways, which served as access to military and navy reservations and to those highways which are part of the strategic network…
>
> As most military and navy reservations are adjacent to and are served by the main public highways, large sums of Federal access money were spent on the latter with the result that all traffic has benefited by these improvements.[18]

The term "access money" was explained in the Superintendent of Public Works 1945 report, as 100% Federal funding for those military access roads or strategic network of highways.[19] At the end of the war in August 1945, "all proposed access road projects were dropped by the Federal Government …; but access road projects under construction were allowed to continue to their completion."[20] This widened part of Kamehameha Highway improved access between the main part of the Pearl Harbor Naval Base and its outlying activities near Pearl City Peninsula, Waipio Peninsula, and further west.

E.E. Black, Ltd., a well-known Hawaii contracting firm, obtained two separate construction contracts in 1945 for the highway improvements near Aiea (between Pearl Harbor installation and outlying Navy activities to the west). The amount of the contract for the two new Kamehameha Highway westbound lanes was $381,177.40; and their accepted bid for three new bridges (the 1945 Waimalu, Kalauao Springs, and Kalauao Stream bridges) along this corridor was $139,207.50.[21]

In 1966, the State of Hawaii, Department of Transportation carried out another improvement to this segment of Kamehameha Highway, adding a third lane to both existing two-lane roadways. This was accomplished under FAP No. U-090-I (9). This widening project was in response to numerous complaints about "bumper-to-bumper Kamehameha Highway rush hour traffic past Pearl Harbor," with protests reported at least as early as 1964.[22] The third lane was added on

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[14] "Chester R. Clarke Dies Here After Operation," *Honolulu Advertiser*, April 1, 1956. Clipping in pamphlet file at Hawaii State Library, Hawaii and Pacific Room.
[15] "Aiea Highway Link Dedicated," *Honolulu Star Bulletin*, August 25, 1937. p. 6.
[16] "Company Showcase: Walker-Moody Construction Co., Ltd.," *Building Industry*, July 2011. p. 100.
[17] State of Hawaii, Department of Transportation, Highways Division, Design Branch, Project No. DA-WR 10 (3), Plans of Three Bridges on Kamehameha Highway, Drawing 5157.1. June 18, 1945.
[18] Superintendent of Public Works. *Report to the Governor, Territory of Hawaii for the Year Ending June 30, 1946* [Honolulu: author] [1946]. p. 17.
[19] Ibid., [1945]. p 13.
[20] Ibid., [1946]. p. 17.
[21] Ibid., [1946]. p. 26.
[22] "Pearl City Traffic Saddens Police, Too," *Honolulu Star Bulletin*, June 22, 1964. p. 3.

the outer edge (opposite the median) of each roadway. This resulted in the demolition of the outer parapets, stanchions, and walkways of the 1936 and 1945 bridges, and the construction of the extant 1966 replacements of these elements on the outer edges of the new traffic lanes.[23]

Kamehameha Highway in this section, while also important to the military, has always linked the Aiea and Pearl City civilian communities. See the history of Pearl City in the report on Waiawa Bridge (HAER No. HI-101).

Honolulu Plantation Company, Aiea

Before the construction of the 1937 Aiea – Pearl City link, most of the land around Aiea, especially *mauka* of Kamehameha Highway, was planted in sugarcane. This sugarcane land extended up to about the 500-foot elevation level. A portion of the land *makai* of the highway was also planted in sugarcane, but here it was typically interspersed with farm plots of various crops and scattered residences. These extensive sugarcane plantings were part of the field system of Honolulu Plantation Company (HPC), a company based in Aiea, which began in 1899 and which had about 6,500 acres under cultivation during the 1920s. HPC lands reached from Waimalu and Halawa Valley down past the Southeast Loch of Pearl Harbor, almost to Bishop Point and Fort Kamehameha at the harbor mouth, as well as east to Kalihi. All HPC-cultivated land was leased, with non-contiguous parcels in the eastern section. The only fee-simple land owned by the company was at the mill, main camps, reservoirs, and pump sites.

HPC made its first harvest in 1901. The mill and main plantation community were centered at Aiea, about ½ mile inland from the mouth of Aiea Stream. In 1906, HPC added a sugar refinery to the mill and began producing refined sugar for use locally. HPC was the only producer in Hawaii that refined its sugar; all other producers shipped their unrefined sugar out for refining elsewhere, usually to the California & Hawaiian Sugar Company refinery in Crockett, CA. Most of the HPC-refined sugar was used in locally bottled soft drinks and by the pineapple canneries. HPC shipped to the mainland any refined sugar in excess of local.[24]

HPC was one of the very few sugar plantations in Hawaii that had a year-round water supply that was sufficient for its irrigation needs.[25] About 20 million gallons per day flowed to the surface at the two springs at Kalauao. HPC pumped this water to its upper fields for irrigation, and fluming, using less than half of the daily supply. The rest flowed into Pearl Harbor.

Although HPC had employee camps scattered about the plantation, Aiea was the hub and main settlement. HPC's refinery and its hospital formed a nucleus for the community of Aiea, which grew up around these facilities. By the mid-1920s, HPC had begun replacing former barracks-type housing facilities with single-family and duplex cottages. The newer cottages provided more privacy, and also had electricity, water, and kitchens in each unit. Individual kitchens were an improvement from the older barracks that had communal kitchens separated from sleeping quarters. In addition, the 1920s cottages were typically on 50' x 80' lots, which allowed space for gardens and fruit trees. The HPC community at Aiea also had churches, baseball fields, volleyball, basketball, and tennis courts, and a general store. Additionally, there was an assured milk supply for the plantation because HPC sponsored a private dairy.[26]

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[23] State of Hawaii, Department of Transportation, Highways Division, Design Branch, FAP No. U-090-I (9), As Built Plans of Kamehameha Highway Widening, Drawings 1-6 & 58-87. July 22, 1965.

[24] William H. Dorrance, *Sugar Islands, The 165-year Story of Sugar in Hawaii* (Honolulu: Mutual Publishing LLC) 2000. p. 50.

[25] Jared G. Smith, *Plantation Sketches* (Honolulu: Advertiser Press) 1924. p. 132.

[26] Ibid. p. 138-39.

Over the years, HPC lost much of its leased acreage; this included loss of some at Pearl Harbor, in 1907 for the naval base, and additional leased lands east of Bishop Point, in 1935 for Hickam Field. The military occupied other HPC sugarcane fields during World War II. One author states the military confiscation of HPC land led to its closure in 1947.[27] Another writer notes "post-war urban growth supplied the final blow."[28] After the plantation closed, Oahu Sugar Company purchased most equipment and obtained leases on the remaining land . California & Hawaiian Sugar Company acquired the Aiea refinery and continued to refine sugar there until 1996, when local bottlers switched to corn syrup for sweetening.[29]

Kalauao Springs

The Kalauao Springs were the main sources of water for HPC. These were two natural springs of percolating water located about ¾ mile east of Waimalu Bridge. Commercial farming in the area around these springs dates back to at least the late-1800s, when rice was a primary crop. In earlier times, the springs irrigated taro loi (common Hawaiian term for flooded terraces). Near the end of the nineteenth century, a tannery was located at the springs. In 1928, Moriichi and Makiyo Sumida began farming assorted wetland produce on a two-acre plot of land at the springs that they leased from Kamehameha Schools/Bishop Estate. At this time, the area of the springs contained many small farms growing similar produce -- bananas, taro, rice, and watercress. Through the ensuing years, the Sumida property grew as they acquired neighboring leases and, by 1950, watercress was the sole crop grown.

The Pearl Ridge Shopping Center was developed, ca. 1969, on a portion of the property previously leased to the Sumida family. The lower part of the shopping center is located to the east of the present farm and spring. This development covered one of the springs at Kalauao with pavement, leaving only the present spring actively flowing.[30]

Reinforced-Concrete Girder Bridges

Reinforced-concrete girder bridges are a type that was common in the early twentieth century. The character-defining features include a monolithic deck and girder system.[31] This type generally uses cast-in-place concrete girders to bridge short spans, and replaced earlier concrete arch bridges, which had even more limited spans. This type of bridge was also a more economical choice than concrete arch bridges. Up until the 1930s, this type was often used in Hawaii to span short distances, but does not have the load-carrying capacity of the tee-beam bridge type.[32] (See the report on Waikele Canal Bridge and Highway Overpass, HAER No. HI-100, for information on the tee-beam bridge type.)

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[27] Edward D. Beechert. *Working in Hawaii, A Labor History* (Honolulu: University of Hawaii Press) 1985. p. 304.
[28] William H. Dorrance, *Sugar Islands, The 165-year Story of Sugar in Hawaii* (Honolulu: Mutual Publishing LLC) 2000. p. 50.
[29] Ibid.
[30] Dee Ruzicka, interview with David and Barbara Sumida, March 9, 2006.
[31] Parsons Brinckerhoff and Engineering and Industrial Heritage, A Context for Historic Bridge Types, NCHRP Project 25-25, Task 15 (Prepared for the National Cooperative Highway Research Program) October 2005. p. 3-93.
[32] Heritage Center, School of Architecture, University of Hawaii at Manoa, State of Hawaii, Historic Bridge Inventory and Evaluation (Draft prepared for the State of Hawaii, Department of Transportation, Highways Division) 2008. pp. I-71 and I-72.

The 1936 and 1945 portions of the Waimalu Stream Bridge were constructed as relatively short-span, narrow (two-lane) bridges using cast-in-place concrete girders. The portions of the bridges added in 1966 used prestressed girders.[33]

"Although the through girder was common from the 1910 to the 1930s, the type is best suited to short spans from 15 to 40 feet and was not economical for wide roadways of more than 24 feet. Precast reinforced concrete girders were used on a few projects to widen existing cast-in-place concrete girder spans."[34]

Part II. Structural/ Design Information:

A. General Statement:

1. **Character**: The 1936 and 1945 portions of the Waimalu Bridge each retain one original parapet and the original structural design. The eastbound bridge has the 1936 parapet, end stanchions, and structure that are typical of reinforced-concrete bridges constructed in Hawaii in the latter half of the 1930s. The westbound bridge retains the 1945 parapet, end stanchions and structure that are typical of reinforced-concrete bridges constructed in Hawaii during the 1940s. Both have a parapet design featuring cross-shaped voids. The 1936 curved end stanchions are typical of the bridges up to that date, and the 1945 rectangular stanchions are typical of bridges built in the 1940s. Both the eastbound bridge and the westbound bridge are approximately 143' in length, with three spans of about 47' each. The 1966 additions to the bridges are quite different in the design of their structure, parapets, and stanchions. This contrast, however, conveys the history of the area and its rapid post-statehood growth. The 1966 sections of the bridges are not considered detracting features.
2. **Condition of Fabric**: Good. The overall integrity of the property remains high, except for the setting, which has changed from rural to urban. The guardrail additions are minor alterations.

B. Description:

Both reinforced-concrete three-lane bridges carry Kamehameha Highway across Waimalu Stream. Eastbound traffic travels on the *makai* bridge and the *mauka* bridge carries westbound traffic. Both bridges are about 143' long with a roadway approximately 40' wide. Each bridge has one or two concrete walkways, approximately 4' wide and about 4” higher than the roadway surface. The eastbound bridge has walkways along both its *mauka* (1936) parapet and along its *makai* (1966) edge, while the westbound bridge has a walkway only along its *mauka* (1966) parapet. The walkway along the 1936 parapet is now in the highway median and utilized by few pedestrians.

The inner parapet on each bridge is the original parapet and stanchions, from either 1936 (on the eastbound bridge) or 1945 (on the westbound bridge). This original (1936 and 1945) construction on each bridge includes the structure supporting the two traffic lanes adjacent to the original parapets. The 1966 widening increased the width of each bridge from two to three traffic lanes and built replacement walkways along the new parapets.

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[33] State of Hawaii, Department of Transportation, Highways Division, Design Branch, FAP No. U-090-I (9), Waimalu Stream Bridge Widening, Drawing 73. June 1965.

[34] Parsons Brinckerhoff and Engineering and Industrial Heritage, A Context for Historic Bridge Types, NCHRP Project 25-25, Task 15 (Prepared for the National Cooperative Highway Research Program) October 2005. p. 3-93.

Eastbound Bridge (1936/1966)

This bridge has three eastbound lanes on an asphalt-surfaced roadway. The 1936 concrete parapet and stanchions are on the *mauka* side of this bridge. This parapet is 2'-10" high and about 143' long. The parapet has a top railing 1'-0" wide and 7" high with 1½" stepped corners. Below the railing is a series of vertical concrete balusters (6" wide and 6" thick) that are typically spaced at 1'-7" on center. The sections of each parapet that are between the balusters are slightly thinner (4" thick) and each section was formed with a cross-shaped void. These voids are typical of concrete bridge design in Hawaii during the 1930s and 1940s and are commonly referred to as a Greek-cross shape.[35] Each cross void is 1'-3" high and 8" wide. The base of the 1936 parapet is 7" high and 10" thick along its full length. On the inboard side of the parapet is a walkway, 3'-0" wide and about 4" higher than the road pavement. The height differential results in a 4"-high concrete curb along the road.

The 1936 concrete end stanchions are 3'-3" high, measured from the roadway, 1'-9" thick, and about 6' long. In plan, they form an arc of a circle spanning about 45 degrees. One stanchion end squarely abuts the parapet and the stanchion arcs away from the roadway, presenting a curving face to the traffic lanes. Each stanchion has 1½" stepped corners, with a top surface that is 1'-3" wide. The west stanchion has an added wedge of concrete on its outer (road-facing) surface that anchors a steel W-beam guardrail, which extends along the roadway at the approach. Typically, concrete bridges of this type and period have date and name inscriptions on their end stanchions, as is the case here. However, the concrete wedge covers the name inscription on this stanchion. The east end stanchion has the date inscription "1936" in 3" high block numbers.

The 1966 parapet and end stanchions of the eastbound bridge are on its *makai* side. The lower part of the 1966 parapet has three concrete sections of slightly varying lengths, but all measuring 1'-2" thick and 1'-6" high. There is a horizontal line incised across each panel at the height of 9". The upper section of the 1966 parapet is a metal railing composed of two horizontal cylinders supported by slightly curved rail posts. The 1966 drawings indicate that the railings can be either aluminum or steel. The bottom rail cylinder is 5" in diameter and the top rail is 3" in diameter. The posts are spaced about 7' apart along the length of the parapet, but are closer together near the expansion joints between parapet sections. These posts are bolted to the top surface of the lower concrete section. The 1966 end stanchions are rectangular concrete, 1'-2" thick, 3'-1" high, and 5'-0" long. Each has 1" wide horizontal lines incised around its circumference at heights of 9" and 1'-6" above the walkway. The west stanchion is inscribed "Waimalu Stream Bridge 1966" in 3" high block lettering. A steel W-beam guardrail, backed by an added grid of metal, runs along the *mauka* side of the walkway, to provide it protection from the traffic. A metal grid is also located on the outer side of the upper parapet railing.

The underside of the eastbound bridge shows the structural design of both the original 1936 bridge and the added 1966 traffic lane and walkway. The 1936 portion carries the two *mauka* lanes. It is board-formed concrete with five longitudinal girders and two supporting frames. Each frame is an inverted-U shape with two reinforced-concrete legs extending down into the streambed. Reinforced-concrete beams join each pair of legs and support the girders. The added 1966 portion carries the third lane and walkway on the *makai* side of the bridge. Its structure consists of two prestressed-concrete longitudinal girders; these are supported, in line

[35] Heritage Center, School of Architecture, University of Hawaii at Manoa, State of Hawaii, Historic Bridge Inventory and Evaluation (Draft prepared for the State of Hawaii, Department of Transportation, Highways Division) 2008. p. I-30.

with each of the 1936 frames, by three octagonal-cross-section concrete piles capped with a concrete beam. The bridge abutments are board-formed concrete, supported by complex pile foundations for the 1966 section. The exact foundation design of the original 1936 abutments is not known, since drawings for that project were not located at the State of Hawaii, Department of Transportation, Highways Division, Design Branch.

Westbound Bridge (1945/1966)

This westbound bridge has three traffic lanes on an asphalt-surfaced roadway. The 1945 concrete parapet and stanchions are on the *makai* side of this bridge. This parapet is almost identical to the 1936 parapet described above; however, instead of having a walkway extending along its length it has a 6"-high, 10"-wide concrete curb. Another difference is the 1945 concrete end stanchions are rectangular, not curved. The newer stanchions are similar in height and thickness, but shorter in length than the 1936 ones; the 1945 stanchions measure 3'-3" high, 1'-9" thick, and 3'-6" long. Each end stanchion has 1½" stepped corners and squarely abuts the parapet. The east end stanchion has an added W-beam guardrail that is through-bolted to the stanchion. Although the guardrail partially conceals the name inscription, the letters "ALU" remain visible. The west end stanchion has no added guardrail and "1945" is inscribed in 3"-high block numbers.

The 1966 parapet of this westbound bridge was constructed exactly like 1966 parapet of the eastbound bridge (see description above). Unlike that one, no guardrail runs between the walkway and the traffic lanes, and there is no added grid of metal on the outer side of the upper parapet railing.

The underside of the westbound bridge shows the structural design of both the original 1945 bridge and the added 1966 traffic lane and walkway. The 1945 portion carries the two *makai* lanes of westbound vehicles. It is board-formed concrete with five longitudinal girders and two supporting frames (or piers, as labeled on the drawings). Each frame, or pier, consists of 10 pairs of square-cross-section concrete piles, topped by a concrete pile cap, or beam, that carries the girders. The added 1966 portion carries the third lane and walkway on the *mauka* side of the bridge. This portion is supported, in line with each of the 1945 frames, by four octagonal-cross-section concrete piles topped by pile caps that carry the two longitudinal prestressed-concrete girders. The 1945 drawings show the 1945 piles are composites; the upper portions, labeled as concrete "Socket Piles," have wider bottom sections that fit over the lower "Untreated Timber Piles." The 1945 bridge abutments are board-formed concrete, supported by single lines of the concrete-and-timber composite piles. The abutments at the 1966 widened section have a more complex pile foundation.

C. Site Information:

The Waimalu Bridge is located along an urban section of Kamehameha Highway that is fronted by small-scale businesses (typically one- to two-stories), including the block-long Waimalu Shopping Center (built in 1963), various fast food restaurants, and some residences. Neal Blaisdell Park is adjacent to the southwest. In Hawaii, roads are not given Tax Map Key (TMK) designations. This bridge lies just north of TMK 9-8-009: 004. The setting around the bridge has changed greatly since its 1936 and 1945 construction dates. Ca. 1940 the area was primarily rural, with sugarcane fields, small farm plots, and vacant land occupying most of the frontage of Kamehameha Highway. A cluster of small lots with buildings was present west of the area that would become Blaisdell Park. Paakea Fishpond was then present in Pearl Harbor at the mouth of Waimalu Stream. Historic aerial photographs indicate that, by 1954,

development of the area to the west had grown denser with buildings, and an area to the east had been developed, near the present intersection of Kamehameha Highway and Kanuku Street. Historic aerial photographs also indicate that, by 1962, large subdivisions were built *mauka* at Kanuku Street and Waimano Home Road, and by 1968, Paakea Fishpond was filled. Currently, commercial properties and residences line the highway in both directions, with only a few exceptions – Sumida [watercress] Farm, Blaisdell Park, and Waiau Spring. . Post-World War II development of housing and businesses along this corridor was accommodated or spurred by the addition of the 1945 bridges, and by the 1966 widening of all six bridges in this segment of Kamehameha Highway.

Part III. Sources of Information:

A. Primary Sources:

Architectural Drawings and Early Views

No drawings or early photographs of the original 1936 bridge were located for this report.

The 1945 and 1966 construction drawings are electronic files (scans) located in the database at the State of Hawaii, Department of Transportation, Highways Division, Design Branch:
1945 – Hawaii Project No. DA-WR 10 (3), dated June 18, 1945.
1966 – FAP No. U-090-I (9) dated, July 22, 1965.
Drawings of the Waimalu Bridge in this database were created by the Territorial or State Department of Transportation and are considered in the public domain.

Historic maps and aerial photos are located in the collection of the Hawaii State Archives. The maps were created and published by the U.S. Geological Survey and are public domain materials. Aerial photos used in this report were created for or collected by the Hawaii Territorial/ State Land Use Bureau and are unrestricted public records. An early photograph of Kamehameha Highway in the Pearl City area is located at the Hawaii State Archives, in the Superintendent of Public Works *Report to the Governor, Territory of Hawaii, for the Year ending June 30, 1937*. This photo was created by the Territorial Department of Public Works, or under contract for the department, and is considered in the public domain.

B. Secondary Sources:

Beechert, Edward D. *Working in Hawaii, A Labor History*. Honolulu: University of Hawaii Press. 1985.

"Chester R. Clarke Dies Here After Operation," *Honolulu Advertiser.* April 1, 1956. Clipping in pamphlet file at Hawaii State Library, Hawaii and Pacific Room.

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"Hawaii Road Building Projects Selected; Work to Start July 1." June 24, 1933. p. 1.

"Allotment to Hawaii Roads is Agreed On." August 3, 1933. p. 1.

"$2,631,000 To Be Spent For Island Roads." August 16, 1933. p. 1.

"Moses Akiona is Low Bidder on Puuloa Road." November 10, 1933. p. 1.

"Cain Submits Road Plan to U.S. Officials." May 3, 1935. p. 1.

"Cain Reveals Road Scheme for 5 Islands." March 6, 1937. p. 1.

"New Aiea Road Open August 20." August 3, 1937. p. 5.

"Ceremony Will Open New Road." August 23, 1937. p. 7.

"Aiea Highway Link Dedicated." August 25, 1937. p. 6.

"Pearl City Traffic Saddens Police, Too." June 22, 1964. p. 3.

National Bridge Inventory Database. Waimalu Bridges, on website nationalbridges.com, accessed May 23, 2012.

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Smith, Jared G. *Plantation Sketches, A Record of Hawaiian Industries as They Appeared to an Itinerant Journalist in 1923: published in the Columns of the Advertiser.* Honolulu: Advertiser Press. 1924.

Superintendent of Public Works. *Report to the Governor, Territory of Hawaii, for the Year Ending June 30.* Honolulu: Various Publishers. Various Years.

Territorial Highway Department, Hawaii Highway Planning Survey. Bridge Inventory for the Island of Oahu. Prepared in Cooperation with the U.S. Department of Commerce, Bureau of Public Roads. September 1950.

Thompson, Bethany. Historic Bridge Inventory, Island Of Oahu. Prepared for the State of Hawaii, Department of Transportation, Highways Division. June 1983.

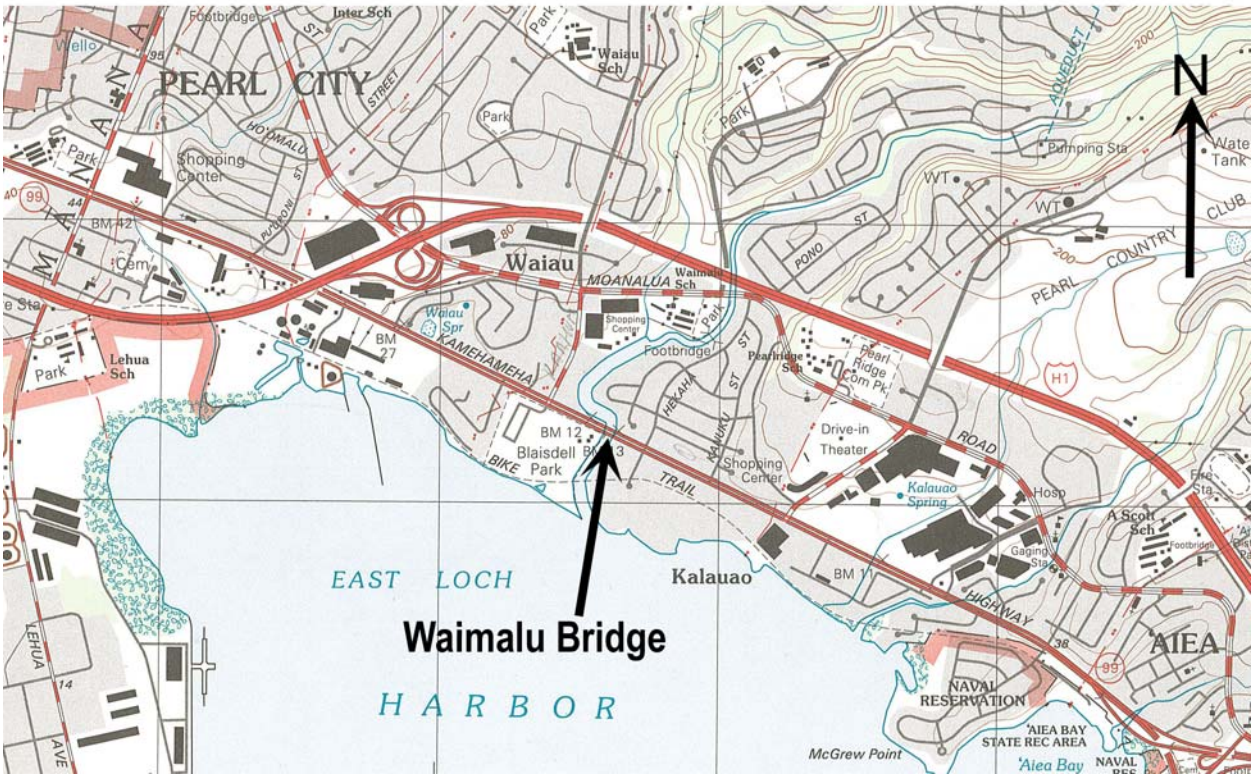
Newspaper articles on W.R. Bartels are available at the University of Hawaii, Hamilton Library, Honolulu Newspapers Clippings Morgue, on microfiche in Biography section under: Bartels. Various Dates.

C. Likely Sources Not Yet Investigated:

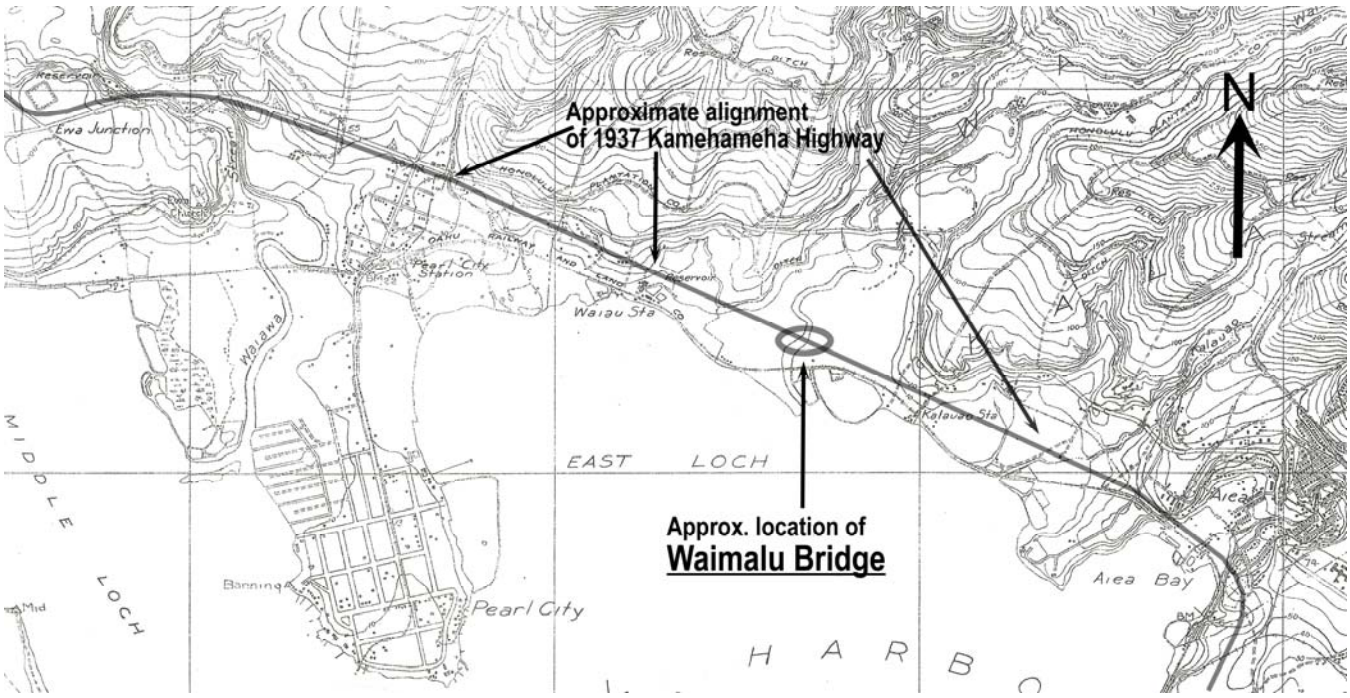
National Archives and Records Administration files for the U.S. Department of Transportation, Federal Highway Administration and for predecessor agencies such as U.S. Department of Commerce, Bureau of Public Roads.

Additional information on the Honolulu Plantation Company's activities in Aiea might be located in the Hawaiian Sugar Planters' Association Plantation Archives collection at the University of Hawaii at Manoa, Hamilton Library, Hawaiian Collection, within the material pertaining to Oahu Sugar Co.

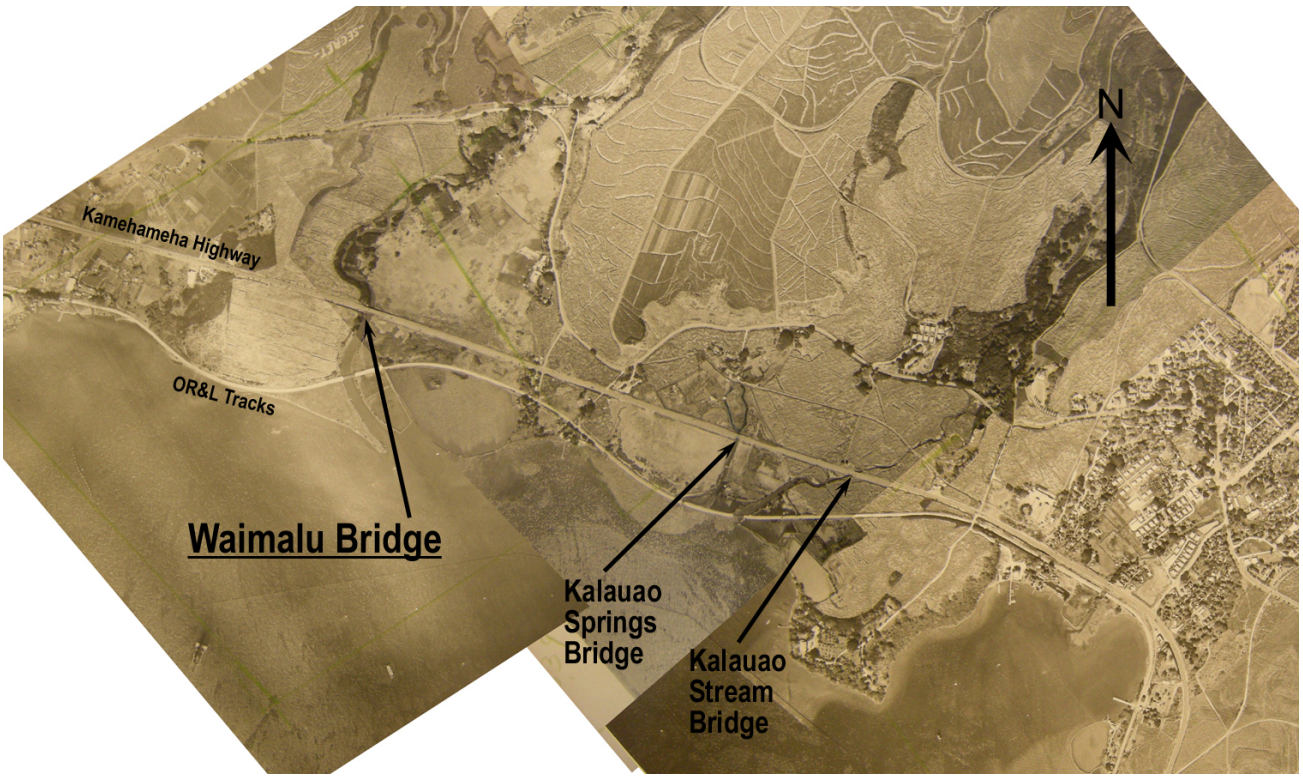
Location Map



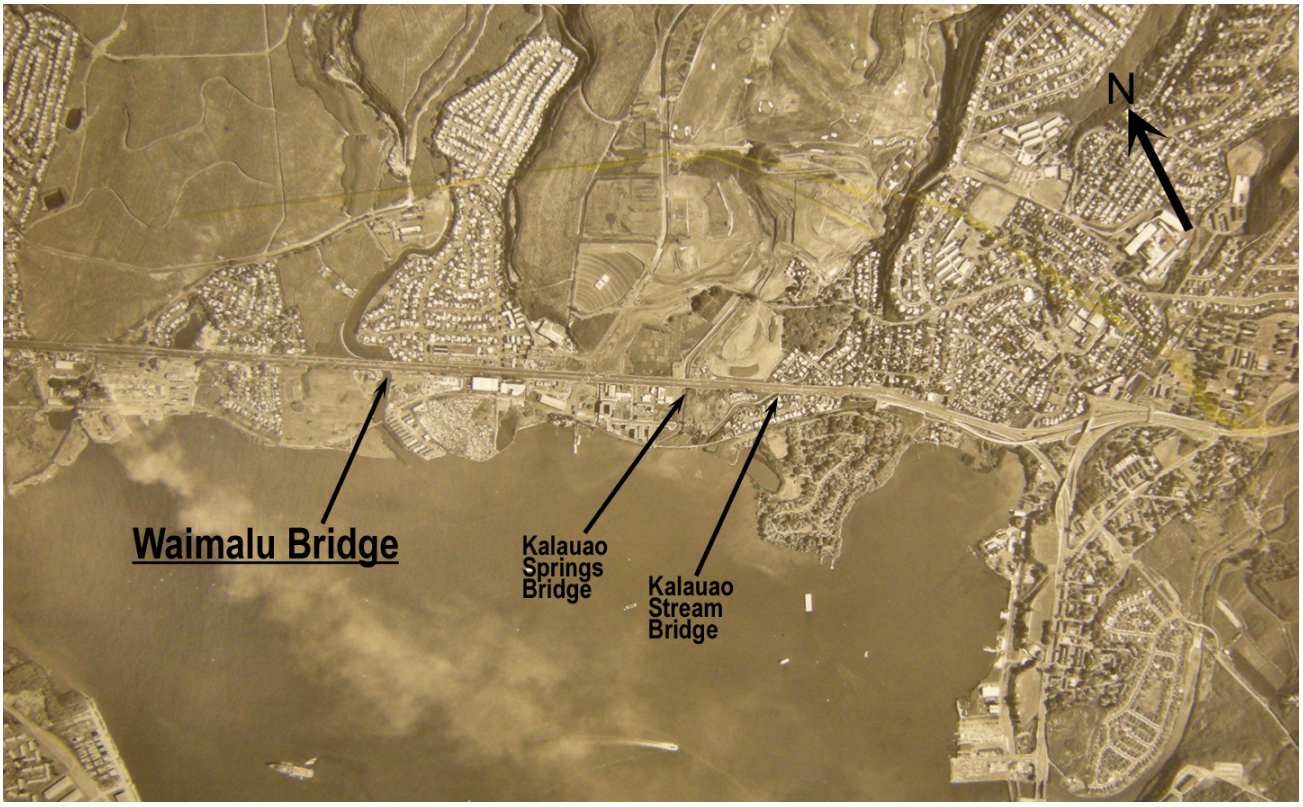
Portion of topographic map from 1927, showing the area around the (future) Waimalu Bridge. The approximate alignment of Kamehameha Highway, which would be opened in 1937, has been added. *U.S. Geological Survey. Waipahu Quadrangle, 1:20,000, 1927*.



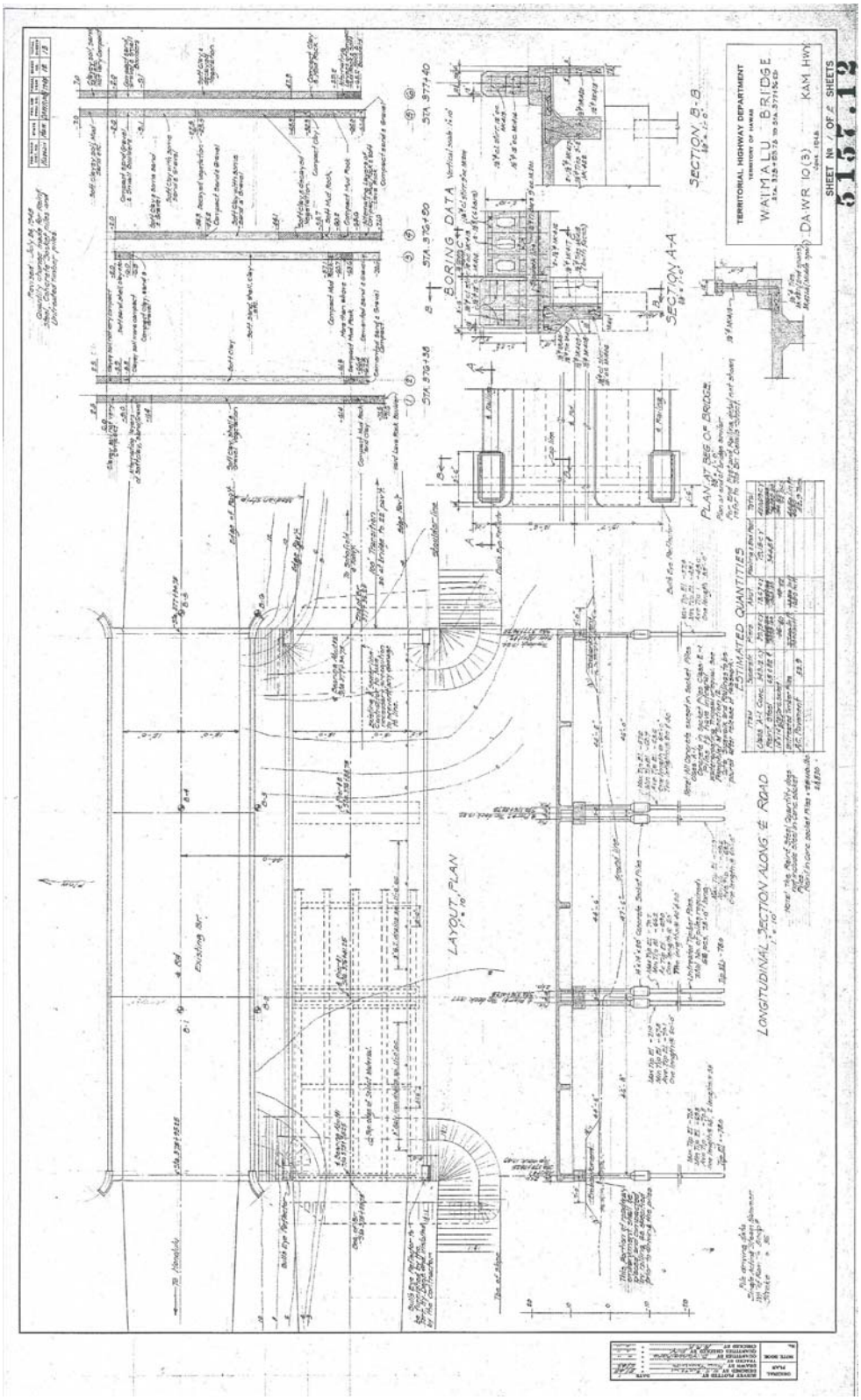
Composite of aerial photos, ca. 1940, showing the area around the Waimalu Bridge (added lettering and arrows). *Hawaii State Archives, Folder PPA-59-1, photos M-58.67 & M-58.69; and Folder PPA-58-5, photo M-58.37 (public domain). U.S. Army Air Corps 1939-41.*



Aerial photo dated February 6,1968, showing area around Waimalu Bridge (added lettering and arrows). *Hawaii State Archives, Folder PPA-49-3, photo 2-14 (public domain).*



Original drawing of Waimalu Bridge. *State of Hawaii, Department of Transportation, Highways Division, Design Branch, Project No. DA-WR 10 (3), drawing 5157.12, June 1945.*



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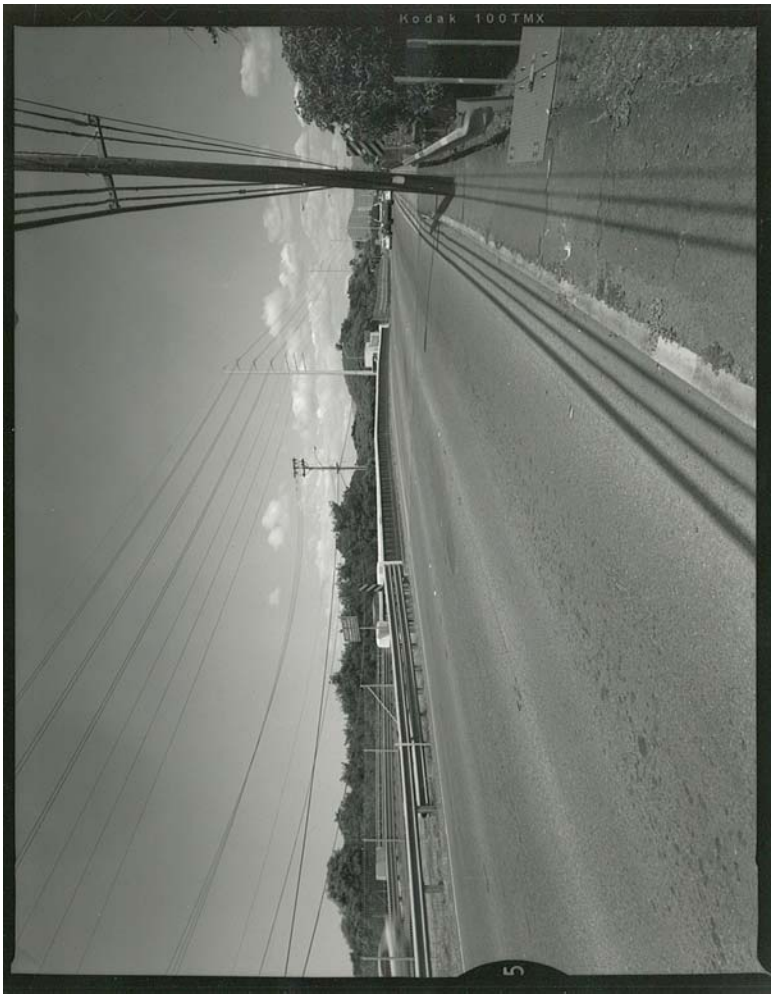

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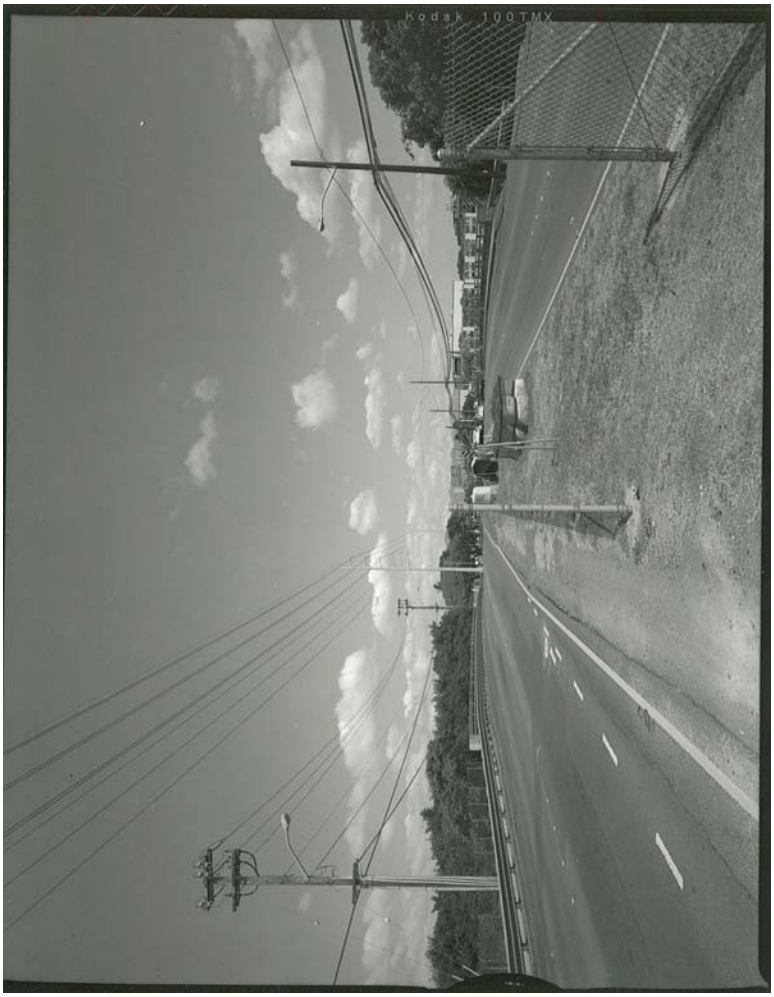

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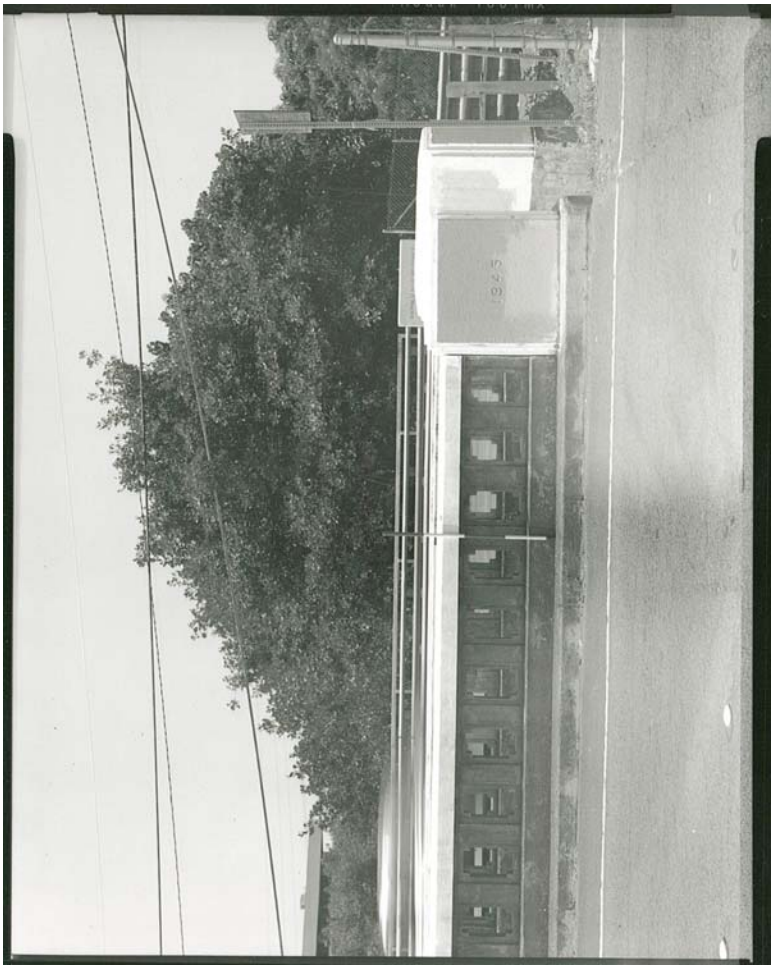

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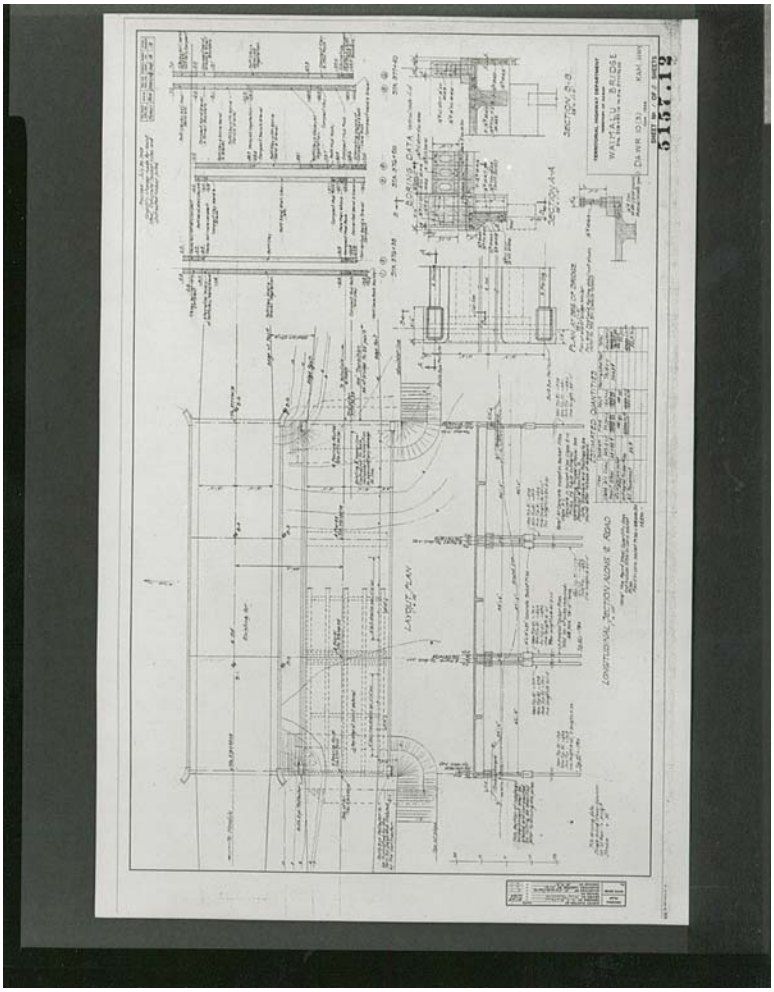

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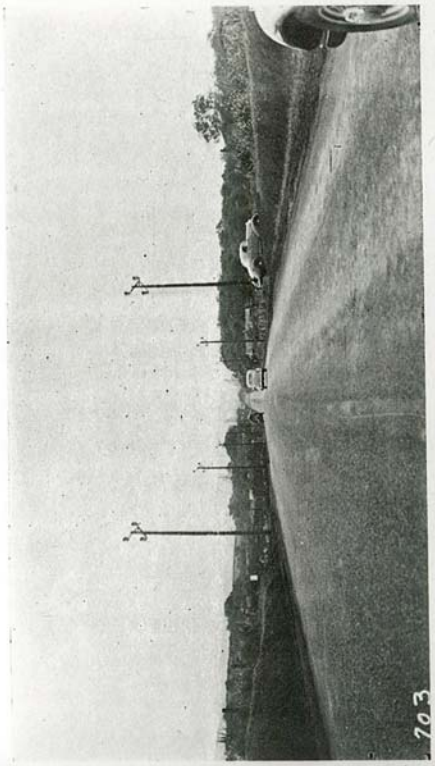

Kamehameha Highway near Pearl City, Oahu,
looking toward Honolulu.