Final
Archaeological Assessment of the Proposed Halekauwila Place Project Kakaʻako, Honolulu District, Oʻahu Island TMK: [1] 2-1-051:009 por.

Prepared for

Halekauwila Partners, LLC

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(Job Code: KAKAAKO 13)

August 2009

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Management Summary

Reference	Archaeological Assessment of the Proposed Halekauwila Place Project, Kaka‘ako, Honolulu District, O‘ahu Island (TMK: [1] 2-1-051:009 por.) (Tulchin, Altizer, Borthwick, and Hammatt 2009)
Date	August 2009
Project Number (s)	Cultural Surveys Hawai‘i Inc. (CSH) Job Code: KAKAAKO 13
Investigation Permit Number	The fieldwork component of the archaeological assessment investigation was carried out under archaeological permit number 09-20, issued by the Hawai‘i State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR), per Hawai‘i Administrative Rules (HAR) Chapter 13-282.
Project Location	The project area is located in the *mauka* (inland) area of Kaka‘ako, consisting of the northeastern portion of the block bounded by Halekauwila Street, Keawe Street, Pohukaina Street, and the Mother Waldron Park. The project area is depicted on the U.S. Geological Survey 7.5-Minute Series Topographic Map, Honolulu Quadrangle (1998).
Land Jurisdiction	Government; State of Hawai‘i
Agencies	Hawai‘i Community Development Authority (HCDA); State Historic Preservation Division / Department of Land and Natural Resources (SHPD/DLNR)
Project Description	The proposed Halekauwila Place Project consists of development of a mixed-income urban housing community, including: a 19-story residential tower with ground-level retail and meeting spaces; condominium townhomes; and a multi-level parking garage with ground-level retail spaces. Minimally, land disturbing activities would include: grubbing and grading; excavations for building foundations and subsurface utilities; and associated infrastructure improvements.
Project Acreage	1.25 acres
Area of Potential Effect (APE) and Survey Acreage	The proposed project’s area of potential effect (APE) is defined as the entire 1.25-acre project area. The survey area for the current archaeological assessment included the entire 1.25-acre APE.

Historic Preservation Regulatory Context	This document was prepared to support the planned project's historic preservation review under Hawai‘i Revised Statutes (HRS) Chapter 6E-8 and Hawai‘i Administrative Rules (HAR) Chapter 13-13-275. In consultation with the State Historic Preservation Division (SHPD), an archaeological inventory survey plan was prepared prior to conducting the current archaeological assessment study. The *Archaeological Inventory Survey Plan for the Proposed Halekauwila Place Project, Kaka‘ako, Kona District, O‘ahu Island* (Hammatt and Shideler 2008) was reviewed and accepted by SHPD in 2008 (LOG NO: 2008.2059, DOC NO: 0808LM05; see Appedix A). In consultation with the SHPD, the archaeological inventory survey investigation was designed to fulfill the State requirements for an archaeological inventory survey, per HAR Chapter 13-13-276. Because no historic properties were identified in the project area, this investigation is termed an archaeological assessment, per HAR Chapter 13-13-284-5.
Fieldwork Effort	Fieldwork was conducted from June 4-9, 2009 and required 14 person-days to complete. The CSH field crew consisted of: Douglas Borthwick, B.A.; Todd Tulchin, B.S.; Jeff Fong, M.A.; Mindy Simonson, M.A.; and Darienne Dey, B.A.; under the general supervision of principal investigator Hallett H. Hammatt, Ph.D.
Number of Historic Properties Identified	None
Effect Recommendation	No historic properties were identified during the current archaeological assessment study. However, based on background research, including the previous identification of human skeletal remains in the immediate vicinity of the project area, there is potential for encountering human skeletal remains within the natural sandy clay-type sediments underlying fill material in the project area. Due to the potential adverse effect on significant historic properties within the project's APE, specifically inadvertent burial discoveries, CSH's project-specific effect recommendation is "effect, with proposed mitigation commitments."
Mitigation Recommendation	Archaeolgical monitoring is recommended during all land disturbing activities within the project area. Archaeological monitoring will ensure proper treatment and documentation should any historic properties be discovered during project-related construction activities. An archaeological monitoring plan should be prepared for review and approval of the State Historic Preservation Divison (SHPD) prior to project construction. In accordance with HAR 13-279, the monitoring plan should detail specific archaeological monitoring provisions.

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Section 1 Introduction

1.1 Project Background

At the request of Halekauwila Partners, LLC, Cultural Surveys Hawai‘i, Inc. (CSH) completed an archaeological assessment of the proposed Halekauwila Place Project, Kaka‘ako, Honolulu District, O‘ahu Island (TMK: [1] 2-1-051:009 por.). The project area is located in the *mauka* (inland) area of Kaka‘ako, consisting of the northeastern portion of the block bounded by Halekauwila Street, Keawe Street, Pohukaina Street, and the Mother Waldron Park (Figures 1-3). The project area is depicted on the U.S. Geological Survey 7.5-Minute Series Topographic Map, Honolulu Quadrangle (1998).

The project area is government-owned by the State of Hawai‘i, under the jurisdiction of the Hawai‘i Community Development Authority (HCDA). The proposed Halekauwila Place Project consists of development of a mixed-income urban housing community, including: a 19-story residential tower with ground-level retail and meeting spaces; condominium townhomes; and a multi-level parking garage with ground-level retail spaces (Figure 4 and Figure 5). Minimally, land disturbing activities would include: grubbing and grading; excavations for building foundations and subsurface utilities; and associated infrastructure improvements. The proposed project’s area of potential effect (APE) is defined as the entire 1.25-acre project area. The survey area for the current archaeological assessment included the entire 1.25-acre APE.

This document was prepared to support the planned project’s historic preservation review under Hawai‘i Revised Statutes (HRS) Chapter 6E-8 and Hawai‘i Administrative Rules (HAR) Chapter 13-13-275. In consultation with the State Historic Preservation Division (SHPD), an archaeological inventory survey plan was prepared prior to conducting the current archaeological assessment study. The *Archaeological Inventory Survey Plan for the Proposed Halekauwila Place Project, Kaka‘ako, Kona District, O‘ahu Island* (Hammatt and Shideler 2008) was reviewed and accepted by SHPD in 2008 (LOG NO: 2008.2059, DOC NO: 0808LM05; see Appedix A). In consultation with the SHPD, the archaeological inventory survey investigation was designed to fulfill the State requirements for an archaeological inventory survey, per HAR Chapter 13-13-276. Because no historic properties were identified in the project area, this investigation is termed an archaeological assessment, per HAR Chapter 13-13-284-5.

1.2 Scope of Work

The following scope of work satisfies State and County requirements for an archaeological inventory survey [per HAR 13-13-276]. The scope of work included:

1. Appropriate consultation with knowledgeable members of the community, requesting information on historic properties in the project area.

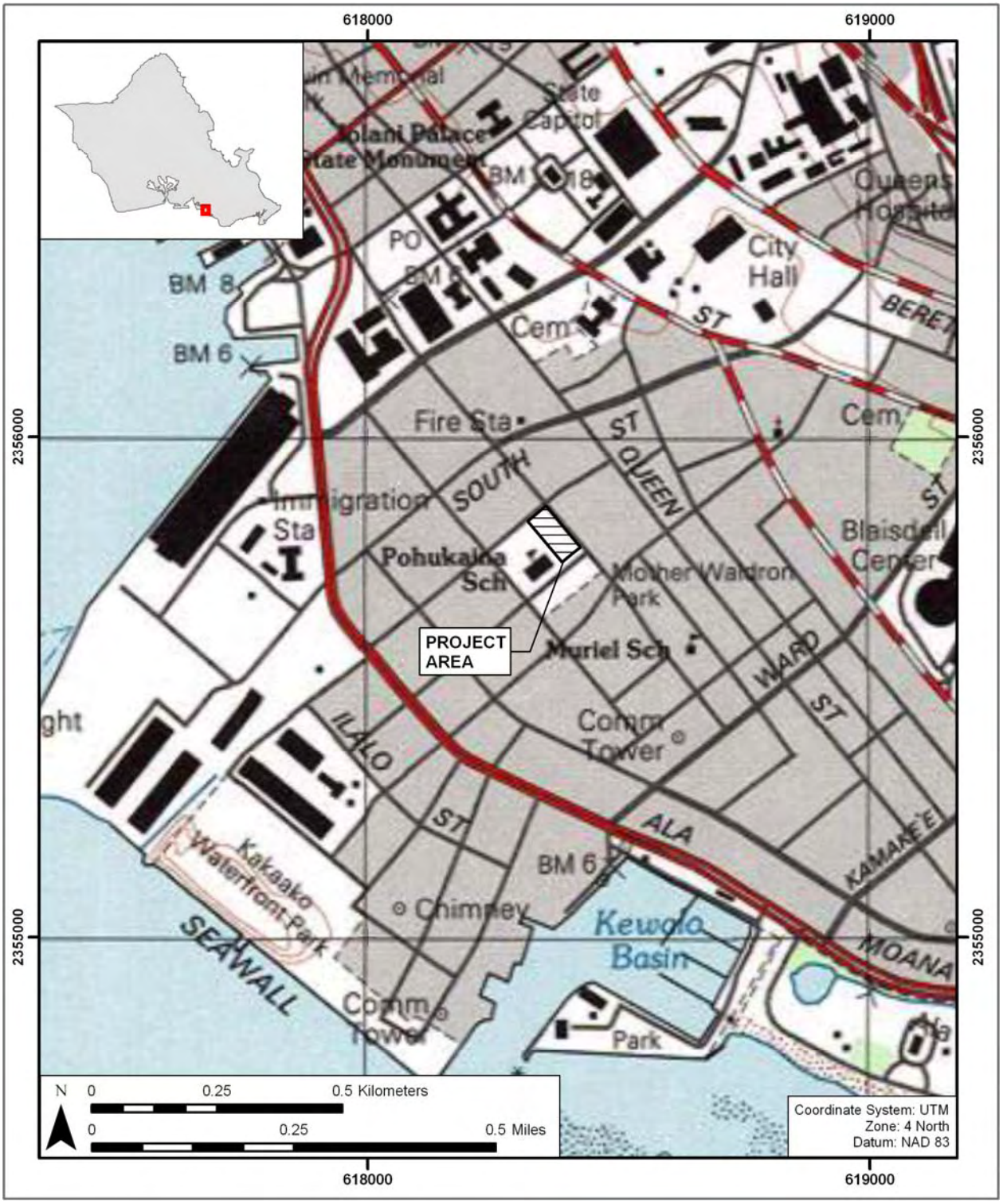

Figure 1. U.S. Geological Survey 7.5-Minute Series Topographic Map, Honolulu Quadrangle (1998), showing the location of the project area

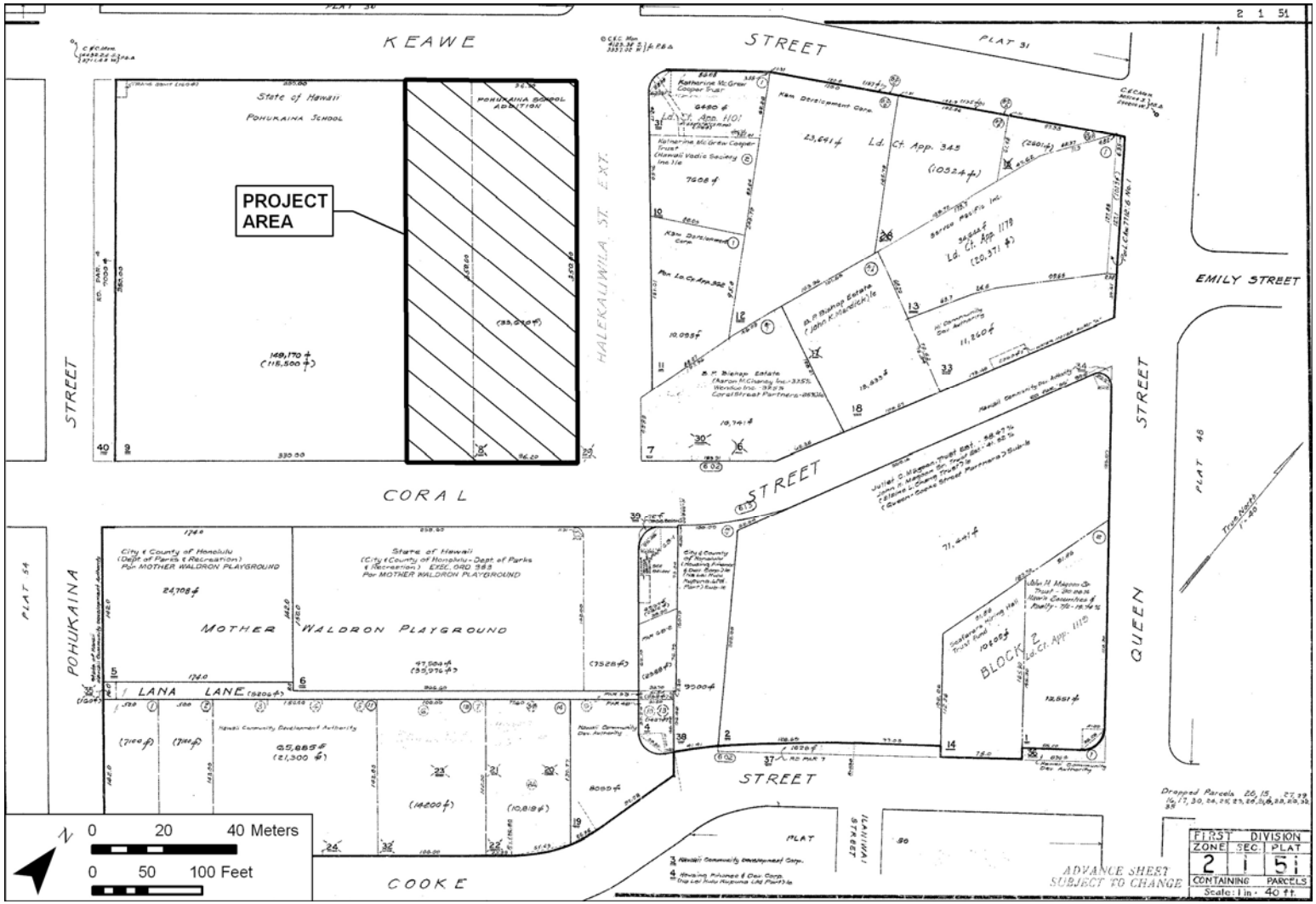

Figure 2. Tax Map Key [1] 2-1-051, showing the location of the project area

Figure 3. Aerial photograph (source: U.S.G.S. Orthoimagery 2005), showing the location of the project area

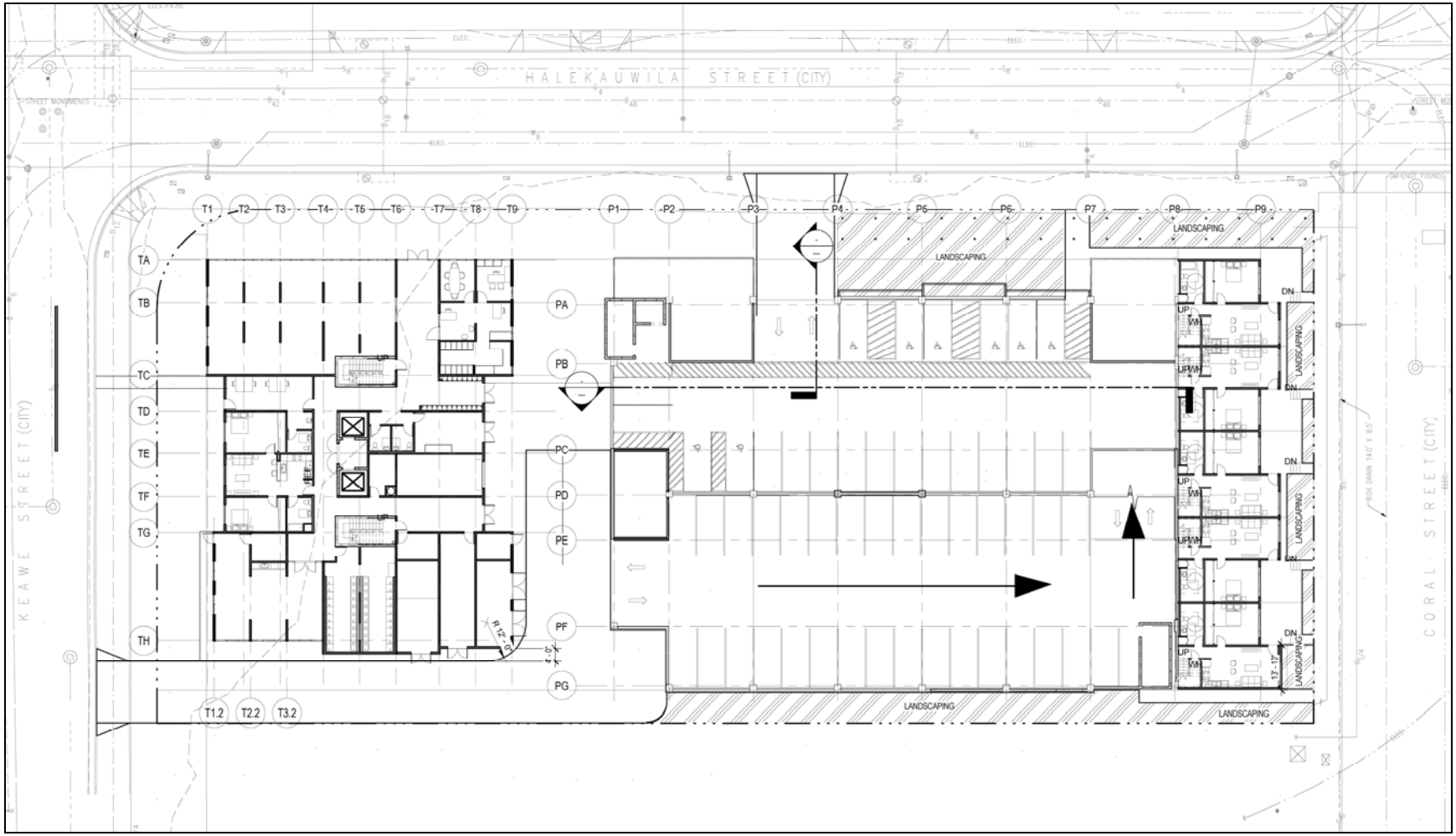

Figure 4. Ground-level site plan of the proposed Halekauwila Place Project (source: Halekauwila Partners, LLC)

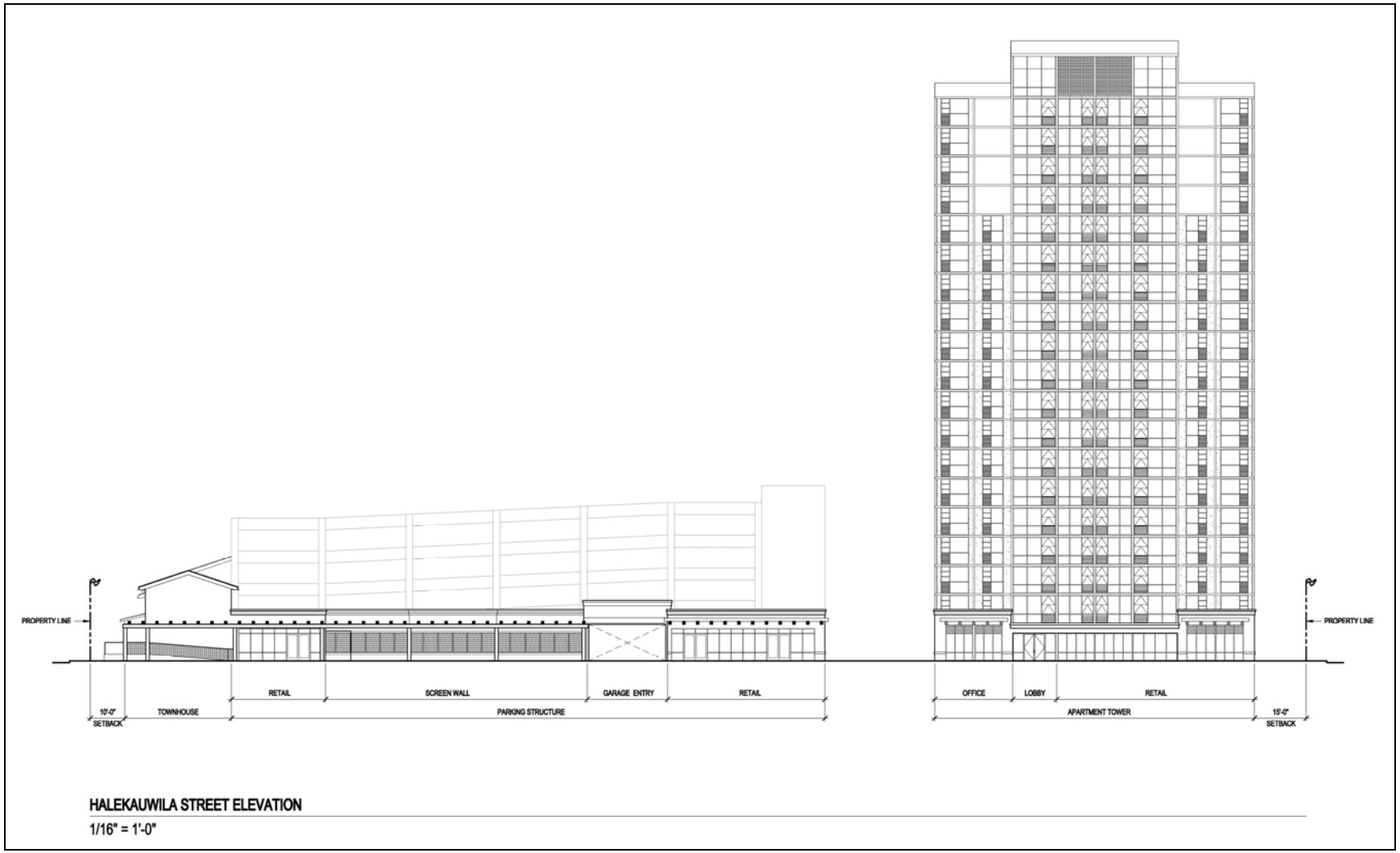

Figure 5. Cross-section diagram of the proposed Halekauwila Place Project (source: Halekauwila Partners, LLC)

2. A complete ground survey of the entire project area for the purpose of historic property identification and documentation. All historic properties would be located, described, and mapped with evaluation of function, interrelationships, and significance. Documentation would include photographs and scale drawings of selected historic properties. All historic properties would be assigned *Inventory of Historic Properties* numbers by the State. All historic properties would be located with Trimble GPS equipment and presented in the report in ArcGIS format.
3. Eighteen trenches utilizing a combination of mechanical and manual excavation were excavated across the parcel in order to identify any buried cultural deposits and /or human burials. If appropriate samples from these excavations were found, they would be analyzed for chronological and paleoenvironmental information.
4. Research on historic and archaeological background, including search of historic maps, written records, and Land Commission Award documents. This research focused on the specific project area, with general background on the *ahupua‘a* and district, and emphasizes settlement patterns.
5. Preparation of this archaeological assessment report, including the following:
    a. A topographic map of the survey area showing all historic properties;
    b. Results of consultation with knowledgeable community members about the property’s past land use and historic properties;
    c. Description of all historic properties with selected photographs, scale drawings, and discussions of function;
    d. Historical and archaeological background sections summarizing prehistoric and historic land use as they relate to the project area’s historic properties;
    e. Recommendations based on all information generated that will specify what steps should be taken to mitigate the impact of development on the project area’s significant historic properties - such as data recovery (excavation) and preservation of specific areas. These recommendations were developed in consultation with the client and the State agencies.

This scope of work also included full coordination with the State Historic Preservation Division (SHPD) and City and County of Honolulu relating to archaeological matters. This coordination takes place after consent of the owner or representatives.

1.3 Environmental Setting

1.3.1 Natural Environment

The project area is located on the nearly-level coastal plain of Kaka‘ako, in southern O‘ahu. The elevation of the project area is approximately 1.5 m (5.0 ft.) above mean sea level. Sediments within the project area are primarily designated Mixed Fill Land (FL), with Ewa Silty Clay Loam (EmA) in the northwestern portion of the project area (Foote et al. 1972) (Figure 6). Mixed Fill Land is described as land used for urban development and the fill as “materials dredged from the ocean or hauled from nearby areas, garbage, and general material from other

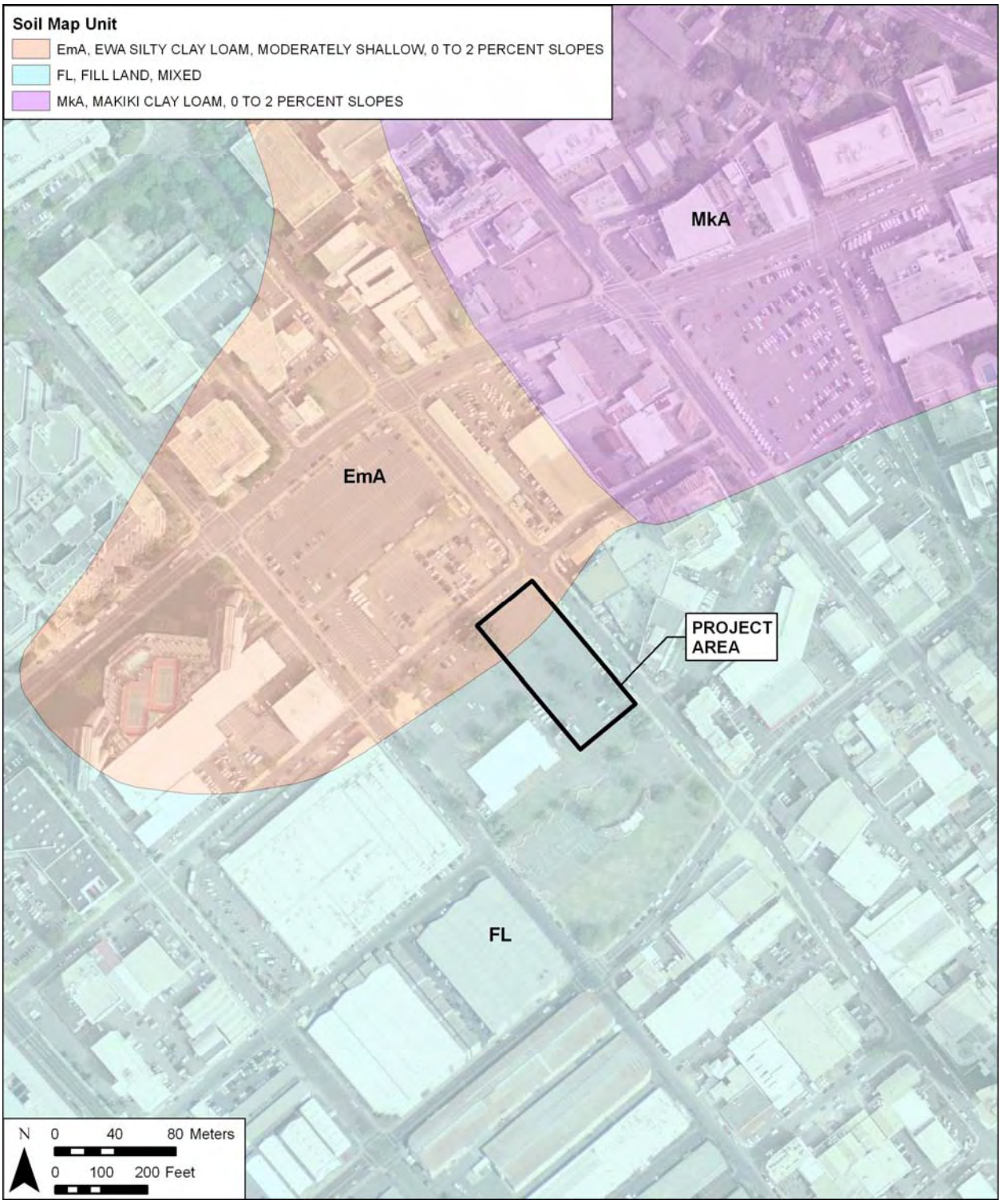

Figure 6. Aerial photograph (source: U.S.G.S. Orthoimagery 2005) with overlay of the Soil Survey of Hawai‘i (Foote et al. 1972), indicating sediment types within the project area

sources” (Foote et al. 1972). The filling and subsequent development of the low-lying marshes, tidal flats, fish ponds, and reef areas, which constituted the undeveloped natural condition of the Kaka‘ako area, permanently changed it into its present fully urbanized character. Sediments of the Ewa Series are described as “well-drained soils in basins and on alluvial fans…developed in alluvium derived from basic igneous rock,” with Ewa Silty Clay Loam typically overlying coral limestone at depths of 0.5-1.5 m (Foote et al. 1972).

The project area receives approximately 600 mm (24 in.) of annual rainfall (Giambelluca et al. 1986). As the project area is almost entirely asphalt-paved, vegetation within the project area is limited to a few monkey-pod trees (*Pithecellobium saman*) and one large ficus tree (*Ficus sp.*).

1.3.2 Built Environment

The project area is almost entirely asphalt-paved and is currently used as a parking lot. A large warehouse is located southwest of the project area, on the same block. The Mother Waldron Park, with landscaped areas, athletic facilities, and restroom facilities is located southeast of the project area. The surrounding Kaka‘ako area is urban, with a mix of industrial warehouses, low-rise commercial buildings, and high-rise residential buildings.

Section 2 Methods

2.1 Field Methods

The fieldwork component of the archaeological assessment investigation was carried out under archaeological permit number 09-20, issued by the Hawai‘i State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR), per Hawai‘i Administrative Rules (HAR) Chapter 13-282. Fieldwork was conducted from June 4-9, 2009 and required 14 person-days to complete. The CSH field crew consisted of: Douglas Borthwick, B.A.; Todd Tulchin, B.S.; Jeff Fong, M.A.; Mindy Simonson, M.A.; and Darienne Dey, B.A.; under the general supervision of principal investigator Hallett H. Hammatt, Ph.D.

Fieldwork consisted of a complete pedestrian inspection of the project area, as well as a program of subsurface testing. The subsurface testing program consisted of the excavation of 18 test trenches, with each trench measuring approximately 6 m long and 0.8 m wide, for a total excavation of approximately 86 m^2. This represented a sample size of approximately 2 % of the project area. Test trenches were distributed throughout the project area to provide representative coverage and assess the stratigraphy and potential for subsurface cultural resources in the project area. The testing program also focused on characterizing the remnants of the project area’s buried land surface that predated the historic and modern fill layers. These remnants of the older land surface were more likely to be associated with significant cultural deposits. All trenches were excavated down to the underlying coral shelf or below the water table.

A standard backhoe with a two-foot wide bucket was used to excavate at least portions of each test trench. The backhoe was initially used to remove asphalt paving and overlying fill deposits within each test trench. When excavation occurred through native soil deposits, which are more likely to contain human skeletal remains or other significant cultural deposits, the entire trench including the base of the trench and the side walls was cleaned with hand tools to reveal any potential cultural features such as pits, postholes or any other cultural disturbances to the natural sediment. If cultural features were identified, they were explored and carefully excavated with hand tools to reveal their nature and content. Following cleaning of the trench, if no potential cultural features were identified, limited hand-excavation testing was then undertaken. Hand excavation consisted of a continuous linear trench down the entire long axis of the backhoe trench. Following hand-excavation, if no evidence of cultural features was present and the natural sediment was determined to be sterile, the backhoe was utilized to complete the excavation.

Each test trench was documented with a scale section profile, photographs, and sediment descriptions. Sediment descriptions, using standard USDA soil description observations/terminology, included: Munsell color designations; texture; consistency; structure; plasticity; cementation; origin of sediments; descriptions of any inclusions, such as cultural material and/or roots and rootlets; lower boundary distinctiveness and topography; and other general observations. Cultural features were represented on the trench profile. Feature documentation included profiles and/or plan views, collected samples, stratigraphic descriptions, and photographs. The location of each test trench was recorded using a Trimble ProXH GPS unit (sub-foot horizontal accuracy).

2.2 Laboratory Methods

In general, artifact analysis focused on establishing, to the greatest extent possible, material type, formal/function type, cultural affiliation and/or age of manufacture. Following the completion of fieldwork, all collected materials were analyzed using current standard archaeological laboratory techniques. Historic materials collected in the field were returned to the CSH laboratory and washed, examined, and, as appropriate, photographed. Historic artifacts were identified using standard reference materials and the resources available over the internet.

2.3 Document Review

Historic and archival research included information obtained from the UH Hamilton Library, the State Historic Preservation Division Library, the Hawai‘i State Archives, the State Land Survey Division, and the Archives of the Bishop Museum. Previous archaeological reports for the area were reviewed, as were historic maps and primary and secondary historical sources. Information on Land Commission Awards was accessed through Waihona ‘Āina Corporation’s Māhele Data Base (www.waihona.com).

2.4 Consultation

In 2001, CSH conducted a cultural impact assessment for the Mother Waldron Playground and the Former Pohukaina School Site, an area that includes the current project area (McGuire and Hammatt 2001). The following are the results of the cultural impact assessment.

The results of the community consultations are summarized in Table 1. In consultation with the SHPD Culture/History Branch, it was determined that the consultation process need not be as broad as originally intended, due to several factors: 1) the Kaka‘ako area previously consisted of fish ponds and tidal flats and was subject to intertidal influences; 2) the soil in the project area is predominantly Fill (FL) (Foote et al. 1972). (The historic record confirms that in the early 20th century, the Kaka`ako area was filled in due to expansion activities.); 3) the project area is in a developed and previously disturbed area; and 4) due to development of the commercial and industrial district, the original homes were torn down in the last 10-15 years and the once tight-knit community dispersed and relocated elsewhere. Based on SHPD’s recommendations, the individuals and organizations listed in Table 1 were consulted with and deemed to be sufficient. None of the individuals or organizations contacted had any knowledge of Hawaiian traditional cultural practices occurring in the project area. Additionally no cultural concerns were expressed. Two referrals (Akea family and Henry Huihui) were not contacted due to no contact phone number or forwarding address. Two people who knew Mother Waldron were contacted: Aaron Chaney and Harold W. Horne, grandson of Mother Waldron. Though they gave details on the life of Mother Waldron, they had no knowledge of specific cultural practices which might have occurred in the project area.

Table 1. Results of Community Consultations

Name	Affiliation	Contacted (Y/N/A/U)	Personal Knowledge (Y/N/S/D)	Referral(s) (Y/N)	Comments
Akea family		U	–	–	No phone or forwarding address
Ayau, Halealoha	HMINK	Y	–	N	To his knowledge, no burials found in the project area
Chaney, Aaron		Y	Y	Y	Knew Mother Waldron. Informal talk-story.
Collins, Sarah	SHPD, archaeologist	Y	D	Y	Referred to Culture/History Branch of SHPD
Diamond, A. Van Horn	OIBC Chair & Kona Rep	Y	N	Y	Consulted with SHPD burial staff
Horne, Harold Waldron		Y	Y	N	Grandson of Mother Waldron; informal talk-story
Huihui, Henry		U	–	–	No phone or forwarding address
Jourdane, Muffet	SHPD, archaeologist	Y	–	Y	Referred to Culture/History Branch of SHPD
Lurline Naone Salvador	Kamehameha Schools	Y	N	N	OIBC rep. for KSBE
Neil Hannahs	Kamehameha Schools	Y	N	Y	Referred to Hammatt report (Aug. 1995) done for KSBE
Keala, Jalna	OI-Comm. Resource Coordinator	Y	N	Y	Colin Kippen’s office (OHA)
Kippen, Collin	OHA-Native Rights Div.	Y	N	Y	None

Name	Affiliation	Contacted (Y/N/A/U)	Personal Knowledge (Y/N/S/D)	Referral(s) (Y/N)	Comments
Markell, Kai	SHPD Burial Staff	Y	–	Y	None
Mc Eldowney, Holly	SHPD, Culture & History	Y	Y	N	None
Napoka, Nathan	SHPD, History & Culture Branch Chief	Y	Y	Y	None
Nihipali, Kūnani	HMINK	Y	Y	Y	Referred to Halealoha Ayau for HMINK
Oral History Ctr.	UH-Mānoa	Y	–	Y	(Kaka`ako Transcripts)
Wahilani, Kalā‘au	SHPD Burial staff	Y	–	Y	Communication through Van Horn Diamond

Key:

HMINK = Hui Mālama i Nā Kūpuna o Hawai`i Nei

OIBC = O`ahu Island Burial Council

OHA = Office of Hawaiian Affairs

SHPD = State Historic Preservation Division

Y = Yes

N = No

S = Some knowledge

D = Declined to comment

U = Unable to contact due to no phone or address

A = Attempted (at least 3 attempts were made to contact individual, with no response)

U = unable to contact, i.e., no known phone number or forwarding address

Section 3 Background Research

3.1 Traditional and Historical Background

3.1.1 Overview of Kaka‘ako

The modern urban district known as Kaka‘ako is significantly larger than the traditional area of the same name, which is described in mid-19th century documents and maps as a small *‘ili* (traditional land unit within an *ahupua‘a*) within the *ahupua‘a* (traditional land division) of Honolulu. In addition to the *‘ili* of Kaka‘ako, the modern Kaka‘ako area also includes lands once known as Ka‘ākaukukui, Kukuluāe‘o, and Kewalo, and even smaller areas—possibly portions of *‘ili*—called Kawaiaha‘o, Honuakaha, Pu‘unui, Ka‘ala‘a, ‘Āpua, and ‘Auwaiolimu, as shown on late 19th century maps (Figure 7, Figure 8, and Figure 9). The current project area is located within the Pu‘unui area of Ka‘ākaukukui ‘Ili.

The original location and extent of an area called Kaka‘ako is ambiguous. The ethnographer Henry Kekahuna (1958:4), who was born in Hawai‘i in 1891 and was a long-time resident of O‘ahu, placed it “on the Ewa side of Kuloloia Stream where the Honolulu Iron Works and Fort Armstrong are now,” an area now covered by One Waterfront Plaza (between South and Punchbowl Streets). Kekahuna (1958:4) also related that “there were formerly scattered dunes of white sand there. Gilbert Islanders (Kilipaki) squatted there, and made a living by fishing, collecting coral for curios, and catching octopus.” Only four LCA claims list their location as within the *‘ili* of Kaka‘ako. These are also generally located adjacent to the sea, east of Punchbowl Street between Pohukaina Street and Reed Lane. The 1884 map of the “Kewalo” section of Honolulu by S.E. Bishop (Figure 7) does not show an area named Kaka‘ako at all. On an 1897 map of Honolulu by M.D. Monsarrat, the area adjacent to the coastal wharfs is labeled Kaka‘ako (Figure 8). These maps and documents all place the *‘ili* of Kaka‘ako at the western end of the modern Kaka‘ako district. The only late nineteenth century map that has a mark for Kaka‘ako east of this general area is an 1876 C.J. Lyons map of Ka‘ākaukukui and Pu‘unui, which has a coastal point (marked by a triangle) labeled Kaka‘ako (Figure 9). However, this is likely a triangulation station used by surveyors for mapping, rather than a point marking the central section of Kaka‘ako.

Until the end of the 19th century, Kaka‘ako was considered to be something of a wasteland, or empty space, between the better-known locations of Kou (modern-day Honolulu) and Waikīkī. Recent archaeological projects, associated with development and construction in the area, have documented several large cemeteries dating from the earlier historic period and perhaps late pre-Contact times. Otherwise, the place is known, and famous in a traditional sense, for its low-lying marshes, fishponds and salt making.

It does not appear that the current project area was in an area of dense or permanent settlement in traditional times. Most of the pre-contact and early post-contact population was clustered in the village of Honuakaha, northwest of the current project area, or scattered adjacent to the main trails (i.e. Queen and King Streets), north of the current project area. However, in later post-contact times (post-1850), this changed, as population pressure in Honolulu and urban expansion led to the infilling of marshes and wetlands on the outskirts of Honolulu, and the subsequent development of the Kaka‘ako area.

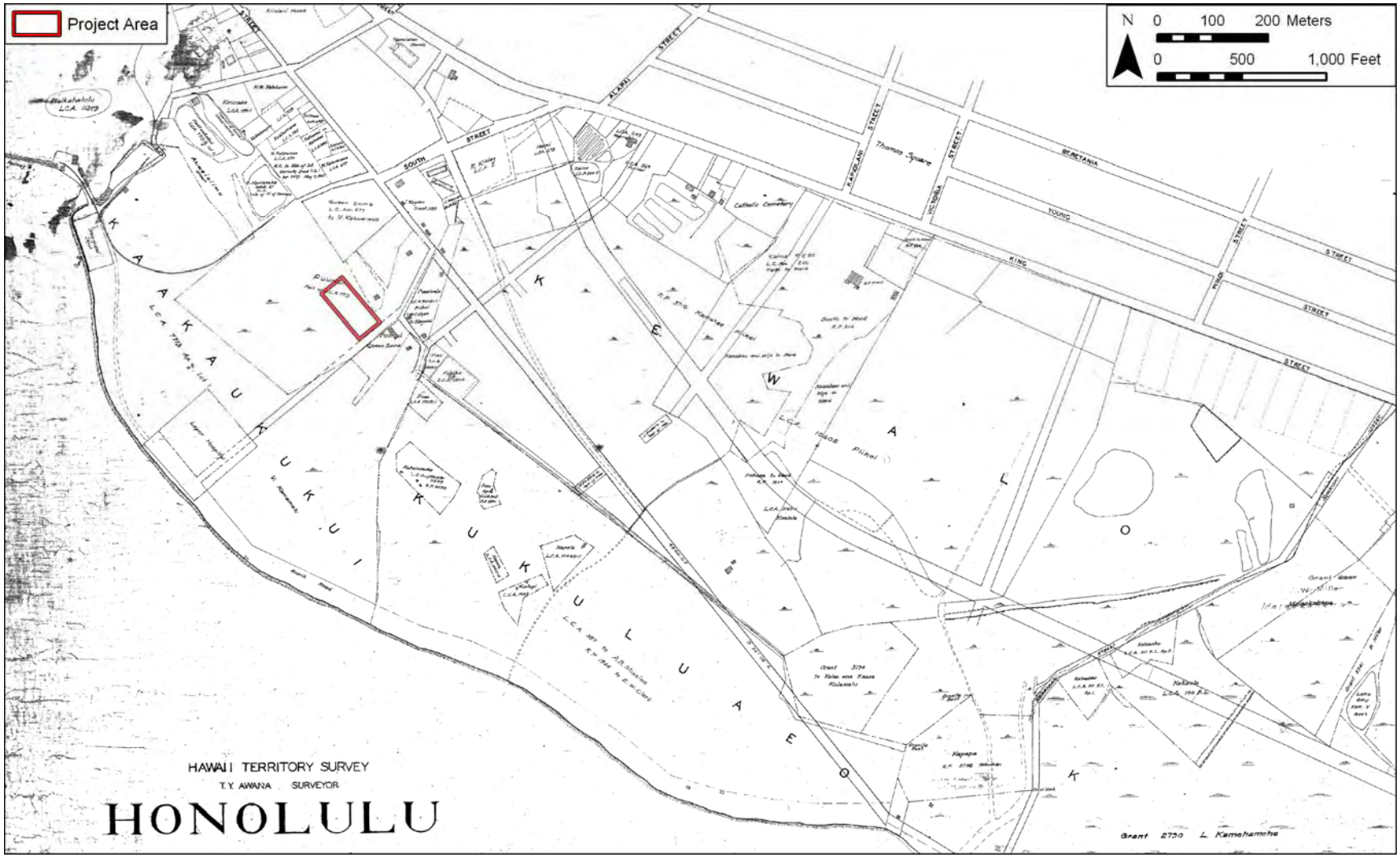

Figure 7. 1884 Map of Honolulu, Kewalo Section, by S.E. Bishop (Reg. Map 1090), showing the location of the project area and traditional place names in the vicinity

Figure 8. 1897 Map of Honolulu by M.D. Monsarrat (Reg. Map 1910), showing the location of the project area and traditional place names in the vicinity

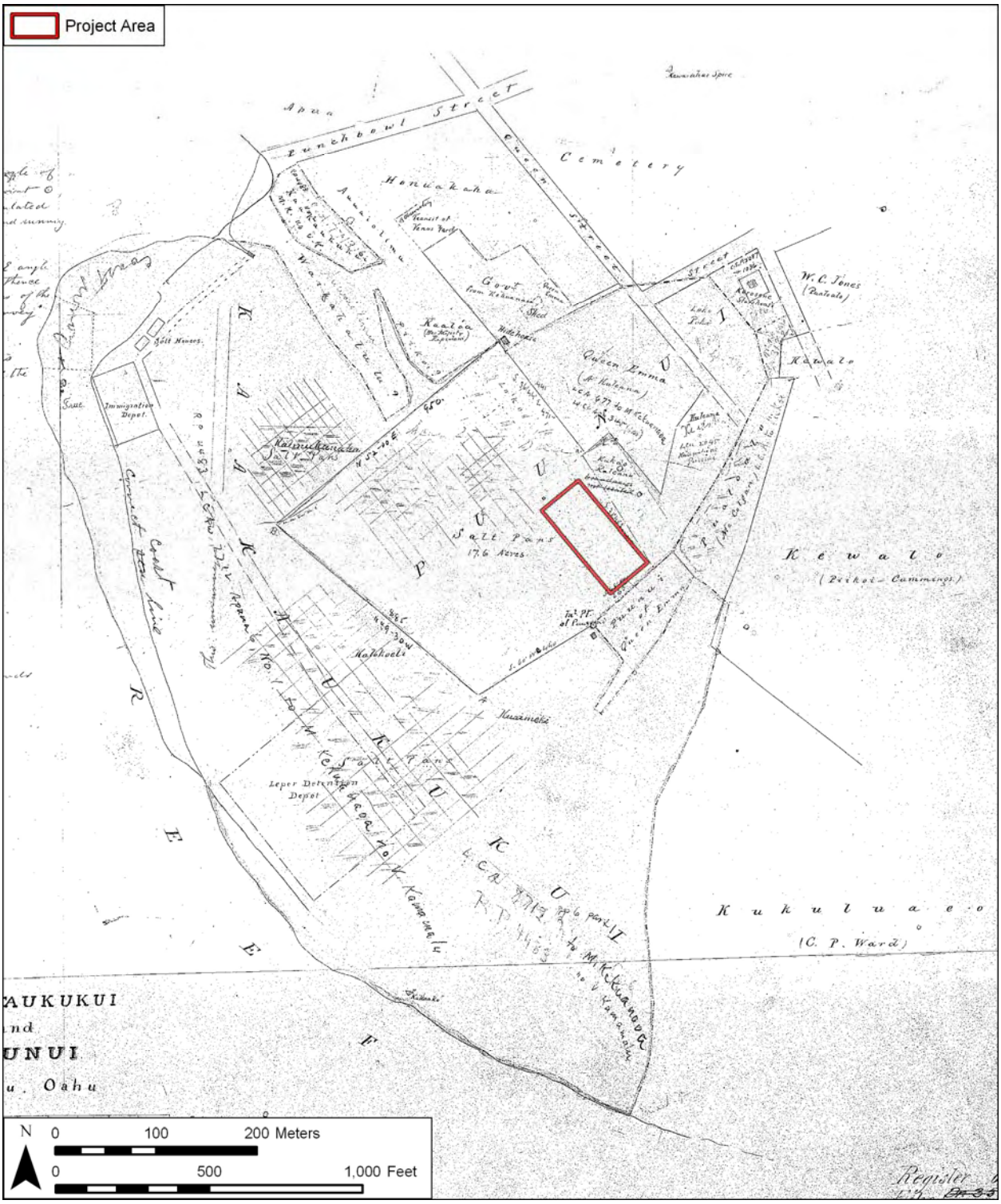

Figure 9. 1876 Map of Kaakaukukui and Puunui, Honolulu, by C.J. Lyons (Reg. Map 611), showing the location of the project area and traditional place names in the vicinity

3.1.2 Place Names

Place name translations presented without attribution in this subsection are from *Place Names of Hawai‘i* (Pukui et al. 1974), unless indicated otherwise. The researchers for this book based their interpretations not only on literal (phonetic) translations of the words, but also on oral traditions and historic documents. In this work, the place names of geographic features and *ahupua‘a* names are translated; however, *‘ili* names are not usually presented.

Thomas Thrum also published a short paper on place names in the 1922 edition of Lorrin Andrews *A Dictionary of the Hawaiian Language*, based only on the phonetic translations of the place names. This work does have a large number of translated *‘ili* names. However, because there are no oral or written documents to confirm Thrum’s interpretations, Mary Pukui (Pukui et al. 1974:136) cautioned that Thrum’s translations were sometimes “unreliable.” Thrums’s translations are presented here since it is our only source for many *‘ili* names, but Pukui’s cautionary note for these interpretations should be kept in mind.

Many of the place names listed below are associated with specific *mo‘olelo* (oral histories) and *wahi pana* (legendary or storied places). The locations of some of these place names can be seen on Figure 7, Figure 8, and Figure 9.

Pukui et al. (1974) do not give a meaning for the place name **Kaka‘ako**, but the Hawaiian word *kākā‘āko* can be translated as “dull, slow” (Pukui and Elbert 1986:110). Thrum (1922:639) translated the word as “prepare the thatching” (*kākā*=to chop, beat, or thresh; *ako*=thatch). If Thrum’s translation is correct, it could be related to the fact that salt marshes, such as areas like Kaka‘ako, were excellent places to gather tall *pili* grass, which the Hawaiians traditionally used to thatch their houses.

According to Kekahuna (1958:4), **Ka‘ākaukukui** was “a beautiful sand beach that formerly extended along Ala Moana Park to Kewalo Basin, a quarter mile long reef extended along the shore.” An 1884 map (see Figure 7) shows it extending from Punchbowl to Cooke Street, *makai* of Queen Street. Pukui et al. (1974) describe Ka‘ākaukukui as a “filled-in reef,” and literally translate the name as “the right (or north) light,” possibly referring to a maritime navigation landmark. Thrum (1922:635) translates it as “radiating place for lamp.” In the early twentieth century, it was translated as “to the right of the lighthouse” by the squatters who lived in the area (Gessler 1938:187). This would have been an accurate description of the area at that time as Ka‘ākaukukui was east, or “to the right” of the Honolulu Lighthouse in the harbor. However, this is probably a historic, not an ancient, interpretation as the Honolulu Lighthouse, was not built until 1869 (Dean 1991:7).

The area around One Waterfront Plaza, west of the current project area, was the location of a pond called **Umukanaka,** or Kaimukanaka, as seen on the 1876 Lyons map (see Figure 9). Griffin et al. (1987:39) suggested that this pond may have been the same as a place called **Ka-imu-hai-kanaka**, which means “the oven of human sacrifice.” However, Henry Kekahuna, a noted ethnologist born in the islands in 1881 (1958:6, 20), states that Kaimuhaikanaka was actually the original name for the Honolulu Fort, built by Kamehameha I in 1816, which was located at the corner of Queen and Fort Streets, north of the current project area. Honolulu Fort was adjacent to the main temple of Honolulu, Pākākā Heiau, which was used for human sacrifice.

Several of these place names are mentioned in the chant “The Battle of Nu‘uanu,” which concerns the 1795 invasion and conquer of O‘ahu by Kamehameha I. One section of the chant describes locations in Honolulu, listing them from east to west:

> *75 Lauwili i Puke (**Pu‘ukea**), i **Ka-imu-hai-kanaka**,*
> *76 I Kai-kua, i **Kakaako**, i **Mamala**,*
> *77 I ke kai o **Kuloloia**, **Pakaka**,*
> *78 **I ka-imu-hai-kanaka**, i ka-wai-apuka-Kanē.*
>
> [Kala‘ikuahulu 1880:131]

Pu‘ukea (“white hill”) is a small land division and *heiau* in Kukuluāe‘o. **Māmala** (“to protect”) is the name of a canoe landing in Honolulu Bay. **Kuloloia** (meaning unknown) is a stream, the harbor, and beach at the end of Fort Street. **Pākākā** is the name of a canoe landing and an important *heiau*, also located at the foot of Fort Street (Griffin et al. 1987:39). There are several interpretations for the name Pākākā. In *Place Names of Hawai‘i* (Pukui et al. 1974:175), the name is translated as “to skim, as stones over water.” In the *Hawaiian Dictionary* by Pukui and Elbert (1986:304), *pākākā* is translated as “low and broad.” Lebo has suggested that the correct translation may be “courtyard for smiting,” as this *heiau* was used for human sacrifice. Westervelt (1963:21), in his collection on Honolulu legends, noted that the *heiau*:

> …was standing on the western side of the foot of Fort Street long after the [Honolulu] fort was built from which the street was named. It was just below the fort…In this temple, the school of the priests of Oahu had its headquarters for centuries. The walls of the temple were adorned with heads of men offered in sacrifice.

The root word *hai*, “sacrifice” is found in the place name Ka-imu-hai-kanaka (“the oven of human sacrifice”), a place probably associated with, and located near Pākākā, a sacrificial *heiau*. It is not found in the place name for the pond Ka-imu-kanaka in Ka‘ākaukukui, so there is no indication that this was also a place for sacrifice. However in the Battle of Nu‘uanu chant presented above, the place name Ka-imu-hai-Kanaka is used twice. If the chant is listing places from east to west, then the place names are Pu‘ukea, Ka-imu-hai-kanaka, Kaka‘ako, Kuloloia, Pākākā, and Ka-imu-hai-kanaka. Pu‘ukea is in the land of Kukuluāe‘o, southeast of the project area. Kuloloia and Pākākā are northwest of the project area near downtown Honolulu. It is possible that there was also a place called Ka-imu-hai-kanaka near the project area, in the land of Ka‘ākaukukui.

> Ka‘ākaukukui was a *lele*, or jump land. That is, it had several non-contiguous parcels, one at the coast and two others were inland. It was adjacent on the *mauka* side to several other small *‘ili* and *lele* lands, including portions of **Pu‘unui** (“big hill”), **Ka‘ala‘a** (“sacred radiance”) (Thrum:1922:635), **Honuakaha** (“flat land” Thrum 1922:633), **Pualoalo** (“hibiscus *kokio*”; Thrum 1922:667), **‘Āpua** (“fish basket”), and **‘Auwaiolimu** (“ditch of moss”).

There are a few other names on the 1876 map (see Figure 9) near the current project area. The westernmost salt pan area is labeled **Kaimukanaka**, the name of a pond and also an *‘ili*. One claim was made for the *‘ili* of Kaimukanaka (LCA 8057 to Ehu), but it was not awarded. Two

other names in the salt pan area are **Kalokoeli,** “the dug pond” (Pukui et al. 1974:78) and **Kuaimeki (**unknown meaning; *meki* may mean “pit.”) These may be *‘ili* or pond names, or both.

Kukuluāe‘o, translated literally is the “Hawaiian stilt (bird),” *Himantopus himantopus*, and from the word *kukuluāe‘o*, which means “to walk on stilts.” Pukui et al. (1974) described the area as “formerly fronting Ke-walo Basin” and “containing marshes, salt ponds, and small fishponds,” an environment well suited for this type of bird (Griffin et al. 1987:36). Kekahuna (1958:4) described it as “the land on the upland side of Ka‘ākaukukui. Salt was formerly made there.”

Kewalo literally means “the calling (as an echo).” Land Commission Award and other historic-era documents identify it as the area between Cooke and Sheridan Streets, *mauka* of Queen Street and the coastal sections of Ka‘ākaukukui, Kukuluāe‘o, and Kālia. According to Pukui et al. (1974:109), “outcasts (*kauwā*) intended for sacrifice were drowned here” (see *mo‘olelo* below). Kekahuna said that at one time, it also had a sand beach as a part of the area, where various sports, such as surfing, were held.

3.1.3 Mo‘olelo Associated with Place Names

Thecurrent project area is located in a region known as Ka‘ākaukukui. It is *makai* of Kewalo on early historic maps and west of the land called Kukuluāe‘o. The names Ka‘ākaukukui and Kukuluāe‘o do not appear in any citations in *Hawaiian Island Legends Index* or in the index to *Fornander’s Collection of Hawaiian Antiquities and Folklore*. There are a few mentions of the place names “Kewalo” and Kaka‘ako in various legends and traditions. Kaka‘ako and Kukuluāe‘o are mentioned in some post-contact chants.

From these legendary accounts it can be seen that Ka‘ākaukukui, Kukuluāe‘o, and Kewalo were traditionally noted for: their fishponds and salt pans; the marsh lands where *pili* grass and other plants could be collected; ceremonial sites such as Pu‘ukea Heiau, Kewalo Spring, and Kawailumalumai Pond, at which sacrifices were made; and their trails that allowed transport between the more populated areas of Waikīkī and Honolulu. Important chiefs were born in the area and conducted religious rites, and commoners traveled to the area to procure food and other resources. Some commoners probably also lived in the area, possibly adjacent to the ponds and the trails.

3.1.3.1 Kaka‘ako

Kaka‘ako is mentioned in Thrum’s version of the legend of Kū‘ula, the god presiding over the fish, and his son ‘Ai‘ai, who was the first to teach the Hawaiians how to make various fishing lines and nets, the first to set up a *ko‘a kū‘ula*, a rock shrine on which the fishermen would place their first catch as an offering to Kū‘ula, and the first to set up *ko‘a ia*, fishing stations where certain fish were known to gather. Leaving his birthplace in Maui, ‘Ai‘ai traveled around the islands, establishing *ko‘a kū‘ula* and *ko‘a ia*. On O‘ahu, he landed first at Makapu‘u in Ko‘olaupoko, then traveled clockwise around the island.

> Aiai came to Kalia [Waikīkī] and so on to Kakaako. Here he was befriended by a man named Apua, with whom he remained several days, observing and listening to the murmurs of the chief named Kou. This chief was a skillful haiku [*Katsuwonus pelamis*; bonito] fisherman, his grounds being outside of Mamala

> until you came to Moanalua. There was none so skilled as he, and generous withal, giving akus to the people throughout the district. [Thrum 1998:242]

3.1.3.2 Kewalo

Kewalo once had a freshwater spring in the central portion, as seen in the proverb "*Ka wai huahua‘i o Kewalo*," which translates as "The bubbling water of Kewalo." Two springs are mentioned in a traditional story of the Waters of Ha‘o. This legend tells of two children of the chief Ha‘o who ran away from their cruel stepmother. They stayed a time with the caretakers of Kewalo Spring, which may have been located close to the trail that connected Waikīkī and Honolulu. The children then left when they heard that the chiefess had sent men to look for them. The two children followed the moonlit trail across the plain toward Kou (Honolulu), but finally collapsed from weariness and thirst. In a dream, the boy's mother told him to pull up a plant close to his feet. When he did, he found a spring under the plant, which was called the Water of Ha‘o, or Kawaiaha‘o. This spring is located at the western end of the trail, near Kawaiaha‘o Church in Kaka‘ako (Pukui 1988:87-89).

Kewalo also once had a famous fishpond that was used to drown members of a pariah caste (*kauwā*) or *kapu* (taboo) breakers as the first step in a sacrificial ritual known as *Kānāwai Kaihehe‘e* (Kamakau 1991:6) or *Ke-kai-he‘ehe‘e*, which translates as "sea sliding along," suggesting the victims were slid under the sea (Westervelt 1963:16). Kewalo is described as:

> A fishpond and surrounding land on the plains below King Street, and beyond. It contains a spring rather famous in the times previous to the conversion to Christianity, as the place where victims designed for the Heiau of Kanelaau on Punchbowl slopes, was first drowned. The priest holding the victim's head under water would say to her or him on any signs of struggling, "Moe malie i ke kai o ko haku." "Lie still in the waters of your superiors." From this it was called Kawailumalumai, "Drowning waters." [Sterling and Summers 1978: 292]

Kewalo is mentioned in a legend as a marsh near the beach, where tall *pili* grass was growing. A man named Kapoi went to this area to get thatching for his house. While there, Kapoi found seven owls eggs and took them home to cook for his supper. An owl perched on the fence surrounding his house and cried out "O Kapoi, give me my eggs!" After several such pleas, Kapoi eventually returned the eggs. In return, the owl became his *‘aumakua* (family god) and instructed him to build a *heiau* (pre-Christian place of worship) named Mānoa. Kapoi built the *heiau*, placed some bananas on the altar as a sacrifice, and set the *kapu* days for its dedication. The king of O‘ahu, Kākuhihewa, who was building his own *heiau* in Waikīkī, had made a law that if any man among his people erected a *heiau* and set the *kapu* before him, that man should die. Kapoi was seized and taken to the *heiau* of Kūpalaha, at Waikīkī. Kapoi's *‘aumakua* owl asked for aid from the king of the owls at Owl's Hill (Pu‘u Pu‘eo) in Mānoa, who gathered all of the owls of the islands. They flew to Kūpalaha and battled the king's men, who finally surrendered. From this time, the owl was considered a powerful *akua* (god). The battle area was known as Kukaeunahio-ka-pueo, which means "the confused noise of owls rising in masses" (Westervelt 1963: 135-137; Thrum 1998: 200-202).

Kewalo was the birthplace of the great chief Hua-nui-ka-la-la‘ila‘i, as mentioned in this *mele* (story) chanted by Kamakau (1991 24):

‘O Hua-a-Kamapau ke ‘li‘i	Hua-a-Kamapau the chief
O Honolulu o Waikīkī	O Honolulu, of Waikīkī
I hanau no la i kahua la i Kewalo,	Was born at Kewalo,
‘O Kālia la kahua	Kālia was the place [the site]
O Makiki la ke ēwe,	At Makiki the placenta,
I Kānelā‘au i Kahehuna ke piko,	At Kānelā‘au at Kahehuna the navel cord,
I Kalo i Pauoa ka ‘a‘a;	At Kalo at Pauoa the caul;
I uka i Kaho‘iwai i	Upland at Kaho‘iwai, at
Kanaloaho‘okau . . .	Kanaloaho‘okau. . .

The chief Hua was famous for his love of cultivation and his care for the people. His *heiau*, called Pu‘ukea, was in Kukuluāe‘o in Honolulu; it is mentioned in a traditional *wānana* (prophecy) recorded by Kamakau (1991:24-25).

[Ka makaua ua kahi o ‘Ewa]	[The increasing “first rain” of ‘Ewa]
Ua puni ka i‘a o Mokumoa,	Overcomes the fish of Mokumoa,
Ua kau i‘a ka nene;	Washes up fish to the nene plants;
Ua ha‘a kalo ha‘a nu;	Lays low the taro as it patters down;
Ha‘a ka i‘a o kewalo,	Lays low the fish of Kewalo,
Ha‘a na ‘ualu o Pahua,	Lays low the sweet potatoes of Pahua,
Ha‘a ka mahiki i Pu‘ukea,	Lays low the mahiki grass at Pu‘ukea,
Ha‘a ka unuunu i Pele‘ula,	Lays low the growing things at Pele‘ula
Ha‘a Makaaho i ke ala.	Lays low Makaaho [Makāho] in its path
E Kū e, ma ke kaha ka ua, e Kū,	O Kū, the rain goes along the edge [of the island], O Kū
[I ‘ai ‘na ka i‘a o Maunalua] . . .	[Eating” the fish of Maunalua] . . .

The chant mentions the *mahiki* grass of Pu‘ukea Heiau. The Hawaiian term *mahiki* means “to peel off” (Andrews 2003:369). The word was also used to describe a rite to exorcise an evil spirit, as the skilled *kahuna* (priest) “peeled” the malicious spirit from the afflicted. Used in the ritual was a shrimp called *mahiki* or a native grass called *mahiki*. *Mahiki*, or ‘*aki‘aki*, is a tufted rush (*Sporobolos* sp.) found near the seashore. The ethnologist, Mary Pukui, states that even during her youth, parents put “*tī* leaves, or *hala*, or *‘aki‘aki* grass, in a little sea-salt water and [would] have the child drink it” (Pukui et al. 1972:163) to rid them of badly-behaving spirits. The use of this grass in a ritual may explain its association with a ceremonial *heiau*, or it may simply be that the Kukuluāe‘o coast was a good habitat and thus a favored place for healers to collect this type of grass.

3.1.3.3 Ka‘ākaukukui

Ka‘ākaukukui is briefly mentioned in the legend of Hi‘iaka, beloved sister of the Hawaiian volcano goddess, Pele. Hi‘iaka and her companions had been traveling around O‘ahu on the land trails, but decided to travel from Pu‘uloa (on Pearl Harbor in ‘Ewa) to Waikīkī by canoe. At Pu‘uloa, Hi‘iaka met a party who were planning on traveling to the house of the chiefess Pele‘ula in Waikīkī. Hi‘iaka recited a chant, telling the people although they were going by land and she was going by sea they would meet again in Kou (ancient name of Honolulu). One portion of the

chant mentions the place Ka‘ākaukukui, with reference to a pool, possibly a reference to the salt ponds of the area:

A pehea lā au, e Honoka‘upu, ku‘u aloha	And what of me, O Honoka‘upu, my love
I ka welelau nalu kai o Uhi, o ‘Ōa	Upon the crest of the surf at Uhi and ‘Oā
‘O nā makai ke ao (pō) o poina	Eyes in the living realm (night) of oblivion
Ma hea lā wau, e ke aloha lā	Where am I, O my love
‘O Kou ka papa	Kou is the coral flat
‘O Ka‘ākaukukui ka loko	Ka‘ākaukukui is the pool
‘O ka ‘alamihi a‘e nō	Some ‘*alamihi* indeed
‘O ka lā a pō iho	Wait all day until night
Hui aku i Kou nā maka.	Friends shall meet in Kou.

[Ho‘oulumāhiehie 2006a:297; Ho‘oulumāhiehie 2006b:277]

The exact meaning of the word *alamihi* within this chant is unknown. ‘*Alamihi* is the name of a native Hawaiian small black crab (*Metopograpsus thukuhar*), a scavenger that is often associated in Hawaiian sayings with corpse-eating (Pukui and Elbert 1986:18). *Alamihi* is also used as a place name that can mean “path [of] regret” (Pukui et al. 1974:9).

3.1.4 Heiau of Honolulu

There is no mention in historical documents for any *heiau* on the coastal Ka‘ākaukukui or Pu‘unui lands. However, there were at least three *heiau* in the general coastal Honolulu area.

In the chant to the chief Hua, the *heiau* of Pu‘ukea in Kukuluāe‘o is mentioned. The literal meaning of Pu‘ukea is “white hill” (although it may have alternate meanings). Pu‘ukea is also the name of a small land division within the ‘*ili* of Kukuluāe‘o, mentioned in at least two Land Commission Awards, LCA 1502 (not awarded) and LCA 1504. LCA 1504 was located near the junction of Halekauwila Street and Cooke Street. It is fairly common for a *heiau* to have the same name as the ‘*ili* in which it is located, so it is possible that Pu‘ukea Heiau was also near the junction of Halekauwila and Cooke streets. The majority of the housesites in the mid-nineteenth century in Kukuluāe‘o were located near Halekauwila Street and Queen Street, *mauka* of the low-lying coastal swamplands on higher, dry ground. It is possible that the *heiau* platform or the area that it was built on was one of the few “high spots” in the flat, low-lying swamp that surrounded it, and thus gained the name *pu‘u kea* (white hill).

The second *heiau* known for the Honolulu area is Pākākā Heiau, once located at the foot of Fort Street. Kamehameha I lived in a complex around Pākākā Heiau from 1809 to 1812. The site’s use as a ceremonial structure ended in 1819 with the abolition of the *kapu* (tabu) system. The area of the *heiau* platform was part of a royal village up to 1826, when Ka‘ahumanu, wife of Kamehameha, moved from this complex to a site nearer Kawaiaha‘o Church to be near the houses of the new American missionaries (Kamakau 1961:265). In 1816, the Honolulu Fort had been built to the east of the complex. The fort was demolished in 1857 to make way for expansion of the harbor complex (Judd 1975:59).

Thomas Thrum, who made several lists and surveys for Hawaiian *heiau*, does list Pākākā but does not mention Pu‘ukea Heiau. He adds a third Honolulu temple, Ka‘ahaimauli Heiau (Thrum

1906a:44), destroyed by the time of his survey, but once located in downtown Honolulu in the general area of ‘Iolani Palace. In a report on the survey of O‘ahu sites conducted in the early 1930s, McAllister (1933:80) says of Honolulu “Information regarding former sites within the present limits of Honolulu must come entirely from literary sources.” He does mention Pākākā Heiau, once the main royal temple in Honolulu; this *heiau* would have been located around the foot (*makai end*) of Fort Street. He does not list Pu‘ukea or Ka‘ahaimauli Heiau, but he does note that Peter Corney, a visitor to the island in 1819, saw several *heiau* (*morai*) along the Honolulu shore:

> There are several morais, or churches in the village, and at new moon the priests, chiefs and hikanees (aikane) [counselors] enter them with offerings of hogs, plantains, and cocoanuts, which they set before the wooden images. The place is fenced in, and have pieces of white flags flying on the fences [Corney 1896:101].

3.1.5 Trails

John Papa ‘Ī‘ī mentions some of the previously described place names while discussing early nineteenth century trails in the Honolulu/Waikīkī area (Figure 10 and Figure 11). The fact that a trail traversed this region – characterized by ponds, marshlands and *lo‘i* – suggests that the trail, especially as it neared the coastline at Kālia, must have run on a sand berm raised above surrounding wetlands and coral flats. The middle trail (probably close to the current alignment of Queen Street), was described walking from Waikīkī to Honolulu as:

> The trail from Kalia led to Kukuluaeo, then along the graves of those who died in the smallpox epidemic of 1853, and into the center of the coconut grove of Honuakaha. On the upper side of the trail was the place of Kinau, the father of Kekauonohi. [‘Ī‘ī 1959:89]

The grave site referred to is the Honuakaha Cemetery at the *makai* corner of Halekauwila and South Streets, *makai* of Kawaiaha‘o Church and northwest of the current project area. Honuakaha was a settlement located generally between Punchbowl and South Streets, on the *makai* side of Queen Street. The lower, coastal trail, was described walking from Honolulu towards Waikīkī as:

> From the makai side of Kaoaopa was a trail to the sea at Kakaako, where stood the homes of the fishermen. Below the trail lived Hehehewa and his fellow kahunas. [‘Ī‘ī 1959:89]

3.1.6 Early Post-Contact History and Population Centers

The modern urban area known as Kaka‘ako is located between two longtime centers of population: Honolulu, known as Kou in older times, and Waikīkī. In Waikīkī, a system of taro *lo‘i* (irrigated terraces) fed by streams descending from Makiki, Mānoa, and Pālolo Valleys covered the coastal plain, and networks of fishponds dotted the shoreline. Similarly, Kou – the area of downtown Honolulu surrounding the harbor - possessed shoreward fishponds and irrigated fields watered by streams descending from Nu‘uanu and Pauoa Valleys. The pre-contact population and land-use patterns of the Kaka‘ako area may have derived from its

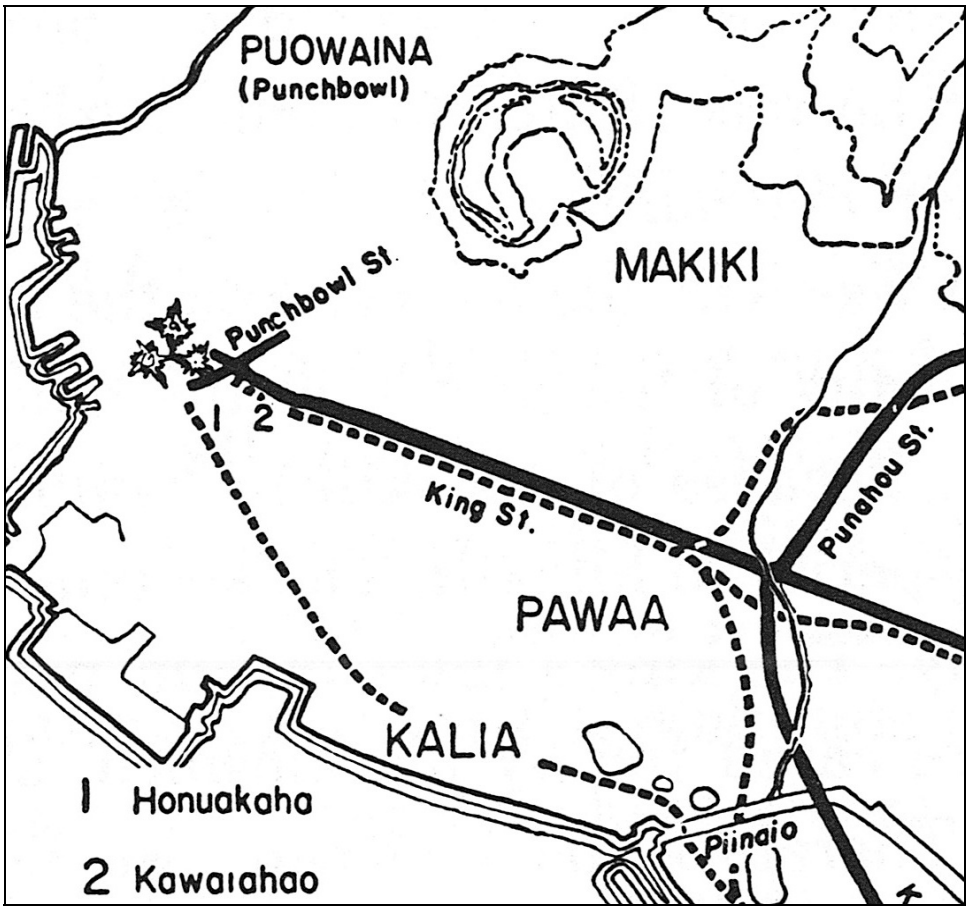

Figure 10. Map showing trails in the Honolulu/Waikīkī area circa 1810 (Gerald Ober illustration from ‘Ī‘ī 1959:93). Note: Ka‘ākaukukui was *makai* of the Honuakaha settlement

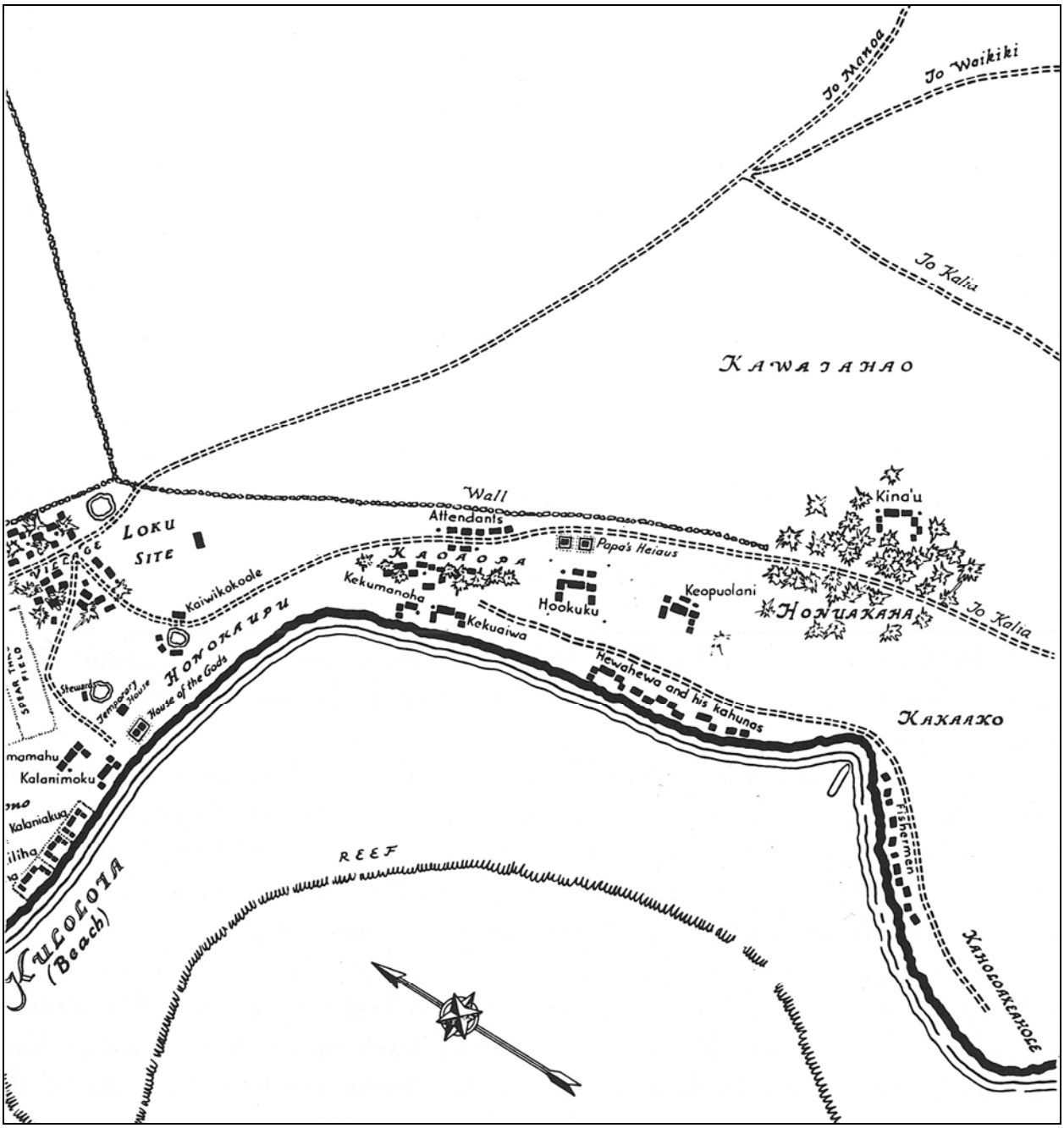

Figure 11. Map of the area from Kuloloia Beach to Kaka‘ako, circa 1810 (Paul Rockwood illustration from ‘Ī‘ī 1959:90). Note: Kaka‘ako is labeled at the point of a landing

relationship to these two densely populated areas. Thus, the attempt to reconstruct the region as it existed for the Hawaiians during the centuries before western contact must begin with accounts of Kou and Waikīkī.

Waikīkī is actually the name of the large *ahupua‘a* (land division) encompassing lands stretching from Honolulu to Maunalua Bay. By the time of the arrival of Europeans during the late eighteenth century, the area today known as Waikīkī had long been a center of population and political power on O‘ahu. According to Beckwith (1940:383), by the end of the fourteenth century, Waikīkī had become “the ruling seat of the chiefs of O‘ahu.” The pre-eminence of Waikīkī continued into the eighteenth century and is confirmed by the decision of Kamehameha I, in the midst of unifying control of the islands, to reside there after wresting control of O‘ahu by defeating the island’s chief, Kalanikūpule.

Chiefly residences were only one element of a complex of features sustaining a large population that characterized Waikīkī through pre-contact times. Beginning in the fifteenth century, a vast system of irrigated taro fields was constructed, extending across the littoral plain from Waikīkī to lower Mānoa and Pālolo Valleys. This field system, an impressive feat of engineering, the design of which is traditionally attributed to the chief Kalamakua, took advantage of streams descending from Makiki, Mānoa, and Pālolo Valleys, which also provided ample fresh water for the Hawaiians living in the *ahupua‘a*. Water was also available from springs in nearby Mō‘ili‘ili and Punahou. Closer to the Waikīkī shoreline, coconut groves and fishponds dotted the landscape. A continuous zone of population and cultivation, from the shoreline of present day Waikīkī Beach, extended north well into Mānoa Valley. The western and eastern bounds of this zone are less clear, and there are no specific references to Waikīkī’s abundance reaching into the Ka‘ākaukukui region.

A basic description of Honolulu, or Kou, up to western contact, is given by E. S. Craighill and Elizabeth Handy:

> What is now Honolulu was originally that flatland area between the lower ends of Nu‘uanu and Pauoa Valleys and the harbor. Westervelt…wrote that “‘Honolulu’ was probably a name given to a very rich district of farm land near what is now…the junction of Liliha and School Streets, because its chief was Honolulu, one of the high chiefs at the time of Kākuhihewa…It is probable that the chief referred to by Westervelt took his name from the harbor and adjoining land. The original name of the land where the town grew when the harbor became a haven for foreign ships was Kou…The number of *heiau* in this area indicates that it was a place of first importance before the era of foreign contact. [Handy and Handy 1972:479]

Rev. Hiram Bingham, arriving in Honolulu in 1820, described a still predominantly native Hawaiian environment - still a “village” - on the brink of western-induced transformations:

> We can anchor in the roadstead abreast of Honolulu village, on the south side of the island, about 17 miles from the eastern extremity…Passing through the irregular village of some thousands of inhabitants, whose grass thatched habitations were mostly small and mean, while some were more spacious, we walked about a mile northwardly to the opening of the valley of Pauoa, then

> turning southeasterly, ascending to the top of Punchbowl Hill, an extinguished crater, whose base bounds the northeast part of the village or town…Below us, on the south and west, spread the plain of Honolulu, having its fishponds and salt making pools along the seashore, the village and fort between us and the harbor, and the valley stretching a few miles north into the interior, which presented its scattered habitations and numerous beds of kalo (arum esculentum) in its various stages of growth, with its large green leaves, beautifully embossed on the silvery water, in which it flourishes. [Bingham 1847:92-93]

The Ka‘ākaukukui area would have been in Bingham’s view as he stood atop “Punchbowl Hill” looking toward Waikīkī to the south; it would have comprised part of the area he describes as the ‘plain of Honolulu’ with its “fishponds and salt making pools along the seashore.”

Another visitor to Honolulu in the 1820s, Capt. Jacobus Boelen, hints at the possible pre-Contact character of Honolulu and its environs, including the Ka‘ākaukukui area:

> It would be difficult to say much about Honoruru. On its southern side is the harbor or the basin of that name (which as a result of variations in pronunciation [sic] is also written as Honolulu, and on some maps, Honoonoono). The landlocked side in the northwest consists mostly of taro fields. More to the north there are some sugar plantations and a sugar mill, worked by a team of mules. From the north toward the east, where the beach forms the bight of Whytetee, the soil around the village is less fertile, or at least not greatly cultivated. [Boelen 1988:62]

Boelen’s description implies that the Ka‘ākaukukui area is within a “not greatly cultivated” region of Honolulu, perhaps extending from Pūowaina (Punchbowl Crater) at the north, through Kaka‘ako, to the Kālia portion of Waikīkī in the east.

An early, somewhat generalized, depiction of the pre-Contact native Hawaiian shaping of Waikīkī, Kou (Honolulu), and the Kaka‘ako area is shown on an 1817 map (Figure 12) by Otto von Kotzebue (1821), commander of the Russian ship *Rurick*, who had visited O‘ahu the previous year. The map shows taro *lo‘i* (illustrated as rectangles, representing irrigated fields) massed around the streams descending from Nu‘uanu and Mānoa valleys. The depicted areas of population and habitation concentration (illustrated as the trapezoids) probably reflect early historic-era patterns, unlike those of pre-contact times, influenced by the post-contact shift of the population to the area around Honolulu harbor - the only sheltered landing for large western-sized vessels on O‘ahu and the center of increasing trade with visiting foreign vessels. Kamehameha himself had moved from Waikīkī to Honolulu in 1809.

Kotzebue’s map illustrates that the land between Pūowaina (Punchbowl Crater) and the shoreline - which would include the Ka‘ākaukukui area - formed a “break” between the heavily populated and cultivated centers of Honolulu and Waikīkī. The area is characterized by fishponds, salt ponds, trails connecting Honolulu and Waikīkī, and occasional taro *lo‘i* and habitation sites. An 1855 map of Honolulu by Joseph de LaPasse, a lieutenant aboard the French vessel, *L`Eurydice*, pictures the project parcels within an area labeled within an area labeled “Pecheries” (“Fishponds”) (Figure 13).

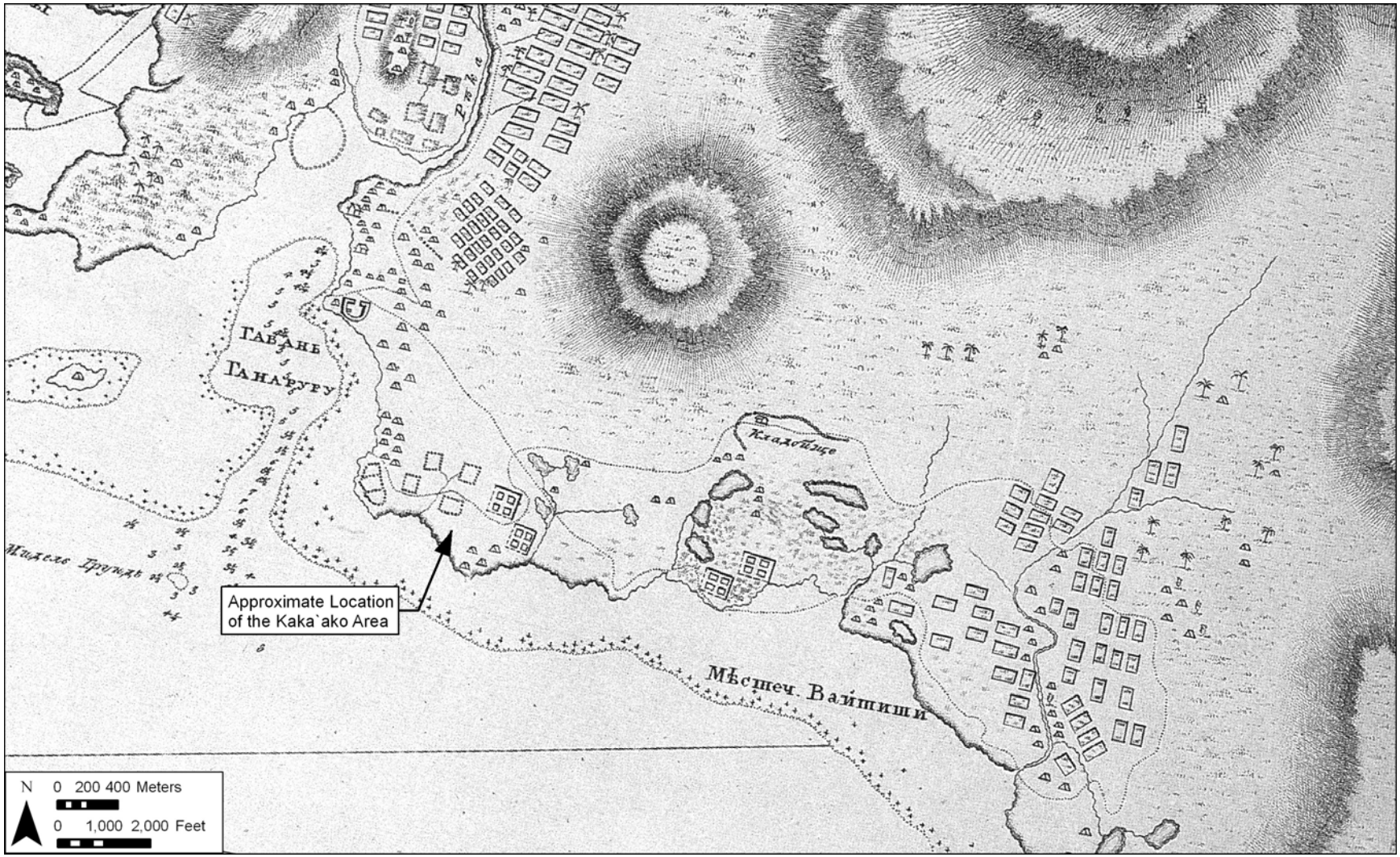

Figure 12. 1817 Map of the South Coast of O‘ahu by Otto von Kotzebue, showing taro *lo‘i*, fishponds, and salt pans in Honolulu and Waikīkī

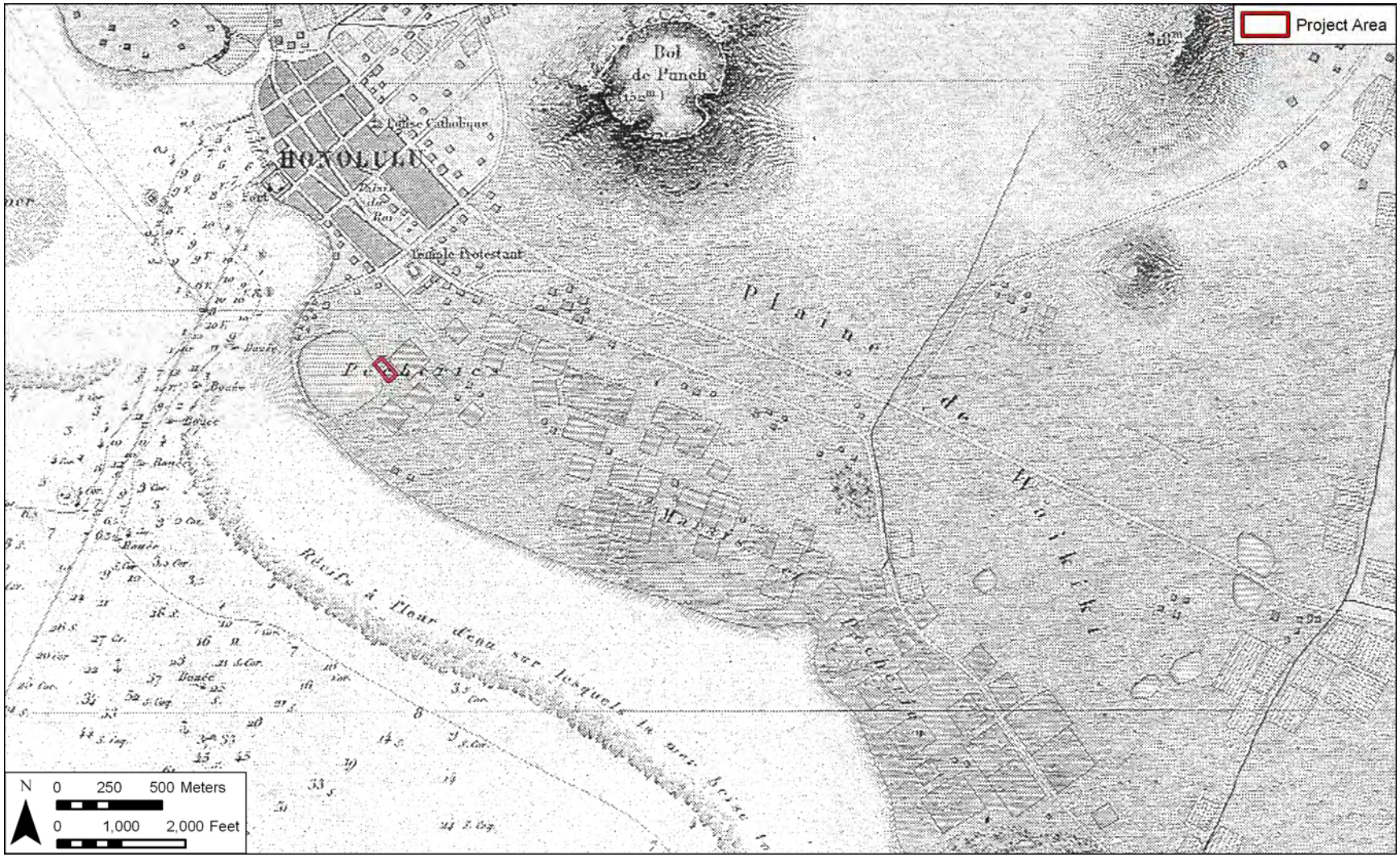

Figure 13. 1855 Map of Honolulu by Lt. Joseph de LaPasse of the French vessel, *L`Eurydice* (map reprinted in Fitzpatrick 1986:82-83). Note: The current project area is located within an area labeled “Pecheries” (“Fishponds”)

A clearer picture of Ka‘ākaukukui develops with accounts of other visitors to, and settlers of, Honolulu during the first half of the nineteenth century. Gorman D. Gilman, who arrived in Honolulu in 1841, recalled in a memoir the limits of Honolulu during the early 1840s:

> The boundaries of the old town may be said to have been, on the makai [seaward] side, the waters of the harbor; on the mauka [inland] side, Beretania street; on the Waikīkī [east] side, the barren and dusty plain [i.e. the area just beyond Punchbowl Street], and on the Ewa [west] side, the Nuuanu Stream. [Gilman 1904:97]

Gilman further describes the “barren and dusty plain” beyond (east of) Punchbowl Street:

> The next and last street running parallel [he had been describing the streets running *mauka-makai*, or from the mountains to the shore] was that known as Punchbowl Street. There was on the entire length of this street, from the makai side to the slopes of Punchbowl, but one residence, the two-story house of Mr. Henry Diamond, mauka of King Street. Beyond the street was the old Kawaiahao church and burying ground. A more forsaken, desolate looking place than the latter can scarcely be imagined. One, to see it in its present attractiveness of fences, trees and shrubbery, can hardly believe its former desolation, when without enclosure, horses and cattle had free access to the whole place. [Gilman 1904:89]

That the environs of the missionary enclave and Kawaiaha‘o Church were indeed “forsaken” and “desolate looking” in the 1820s when the missionaries first settled there is also noted in the memoirs of the American missionary C. S. Stewart who, arriving on Maui after living at the mission, declared Lahaina to be “like the delights of an Eden” after “four weeks residence on the dreary plain of Honoruru” (Stewart 1970:177). It is likely that these descriptions of the Honolulu plain also include the Ka‘ākaukukui region.

The barrenness of the Kaka‘ako area is also illustrated in two sketches, one made in 1834 when Kawaiaha‘o Church was still a long grass-thatched building (Figure 14), and one made in 1850 after the grass hut had been replaced by a large coral stone structure with a steeple (Figure 15). Between Kawaiaha‘o Church and the sea, which is the Kaka‘ako area, there are only a few scattered huts along the shore and aligned along the inland trail (now covered by King Street). An 1887 photograph of the area also shows the marshy nature of the area, with only scattered houses near the ponds or near the shore *makai* of Kawaiaha‘o Church (Figure 16).

3.1.7 Mid 19th Century and the Māhele

Among the first descriptions of Ka‘ākaukukui by the Hawaiians themselves are the testimonies recorded during the 1840s in documents associated with Land Commission Awards (LCA) and awardees of the Māhele. The LCA records indicate that the traditional Hawaiian usage of the region and its environs may have been confined to salt making and farming of fishponds, with some wetland agriculture in those areas *mauka* or toward Waikīkī at the very limits of the field system descending from Makiki and Mānoa valleys. However, the testimonies do indicate that the area was lived-on and was shaped by Hawaiians before the nineteenth century. The LCA records also reveal that midway through the nineteenth century, taro

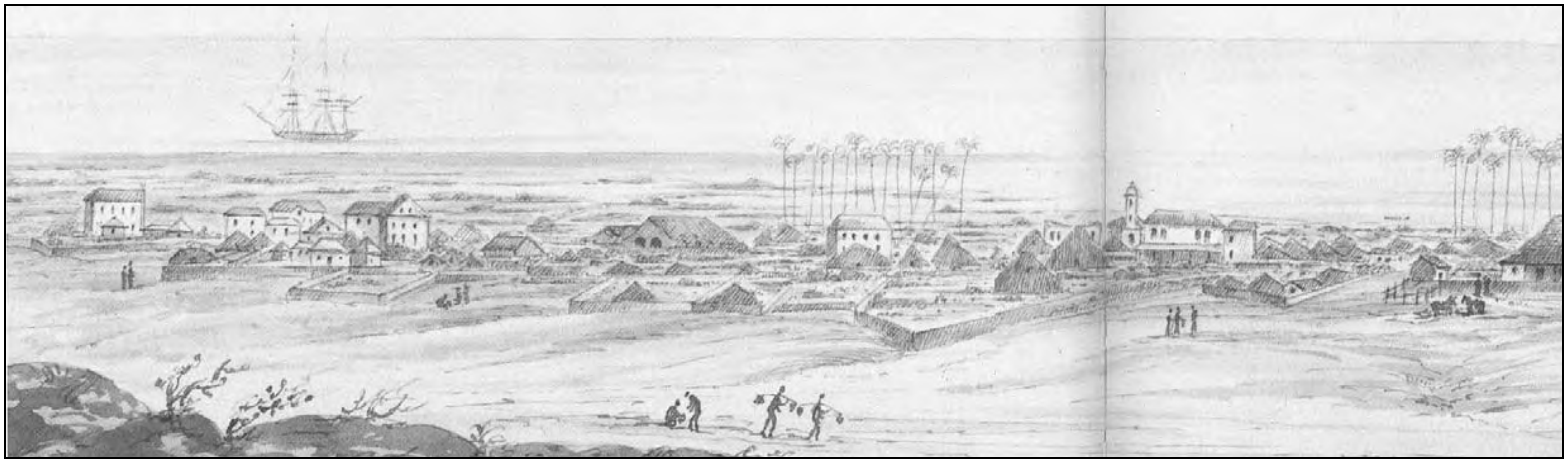

Figure 14. Portion of 1834 sketch by anonymous illustrator entitled “Town of Honolulu: Island of Woahoo: Sandwich Islands” (original sketch at Bernice P. Bishop Museum; reprinted in Grant 2000:64-65)

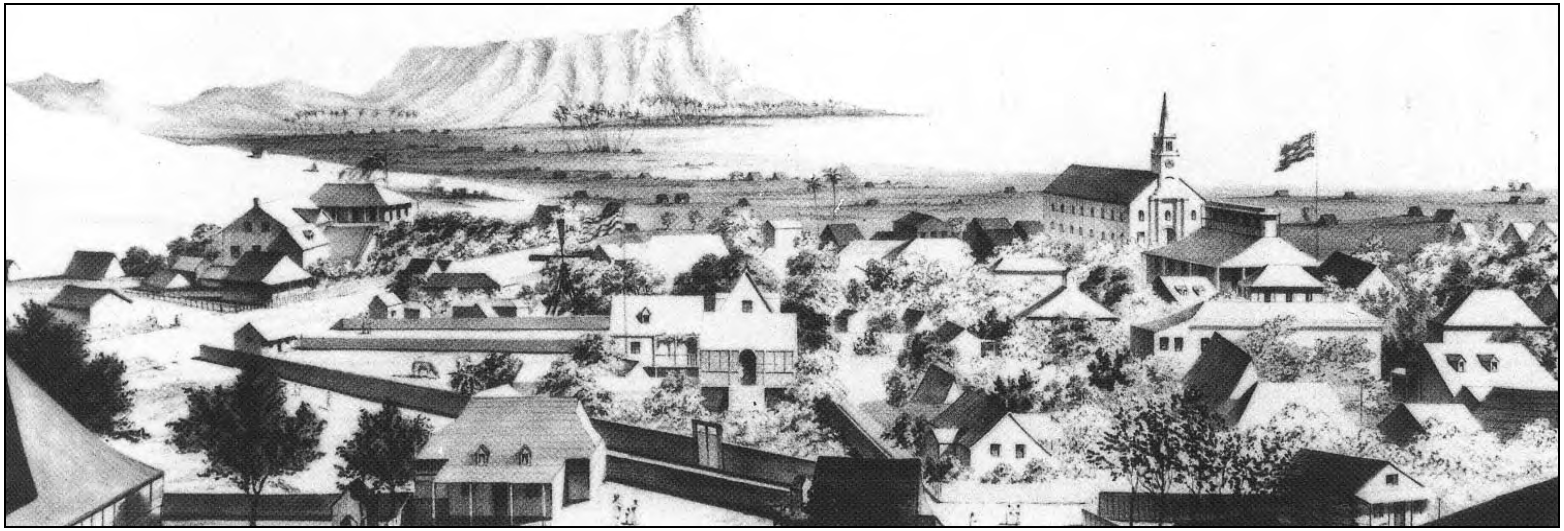

Figure 15. 1850 Sketch by Paul Emmert (original sketch at Hawaiian Historical Society; reprinted in Grant 2000:5)

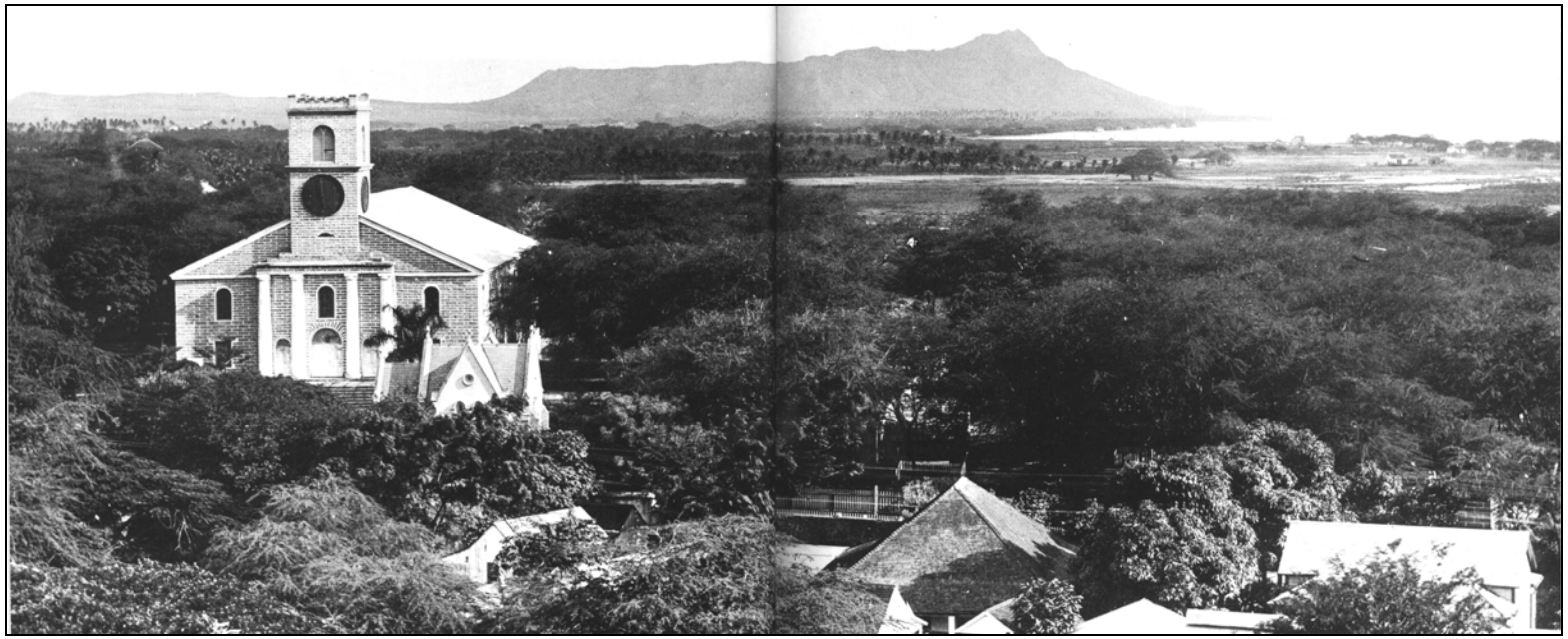

Figure 16. Circa 1887 photograph of Honolulu and Waikīkī; Kawaiaha‘o Church in left foreground; the Kaka‘ako area is within the marshlands seen in the right upper background (original photograph at Hawai‘i State Archives, Henry L. Chase Collection; reprinted in Stone 1983:84-85)

cultivation, traditional salt making, and fishpond farming activities continued in the Ka‘ākaukukui area. These activities and the land features that supported them would later be eliminated, or buried, during the remainder of the nineteenth century by the urbanization of Honolulu. The LCA records, historic maps, and archival photographs document more precisely traditional Hawaiian settlement and subsequent historic land usage within and around the current project area.

The Organic Acts of 1845 and 1846 initiated the process of the Māhele – the division of Hawaiian lands – which introduced private property into Hawaiian society. In 1848, the crown, the Hawaiian government, and the *ali‘i* (chiefs) received their land titles. The current project area is located in the land section of Pu‘unui, within Land Commission Award 7713, as shown on Figure 17. An 1876 map of the *‘ili* of Ka‘ākaukukui and Pu‘unui (see Figure 9) shows that the current project area is in an area of salt pans, with no *kuleana* lots to commoners, and no habitation structures. All habitation lots near Ka‘ākaukukui and Kukuluāe‘o are located in clusters near Queen Street, with most in the settlement at Honuakaha, or further inland along King Street, as shown on an 1884 map (Figure 17) and an 1887 map (Figure 18).

The *‘ili* of Ka‘ākaukukui (LCA 7713) was awarded to Victoria Kamāmalu, the sister of Kamehameha IV and Kamehameha V. Ka‘ākaukukui consisted of three non-contiguous sections, a type of *‘āina* (land) called a *lele*. An early surveyor for the Hawaiian Government Survey office explains about *lele* in general, and Ka‘ākaukukui in particular:

> There were two features of the ili, referred to by the terms *lele*…the ili often consisted of several distinct sections of land—one, for instance, on the seashore, another on dry, open land, or *kula*, another in the regularly terraced and watered kalo patch or *aina loi* district, and another still in the forest, thus again carrying out the equable division system which we have seen in the ahupuaa.
>
> These separate pieces were called, *lele*, i.e., “jumps,” and were most common on O‘ahu…Kaakaukukui held Fisherman’s Point and the present harbor of Honolulu; then kalo land near the present Kukui street, and also a large tract of forest at the head of Pouoa [Pauoa] Valley…
>
> These different pieces were called variously, either by their own individual name or by that of the whole ili, thus puzzling one sadly when attempting to obtain information with respect to them. [Lyons 1894:1697]

There are no *kuleana* awards to commoners within LCA 7713. The award also included the southern portion of the *‘ili* of Pu‘unui and a large fishpond (labeled Loko Ka‘ākaukukui) surrounded by land in the *‘ili* of ‘Auwaiolimu. Loko Ka‘ākaukukui was probably a fishpond fed by spring-water, but the other ponds in LCA 7713, Loko Kaimukanaka, Loko Kalokoeli, and possibly Loko Kuaimeki, were probably salt ponds filled by tidal waters. There are no houses within LCA 7713 shown on the 1874-1891 maps. There are two structures labeled “Salt Houses,” presumably for drying or storing salt, and a few other structures associated with the wharfs and the Marine Railway leading to the reef. This land does not seem to have been used during this period for habitation.

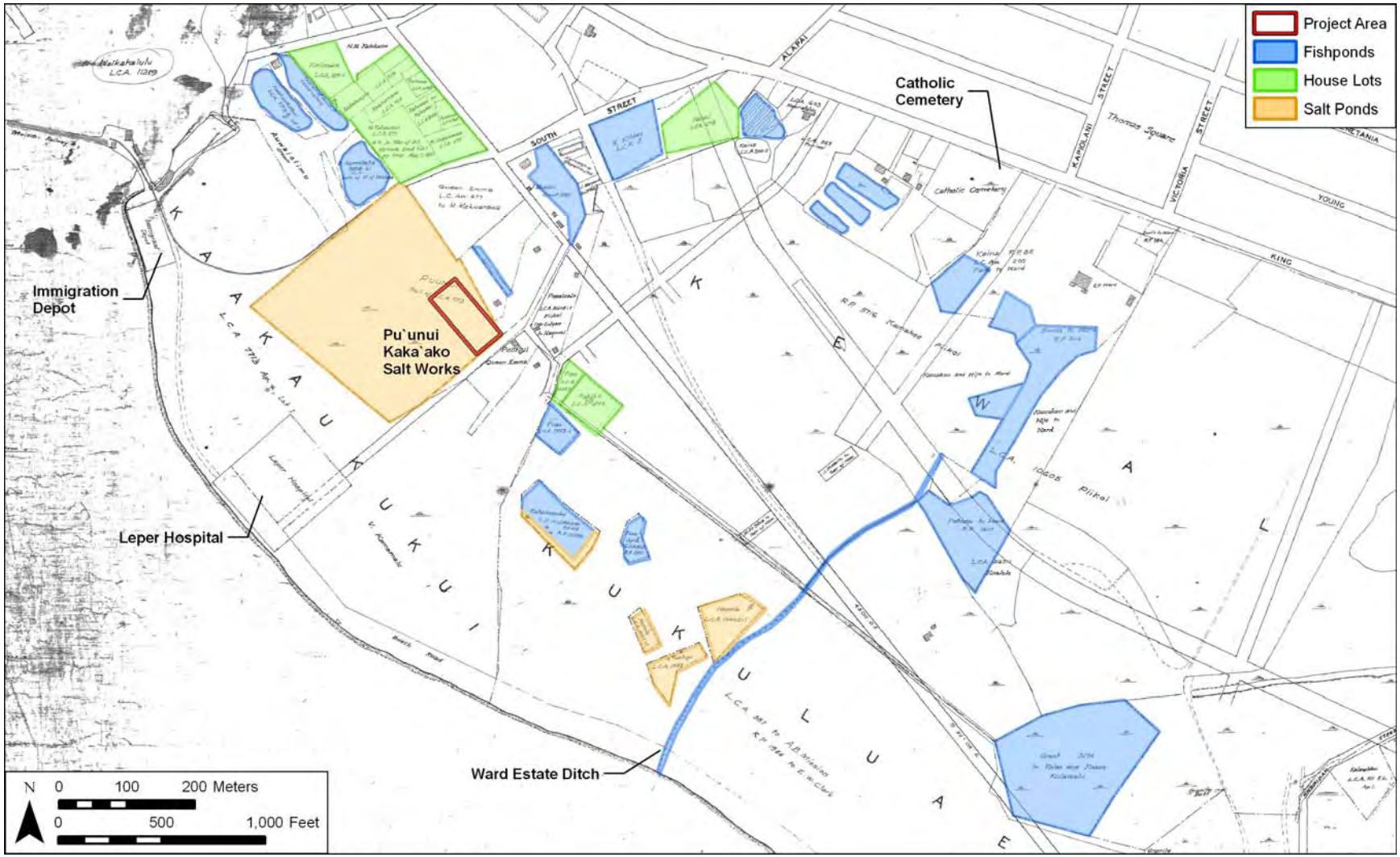

Figure 17. 1884 Map of Honolulu, Kewalo Section, by S.E. Bishop (Reg. Map 1090), showing the locations of LCA parcels, fishponds, salt ponds, and houselots

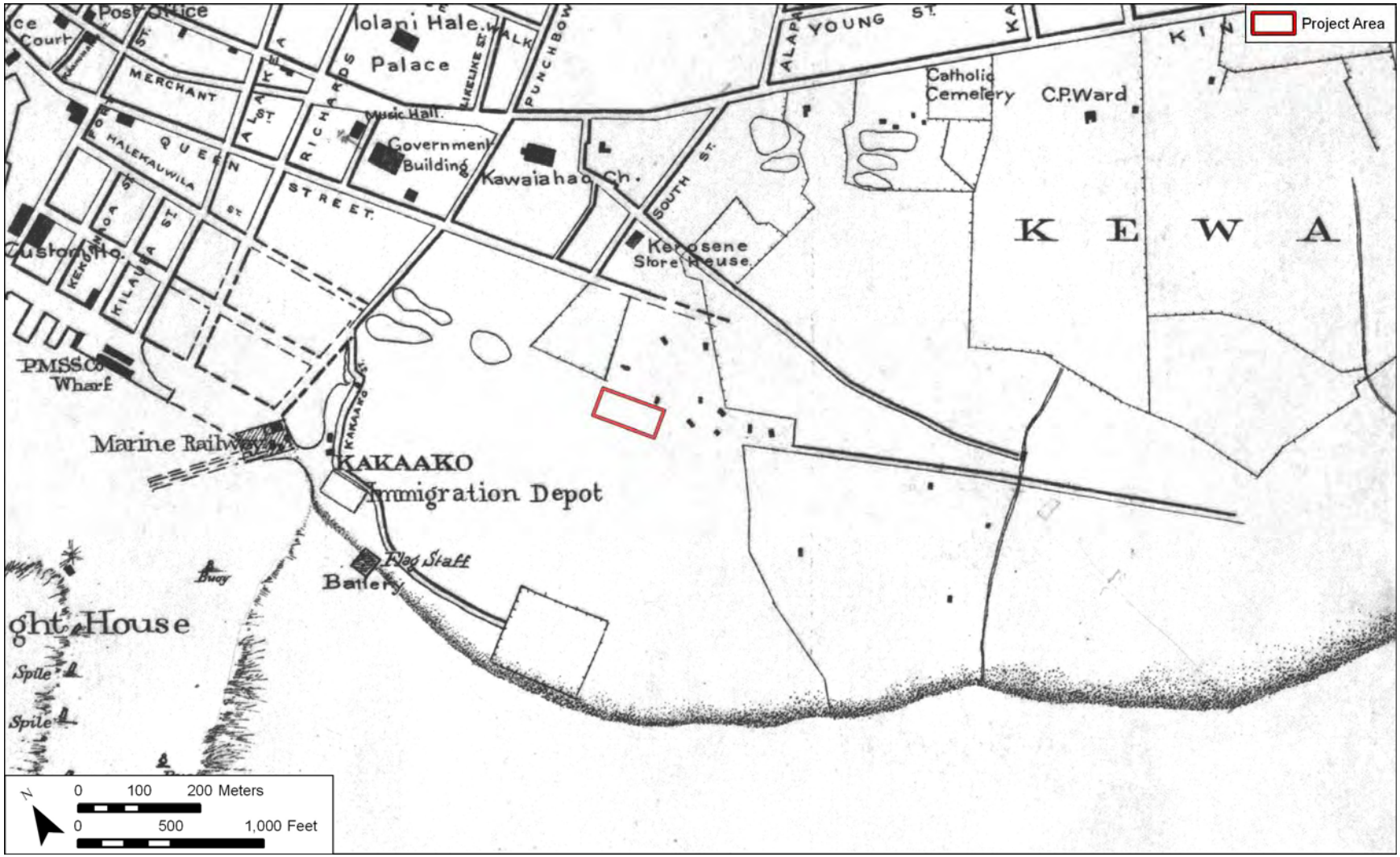

Figure 18. 1887 Hawaiian Government Survey Map of Honolulu and Vicinity, by W.A. Wall (map on file at Library of Congress)

The *‘ili* of Pu‘unui, which also had several *lele* lands, included the large rectangular section in the center of the 1876 Lyons map (see Figure 9). The *mauka* portion of Pu‘unui was a portion of LCA 677 to Matio Kekūanao‘a, a high *ali‘i* who was a close friend to Kamehameha II and was married to Kīna‘u, the daughter of Kamehameha I**.** Also on the 1876 Lyons map, LCA 2045 is shown within Pu‘unui. This lot was awarded to Kauwahi, who received the parcel in the time of Kamehameha I.

There are three LCA Awards shown on maps as being located on the northwestern border of Ka‘ākaukukui. In the Māhele testimony, these awards are listed as within the *‘ili* of Kaka‘ako. LCA 4457 to Ana Kaloa, inhabited by her family since the days of Kamehameha I, consisted of four fishponds, an *‘auwai* (irrigation ditch) and a house enclosed by a fence. LCA 3455 to Kaule for Liliha, inherited from Kamehameha I, consisted of a houselot (*pāhale*) bound by the sea and the mouth of a stream (*muliwai*). LCA 247, a house lot, was claimed by Charles Kana‘ina for W. C Lunalilo, who received his land before the Māhele from his mother (*mamua loa*). Kana‘ina was a friend to Kamehameha II and married his fifth wife Kekāuluohi. Their son was Lunalilo, who became the sixth monarch of Hawai‘i.

The *‘ili* of Pualoalo, or Puaaloalo, (LCA 10605-A) was awarded to Iona (Jonah) Pi‘ikoi. Pi‘ikoi was an *ali‘i*, a retainer of Kauikeaouli (Kamehameha III), and held several government posts. It consisted of three *lele* lands, two in Nu‘uanu Valley and a parcel shown on the 1876 Lyons map (see Figure 9), bordering the northeast corner of Ka‘ākaukukui. On the 1884 Bishop map (see Figure 17), four houses are shown on this property.

The *‘ili* of Ka‘ala‘a, northwest of the current project area, was awarded to Beneli (Bennett) Nāmakehā, a member of Kamehameha II’s privy council. He was the uncle of Queen Emma (wife of Kamehameha IV) and the first husband of Kapi‘olani, who later married King Kalākaua, the seventh Hawaiian monarch (Kame‘eleihiwa 1992:276.) In his will, Nāmakehā gave the *lele* of Ka‘ala‘a to his widow Kapi‘olani. In a legal suit concerning the property, the *lele* is described as:

> …a piece of land situate at Honuakaha, Honolulu, and containing an area of 1.6 acres. The property consisted formerly of a fishpond and its banks and, perhaps, a small piece, additional, of dry land, and was a lele of the Ili of Kaalaa…
>
> …from 1852 or, perhaps, 1850, (Kapiolani and Namakeha married in 1850) Kapiolani at various times had the pond cleaned out, that her servants by her direction fished therein and delivered the fish to her for her use, that she sometimes gave them some of the fish, that she erected a small building on the bank of the pond or on the kula adjoining, that a man employed and directed by her to care for and the care of the pond occasionally lived in that building, and that she at times objected to horses being pastured on the kula of the pond because the animals might enter the pond and cause injury to it. [Hawaii Supreme Court 1903:321, 324]

The *‘ili* of ‘Auwaiolimu, which consisted of several *lele*, was awarded to Kalaeokekoi. He later returned the land to the government, and it subsequently became Crown Land. Kalaeokekoi was married to the Kaulahua, who is believed to be the niece of Charles Kana‘ina (awarded LCA 247 in Kaka‘ako).

A large section of the ‘*ili* of Honuakaha was awarded to Mataio Kekūanao‘a (father of Victoria Kamāmalu), with the remainder of the ‘*ili* divided into small lots. This was the main habitation area to the east of central Honolulu, and is noted as a village as early as 1810 (‘Ī‘ī 1959:92). The Waihona ‘Āina database notes seven awards in the ‘*ili* of Honuakaha, though additional awards in this ‘*ili* extended on both sides of Punchbowl Street. In many of the awards the ‘*ili* name is not given, only the location on Punchbowl or Queen Street.

The ‘*ili* of ‘Āpua was not awarded to one person. LCA 704, between the two long fishponds in the northwest of the study parcels, was located within the ‘*ili* of ‘Āpua. The claim is for a houselot to Honaunau, which he received prior to the death of Kīna‘u in 1837.

The ‘*ili* of Kukuluāe‘o (LCA 387) was awarded to the American Board of Commissioners for Foreign Missions (ABCFM). Initially this land was associated with Punahou School in Mānoa Valley, as Chief Boki gave the Punahou lands to Hiram Bingham, pastor of Kawaiaha‘o Church in 1829 (DeLeon 1978:3). In the Māhele, however, this sea land became “detached” from the Mānoa award and was instead given to the pastor of the Kawaiaha‘o Church, as noted in a history of the Punahou School (Punahou School and Oahu College 1866). Curtis Perry Ward, a native of Kentucky, came to the Hawaiian Islands in 1853, and soon established a livery and draying business. In 1865, he bought a large 12-acre estate *mauka* of King Street. Sometime before 1875, Ward added to his property with the purchase of 77 acres and 3,000 feet of ocean frontage in the ‘*ili* of Kukuluāe‘o, *makai* of Queen Street.

LCA 982 to Kukao, immediatedly northeast of the current project area, is shown on the 1876 Lyons map (see Figure 9) as being located in the Pu‘unui area. However, according to the Māhele testimony, it was within the ‘*ili* of Kukuluāe‘o. Kukao testified that it had four houses on the fenced lot, one belonging to him, one to the witness, Auhili, and one to a man named Koke. The property had been passed down from his father, who lived in the time of Kamehameha I.

The ‘*ili* of Kewalo (LCA 10605) was awarded to Kamake‘e Pi‘ikoi, wife of Jonah Pi‘ikoi (awardee of Pualoalo ‘Ili), as part of LCA 10605, ‘*āpana* (lot) 7. The award was shared between husband and wife (Kame‘eleihiwa 1992:269). Kewalo was a large 270.84-acre land section extending from Kawaiaha‘o Church to Sheridan Street. This land section had numerous large fishponds, which were awarded as part of the claim to Pi‘ikoi.

In summary, the current project area is completely within LCA 7713 to Victoria Kamāmalu, which included the Ka‘ākaukukui area and the southern portion of the coastal Pu‘unui area. The current project area was within or adjacent to large salt marsh, where salt pans were constructed using the tidal waters. The main habitation concentration for this general area was in the old settlement of Honuakaha, near the junction of Punchbowl and Queen Streets. Late nineteenth century maps do show some scattered houselots in the ‘*ili* of Pu‘unui, Pualoalo, Kaka‘ako, and ‘Āpua, in the vicinity of the current project area. Some of these may have belonged to the caretakers of the fishponds and salt ponds in the area.

3.1.8 The 1874 Transit of Venus Observatory at ‘Āpua

On the 1876 map of Ka‘ākaukukui (see Figure 9), an area labeled “Transit of Venus” yard and “Observatory” is labeled for a lot northwest of the current project area. On other historic maps, this land section is called ‘Āpua. This lot was used to house a large portable observatory in 1874,

an event of so much interest that the lot continued to be labeled as the Transit of Venus yard many years after the portable observatory had been dismantled (Figure 19 and Figure 20).

In 1874, several astronomical teams from Great Britain traveled to different parts of the world to observe a rare transit of the planet Venus across the sun. The “purpose of the observations was to better determine the value of the astronomical unit (AU)—the Earth-sun distance—and thereby the absolute scale of the solar system” (Chauvin 2004:xii). This project attracted enormous interest in Hawai‘i, and members of the Hawaiian Government Survey worked with the British team, who set up observatories on Hawai‘i, Kaua‘i, and O‘ahu Islands. Each station needed an equatorial telescope, other telescopes, a transit instrument, an altazimuth (surrounded by a portable wooden observatory with a revolving dome), and several clocks, chronometers, compasses, micrometers, reflecting circles, and artificial horizons (Chauvin 2004:51, 60).

Upon reaching Honolulu, the British team of seven astronomers temporarily moved into the Hawaiian Hotel in downtown Honolulu, and began to look about for a proper place to set up their O‘ahu observatory. King Kalākaua, who strongly supported the project, gave them permission to use a piece of land in the ‘*ili* of ‘Āpua. Captain Tupman, head of the expedition wrote:

> Difficulty was experienced in finding a suitable place of observation, as I considered it of great importance that the observers should be lodged very close to the instruments; and house accommodation is rather limited. However we have been enabled to rent a cottage belonging to the Princess Ruth, Governess of Molokai, capable of accommodating the Head Station observers, and adjoining some land owned by His Majesty the King who had kindly given us permission to erect our instruments Etc. and enclose as much land as may be necessary. [cited in Chauvin 2004:76-77]

The land in question was a 0.3-acre “open piece of grass land in the district called Apua. south of Punchbowl street, and west of Queen Street.” Several buildings were erected, including a barracks and workshop, a cookhouse, a photo hut thatched with grass, the stages (platforms) for the instruments, and a wooden palisade to enclose the lot. The observations of the Transit of Venus on December 8, 1874 in Honolulu were a great success, and the British party was feted by the king and other prominent families of Hawai‘i. All that was left was to dismantle the temporary buildings at ‘Āpua. Tupman wrote:

> Mar. 13. The sale. Our household goods sold well, many friends desiring to obtain a memento of our visit. The long shed, Cook house, walls of huts, transit hut complete, water pipes & taps, 6-foot fencing and a large pile of lumber were knocked down to His Majesty the King for a very small sum, as no one would bid against him. We were not altogether sorry for this as His Majesty has given us the land rent free & had aided us in many ways tending to save expense to the British Government. [cited in Chauvin 2004:124]

3.1.9 Kaka‘ako Salt Works and the Salt Pans of Kewalo and Kukuluāe‘o

As noted in the Land Commission Award testimony, much of the land in Ka‘ākaukukui was used to produce salt. The Hawaiians used *pa‘akai* (salt) for a variety of purposes: to flavor food, to preserve fish by salting, for medicines, and for ceremonial purposes. David Malo described the traditional method of making salt:

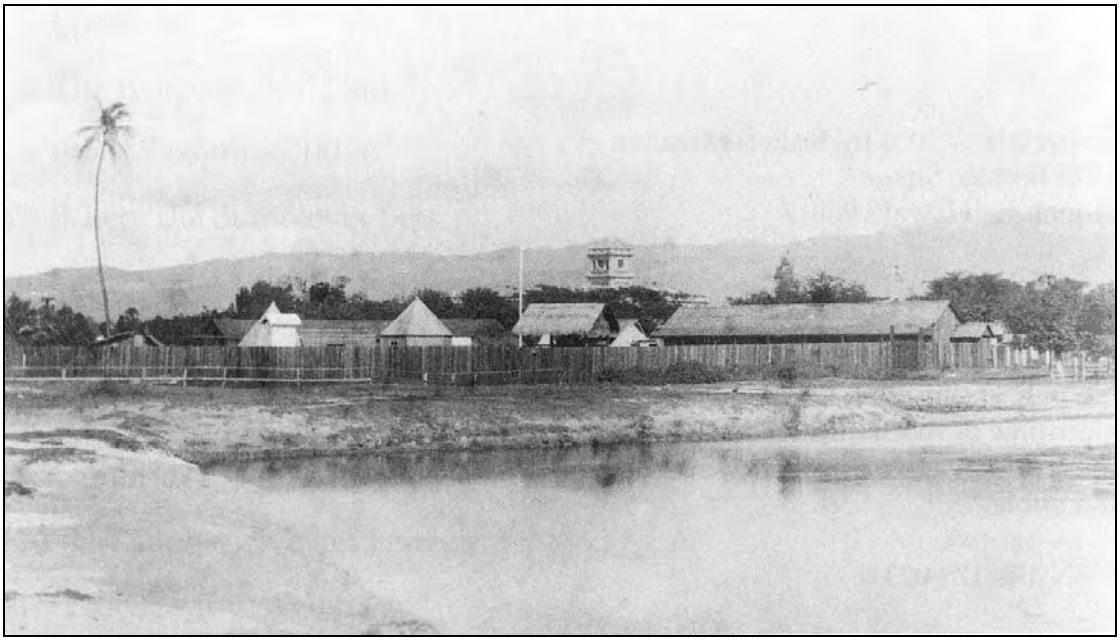

Figure 19. 1874 Photograph of Transit of Venus station at ‘Āpua near Honolulu, view to north (Bishop Museum Archives, reprinted in Chauvin 2004:iii). Note the pond (part of ‘Auwaiolimu) in the foreground, the long barracks / workshops and other buildings of the station in the mid-ground, and the spire of Kawaiaha‘o Church in the background

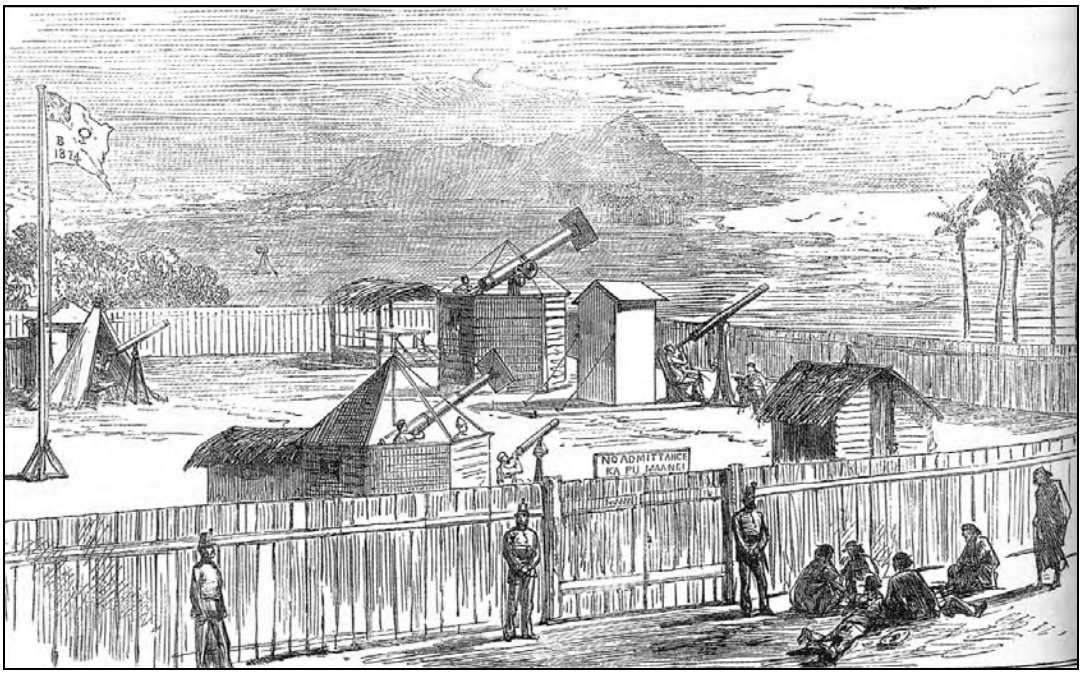

Figure 20. Sketch of the Transit of Venus station at ‘Āpua near Honolulu, view to east (sketch from *Illustrated London News*, January 23, 1875; reprinted in Chauvin 2004:108). Note armed guards keeping curious onlookers outside the fenced enclosure

> *O ka paakai kekahi mea e pono ai, he mea e ono ai, ka ia, a me ke koekoe o ka paina ana, he mea hana ia ka paakai, ma kekahi aina, aole i hana a ma kekahi aina, o ke kai makai, e kii aku no ka wahine, a lawe mai ma ke poi, a ke kai hooholo ia mai kekahi ma kauwahi mai.*
>
> *E waiho kela kai ma kekahi poho paha, he ekaha paha, he kahe ka paha, a liu malaila, alaila lawe ana kauwahi e, a paakai iho la no ia, o ka papa laau ka mea kui poi.* [Malo 2006:73]
>
> Translation
>
> Pa‘akai (salt) is another beneficial item. It is used to make fish delicious and tasteless foods edible. Pa‘akai is made at a particular place, [but] it [salt] is not actually made from this spot, rather it [salt water] came from the sea. A woman went to get some when the sea crashed [upon the rocks] and she ran back [the salt water] to this particular spot.
>
> That salt water (kai) is placed in, perhaps, a depression (poho) or a “Bird’s nest” (ēkeha) or rock basin (kāheka) and allowed to evaporate (liu). Then it is taken to another spot and is formed into pa‘akai. Wooden boards (papa lā‘au) are used to pound poi (*mashed cooked* kalo *corms*) on. [Malo 2006:95]

In 1903, Nathaniel Emerson translated David Malo’s articles on early Hawaiian life. In his publication, the translations are not literal, but include information that Emerson added to clarify the accounts. In Emerson’s translation:

> Salt was one of the necessities and was a condiment used with fish and meat, also as a relish with fresh food. Salt was manufactured in certain places. The women brought sea-water in calabashes, or conducted it in ditches to natural holes, hollows and shallow ponds (*kekaha*) on the sea-coast, where it soon became strong brine from evaporation. Thence it was transferred to another hollow or shallow vat, where crystallization into salt was completed. [Malo 1951:123]

Captain Cook was the first to note the method of making salt in prepared “saltpans”:

> Amongst their arts, we must not forget that of making salt, with which we were amply supplied, during our stay at these islands, and which was perfectly good of its kind. Their saltpans are made of earth, lined with clay; being generally six or eight feet square, and about eight inches deep. They are raised upon a bank of stones near the high-water mark, from whence the salt water is conducted to the foot of them, in small trenches, out of which they are filled, and the sun quickly performs the necessary process of evaporation…Besides the quantity we used in salting pork, we filled all our empty casks, amounting to sixteen puncheons, in the Resolution only. [Cook 1784:151]

In the next years after the first sightings of the Hawaiian Islands by Captain Cook in 1778, most visitors to the islands were British and American fur-traders, who stopped at Hawai‘i on their way to China. One reason for their visit was to stock up on food and water, but another concern was to buy or trade for salt, which was used to cure the seal and mammal pelts collected

from the Northwest Coast. During Kotzebue’s visit in 1816 and 1817, he noted that “Salt and sandalwood were the chief items of export” (in Thrum 1905:50).

> The journals of none mention the object of call other than for refreshments, though one, 3 some years later, records the scarcity and high price of salt at the several points touched at, with which to serve them in the curing of furs obtained on the coast. In all probability salt was the first article of export trade of the islands and an object, if not the object, of these pioneer fur-traders’ call. [Thrum 1905:45].

The missionary William Ellis, on a tour of the Hawaiian Islands in 1822 and 1823, also noted these salt pans and recorded the final step of crystallization:

> The natives of this district (Kawaihae) manufacture large quantities of salt, by evaporating the sea water. We saw a number of their pans, in the disposition of which they display great ingenuity. They have generally one large pond near the sea, into which the water flows by a channel cut through the rocks, or is carried thither by the natives in large calabashes. After remaining there for some time, it is conducted into a number of smaller pans about six or eight inches in depth, which are made with great care, and frequently lined with large evergreen leaves, in order to prevent absorption. Along the narrow banks or partitions between the different pans, we saw a number of large evergreen leaves placed. They were tied up at each end, so as to resemble a narrow dish, and filled with sea water, in which the crystals of salt were abundant. [Ellis 1827:403-404]

In an article on Hawaiian salt works, Thomas Thrum discusses the large salt works at Ālia Pa‘akai (Salt Lake in Moanalua) and at Pu‘uloa on the western loch of Pearl Harbor. Kamakau (1961:409) reported “The king and Isaac of Pu‘uloa are getting rich by running the salt water into patches and trading salt with other islands.” The salt was sent to Russian settlements in the Pacific Northwest, where it was used to pack salmon (*Hawaiian Gazette*, January 29, 1897). Thrum also mentions a salt works in Kaka‘ako.

> Honolulu had another salt-making section in early days, known as the Kakaako salt works, the property of Kamehameha IV, but leased to and conducted by E.O. Hall, and subsequently E.O. Hall & Son, until comparatively recent years. This enterprise was carried on very much after the ancient method of earth saltpans as described by Cook and Ellis. [Thrum 1924:116]

In the testimony for LCA 1903, Lolopi claimed two *ālia* (salt beds), 15 *ho‘oliu* (drains), two *poho kai* (depressions where salt is gathered) and 1 salt *kula* (dryland or wasteland). Four separate types of salt features are mentioned: the ponds near the shore that fill with salt water at high tide (*ālia*); the drains (*ho‘oliu*) where the salt water is transferred to smaller clay-lined or leaf-lined channels; the natural depressions (or modified depressions) in the rocks along the shore where salt formed naturally; and the salt *kula*, which was waste land, land that could probably not be used for agriculture as it was impregnated with salt. Lolopi did not live near his salt lands, but Pahiha, claimant of LCA 1504, did have a house near his fish pond and salt bed. The house was probably a simple grass hut, similar to those shown on an 1838 sketch entitled “Honolulu Salt Pans, Near Kakaako” and the one shown on an 1845 sketch of the “Old Salt

Pans” (Figure 21 and Figure 22). These sketches show the traditional, long salt ponds parallel to the shore.

The export of salt declined in the late nineteenth century. Thrum (1924:116) states that the apex of the trade was in 1870, but by 1883 he noted that “pulu, salt and oil have disappeared entirely” from the list of yearly exports (Thrum 1884:68). By 1916, only one salt works, the Honolulu Salt Co., was still in operation. However, salt continued to be manufactured for local use. The Kaka‘ako Salt Works appears on maps as late as 1891 and a page in Victoria Ward’s ledger for 1883 notes a yearly income of $651.50 received from her “Salt Lands” in Kukuluāe‘o (Hustace 2000:50). As noted above, Thrum (1924:116) said the Honolulu Salt Co. was the only salt producer on O‘ahu in 1916. A 1916 Commerce Report (Taylor 1916:723) states that the Honolulu Salt Co. operates “salt beds at Puuloa, Kalihi, and Waikiki, on the island of O‘ahu…” No mention is made of Kaka‘ako, suggesting that the Kaka‘ako salt works had closed before 1916.

The traditional method of salt production was gradually replaced by the more labor intensive Chinese method, as the Chinese immigrants began to take over the traditional salt and fish ponds of Honolulu in order to grow rice, to raise ducks, and to make salt. In a 1906 article, Rev. Westervelt (1906:43-46) explained the Chinese method of salt evaporation for the Honolulu salt beds. The Chinese worker first used a water pump to draw the seawater from the larger ditch below to the salt-evaporation beds above. The man moved the two handles back and forth to work the pump. The evaporation beds were lined with clay, wet with sea water, and tramped and pounded down. Each pan was about 20 feet square, covered with about two inches of water, and bound by an earth dyke, as shown in old photograph of the Kewalo salt brine beds (Figure 23). On early historic maps, the area of salt pans is often marked out as a large grid of contiguous squares, as shown on an 1883 map (Figure 24).

After allowing the sun to evaporate some of the water, the worker stepped into the evaporation pan and scraped the salt into a pile in the center with a simple wooden scraper. The worker then threw a large basket-shaped scoop into the brine and used a tin dipper to move the salt to the basket. Two baskets, one on each side of a pole, were then carried on the back of a worker across the thin earth dykes between the salt pans. The baskets were dumped into large drying piles, where the remaining water seeped out into the ground. The salt was then sewn into gunny sacks and sent to the market for sale.

By 1901, most of the fishponds and salt pans *makai* of King Street were reported as abandoned. In that year, the Hawai‘i Legislature (1901:185) proposed to build a ditch to drain away the “foul and filthy water that overflows that district at the present time.”

> The district *makai* of King St. and the Catholic Cemetery, Ewa of Mrs. Ward’s (the Old Plantation), mauka of Clayton St., and Waikiki of the land from King St., leading to the Hoomananaauao Church, consists of six large abandoned fish ponds and a large number of smaller ones, all in filthy condition, fed by springs and flowing into Peck’s ditches. Just makai of these ponds, at the end of Clayton street, next to Mr. Ward’s, is Peck’s place. An artesian well flushing the wash houses flows into two foul ditches, thence to the big pond which is Waikiki of what used to be Cyclomere and next to Mrs. Ward’s line [ditch] extending down to Waimanu St.

Figure 21. 1838 sketch of “Honolulu Salt Pan, near Kaka‘ako” drawn by French visitor Auguste Borget (original sketch at Peabody Essex Museum, Salem, Mass; reprinted in Grant 2000:64-65)

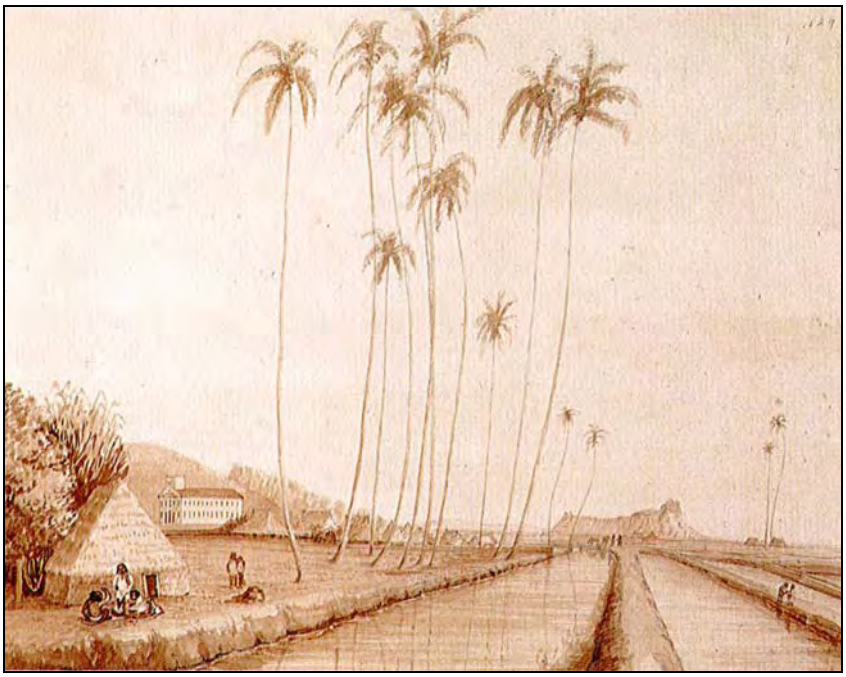

Figure 22. 1845 sketch of “Native Church [Kawaiaha‘o Church], Oahu, from the Old Salt Pans,” drawn by John B. Dale, from the U.S. Exploring Expedition led by Lt. Charles Wilkes (J. Welles Henderson Collection, reprinted in Forbes 1992:126). Note the sketch is probably from the salt pans in the Ka‘ākaukukui area

Figure 23. 1902 photograph of Kewalo brine basins (original photograph at Bernice P. Bishop Museum; reprinted in Scott 1968:579)

Figure 24. 1883 map of the Honolulu Water Works System (Reg. Map 1087). Note the grid symbol southeast of the project parcels represents salt pans

> The rear portion of Mrs. Ward’s property down to Waimanu St. used to be fish ponds all connecting to the sea by a ditch which is fed by an artesian well. These ponds, with the exception of three, are abandoned.

3.1.10 Kaka‘ako’s Role as a Human Quarantine Center and Cemetery Area

The city block now bounded by Punchbowl Street, Pohukaina Street, South Street, and Ala Moana Boulevard (now covered by the Waterfront Plaza complex), west of the current project area, was used as a cemetery from the 1700s (or earlier) up to the early 1800s. This is based on an analysis of artifacts from eight burials disinterred at the site (Griffin et al. 1987:4). The burial ground is currently referred to as the “Ka‘ākaukukui Cemetery,” but its ancient name, if it had one, is unknown.

During the 1853 smallpox epidemic, patients were isolated at a temporary quarantine camp and a hospital was set up at Kaka‘ako (Thrum 1897:98). Victims of the disease were later buried at the Honuakaha Cemetery near the modern junction of Quinn Lane and South Street (Griffin et al. 1987:13; Pfeffer et al. 1993; Hammatt and Pfeffer 1993).

Hansen’s Disease (i.e. leprosy) was first reported in Hawai‘i 1840, and positively identified in 1853. During the next 25 years (i.e. 1853-1878), there were approximately 160 cases per year, and 80 cases per year over the next 50 years (i.e. 1878-1928). The number of cases later decreased to 60 cases per year in 1931 and 20 cases a year in 1951 (Arnold 1956:317). In 1865, a receiving hospital in Kalihi, west of Honolulu, was set up to examine suspected lepers. If the diagnosis was confirmed, the patients were forcibly exiled to the Kalaupapa colony on Moloka‘i. In cases where it was uncertain if the patient had leprosy or some other type of skin disease, the stay at the hospital could extend into weeks while the doctors waited for definite symptoms of leprosy to develop. A branch hospital and receiving station for cases of Hansen’s Disease was opened in 1881 at Kaka‘ako, within the city block now bound by Ala Moana Boulevard, Keawe Street, Auahi Street, and Coral Street (Griffin et al. 1987:55), with 48 patients tended by Dr. George L. Fitch (Hanley and Bushnell 1980:112). This land, at “Fisherman’s Point,” was donated by Princess Ruth Ke‘elikōlani. The “Leper Hospital” is indicated on the 1884 map of Honolulu (see Figure 17).

One of the main purposes of the Kaka‘ako Detention Center was to keep suspected lepers isolated from the general pubic. Sister Leopoldina, a Franciscan sister, described the Kaka‘ako Hospital in 1885 as being like a prison, enclosed by:

> …a high close board fence and large strong locked gates…A large building [sat] over those gates where the lepers were allowed to talk with their relatives through prison bars. No one was allowed to enter without a permit from the Board of Health. [cited in Hanley and Bushnell 1980:114]

As the complex was constructed on a former salt marsh near the sea, it was subject to flooding at high tide. The salt water killed all vegetation and made it impossible to landscape the complex with grass or plants; the water swept away stone-bordered paths, corroded metal, and destroyed the whitewash on the buildings. Even so, the Board of Health expected the patients to help feed themselves by growing their own vegetables in gardens on the center’s grounds. Overcrowding was also a problem. The hospital, built to house 100 patients, had over 200 residents by 1883.

Dr. Fitch was in favor of making the Kaka‘ako station a permanent leprosarium, and often delayed sending confirmed lepers to Molokai.

In 1883, Walter Murray Gibson, a minister in King Kalākaua’s government and head of the Board of Health, sent out a plea for a religious order to care for the sick of Hawai‘i, especially the lepers. The call was answered by the Franciscan Sisters of Syracuse, New York, led by Mother Marianne Cope. The seven sisters arrived in Honolulu and made their first visit to the Kaka‘ako Leper Detention Center in November of 1883. They were appalled with what they saw: tumbled-down cottages, filth and flies in the dining area, and the stench of the leper’s unwashed sores. The hospital steward, J. J. Van Geisen, took them on a tour:

> “Now let me show you the most interesting place,” he announced, leading the group to a narrow building that teetered on pilings over the surf. The structure had been divided into three dingy cubicles, with warped floors and windows ghosted by salt spray. The first of the rooms was the “morgue.” Van Geisen explaining that when a patient’s condition reached a certain point, he was forced into the morgue and remained there until dead. The body was then dragged to the second cubicle, where Fitch performed an autopsy. Finally the remains were moved to the third room, to await a burial team. [Tayman 2006:143]

The sisters later built a convent at the hospital to live near their patients. The convent was a two-story house with a hall, parlor, and refectory on the ground floor, and five bedrooms upstairs. A small chapel was attached to the rear of the structure, dedicated to Saint Philomena. The sisters soon took the running of the hospital in hand, cleaning and whitewashing the cottages, separating the males and females into two wards, and setting up new landscaped areas and gardens (Figure 25).

In 1884, Mother Marianne built a home at Kaka‘ako for the non-leprous daughters of the patients at Kaka‘ako and the exiled lepers of Moloka‘i (Figure 26). The girls’ home was named after Queen Kapi‘olani, who supported the plan by raising funds. A two-story dormitory for the girls was built near the sisters’ chapel (Hanley and Bushnell 1980:222).

In 1888, the Board of Health decided to close the Kaka‘ako Branch, moving the receiving station to Kalihi. They determined that “the buildings at Kakaako should be entirely removed” (Hanley and Bushnell 1980:275). The hospital and several of the larger buildings were dismantled and transported for use at Moloka‘i (Daws 1984:xxiii). A few buildings remained and the Kaka‘ako site continued to be used as a temporary leprosy receiving station. Thrum (1897:101) reports that victims of the cholera epidemic of 1895 were treated at the Kaka‘ako Hospital, indicating the remaining buildings were modified or a new hospital was built during this time. In 1889, the Kapi‘olani School for Girls was also moved to Kalihi (Hanley and Bushnell 1980:326). The buildings were torn down and the new immigration station was built on the former grounds of the home.

In 1899, the first case of bubonic plague was identified in Hawai‘i; the plague spread rapidly through the crowded tenements of Chinatown. The government decided that the best way to eradicate the disease was through “controlled burning” of the wooden buildings. Infected patients were moved to a quarantine camp at Kaka‘ako. Some people whose houses were burned, not necessarily patients, were housed at the barracks of the Kaka‘ako Rifle Range, and their

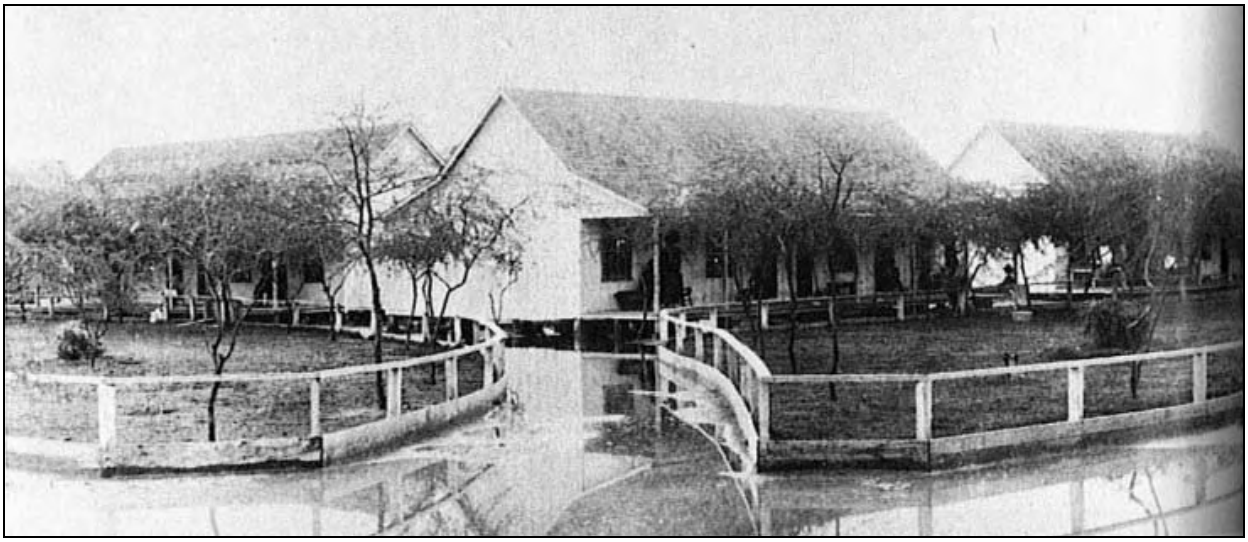

Figure 25. 1886 photograph of patients’ oceanside cottages at the Kaka‘ako Leper Detention Center (reprinted in Hanley and Bushnell 1980:photograph section)

Figure 26. 1886 photograph of the Kapi‘olani Home for Girls within the Kaka‘ako Leper Detention Center; Mother Marianne Cope is the second woman from the right (reprinted in Hanley and Bushnell 1980: photograph section)

belongings were stored in the cellars of Kaumakapili Church. In January, a fire was set in Block 15 between Kaumakapili Church and Nu‘uanu Avenue, which quickly got out of control. No one was killed in the fire, but Chinatown was destroyed. Many people were left homeless, and also bereft of all belongings, which were lost when Kaumakapili Church burned to the ground (Iwamoto 1969:122-124, 130-131).

In 1905, the Kaka‘ako area was used for the incineration of the waste from urban Honolulu. Thomas Thrum reported:

> Early in the year was completed the long projected garbage crematory for the disposal, daily, of the city's refuse by a patent and sanitary process. It is located on the shore of Kakaako, adjoining the sewer pumping station; is two stories in height and built of brick. [Thrum 1906b:177]
>
> The dredging of Honolulu harbor and its channel is completed as far as planned for the present, and excavations for the Alakea and Kinau slips finished, the material therefrom being used to fill in a large area of Kakaako and the flats in the vicinity of the sewer pumping station and garbage crematory. The amount of material removed by the Federal dredging was a million and a half cubic yards [Thrum 1907:148-149].

3.1.11 Military Works at Ka‘ākaukukui

During the monarchy, the point at Kaka‘ako was the location for a battery, with three cannons used to salute visiting naval vessels, which responded with their own cannon salutes. Other saluting batteries were at the top of Punchbowl Crater and at the Honolulu Fort (Dukas 2004:163). The *Hawaiian Annual and Almanac for 1887* (Thrum 1887:37) reported that $4,500 had been spent to build the battery, which was used for gun salutes up to at least the end of the monarchy in 1893 (Judd 1975:57), as shown on an 1887 photograph (Figure 27) and a 1887 map of Honolulu (see Figure 18).

After the annexation of the Hawaiian Islands by the United States in 1899, the U.S. Congress began to plan for the coastal defenses of their new islands. The major batteries were placed at Pearl Harbor and Waikīkī, but a small reservation, named Fort Armstrong, was also set up on the Ka‘ākaukukui Reef as a station for the storage of underwater mines. Battery Tiernon, with two 3-inch guns, was built at this site in 1911, and took over the job of saluting visiting naval vessels once performed by the Kaka‘ako battery (Williford and McGovern 2003:15). In 1917, William Castle noted:

> Fort Armstrong is the saluting station for the port of Honolulu. It is built on the Kaakaukukui Reef, one mile from the centre of the city and at the entrance of the harbour. Its area is 64 acres, and it has as garrison the 104th Company (mine) of the Coast Artillery Corps. Both officers and men are wretchedly housed in temporary board and batten shacks, although the fort has been in use for three years. [Castle 1917:90]

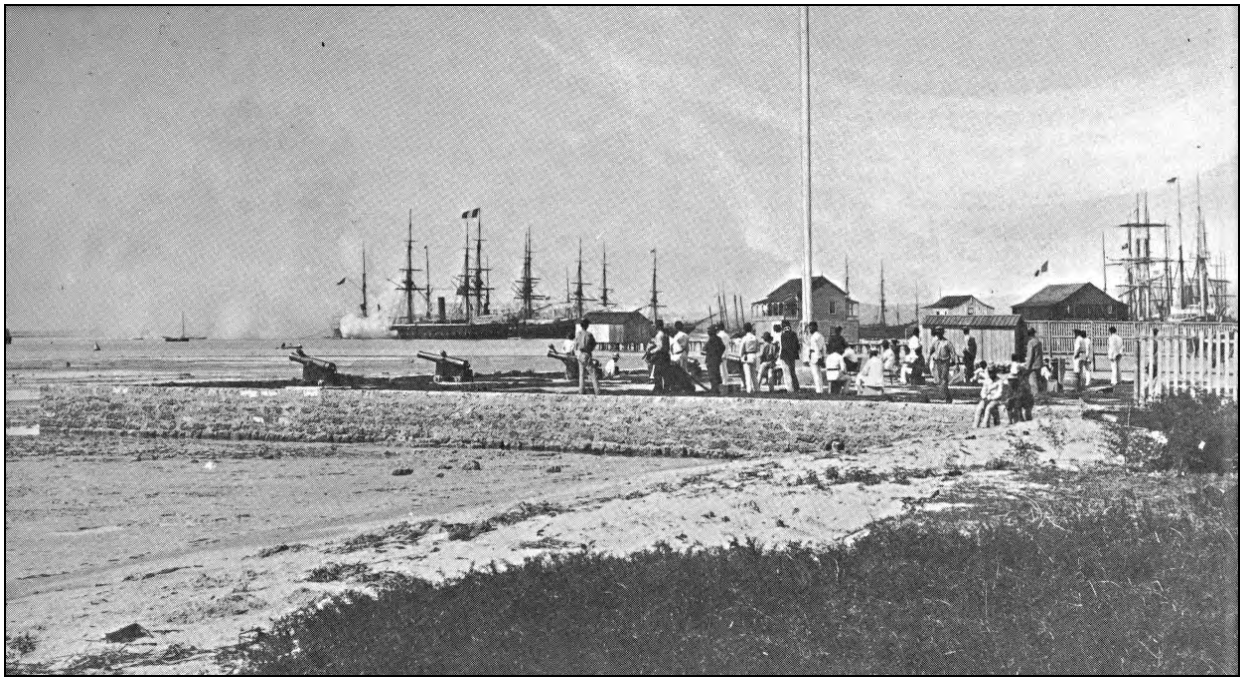

Figure 27. 1887 photograph of the Kaka‘ako Saluting Battery and flagstaff (original photograph taken by Karl Kortum and archived at the San Francisco Maritime Museum; reprinted in Scott 1968:176)

Fort Armstrong saw some small action during World War I. In October 1917, military authorities closed Honolulu Harbor between sunset and sunrise. The steamer *Claudine*, which was sailing from Maui when the edict went into effect, sailed into Honolulu Harbor unknowingly after twilight. The coast artillery at Fort Armstrong shot a few shells across her bow, and the steamer quickly reversed her engines and went back out to sea until the following morning, when she could safely and legally come to shore (Thomas 1983:147). During the Japanese attack of Hawai‘i on December 7, 1941, the Fort Armstrong escaped relatively unscathed. Only one motor pool structure was hit. Anti-aircraft shells were fired from the fort, but were ineffective. At least one shell hit the town rather than any aircraft (Richardson 2005:34). In the 1950s, the federal government returned most of Fort Armstrong to the Territory of Hawai‘i, which used the area to expand the shipping piers of the harbor.

3.1.12 Kerosene Storage Lot and the Magoon Block

On the 1887 map of Honolulu (see Figure 18), a lot is indicated “kerosene store house,” a government facility, located north of the current project area. The danger of locating this storage area so close to downtown Honolulu was emphasized by the compiler of the *Hawaiian Annual*, Thomas Thrum, who noted fires at the kerosene storage warehouse in 1891, and again in 1907:

> And, as if to emphasize the critical condition of the city, fires have been more numerous than usual, with more serious loss thereby than for years past, the

> principal one being the government Kerosene Warehouse in the early part of June last, with some 35,000 cases of oil and gasoline. [Thrum 1892:129]
>
> Early in August a small building at Kakaako of not much value was destroyed by fire. Shortly afterwards, by the prompt response to the firemen to a “still alarm” about 8 a.m. of Sunday, the 11th, an incendiary blaze in the Kerosene warehouse at Kakaako was quenched just in time to avert a serious explosion and conflagration. [Thrum 1908:180-181]

On later historic maps, this land section is referred to as the Magoon Grant or the Magoon Block. John Alfred Magoon was a prominent lawyer in Honolulu who married Emmeline Marie Afong, the daughter of a wealthy Chinese businessman in Hawai‘i (Dye 1997:211-212). Like many businessmen, Magoon bought properties as investments, for development or for sale for a profit at a later date. Under Kamehameha IV, he received Grant 3182 (0.312 acres) in 1878 for $50, and Grant 3183 (1.89 acres) for $260. By 1914, he built on the Queen Street lot a two-story structure with shops on the ground floor and residential apartments on the top floor (Figure 28), described as “Hawaii’s First Apartment House” (Griffin et al. 1987:32, 65). Additional structures were built in the early twentieth century in the parcel called the “Magoon Block.” The apartments were generally low-rent and inhabited by bachelors, although some poorer families crowded into the larger apartments. All of the buildings on the lot were demolished in 1940.

3.1.13 Honolulu Iron Works

In the 1850s, Hawaiian sugar planters became interested in a type of centrifugal machine that could separate sugar from molasses. An engineer named David Weston installed his version of this machine in a Maui sugar mill in 1851. With backing from Hawaiian businessmen, Weston returned to the islands in 1853 and founded the Honolulu Iron Works (Figure 29), which he set up in a building already occupied by a flour mill (Kuykendall 1938:326-327). The flour mill was at first the most successful part of the business, where wheat from Maui and as far away as Chile was ground into flour and then exported to California. However, as the sugar industry became more prominent in the Hawai‘i economy, the Iron Works began to build the machinery needed to operate the new sugar mills, not only in Hawai‘i but all over the world. At one point, the Iron Works employed 1,500 workers, many who lived in the Kaka‘ako area (Nicol 1998:510).

Business began to decline in the 1950s, and in 1973 the works were closed (Nicol 1998:510). At first the old buildings were converted to retail space, but eventually all were torn down; the last warehouse was demolished in 1982 (Kawasaki 2005:2). This main lot for this complex is now covered by One Waterfront Plaza, west of the current project area.

3.1.14 Pohukaina School and Mother Waldron Park

In the surveyor’s notes for an 1873 map of land parcels at the corner of King and Punchbowl streets, the present site of the Hawai‘i State Public Library, one of the parcels is identified as the “lot purchased by the Government of Prince Lunalilo in 1872, said portion now to be transferred to the control of the Board of Education.” The parcel was, in 1874, to become the site of the Pohukaina School for Girls, one of three government supported schools on O‘ahu during the second half of the 19th century. The other two schools were the Royal School for Boys and the Fort Street School.

Figure 28. Undated photograph of the Magoon Block (photograph reprinted in *Kaka‘ako Connection* 2004)

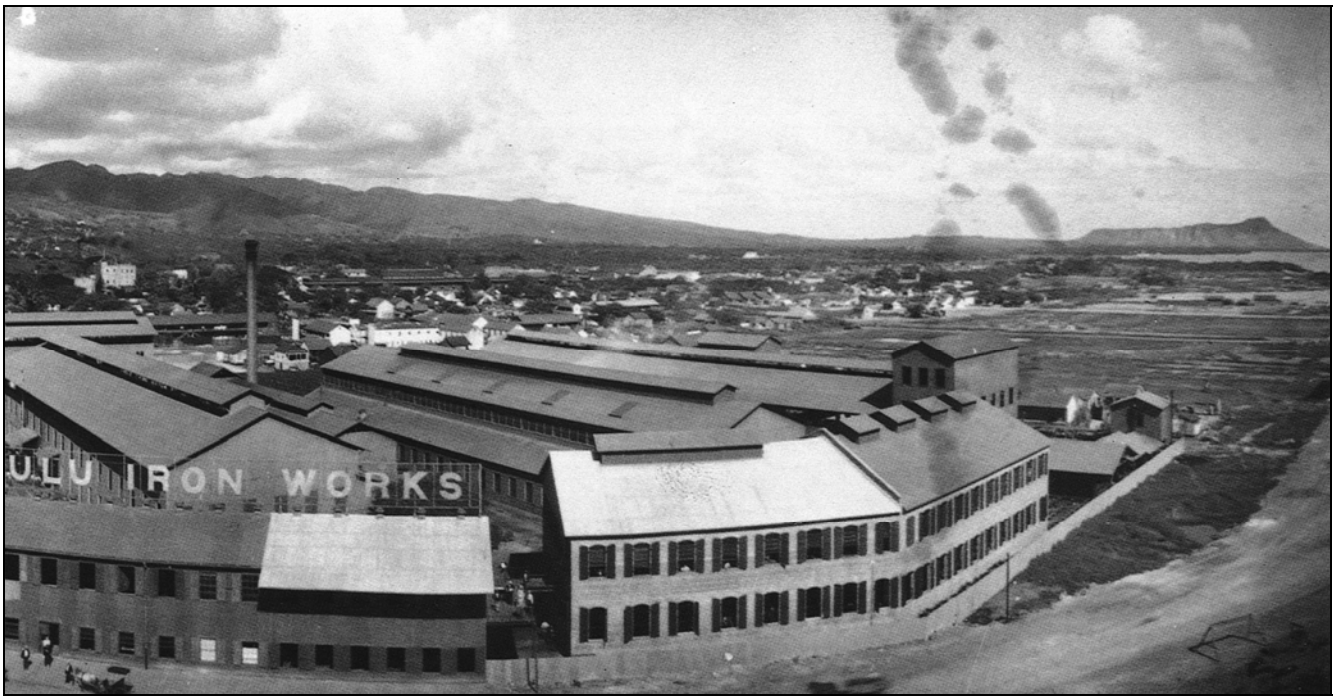

Figure 29. Photograph (circa 1901) of the Honolulu Iron Works complex (original photograph at Bernice P. Bishop Museum; reprinted in Myatt 1991:40-41)

> The Pohukaina Girls' School on King Street will suit those parents who do not care about their girls being mixed up with boys at school or in school playgrounds. Miss S.F. Corney is the Principal, and has for assistants Misses W.P. Luce and J. Dudoit. The young folks who attend this school, and through them (by reflected merit, or, rather, as the originators of the merit), their ladylike teachers, lately received a very pretty pat on the back from the Honorable Mr. Bishop, who is President of the Board of Education. "The pupils of this school are generally known out of the school room by their neat and tidy appearance," was the remark by which, in addition to some decided praise of their application to their studies, he intimated to the Legislative Assembly what benefits they conferred on the community by the Government grant to the Pohukaina Girls' School. [Bowser 1880:451]

In 1907 the Hawai‘i Territorial Legislature passed an act to establish the Library of Hawai‘i. After evaluating several possible locations, the government committee decided that the King Street lot of the Pohukaina School would be the best location. Governor Frear wrote, "I arranged to have Pohukaina School moved to Kakaako- a more central location with reference to its constituency and with much more space for buildings and playgrounds" (Frear 1938, cited in Schilz 1991).

As Gov. Frear noted, Pohukaina School was moved to Kaka‘ako, within the city block bounded by Pohukaina Street, Keawe Street, Halekauwila Street, and Coral Street. The main building was located immediately *makai* (seaward) of the current project area. Constructed at a cost of $28,000, the new school building opened in 1913:

> The structure which was designed by E.C. Petit of the architectural firm headed by H.L. Kerr represents a special study in fire-proofing. It is fitted with specially designed fire walls and doors, with outside staircases.
>
> The building is of reinforced concrete and economically planned, the rooms on the second floor being fitted with folding doors to that they may be thrown together. The design permits of the addition of a number of rooms at the rear of the building when an increase in school population makes this necessary. [*Pacific Commercial Advertiser*; June 22, 1913:A1]

Pohukaina School remained in operation in Kaka‘ako until 1980, by which time it had developed into a special education facility. The buildings were demolished, and in 1981, the Pohukaina School special education program was transferred to the campus of Kaimukī Intermediate School.

One of the teachers at the Pohukaina School was Margaret Waldron. Mrs. Waldron taught at Pohukaina School for 18 years until her retirement in 1934. She was also noted for her volunteer work in Kaka‘ako, and was "generally credited with being the individual who had most influence in transforming the so-called 'Kakaako gangs' into law abiding groups and wiping out the unsavory reputation which at one time clung to the district" (*Honolulu Star-Bulletin*; May 8, 1936:A1). Mrs. Waldron died on May 8, 1936. The following year, when a new playground was constructed across Coral Street from Pohukaina School, the Honolulu Board of Supervisors authorized the park's designation as "Mother Waldron Playground." At the September 20, 1937

opening of the playground, designed by Harry Sims Bent and constructed on the site of the former County stables at a cost of $50,000:

> …officials expressed the hope that the park would be appreciated and enjoyed to the utmost. Reference was made to the dusty roads and barren lands that had marked the site not many years ago. [*Honolulu Advertiser*; September 21, 1937:A1]

The Mother Waldron Playground was then, in 1937, the most modern facility in the Territory. The following year, Lewis Mumford, the noted author and social scientist, was invited by the Honolulu Park Board to study the county's parks and playgrounds. He noted the "spirit called forth in the Mother Waldron Playground." Mumford defined that spirit exemplified by Mother Waldron Playground and other county parks:

> That the very spirit of play is enhanced by taking place in a setting that shows order and vision often does not occur to the municipal departments concerned; hence, ugly chicken-wire fences, clay or bare asphalt surfaces, and a complete innocence of all aesthetic device. Honolulu has made a valuable departure from this stale tradition by providing, in some of its new playgrounds, structures that have none of this tawdry makeshift quality; they are rather examples of building art worthy to have a place beside the open-air gymnasiums or palestra of the Greeks. The handsome bounding wall, the judicious planting of shade trees, the retention of grass wherever possible, translate the spirit of organized play to the area itself. [Mumford 1938:42]

Mumford also reported: "The architectural treatment of Ala Moana Park and the design of the Mother Waldron playground seem to me particularly successful…" (Mumford 1938:48).

3.1.15 Squattersville

Poor people, mainly native Hawaiians, lived in shacks and sturdy houses in the 1920s on lands reclaimed during the construction of Fort Armstrong and areas to the east. The area was called "Squattersville," named because the people were living on government land without authorization (Figure 30). This camp in the Ka‘ākaukukui area (shortened to ‘Ākaukukui), was generally located around Olomehani Street near the shoreline, protected from the waves by a long sea wall. There were around 700 Hawaiians and part-Hawaiians living in shoreward camps in the mid-1920s, but by 1926 they were all gone. The government evicted the families and razed the houses (Clark 1977:64).

Clark further reports on the developments in the area after the demise of Squattersville:

> During the 1930's and 1940's, the Ka‘ākaukukui area continued to be heavily utilized as a fishing and swimming area, especially by children from the neighboring community of Kaka‘ako. The children surfed on redwood planks in the break they called "Stonewall." Many varieties of fish were abundant. Younger divers were warned by the old-time residents to stay away from the large sharkhole on the Waikīkī side of Kewalo Channel. Many people came to this area to pick limu [seaweed] and wana [sea urchin], and also to catch squid on the shallow reef. [Clark 1977: 64]

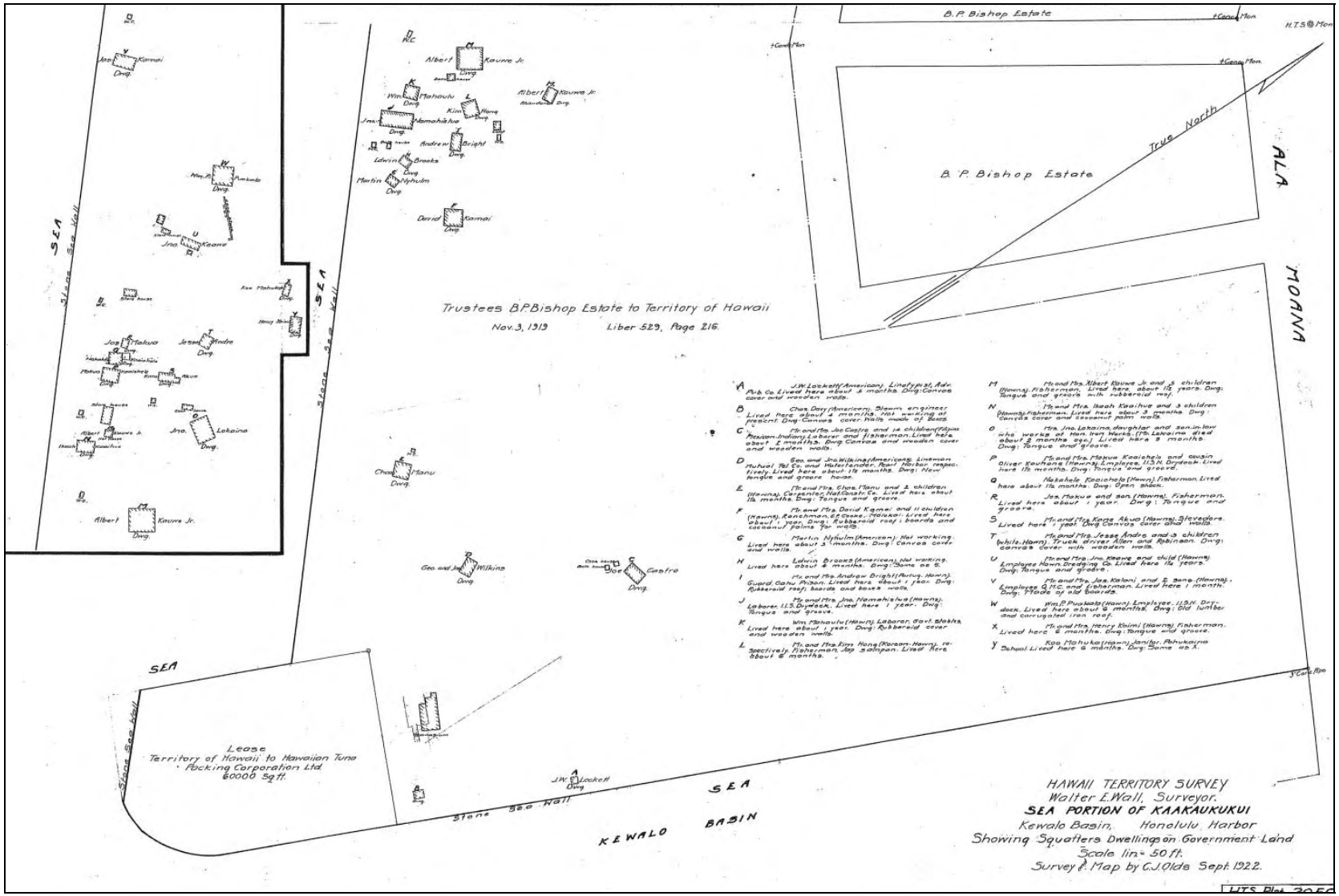

Figure 30. 1922 map of “Squattersville,” by Walter E. Wall (Hawai‘i Territory Survey Plat Map 2050)

3.1.16 Early Twentieth Century Land Reclamation Projects

3.1.16.1 Kaka‘ako Reclamation

The first efforts to deepen Honolulu Harbor were made in the 1840s. The idea to use the dredged material, composed of sand and crushed coral, to fill in low-lying lands, was quickly adopted. From 1857 to 1870, the “Esplanade” between Fort and Alakea streets was created on 22 acres of filled-in former reef and tideland. By 1874, Sand (Quarantine) Island, site of the first immigration station, had been created over “reclaimed” land on reefs.

By the 1880s, infilling of the mud flats, marshes, salt ponds in the Kaka‘ako area had begun. This infilling was driven by three separate, but overlapping, improvement justifications. The first directive was for the construction of new roads and improving older roads by raising the grade so the improvements would not be washed away by flooding during heavy rains. A report by the Hawaii Board of Health (1908:80) noted:

> I beg to call attention to the built-up section of Kewalo, “Kaka‘ako,” where extensive street improvements, filling and grading have been done. This, no doubt, is greatly appreciated and desirable to the property owners of that locality, but from a sanitary point of view is dangerous, inasmuch as no provision has been made to drain the improved section, on which have been erected neat cottages occupied for the greater part by Hawaiian and Portuguese families, now being from one to three feet below the street surface, and which will be entirely flooded during the rainy season. Unless this is remedied this locality will be susceptible to an outbreak [of cholera] such as we experienced in the past.

As mentioned in the above section, the justification for infilling of low-lying areas most frequently cited was public health and sanitation: the desire to clean up rivers and ponds that were reservoirs for diseases such as cholera and acted as breeding places for rats and mosquitoes. Thus, as early as 1902 (Hawaii Board of Health 1902:80), it is reported that:

> The Board has paid a great deal of attention to low-lying stagnant ponds in different parts of the city, and has condemned a number of them. The Superintendent of Public Works has given great assistance to seeing that the ponds condemned by the Board are filled. In September a pond on South Street was condemned as deleterious to the public health.

The first areas to be filled were those areas closest to Honolulu, then moving outwards to Kaka‘ako (Griffin et al. 1987:13). The first fill material may have been set down in 1881 for the Kaka‘ako Leper Branch Hospital, which had been built on a salt marsh. Laborers were hired to “haul in wagonloads of rubble and earth to fill up that end of the marsh” (Hanley and Bushnell 1980:113). In 1903, five more lots in Kewalo, on Ilaniwai, Queen, and Cooke streets, were condemned and ordered to be filled (Hawaii Board of Health 1903:6).

Although public health and safety were prominently cited, according to Nakamura (1979), the main desire (and third justification) to infill Honolulu, Kewalo, and then Waikīkī lands was to provide more room for residential subdivisions, industrial areas, and finally tourist resorts. In the early part of the twentieth century, Kaka‘ako was becoming a prime spot for large industrial complexes, such as iron works, lumber yards, and draying companies, which needed large spaces

for their stables, feed lots, and wagon sheds. In 1900 (Thrum 1901:172), the Honolulu Iron Works, which produced most of the large equipment for the Hawaiian plantation sugar mills, moved from their old location at Queen and Merchant Street near downtown Honolulu to the shore at Kaka‘ako, on land that had been filled from dredged material during the deepening of Honolulu Harbor. Other businesses soon followed. Thrum (1902:168) noted:

> The Union Feed Co. is another concern whose business has outgrown the limits of its old location, corner of Queen and Edinburgh streets. Like the Iron Works Co. they have secured spacious premises at Kakaako, erecting buildings specially adapted to the needs of their extensive business at the corner of Ala Moana (Ocean Road) and South Street.

Private enterprises were not the only new occupants of Kaka‘ako. A sewer pumping station, an immigrant station, and a garbage incinerator were also built on “reclaimed land.” Thrum (1907:148-149) noted:

> The dredging of Honolulu harbor and its channel is completed as far as planed for the present…the material there from being used to fill in a large area of Kakaako and the flats in the vicinity of the sewer pumping station and garbage crematory.

For the incinerator, Thrum noted:

> The new station is built on piles on reclaimed land that is being filled in from the coral dredgings that is going on, and is gradually taking on a tropical appearance. ….Adjoining its premises on the mauka side is the new building designed for the Planters’s Association for their labor bureau.

The new immigration station (Figure 31) had seven large rooms for dormitories, surrounded by a breezy, open *lanai*, where immigrant workers would stay while waiting for their clearance to go to their new work places on the sugar plantations. Adjacent to the dormitory was a hospital, which was used to check the new immigrants for any “loathsome or dangerous contagious disease” (Hawaii Governor 1905:77). The hospital was also used during epidemics to isolate contagious patients, suffering from such diseases as smallpox, cholera, or plague.

In 1900, a pond surrounded by a bicycle racing track, called the Cyclomere (built in 1897), in the Kewalo area was filled. This was located on the *makai* side of Kapi‘olani Avenue between Cooke Street and Ward Avenue. In 1904, the area around South Street from King to Queen Streets was filled in. The Hawaii Department of Public Works (1904) reported “considerable filling [was] required” for the extension of Queen Street, from South Street to Ward Avenue, which would “greatly relieve the district of Kewalo in the wet season.”

3.1.16.2 Kewalo Reclamation Project

Although the Board of Health could condemn a property and the Department of Public Works could then fill in the land, the process was rather arbitrary and piecemeal. In 1910, after an epidemic of bubonic plague, the Board of Health condemned a large section of Kewalo (including areas in Ka‘ākaukukui), consisting of 140 land parcels which had numerous ponds (Hawaii Department of Public Works 1914:196).

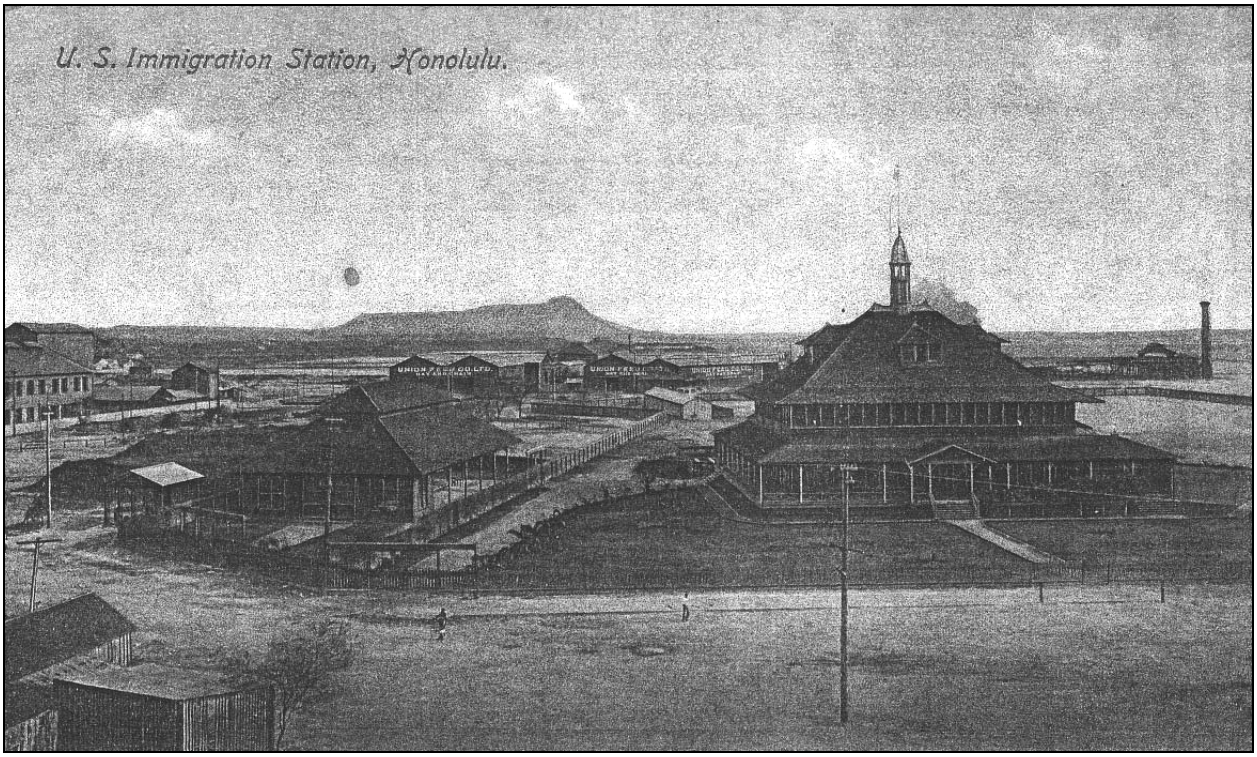

Figure 31. Photograph (circa 1900) of the Immigration Station at Kaka‘ako, Union Feed Co. stables in center background (Hawai‘i State Archives)

In 1914, the entire:

> …locality bounded by King street, Ward avenue, Ala Moana and South street, comprising a total area of about two hundred acres, had been found by the board of health of the Territory to be deleterious to the public health in consequence of being low and below ‘the established grades of the street nearest thereto’ and at times covered or partly covered by water and improperly drained and incapable by reasonable expenditure of effectual drainage, and that said lands were in an insanitary and dangerous condition. [Hawaii Supreme Court 1915:329]

The superintendent then sent a letter to all of the property owners, informing them that they must fill in the lands to the grade of the street level within sixty days. Only a few of the land owners complied, infilling their land with a variety of materials. Most of the land owners did not comply with the notice, and in 1912 the bid was given to Lord-Young Engineering Co. to fill in the land with “sand, coral and material dredged from the harbor or reef and the depositing of the same upon the land by the hydraulic method” (Hawaii Supreme Court 1915:331). The affected land owners sued to stop the work, and in the suit, the method of hydraulic filling is described:

> By this [hydraulic] method the material dredged is carried in suspension or by the influence of water which is forced through large pipes and laid upon the lands and

> intervening streets, and afterwards is distributed and leveled, the water having drained off through ditches provided for the purpose. The work is done in large sections around which bulkheads have been constructed. A section can be filled in about thirty days, the dredger working about fifteen hours per day. And in about two months after a section has been filled the ground will have dried out so as to be fit for use as before…The character of the material varies from very fine sand to coarse bits of coral…
>
> It appears in evidence that though the method employed the finest of the material which is carried upon the land settles when the water which transports it becomes quiet and as the water runs off a sludge or mud remains which forms a strata more or less impervious to water. This strata, however, is covered by the coarser and more porous material…it appears that by mixing in to a depth of a few inches ordinary soil small plants will grow without difficulty…The character of the locality must be considered. It is not adapted to agriculture, but is suited more particularly to such business purposes as it now partly used for, such as stables, laundries, warehouses, mills, etc., and for cottages with small yards for the accommodation of laborers engaged in connection therewith. Upon the whole, we are of the opinion that the material proposed to be used in the fill-in of the lands of the complainants is not of a character as should be held to be improper for any of the reasons urged. [Hawaii Supreme Court 1914:351]

The first land to be filled-in was the portion of the Ward Estate property west of Ward Avenue, which was completely filled-in by June of 1913. In July, “25,000 cubic yards of sand and ground-up coral were deposited on the Bishop Estate property in the vicinity of Ala Moana and Keawe street, the reason for shifting operations to this part of the district being that the Hawaiian Sugar Planter’s Association had erected a reinforced concrete building there and wished to have the lot brought to grade” (Hawaii Department of Public Works 1914:198). By August, the remaining Ward Estate lands west of Ward Avenue had been completely filled-in. By February 1914, all of the land from South Street to Ward Avenue, and from Ala Moana Boulevard to Queen Street had been filled, including the current project area.

The expense of the suit did manage to shut down operations planned for the area from Ward Avenue to Waikīkī (Thrum 1916:159-160). This land was mainly owned by the Bishop Estate, who leased the land to small farmers growing taro and rice and raising ducks in the ponds. In 1916, the Bishop Estate announced that as soon as their present tenant leases expired, they planned to fill the lands and divide them into residence and business lots (Larrison 1917:148-149). In 1919, a portion of the coastal section of the Bishop Estate lands was secured by the government in order to expand the Kewalo Basin (Thrum 1920:148).

3.1.16.3 Waikīkī Reclamation Project

It was during the 1920s that southeast O‘ahu would be transformed, when the construction of the Ala Wai Drainage Canal - begun in 1921 and completed eight years later - resulted in the draining and infilling of the remaining ponds and irrigated fields of Honolulu and Waikīkī. The canal was one element of a plan, first conceived in 1906, to urbanize Waikīkī and the surrounding districts. The final result was a “canal three miles long, with an average depth of

twenty-five feet and a breadth of two hundred fifty feet" (*Honolulu Advertiser*, 17 October 1928:2:16).

Several claims were made against the dredging company, including compensation for destroyed crops and livestock by farmers. For instance, a Chinese tenant farmer named Chang Fow, leasing lands in Waikīkī from the Bishop Trust Company, wrote a letter of complaint indicating that the salt water that leached into his lands as a result of the dredging of the canal had devastated his fishponds and stocks of ducks and chickens (letter from Chang Fow to the Bishop Trust Company, 23 May 1922, cited in Nakamura 1979:100-101). His claims, along with those of other residents of the area, give an impression of the continuing agricultural subsistence base in Waikīkī that lasted into the 1920s.

Information about the actual dredging and infilling process, and the materials dredged-up and used for fill, is minimal. Statements and pictures regarding the event show that dredging was done both off-shore, on the ocean bed, and in the area slated for the canal. Information regarding the filling process of personal properties is unclear. Numerous phases seem to have taken place.

Nakamura (1979:85) writes that the government of the Territory of Hawai‘i solicited bids, in 1920, for the dredge and fill project planned for the environs of Waikīkī. The plan was to create hundreds of acres of urban land, at the expense of wetland agriculture and aquaculture in the area. The advertisement, soliciting bids for the project put forward by Lyman H. Bigelow, masked the significance of the project by stating that "for Dredging a Drainage Canal and Filling and Reclaiming Certain Unsanitary Lands at Waikiki" (Nakamura 1979:85). He further writes that State laws were passed requiring property owners to pay for the infilling of their lands, which apparently was going to be done whether they wanted it or not. A lien would be fixed against their property, and if payment was not made on time, land would be foreclosed on. Nakamura points out that the cost was so high for some of the property owners that the bank lien could extend into a fifteen-year mortgage (Nakamura 1979:89).

Once land that the Territory of Hawai‘i government wanted filled in (ex. for government buildings) was complete, any further dredged materials became the property of the dredging company (i.e. the Hawaiian Dredging Company) and they could then sell the materials to the property owners, who in-turn were forced to buy the product. Walter F Dillingham, of the Hawaiian Dredging Company, died in 1963. *Time* magazine, in their article about him and his involvement in the project stated that "…Walter Dillingham used the muck dragged up from the sea to fill in low, marshy areas around Honolulu, over the years created 5,000 acres of solid ground that now holds a full third of the city's population" (cited in Nakamura 1979:112).

The land surface of modern Honolulu and Waikīkī is situated on the result of this decade long dredging and infilling project, of which the creation of the Ala Wai Canal was included. In Nakamura's (1979:113) *The Story of Waikīkī and the Reclamation Project*, he writes that this land "reclamation" program changed the ecology of Waikīkī from a once viable and important agriculture and aquaculture center, under the subterfuge of "drainage" and "sanitation." Many of the original property owners lost their land or had serious damage to their property as a result of the reclamation activities and/or the costly expense for the mandatory infilling of their properties.

3.1.17 Urban Expansion in the Kaka‘ako Area

Kaka‘ako was considered outside the Honolulu town boundary and was used in the mid to late nineteenth century as a place for cemeteries, burial grounds, and for the quarantine of contagious patients. Then, in the beginning of the twentieth century, the area was used as a place for sewage treatment and garbage burning, finally becoming an area for cheap housing and commercial industries (Griffin et al. 1987:13).

Late nineteenth century maps (see Figure 7 and Figure 8) show the emerging traces of the future development in Kaka‘ako as the grid of roads extending southeast from Honolulu toward Waikiki. Queen Street, which was planned to connect to the beach road near Waikīkī, appears to follow the route of the traditional trail from Kou (Honolulu) to Waikīkī, as described by John Papa ‘I‘i. As previously discussed, this trail likely traversed a sand berm raised above the surrounding marshlands and coral flats. The late nineteenth century maps indicate the vicinity of the current project area remained marshland with fishponds and salt ponds. At this time, the project area was a portion of the Kaka‘ako Salt Works (see Figure 17), which probably ceased its operation sometime before 1916.

A series of U. S. Geological Survey (or wartime U.S. Army) topographic maps shows the gradual expansion of the Honolulu urban district to the edge of Kaka‘ako and beyond in the early twentieth century. During the first half of the twentieth century, both rice fields and marshlands were eliminated as Kaka‘ako lands were filled to accommodate the expanding urbanization of Honolulu.

As previously discussed, the current project area and vicinity were completely filled by 1914, during road improvement projects and the Kaka‘ako/Kewalo Reclamation projects. All of the ponds and the low-lying areas in the vicinity of the current project area were filled, and new land, including the vicinity of Fort Armstrong, was created from dredged material. The 1919 War Department map (Figure 32), shows the extent of land reclamation and development in the Kaka‘ako area. The map indicates that early twentieth century residences in the vicinity of the project area were clustered between Pohukaina and Queen Streets, with several structures indicated within the current project area. The Pohukaina School building is also shown immediately *makai* of the current project area. The current project area appears to be near the edge of the expanding urban area at this time. Streets extending toward Waikīkī are shown as dashed lines, indicating the roads were not yet paved.

The 1927-28 U.S.G.S. map (Figure 33) shows the continued expansion of the urban Honolulu area into the formerly open areas of Kaka‘ako. Material dredged during construction of the Ala Wai Canal, Kewalo Basin, and other near-shore dredging projects, as well as material generated by the city garbage incinerator, continued to be used to fill low-lying and shoreline areas. The 1943 War Department map (Figure 34), shows areas *makai* (seaward) of Ala Moana Boulevard which were formerly ocean, including Kaka‘ako Makai, Kewalo Basin, and Ala Moana Beach Park, as dry land with increasing development. The vicinity of the current project area is also shown as an increasingly urban area, primarily consisting of small residential and commercial structures. With increased urbanization of the Kaka‘ako area, these small buildings were replaced by large commercial and industrial structures, as shown in a 1978 aerial photograph (Figure 35).

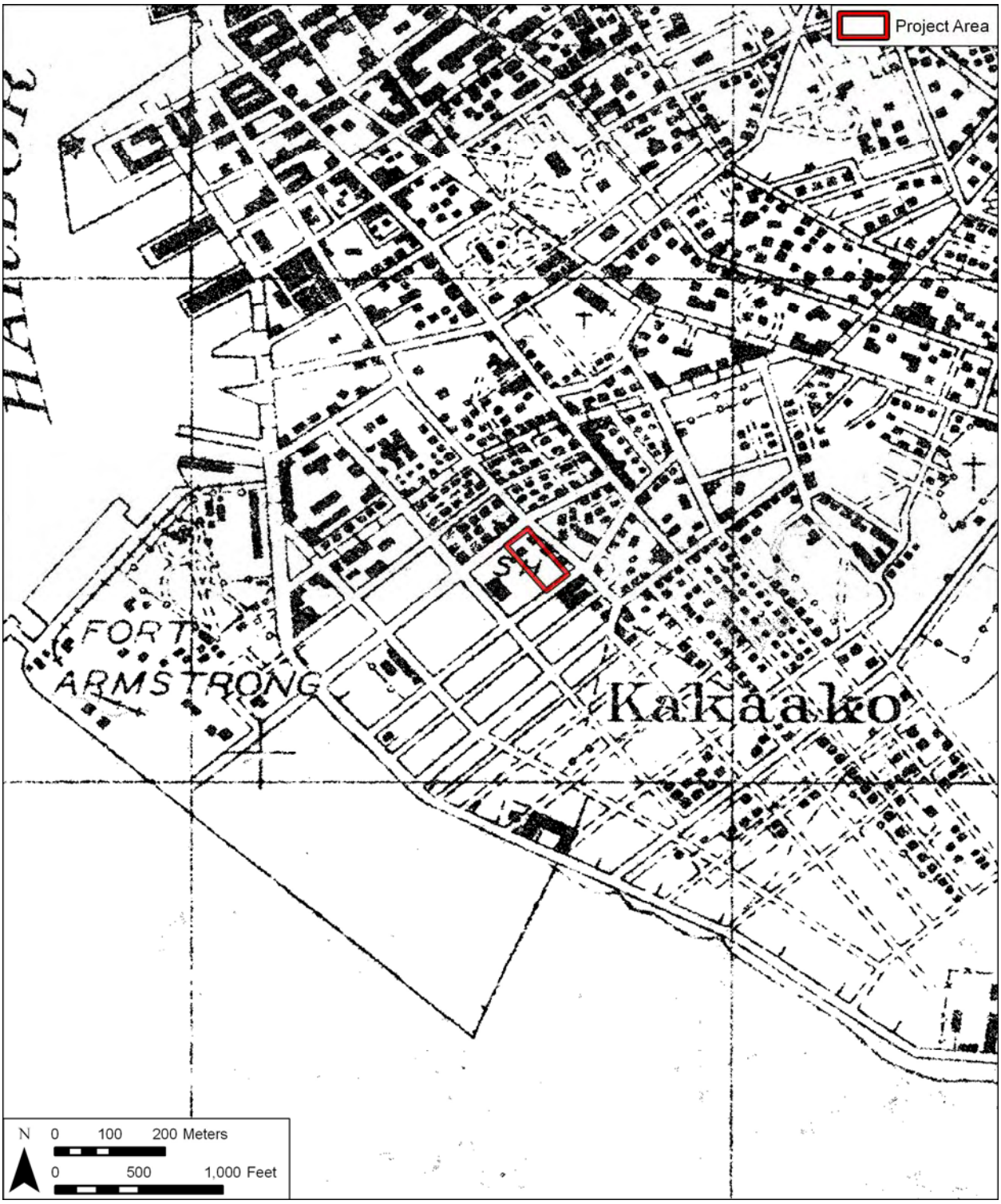

Figure 32. 1919 War Department Topographic Map, Honolulu Quadrangle, showing the location of the project area

Figure 33. 1927-28 U.S.G.S. Topographic Map, Honolulu Quadrangle, showing the location of the project area

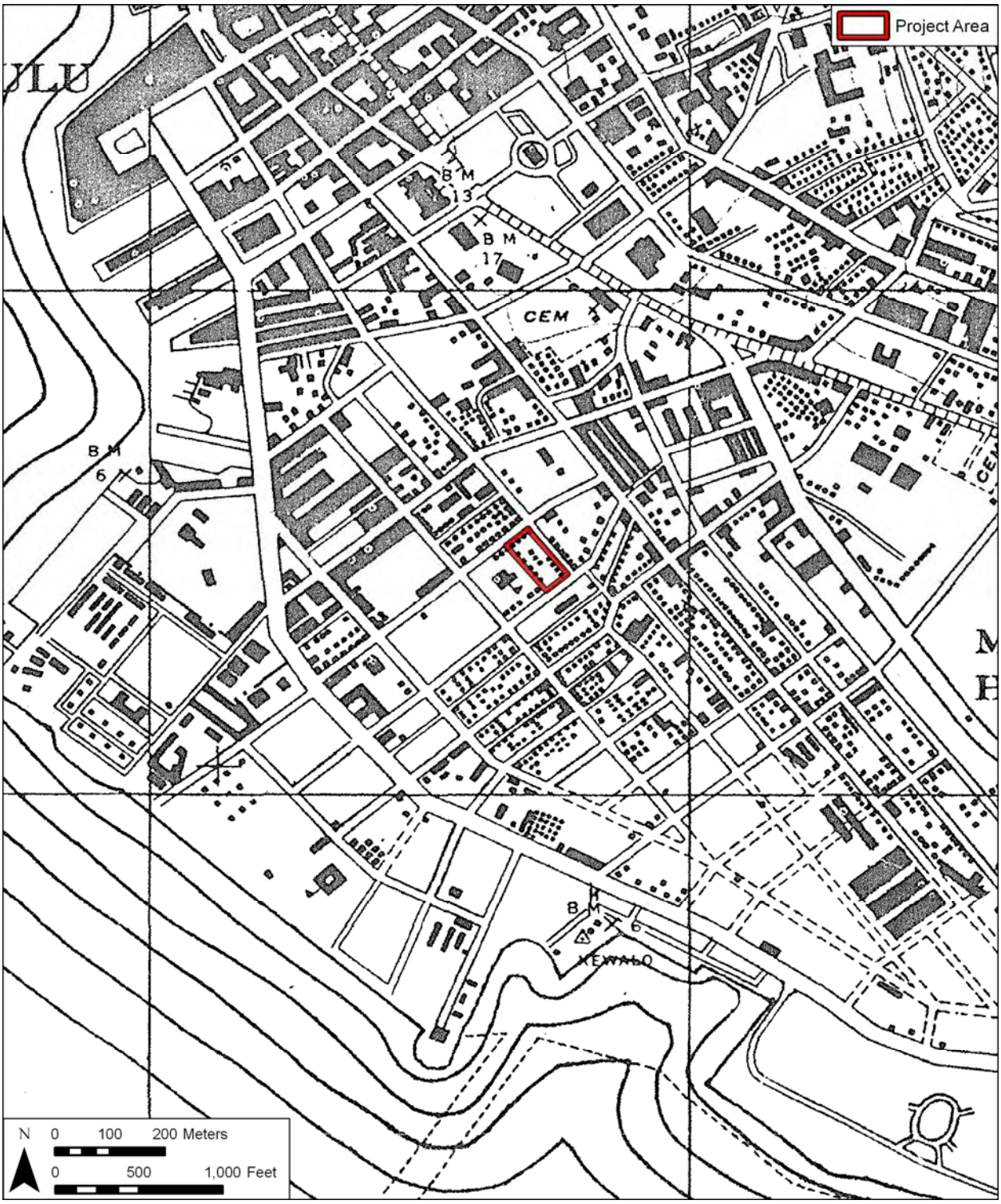

Figure 34. 1943 War Department Topographic Map, Honolulu Quadrangle, showing the location of the project area

Figure 35. 1978 U.S.G.S. Orthophotograph, Honolulu Quadrangle, showing the location of the project area

3.1.18 Development within the Current Project Area

A series of fire insurance maps illustrates the history of the current project area in greater detail. The current project area is not shown on any of the Dakin Fire Insurance maps for 1891, 1899, or 1906, suggesting that there were no permanent structures in the area during those years. The current project area and vicinity is first indicated on the 1914 Sanborn Fire Insurance map (Figure 36). The 1914 map shows the project area within the *mauka* (northeastern) portion of the city block bounded by Keawe Street, 2nd Street (i.e. Pohukaina Street), Coral Street, and an unnamed lane (i.e. future Halekauwila Street). The block is dominated by the "Pohukaina Public School," which occupies much of the *makai* (southwestern) portion of the block. The *mauka* portion of the block, contains small residential "dwellings," portions of which are located within the current project area. The 1927 Sanborn map (Figure 37) continues to show the "Pohukaina Public School" dominating the block. The school has greatly expanded since 1914, with several classroom buildings surrounding the central school building. Several classrooms, an automobile garage, and water closet (i.e. restroom) are located within the current project area. The *mauka* portion of the block continues to be used for residential "dwellings." By 1950, the "Pohukaina Public School" has expanded to cover the entire block, including the current project area (Figure 38). Several classroom buildings, an automobile garage, and a portion of the school cafeteria building are located within the current project area. The 1956 Sanborn map (Figure 39) continues to show the "Pohukaina Public School" in the same configuration as the 1950 map. As previously discussed, the Pohukaina School was closed in 1980 and the school buildings were subsequently demolished in 1981.

3.2 Previous Archaeological Research

3.2.1 Archaeological Background

Most traditional Hawaiian surface structures in Honolulu had been demolished by the time of the first scientific archaeological surveys. In his report on the survey of O‘ahu archaeological sites conducted in the early 1930s, McAllister (1933:80) says of Honolulu: "Information regarding former sites within the present limits of Honolulu must come entirely from literary sources." He does mention Pākākā Heiau, once the main royal temple in Honolulu, formerly located near the *makai* (seaward) end of Fort Street. McAllister does not list Pu‘ukea Heiau or Ka‘ahaimauli (discussed in Section 3.1.4), but he does note that Peter Corney, a visitor to the island in 1819, saw several *heiau* (*morai*) along the Honolulu shore:

> There are several morais, or churches in the village, and at new moon the priests, chiefs and hikanees (aikane) [counselors] enter them with offerings of hogs, plantains, and cocoanuts, which they set before the wooden images. The place is fenced in, and have pieces of white flags flying on the fences. [Corney 1896:101]

The Kaka‘ako district of Honolulu became a focus of archaeological work during the 1980s, impelled by the construction of local and federal government buildings and by the state-planned redevelopment of the area. Recent archaeological investigations have been conducted in parcels in the vicinity of the current project area and within road alignments near and adjacent to the project area (Figure 40). Previous archaeological studies in the vicinity of the current project area are listed in Table 2, with the relevant findings of these investigations summarized below.

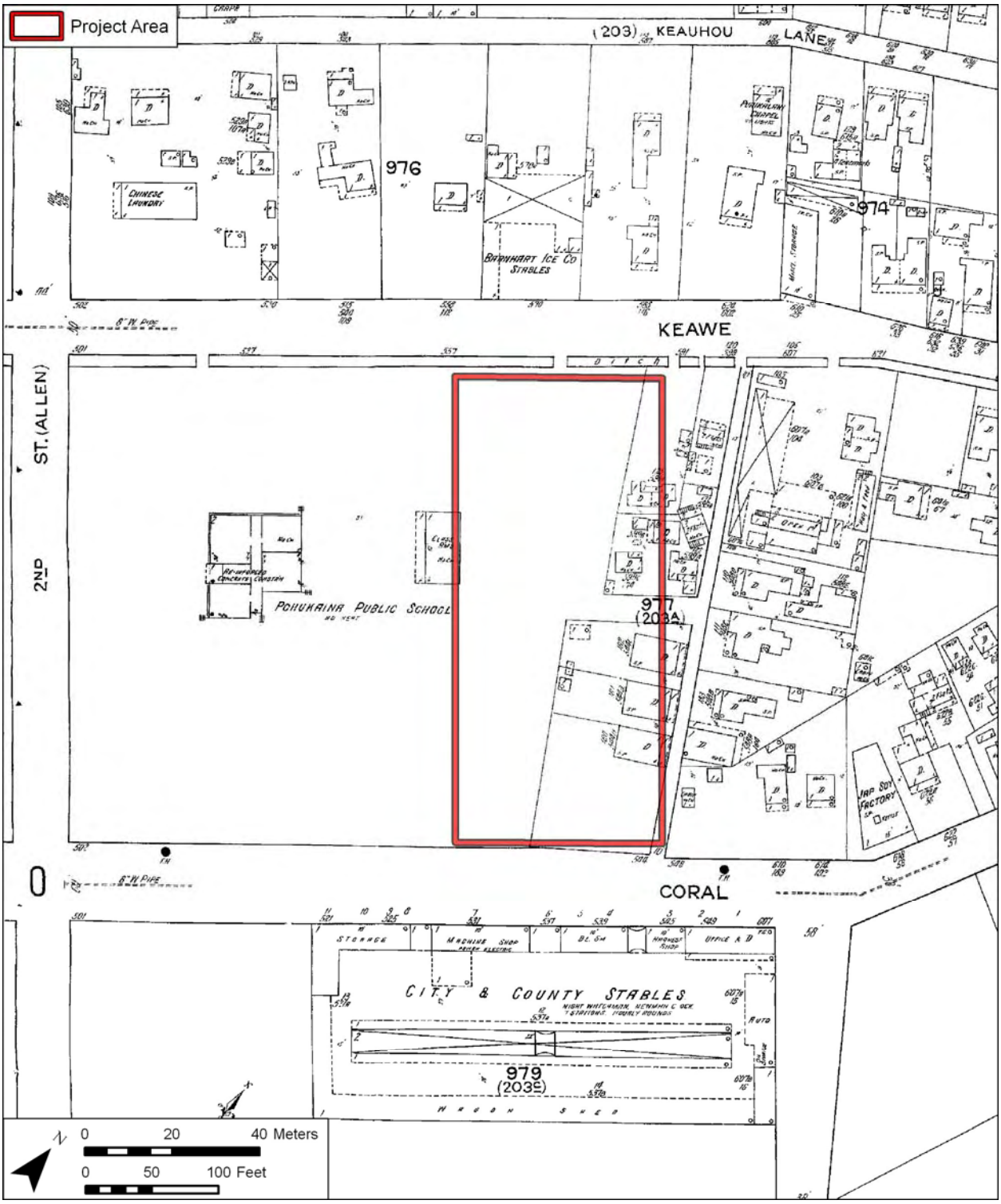

Figure 36. 1914 Sanborn Fire Insurance Map, Honolulu Sheet 74, showing structures within and in the immediate vicinity of the project area

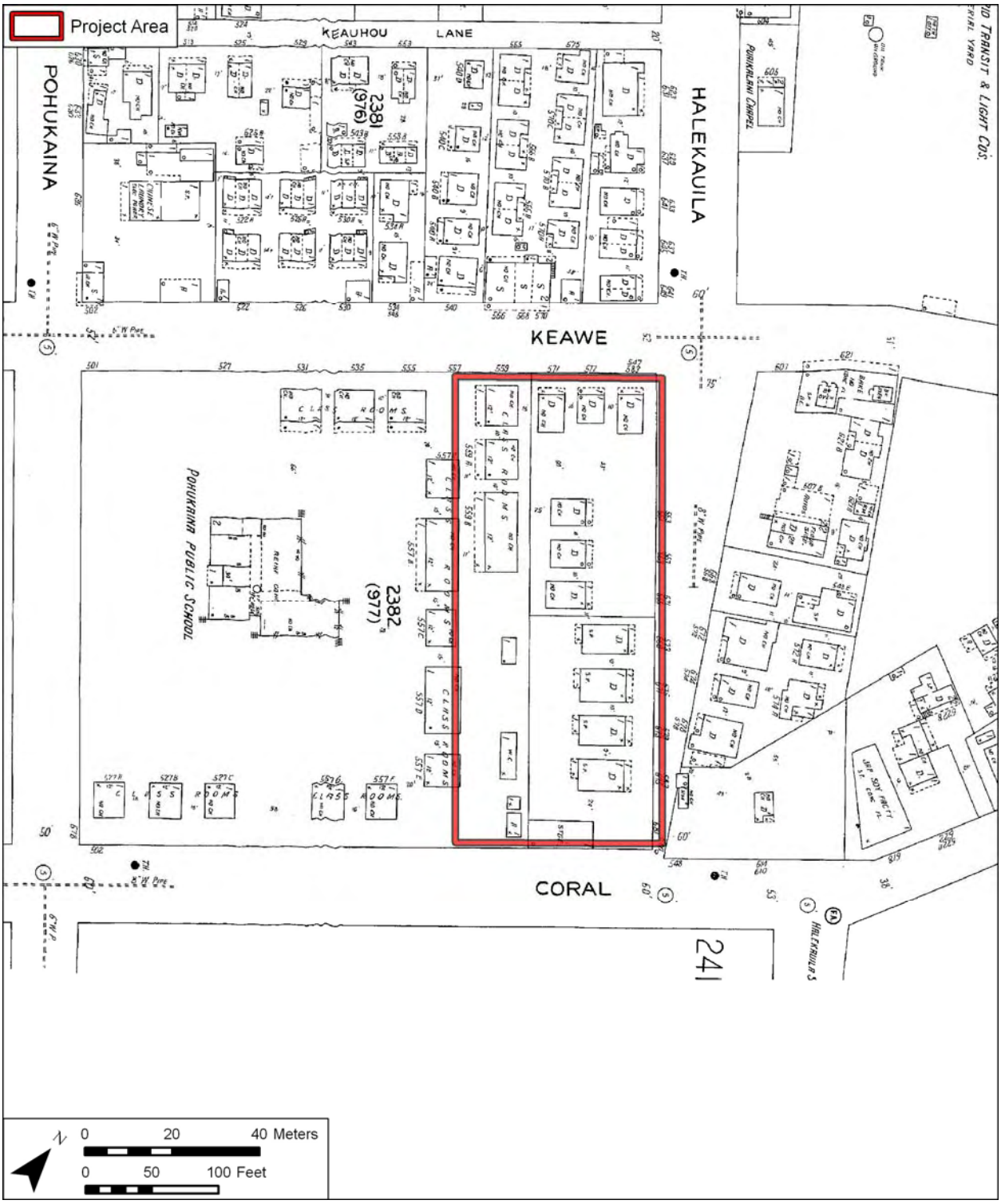

Figure 37. 1927 Sanborn Fire Insurance Map, Honolulu Sheet 240, showing structures within and in the immediate vicinity of the project area

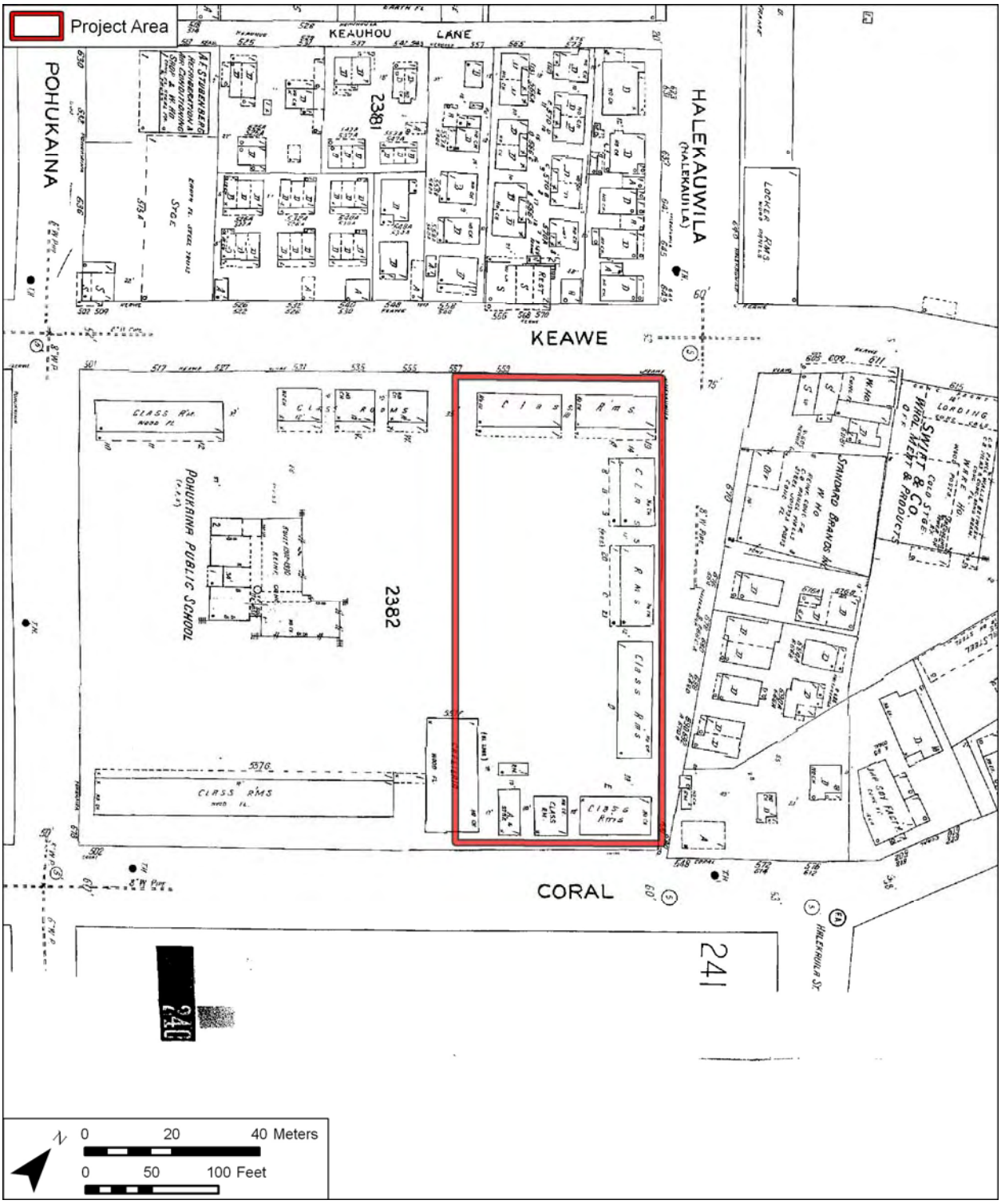

Figure 38. 1950 Sanborn Fire Insurance Map, Honolulu Sheet 240, showing structures within and in the immediate vicinity of the project area

Figure 39. 1956 Sanborn Fire Insurance Map, Honolulu Sheet 240, showing structures within and in the immediate vicinity of the project area

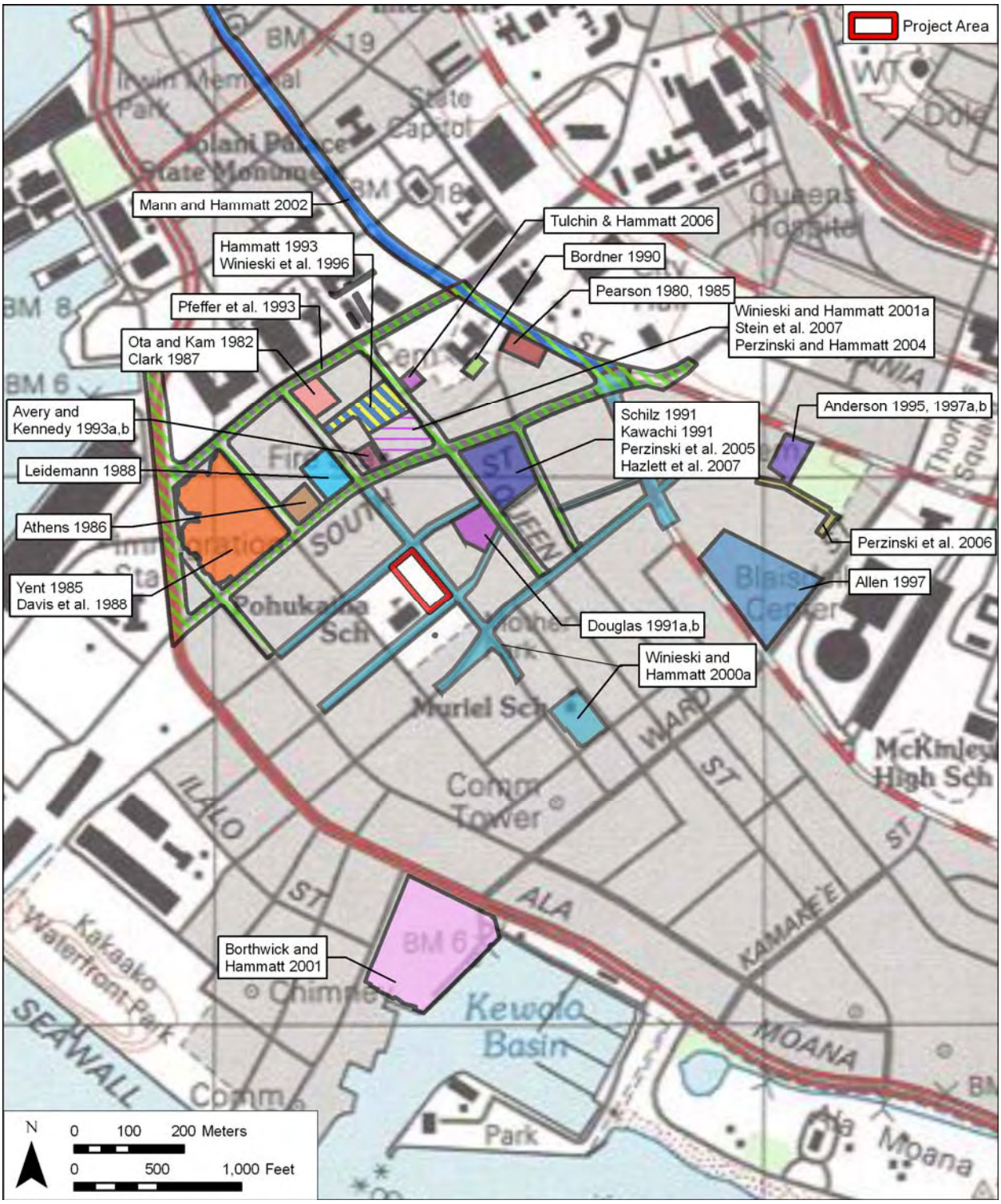

Figure 40. U.S. Geological Survey 7.5-Minute Series Topographic Map, Honolulu Quadrangle (1998), showing previous archaeological study locations in the Kaka‘ako area west of Ward Avenue

Table 2. Previous Archaeological Studies in the Kaka‘ako District

Author	SIHP # 50-80-14	Report Description and Findings
Allen 1997		Monitoring of geotechnical coring in Symphony Park; although a wetland deposit was noted, no site designations were made.
Anderson 1995, 1997a, 1997b	-5373; -5455	Three reports on One Archer Lane project area (inventory survey, monitoring and burial disinterment); minimum of 30 historic human burials from the historic Roman Catholic Church Cemetery (-5455) present, one burial disinterred; some historic refuse pits (-5373) also recorded along western side of the Roman Catholic Cemetery on King St.
Athens 1986	-3984	Monitoring of Judiciary Parking lot, historic deposits (-3984) with artifacts dating late 19th-early 20th centuries.
Avery & Kennedy 1993a	-3712	Monitoring at 1853-1854 Honuakaha Smallpox Cemetery (-3712); 3 historic burials recorded.
Avery & Kennedy 1993b	-3712	Monitoring of South St. Building Complex, 6 burials associated with 1853-1854 Honuakaha Smallpox Cemetery (-3712) found.
Bordner 1990	-9991	Test trenches were excavated in the Kawaiaha‘o Church grounds (-9991); some historic artifacts were recovered.
Clark 1987	-2963	Monitoring at Makai Parking Garage; 7 burials (-2963) found probably dating to pre -1850.
Davis et al. 1988	-2918	During monitoring at the Honolulu Iron Works site, no additional human burials were found in the area surrounding Ka‘ākaukukui Cemetery (-2918).
Douglas 1991a	-4380	Coral and Queen Street area: 8 burials (-4380) recorded and 5 disinterred.
Douglas 1991b	-4380	Coral and Queen Street area: 1 burial recorded (-4380).
Griffin et al. 1987	-2918	Background research and predictive models; reports on an additional 3 burials at Ka‘ākaukukui Cemetery (-2918).
Hammatt & Chiogioji 1995		Archaeological assessment of 20 parcels and background research; no field work conducted.
Hammatt & Chiogioji 1998	-1388	Archaeological Assessment of area that includes Mother Waldron playground (-1388) and Pohukaina Elementary School. No field work.
Hammatt & Pfeffer 1993	-3712; -9917	Subsurface Inventory Survey; found 329 burial pits from the 1853 -1854 Honuakaha Smallpox Cemetery (-3712) and 3 refuse pits associated with the Honolulu Brewing Co. (-9917).

Author	SIHP # 50-80-14	Report Description and Findings
Hazlett et al. 2007a, b	-1604	Monitoring at Queen Emmalani project; 2 human skeletal elements found (-1604).
Heidel & Hammatt 1994	-1346	Background research on the Kaka‘ako Fire Station building (-1346). and lot. No field work.
Kapeliela 1996	-5455	1 historic human burial (-5455) found on west side of Roman Catholic Church on King St.
Kawachi 1991	-1604	Monitoring at the Queen Emmalina Tower project; 1 human skull and 1 femur (-1604) were found in the back dirt pile.
Leidemann 1988	-1973	Monitoring at Federal Building parking lot; historic deposits (-1973) found.
Mann & Hammatt 2002	-6371	Monitoring for King St. Alignment; 1 burial (-6731) found, possibly post-contact due to presence of historic artifact.
Miyasaki and Ogata 1993	-9917	Environmental site assessment of the American Brewery Co. building (-9917). No field work.
Ota & Kam 1982	-2963	Makai Parking Garage; 6 partial burial sets (-2963) found. Tooth evulsion indicates probable pre-contact to 1850 date
Pearson 1980, 1995	-9991	Test pits were excavated near the Mission Houses (-9991); 19th and 20th century artifacts were recovered.
Perzinski & Hammatt 2004	-1346	Monitoring of geotechnical borings at the Kaka‘ako Fire Station (-1346), no cultural material was found in 12 test borings.
Perzinski et al. 2005	-1604; -6766	Inventory survey Queen Emmalina project; 2 isolated human bones (-1604) and remnants of historic occupation (-6766) were recorded.
Perzinski et al. 2006	-5455	Subsurface inventory survey of the Kewalo HECO Dispatch Center; 2 historic coffin burials found on south side of the Roman Catholic Cemetery (site -5455) on King St.
Pfeffer et al. 1993	-3712; -4532; - 4533; -4534	Monitoring for Kaka‘ako ID-1; 31 burials from 1853-1854 Honuakaha Smallpox Cemetery (-3712) at Quinn Lane, 1 historic burial from Punchbowl St. (-4532), 1 possibly pre-contact burial from Halekauwila St. (-4533), and 116 historic burials from Kawaiaha‘o Cemetery (-4534) at Queen St. (used from 1825-1920).
Pietrusewsky et al. 1989	-3712	Osteological study of 28 burials from the historic Honuakaha Smallpox Cemetery (-3712), recorded by Pfeffer et al. (1993).

Author	SIHP # 50-80-14	Report Description and Findings
Schilz 1991	-1604	Background research and property assessment of Queen Emmalina Tower project, a block formerly used for kerosene storage and for tenements (Magoon Block); in subsequent projects, human remains were found and designated -1604.
Stein et al. 2007	-1346	Monitoring during demolition and construction of new structures at the Kaka‘ako Fire Station lot (-1346). No findings.
Tulchin & Hammatt 2006	-4534	Two trenches excavated in the Kawaiaha‘o Cemetery (-4534) *makai* of Queen Street; 13 burial pits with coffins were recorded, but no burials were disinterred.
Winieski & Hammatt 2000	-1388; -4380; -5280	Monitoring at Kaka‘ako ID-3 and other parcels, 9 burials found at the Pohulani Housing area (-4380) and 11 human burials (-5280) found at Mother Waldron Park (-1388) At least two were interred in the post-contact period.
Winieski & Hammatt 2001	-1346	Monitoring for geotechnical sampling at Kaka‘ako Fire Station (-1346); no cultural remains found.
Winieski et al. 1996	-3712	Monitoring at the Honuakaha Housing project; 27 burials from 1853-1854 Honuakaha Smallpox Cemetery (-3712) were disinterred (11 sets reported by Hammatt [1993]).
Yent 1985	-2918	Ka‘ākaukukui Cemetery (-2918) at the Honolulu Iron Works project area; 5 burials (-2918) recorded.

3.2.2 Kaka‘ako Community Development Districts

The Kaka‘ako Community Development District was first designated as an area bounded by Punchbowl Street to the west, Ala Moana Boulevard to the south, King Street to the north, and Pi‘ikoi Street to the east. This development area is larger than the ancient Kaka‘ako, and extends into lands once known as Ka‘ākaukukui, Kukuluāe‘o, and Kewalo.

In 1987, a report entitled, *Kaka‘ako: Prediction of Sub-surface Archaeological Resources, Detailing Archival Research and Archaeological Assessment of the Kaka‘ako Community Development District* (Griffin et al. 1987) provided background information and summarized the historical import of the area:

> Kaka‘ako - the Kaka‘ako Community Development District - is not the center of life in greater Honolulu that is, or was, either Waikiki or ‘downtown’ ewa of Punchbowl. It is, however, relatively rich in the remains of nineteenth century Honolulu, of prehistoric Hawaiian life, and of the ethnic influx from the late 1800’s until 1940. Without doubt the single most striking archaeological deposit, and the one to which we assign the highest priority, is the 1853 Honuakaha Cemetery fronted by South Street and bisected by Quinn Lane. More than 1000 human burials are reportedly therein…
>
> Burials will be found throughout Kaka‘ako. Some will be in sand remnants, others intruding into the pumice deposited from ancient Punchbowl eruptions. Most will be prehistoric or early historic. We expect that, as in the case of the Ka‘akaukukui Cemetery, deaths from pre-1853 epidemics resulted in many burials throughout Kaka‘ako. The chance of high status burials, from residences in adjacent elite locations, is high. [Griffin et al. 1987: 73]

The Kaka‘ako Development area was originally subdivided into seven improvement districts, which have now expanded into 12 improvement districts. These improvement districts consist mainly of adjacent road alignments, as the early work was conducted on roads and utilities. The titles of early archaeological project reports also followed this nomenclature. However, in recent years, development projects have taken place or are planned in many separate parcels. Many of the development parcels overlap with others or with road alignments. For ease of discussion, the projects will be discussed by general location, from the northwestern corner of the Kaka‘ako area at Punchbowl and King Street, and east to Ward Avenue.

3.2.3 Punchbowl to South Street

3.2.3.1 King Street Rehabilitation Project

Between August 2001 and June 2002, Cultural Surveys Hawai‘i (CSH) monitored trenching for the King Street Rehabilitation Project on sections of King Street between Dillingham Blvd. and South Street (Mann and Hammatt 2002). During the course of archaeological monitoring, one human burial, State Inventory of Historic Properties (SIHP) # 50-80-14-6371 was recovered near the intersection of South King Street and Punchbowl Street, within the present road alignment. The burial was a single adult individual between the age of 15 and 21 years. The close proximity of several existing utility lines and the incomplete nature of the skeletal remains

indicated that the burial was disturbed by earlier construction activities. Several historic artifacts, including a porcelain button and a blue glass marble, were recovered in the same stratum, but their association with the burial could not be determined. Up to the nineteenth century, this area would have been within the Honuakaha Village, an early Hawaiian settlement.

3.2.3.2 Kawaiaha‘o Church Grounds and the Mission House

Kawaiaha‘o Church was built in 1842, adjacent to the mission station, where the first foreign missionaries made their home upon arriving in Hawai‘i. The church, the church grounds containing two cemeteries, and the mission houses have been designated SIHP # 50-80-14-9991.

Between 1986 and 1987, students from Chaminade University (Bordner 1990) excavated eight test units and trenches on the Kawaiaha‘o Church grounds. Four test pits (TP 1-4) were placed around the old adobe schoolhouse, which was originally built in 1836. Test pit 1 revealed an old road surface at 6-14 cmbs cm below surface); this roadbed probably dates to c. 1860-1900. Test Pits 3 and 4 were placed near a series of concrete footings in the ground. This is the site of a structure that was on the ground in the 1950s, possibly moved from an earlier location on the corner of King and Kawaiaha‘o Streets, at the northeast corner of the church lot. Surprisingly, no historic debris was found in this area. Test pits near several crypts revealed a sophisticated construction covered by a layer of painted plaster. Several historic artifacts were recovered in this area in the top layer of soil. Four test units were also placed at the northeast corner of the church lot (TP 5-8), where a 1900 photograph shows a building was once located, possibly the same one that was later moved close to the schoolhouse. No evidence for the house structure or any historic debris was found in these units; however, the test units excavated were very shallow.

In 1968 to 1970 (Pearson 1980; 1995), excavations were carried out at the Hawaiian Mission property east (Diamond Head) of Kawaiaha‘o Church. Excavations were conducted adjacent to the Bingham house. No human burials were found, although the early missionary Mrs. Loomis mentions in her diary (archived at the Mission Houses Museum, Honolulu) that a Hawaiian burial was found during the excavation of the framed house cellar in 1821. Excavations were also made adjacent to a bedroom unit. No burials were found, though a pre-contact burial was reportedly found during the original construction of this building in 1841 (Pearson 1995:28). Bottles found in the trenches, units, and wells date the trash to late eighteenth and early nineteenth centuries.

In 1993 (Pfeffer et al. 1993), 116 burial sets were disinterred from below the pavement of Queen Street, which is adjacent to the southern boundary of Kawaiaha‘o Cemetery. This section of the cemetery was designated SIHP # 50-80-14-4534.

In 2006, CSH (Tulchin and Hammatt 2006) excavated two 18-meter long trenches in a 0.2-acre portion of the Kawaiaha‘o Cemetery adjacent to the *makai* side of Queen Street. The intent of the subsurface investigations was to locate coffin/burial pit outlines without directly disturbing human remains in an area for a proposed parking lot. Thirteen coffin burials were noted in one trench and 11 coffin burials were noted in the second trench. The burials were left in place.

3.2.3.3 Honuakaha Smallpox Cemetery

The proposed area for the Honuakaha Affordable Housing Project is a parcel bound by Queen Street on the north, Quinn Lane to the south, and the Kaka‘ako Fire Station to the west (adjacent to South Street). In the nineteenth century, this parcel was within the Honuakaha Village, an early Hawaiian settlement. In the twentieth century, this lot was occupied by the Honolulu Brewing and Malting Co., Ltd., brewers of Primo and Royal brand beers, who constructed their brewing facilities on the lot in 1900. The facility ceased brewing beer in 1920 due to the onset of prohibition. In 1933, the brewery was reoccupied by the American Brewery Co., Ltd., also known as the Royal Brewery (SIHP # 50-80-14-9917). It ceased operations in 1960, and the main building was put on the National Register of Historic Places in 1972. An environmental site assessment for the study area was prepared (Miyasaki and Ogata 1993) to provide some background information and to report on the present condition for one building at the brewery site between South Street and Punchbowl.

Between April 1986 and August 1988, CSH monitored construction activities in the Kaka‘ako ID-1 project area (Pfeffer et al. 1993). This included monitoring along South Street and Quinn Lane. Historic research had shown that Honuakaha Cemetery, created solely for the 1853-1854 smallpox epidemic, was located *makai* of Queen Street on the west side of South Street. This cemetery is now covered by urban development, including the Old Kaka‘ako Fire Station, several buildings, and a portion of the American Brewery lot. The cemetery may contain more than 1000 burials. It appears that the cemetery was not utilized following the epidemic and the burials were left in place.

A total of 31 burials were recorded from the Honuakaha Cemetery (SIHP # 50-80-14-3712) during the 1986-1988 monitoring. One of the “burials” consisted of a wooden coffin with no human remains. Of the remaining 30 individuals, 28 were disinterred. Two burials, which were determined to be outside the project area were left in place. For the 28 disinterments, 18 were determined to be historic, as they were interred in an extended position and contained historic artifacts, including in 12 cases, the wooden remains of a coffin. Two burials were interpreted as possible pre-contact burials as they were interred in a sand layer and did not have any evidence of a wooden coffin or any historic artifacts. The remaining 8 burials were too disturbed to determine date of interment.

In March and April of 1993, during sewer line excavation by Mouse Construction, three burials were inadvertently discovered at 614 South Street in the central portion of the lot (TMK 2-1-31:20) on the southwest corner (TMK 2-1-31:20) of South Street and Quinn Lane. “It was determined that these burials were situated in the Honuakaha cemetery [SIHP # 50-80-14-3712]” (Avery and Kennedy 1993a:9). Subsequent monitoring of the site by Archaeological Consultants of Hawai‘i, Inc. (ACH), identified six additional burials in the same location (Avery and Kennedy 1993b:Appendix), totaling 9 smallpox cemetery burials in this area.

In May through July of 1993, Cultural Surveys Hawai‘i (Hammatt and Pfeffer 1993) conducted an inventory survey of the American Brewery site. The primary goal of testing during the inventory survey was to determine an accurate boundary for the cemetery and to gain an accurate assessment of the number of burials within the parcel. From historical records and maps, the supposed boundary of the Honuakaha Cemetery (SIHP # 50-80-14-3712) was plotted on the south portion of the American Brewery Co. lot. Twenty-one test trenches were then

excavated around this plotted line to determine the actual boundary of the cemetery. Twenty-nine (29) burial pits were located with a backhoe and with hand shoveling. The burials themselves were not disturbed, and were left in place. The study estimated the presence of between 179 and 389 burials within the Brewery/Honuakaha Housing Project parcel. A secondary goal of the survey was to research subsurface traces of the brewery during the early twentieth century. Three refuse pits associated with the brewery were also uncovered.

The identification of the extent of the cemetery was the primary factor in determining the boundary limits for the new construction of the Honuakaha Memorial Park and the Honuakaha Affordable Housing Building. Subsurface construction grading was to be avoided in order to preserve the burials intact. However, even with architectural modifications, it was impossible to place the proposed building foundations in such a way as to avoid impacting all the burials, while at the same time preserving the structural integrity of the building. Therefore prior to construction, it was decided to disinter 7 of the 29 burials (i.e. the 29 burial pits identified in 1993; Hammatt and Pfeffer 1993) from the *mauka* limit of the cemetery (Winieski et al. 1996:7). During the excavation of two of these burials, 2 additional burial pits were discovered, previously disturbed remains were encountered in pit fill, and one cranium was encountered in pit fill, resulting in a total of 11 burial disinterments. Thus, before construction, a total of 33 burials were recorded, and 11 had been disinterred.

Following the disinterment of the 11 burials, construction activities began. A total of 14 human burials (16 individuals) were found during these construction activities, which were monitored by CSH archaeologists between October 1993 and September 1995 (Winieski et al. 1996). These 14 burials were inadvertent discoveries: 3 from the middle of Quinn Lane and the remaining 11 from an area along the Quinn Lane fence line. Findings were limited to the historic era in age, with burials associated with the 1853 Honuakaha smallpox cemetery (SIHP # 50-80-14-3712), and archaeological materials (bottles, metal, etc.) ranging from the 1880s to after the construction of the brewery building at the turn of the 20th Century. The vast majority of the burials present on the property were preserved and commemorated as part of an open garden area on the property, within a specially constructed crypt under the garden.

3.2.3.4 Kaka‘ako Improvement District 1 (ID-1)

From April 1986 through August 1988, Cultural Surveys Hawai‘i (Pfeffer et al. 1993) conducted monitoring, data recovery, and excavation services within the Hawai‘i Community Development Authority’s Kaka‘ako Improvement District 1 (ID-1), which was bounded by Punchbowl Street (west), South Street (east), King Street (north), and Ala Moana Boulevard (south), including extensions east for Kawaiaha‘o Lane, Queen Street, and Auahi Street. Portions of Pohukaina Street, Quinn Lane, and Reed Lane are also within this district. This work was conducted almost exclusively underneath the streets in District 1 and very little private property was excavated. The stratigraphy generally consisted of an upper layer of asphalt, a layer of fill material for road grades, additional fill layers associated with construction, a buried A horizon of sand, which often contained artifacts and human burials, the underlying Tantalus/Sugarloaf cinder deposited thousands of years before human occupation of the Hawaiian Islands, and the coral shelf formed in the last inter-glacial period.

Four burial site areas were encountered - two cemeteries and two isolated burials - with a total of 149 burial sets. The cemetery on Queen Street (SIHP # 50-80-14-4534) contained 116 burial sets. These burials are associated with Kawaiaha‘o Cemetery, which was utilized from about 1875 to 1920. The cemetery section is on the southern border of the Kawaiaha‘o Church grounds. A total of 31 burials were recorded from the South Street/Quinn Lane Cemetery (SIHP # 50-80-14-3712). These burials are associated with the Honuakaha Smallpox Cemetery, which was utilized for burial only from 1853 to 1854. Over 1,000 victims of smallpox were interred in the cemetery during the course of the epidemic. It appears that the cemetery was not utilized following the epidemic and the burials were left in place. The two isolated burial sites – on Punchbowl Street (SIHP # 50-80-14-4532) and Halekauwila Street (SIHP # 50-80-14-4533) – each contained one set of remains. The burial at Halekauwila Street was within LCA 61, a fishpond awarded to Queen Kapi‘olani within the *lele* of Ka‘ala‘a.

A variety of other archaeological and historical features were noted, excavated, and recorded during the monitoring process, including historic trash, layers, historic cultural features, and fill layers associated with the urbanization of the Kaka‘ako area. No osteological analysis was conducted on the 116 sets of remains from the Queen Street area. These were reinterred in a special vault built on the grounds of the present Kawaiaha‘o Cemetery. Osteological analysis was conducted on the burial material from the South Street/Quinn Lane area (Pietrusewsky et al. 1989). These remains were later reinterred in a special vault built next to the Honuakaha Affordable Housing Area (Winieski et al. 1996:5-6). In 2004, a series of geotechnical borings were monitored on a portion of the site (Perzinski and Hammatt 2004). There were no findings.

3.2.3.5 South Street Building Complex

As noted in Section 3.2.3.3 above, in March and April of 1993, during sewer line excavation by Mouse Construction, three burials were inadvertently discovered at 614 South Street, in the central portion of the lot, near the southwest corner of South Street and Quinn Lane. “It was determined that these burials were situated in the Honuakaha cemetery [SIHP # 50-80-14-3712]” (Avery and Kennedy 1993a:9). Subsequent monitoring of the site by ACH identified six additional burials in the same location (Avery and Kennedy 1993b:Appendix), totaling nine smallpox cemetery burials in this area.

3.2.3.6 Kaka‘ako Fire Station (Proposed Fire Department Headquarters)

The Kaka‘ako Fire Station lot is located between Queen Street and Quinn Lane, and is bound by South Street on the east and the American Brewery Site to the west. An assessment of this study area was first conducted by CSH in 1994 (Heidel and Hammatt 1994). Background and archival research conducted to determine the use of the land area from pre-contact times to the modern area, revealed that the area initially was awarded to Hawaiian officials in the nineteenth century, and the lot eventually came under the control of the government. While under government ownership, the property was used for a hospital and cemetery for the smallpox epidemic of 1853-1854. It was subsequently leased to various individuals until it was designated as the site of one of Hawai‘i’s original fire stations in 1928 (SIHP # 50-80-14-1346; Fire Stations of O‘ahu Thematic Group).

A new fire station was constructed on the parcel in the 1970s, with the old fire station in the southwestern corner of the lot and the new station in the northeast corner. In 1979, the old fire

station was nominated to the Hawai‘i and National Register of Historic Places for its architectural and social significance. Plans are to convert this structure into a Fire Department Museum.

Burials associated with the Honuakaha Smallpox Cemetery have been found along Quinn Lane and south of Quinn Lane. Based on background research, the cemetery is understood to partially lie beneath the new street-level parking lot on the southern border of the fire station. Due to the possibility of burials associated with this cemetery, monitoring was conducted in the study area by CSH in February 2001 (Winieski and Hammatt 2001) during geotechnical bore sampling. Five 4-inch diameter bores were excavated, two in the northwest corner of the lot, and three in the central section of the lot. No cultural materials or evidence of human burials were observed during geotechnical sampling, but intact naturally deposited cinder and sand sediments were identified below layers of fill material

In 2004, CSH (Perzinski and Hammatt 2004) conducted a surface and subsurface inventory survey of the lot and excavated 12 backhoe trenches in the area of the proposed Fire Department Headquarters Building at the southeast corner of the lot. No burials or other cultural remains were found. The archaeologists concluded, based on the absence of remains in the test trenches, that the *mauka*, northern border of the Honuakaha Cemetery was probably to the southeast (south of Quinn Lane) and west (under the parking lot surrounding the old fire station).

Subsequent monitoring for the Kaka‘ako Fire Station reconstruction project (Stein et al. 2007) took place between 2004 and 2006. Construction included the building of the new fire department headquarters, trenching for utilities along Queen Street, and most importantly, the excavation of 8 boring holes for parking lot lights in the parking lot area at the southwestern side of the lot. This is the area that was thought to possibly have remains from the Honuakaha Cemetery. The stratigraphy observed during this monitoring project was similar to what had been found during the inventory survey, which was predominately imported fill layers above undisturbed sand deposits with pockets of volcanic cinder. No intact cultural deposits or human remains were found. However, as the eight boring holes were widely spaced across the parking lot, it is still possible that human remains are present below the Quinn Lane corridor and parking lot of the Fire Department Headquarters and museum.

3.2.3.7 State Office Building

In May of 1982, the construction of the new State Judiciary Complex on the southwest corner of Punchbowl and Halekauwila Street was monitored by Science Management Inc. (personal communication from Farley Watanabe, reported in Clark 1987). No pre-contact artifacts or human burials were found, but historic dumps were common features. The study area is within the nineteenth-century Honuakaha Village and overlaps the former yard used for the 1874 Transit of Venus observation station.

In 1982, Jason Ota and Wendell Kam (1982) reported on six partial sets of human remains recovered during excavation for construction of the State Office Building #2 at the southeast corner of Punchbowl and Halekauwila Streets. The remains were in poor to very poor condition and little could be determined from the osteological analyses performed. Two of the burials showed evidence of incisor evulsion. Tooth evulsion was practiced by the late-pre-contact Hawaiian and this may indicate the ethnicity of these two burials. All other burials were located

in sand and pre-contact deposits, although some historic disturbance may have taken place. This burial area was later designated SIHP # 50-80-14-2963.

3.2.3.8 Makai Parking Garage

Between September and November of 1987, the Bernice P. Bishop Museum monitored construction of a parking garage on the southeast corner of Punchbowl and Halekauwila Streets in the same parcel as the earlier Ota and Kam (1982) study area (Clark 1987). Archaeological features revealed both pre-contact and post-contact utilization of the site. Seven human burials, of which four were complete burials with well-defined burial pit features, were unearthed. Two complete burials were in a flexed position, one was a bundle burial, and one was too disturbed to determine burial position. Charcoal from one of the complete burials (Feature 28) was dated to A.D. 1270-1410. Feature 28 also showed post-mortem breakage of the limb bones. Only the femoral heads were still present in the burial pit; the shafts had been broken off and removed (Clark 1987:75-76). Osteological analyses of the burials and analysis of grave goods indicated that the individuals were of Hawaiian ancestry, probably from the commoner class rather than the chiefly (*ali‘i*) class. The burial area was considered part of SIHP # 50-80-14-2963, which was first identified by Ota and Kam (1982). Artifacts recovered at the site ranged from basalt tools - including an adze, a hammer stone, and a poi pounder top - and a coral abrader to glass bottles, ceramic fragments, and metal objects. Clark concluded that the “nineteenth century use of the site area included primarily burying of trash and burial of animals” (Clark 1987: 114).

3.2.3.9 Judiciary Parking Garage

In December of 1985, monitoring was conducted for the proposed Judiciary Parking Garage, at the northwest corner of Pohukaina and South Streets (Athens 1986). In the nineteenth century, this project area would have been in the ‘ili of ‘Auwaiolimu, south of three fishponds. No undisturbed sand layers were noted in the excavations and much of the area appeared to have been disturbed prior to the excavation. It is likely that the area was under water, or was intertidal in pre-contact times, and therefore, little in the way of pre-contact Hawaiian deposits would be found. No pre-contact cultural deposits or artifacts were recorded, but historic artifacts were common in concentrations and scattered throughout the several fill layers exposed in the construction trenches. Soda bottles of three O‘ahu bottlers were found, including the Sunrise Soda Water Works, Pacific Soda Works, and Arctic Soda Works. These blob-top bottles date between 1880 and 1915. The deposit was designated SIHP # 50-80-14-3984.

In 1988, monitoring for the Federal Judiciary Building parking complex was conducted by the B. P. Bishop Museum (Leidemann 1988). The project area is described as on the northwest corner of Pohukaina and South Streets in the text (Leidemann 1988:1), which would make this project area the same as Athens’ 1986 study area. However, on Figure 1 (Leidemann 1988:2), the project area is drawn on the northwest corner of Reed Lane and South Street, which would make this project area immediately north of the Athens’ study area. Leidemann makes no mention of the Athens study in her report. Clark (1987:22) states that the project areas are the same. As in the Athens study, no undisturbed sand deposits were recorded and no pre-contact artifacts were found. Analysis of the artifactual material determined that the most likely time frame for the manufacture and disposal of the historic artifacts found was for the years between 1880 and 1930. The deposit was designated SIHP # 50-80-14-1973.

3.2.3.10 Honolulu Iron Works, Ka‘ākaukukui Cemetery

In 1985, archaeological excavations were conducted at the former location of the Honolulu Iron Works (Pohukaina, South, Punchbowl, Ala Moana block). This industrial complex operated from 1853 to 1973, producing much of the sugar plantation infrastructure and mill works, not only for the Hawaiian Islands, but for sugar plantations around the world. However, by 1982, all of the buildings had been torn down, and as there are no buildings remaining, this complex is not listed on the Hawai‘i or National Register of Historic Places. Today, this block is covered by Waterfront Plaza and Restaurant Row, which includes seven five-story buildings surrounded by green space.

In 1985, five burials were uncovered at the former Honolulu Ironworks lot (Yent 1985), which is the block at the corner of Punchbowl and Pohukaina Street. The burials were found in burial pits in the sand deposit that underlay a least a meter of the ironworks fill. Two of the individuals were in an extended position. A crew from the DLNR Division of State Parks (DSP) disinterred the five burials, which were later designated SIHP # 50-80-14-2918. Yent’s report does not contain a map, so the locations of the burials disinterred by the DSP are unknown.

P. Bion Griffin (Griffin et al. 1987:4) states that eight burials are known from the Honolulu Ironworks area, which he refers to as the Ka‘ākaukukui Cemetery. Griffin seems to be the first to call this burial cluster the Ka‘ākaukukui Cemetery, so this may not be a traditional name. There are no historic documents describing this cemetery. Griffin’s discussion of the Ka‘ākaukukui Cemetery is confusing and the map (Map 1) on which the burials are plotted is missing from the copy at the CSH library. The report is also not available at the Hawai‘i Public Library or the University of Hawai‘i Hamilton Library. Although the SHPD indicates that a copy was once available at their library, it seems to be missing.

Griffin (Griffin et al. 1987:71) states that he “recently” (sometime between 1985 and 1987) assisted in the retrieval of ‘several” burials from the construction site in an area near Auahi and South streets (Plate 9 in his report) and refers to an elevator shaft trench. He does not mention the Division of State Park’s 1985 project or explain when the 8 total burials were found or disinterred. Griffin mentions three, or possibly four, additional burial pits in the trench walls that were left in place. There were no coffins and only a few grave goods, only one button and a few glass beads. Based on this, Griffin decided that the graves probably dated to the early historic period, “around 1800.” He thought the burial cluster might have been a family burial plot, or a place resulting from a single episode of interment, say for an illness. Griffin does not give any information on burial position. Two of the burials recorded by Yent were in an extended position. It is possible that this burial cluster dates to a later period than that proposed by Griffin; possibly dating to the 1853 smallpox epidemic.

There are several possibilities to interpret this incomplete and confusing information. Griffin may have aided the DSP crew in 1985; his total of 8 burials consists of the five individuals disinterred and the three individuals left in place. Thus, all of the burials were found in one cluster near the southeast corner of the property at the junction of Auahi and South streets. The second possibility is that there were two separate burial concentrations, the five disinterred by the DSP crew in 1985, and the three disinterred by Griffin around 1987. In this case, the location of the first cluster is unknown.

Griffin also states that: “Many more burials are very likely to exist along the extent of the old sand beach. As development proceeds in a Diamond Head direction, human burials and house sites are certain to be found” (Griffin et al. 1987:4). A preliminary end of field work report for monitoring at the project was written by a team from Paul H. Rosendahl, Ph.D., Inc. (Davis et al. 1988). No copy of this report could be found at the CSH library, the SHPD library, the Hamilton Library, or the Hawai‘i State Library.

3.2.4 South Street to Cooke Street

3.2.4.1 Queen Emmalani Tower

In 1991, monitoring and test excavations (Schilz 1991) were recommended for a property bound by Kawaiaha‘o Street (north), South Street (west), Queen Street (south), and Emily Street (east) during the construction of the Queen Emmalani Tower. On the 1867 Lyons map, this area is labeled as “Loko Paki,” although a pond outline is not shown. This suggests that the pond had already been filled-in by the last decades of the nineteenth century, probably with dredged material from Honolulu Harbor.

A kerosene storage facility was built on a portion of this lot as early as 1876, and was present up to 1884. Another portion of the property was used for tenements in the “Magoon Block,” which was used for apartments as early as 1884 and was demolished in 1940.

After testing for hazardous waste materials at the site was completed, it was recommended that only a literature and archival research for the project area should be conducted. From background research, the authors (Schliz 1991) concluded that the area was probably a marshland in the early post-contact period. There was no record of a fishpond in the area. The development and construction that began in the 1880s has probably disturbed any subsurface historic deposits.

During monitoring for the project, a human skull was found in the back dirt pile. Carol Kawachi (1991) from the SHPD went to the site to monitor the decontamination of the remaining dirt piles. One additional bone, a humerus, was found. The burial remains were designated SIHP # 50-80-14-1604. The human remains were examined by osteologists from the University of Hawai‘i (Pietrusewsky and Ikehara 1991). Historic artifacts, related to the residential use of the buildings in the Magoon Block, were also found in the back dirt piles.

In 2005, CSH (Perzinski et al. 2005) conducted an archaeological inventory survey in the same area Schilz (1991) worked on, excavating 13 trenches. Perzinski et al. (2005) discovered two additional human skeletal elements, which were considered part of previously identified SIHP # -1604. Three subsurface features, a garbage pit with many historic artifacts (dating to the decades around the turn of the twentieth century), a wall remnant/concrete slab remnant, and a post hole, were considered residential/industrial remains of the late nineteenth/twentieth century occupation and use of the block and were designated SIHP # 50-80-14-6766.

CSH (Hazlett et al. 2007) monitored construction at the Queen Emmalani site (now called the Keola La‘i Condominium). Historic artifacts dating to the decades around the turn of the twentieth century were found in several trenches. Two isolated human skeletal remains in historic fill sediments were discovered in a utility trench near and parallel to Kawaiaha‘o Street.

These human remains were considered part of SIHP # 50-80-14-1604. The scattered human remains are from at least four different individuals.

3.2.4.2 Kaka‘ako Improvement District 3 and Pohulani Elderly Housing

In November of 1990, during construction of an elderly housing project at the southwest corner of Coral and Queen Streets, human bones were uncovered and reported to the State Historic Preservation Division (Douglas 1991a). Disinterment of the burials was recommended and CSH then conducted excavations in November of 1990. Eight separate burials were identified on the east side of the property, with only five removed. A glass bead was found with one burial, suggesting a post-contact date. One burial also exhibited a pre-mortem loss of the mandibular incisors, which suggests deliberate tooth evulsion. This procedure was known to have been practiced by Hawaiians in the pre-contact and early post-contact period. The author concluded that the burials were probably of Hawaiian ethnicity, perhaps representing a nuclear family. This burial area was later designated SIHP # 50-80-14-4380. This project area is within the boundary of LCA 2045 to Kauwahi, who received the parcel in the time of Kamehameha I, indicating that this was a Hawaiian habitation area as early as the beginning of the nineteenth century.

In March of 1991, during excavation of a waterline trench between Coral and Queen Streets across Mother Waldron Park, human skeletal remains were discovered and disinterred (Douglas 1991b). The remains were determined to be of Hawaiian ancestry, with a pig burial possibly associated with the burial. These burials were considered part of SIHP # 50-80-14-4380.

Douglas (1991c) also conducted background research on the property and structures and Mother Waldron Park, which has been designated SIHP # 50-80-14-1388. No subsurface field work was conducted at the park.

Between November 1990 and September 1992, CSH (Winieski and Hammatt 2000) monitored construction at the Kaka‘ako Improvement District 3 area, the Pohulani Elderly Rental Housing project area, and the Kauhale Kaka‘ako Project area. Kaka‘ako Improvement District 3 was bounded by Kapi‘olani and King Streets (north), the northern end of Cooke Street (east), Halekauwila Street (south), and South Street (west). It includes extensions of Keawe and Cooke Streets to the south. The monitoring of sub-surface excavations revealed that although the area had been previously disturbed to a great extent, a cultural layer and *in situ* beach sand and volcanic cinder deposits are still intact below fill layers. The cultural layer contained historic artifacts mixed with scant traditional Hawaiian cultural materials. Twenty human burials were discovered during these projects: 9 at the Pohulani Elderly Rental Housing project (SIHP # 50-80-14-4380) and 11 in and around Mother Waldron Park (SIHP # 50-80-14-5820). Five burials were in an extended position, seven were flexed, and the position of eight could not be determined. One burial was in a coffin and one contained a glass trade bead, suggesting that the burials were of post-contact age. Seventeen of the burials were recovered and reinterred in Mother Waldron Park. Three were left in place beneath the Pohulani Elderly Rental Housing Facility. These scattered burials are all clustered around the location of LCA 982 to Kukao and the Pu‘unui parcel to Queen Emma, an area with a cluster of Hawaiian houselots shown on several late nineteenth century maps.

In 1998, an archaeological assessment for a 6.8 acre land parcel, which includes the current project area, was written by CSH (Hammatt and Chiogioji 1998). The parcel is bound by Halekauwila Street (north), Pohukaina Street (south), Keawe Street (west) and Cooke Street (east). The parcel is the site of a municipal parking lot, a state government building, Mother Waldron Playground and a lawn area. It is also the former site of the Pohukaina Elementary School. This report focused on researching the historic land use of the parcel, especially the history of the Pohukaina Elementary School, which began as a girl’s school in 1913 and the origin of the Mother Waldron Park, which was constructed in 1937. The park area has been designated as SIHP # 50-80-14-1388, as part of a thematic group of Honolulu City and County Art Deco Parks. A reinterment site for the Hawaiian burials discovered during construction within Kaka‘ako ID-3 (Winieski and Hammatt 2000) is already present at the corner of Cooke and Halekauwila Streets, as mentioned above. The SHPD’s burial division has also designated an interment site at the corner of Cooke and Pohukaina Streets, which “will be reserved for future interments” (SHPD memo of July 2, 1992, cited in Hammatt and Chiogioji 1998:29)

3.2.5 Cooke to Ward Avenue

3.2.5.1 King Street Property near the Roman Catholic Church

In 1995, Lisa Anderson (1995) conducted an archaeological subsurface inventory survey of the King Street Place (later called One Archer Lane) property. This lot is adjacent to the western side of the Roman Catholic King Street Cemetery. The western half of the Roman Catholic lot was given to the Catholic Mission in the 1840s, and it was first used as a cemetery in 1851. It continued to be used up to 1928. Eight trenches were excavated on the property. No burials were found, but historic artifacts dating from 1810 to the early 1900s were common in pit features, indicating that the lot had been used for 19th century habitation. During the subsequent monitoring of the lot in 1996, one historic burial (designated SIHP # 50-80-14–5455) was found within a few feet of the cemetery boundary, suggesting that this area was part of the cemetery. A trash concentration, subsurface post holes, a basalt mound, and a recent trash pit were also recorded. The historic trash pits were designated SIHP # 50-80-14-5373.

In August of 1997, two months after monitoring was halted, a concentration of burials was inadvertently found. In all, at least 29 individuals were encountered. Analysis showed that “the burials dated from the mid-1800s to the 1920s” (Anderson 1997a), suggesting that the burials were associated with the cemetery. The burials were regarded as part of SIHP # 50-80-14-5455. Various loose bones recovered may represent an additional individual. In 1997, an exploratory excavation was made for the proposed reinterment plot for the SIHP # 50-80-14–5455 burials at One Archer Lane. Four diagnostic foot bones were found. The author suggests that these bones were missed during the original disinterment process (Anderson 1997b).

In 2006, Cultural Surveys Hawai‘i (Perzinski et al. 2006) conducted an archaeological inventory survey of the Kewalo HECO dispatch area at 11 Archer Lane. Two burials were identified in this study associated with the previously identified SIHP # 50-80-14-5455 and the Roman Catholic King Street Cemetery. These burials were left in place.

3.2.5.2 Symphony Park

Allen (1997) reported on the analysis of two geo-archaeological cores excavated at Symphony Park on Kapi‘olani Boulevard. The three lowest (earliest) strata in the cores were from a marine bay that formed somewhere between 5200 and 2500 B.C. The next stratum contained terrigenous soil, indicating that the area was then solid ground. Between A.D. 300 and 500, a lagoon formed behind a barrier beach; the pollen analysis indicates that this may be the first era of human occupation. The lagoon became a marsh in A.D. 340-600, which stabilized over time. The upper strata were fill layers, deposited to fill in the marches in the late 19th to early 20th centuries.

3.2.6 Summary of Archaeological Resources

A total of 297 burials have been recorded in the Kaka‘ako area from Punchbowl Street to Ward Avenue, including 257 from four historic cemeteries, three additional historic burials, and 37 scattered, possibly pre-contact burials. Based on the archaeological reports, it appears that all pre-contact human burials that have been encountered in the Kaka‘ako area were buried in sandy deposits. The locations of all previously identified historic properties, including burials, near the project area are indicated on Figure 41. A summary of the burials sites is presented in Table 3.

In several cases, the pre-contact/early post-contact burials are located around or within former fishpond areas, such as: SIHP # -1604, four burials recorded in a area once covered by a pre-1867 filled fishpond; SIHP # -4553, a single burial found in an area once covered by a fishpond owned by Queen Kapi‘olani; and SIHP # -2963, 13 burials found adjacent to the former north shore of an ‘Auwaiolimu ‘Ili fishpond. In the eastern section of the Kaka‘ako area, at the eastern extension of Queen Street, a nineteenth century cemetery (SIHP # -6658) was found along the lip of a former fishpond called Kolowalu. It is possible that the artificial earthen berms around fishponds were considered desirable places for burials. These earthen berms would have been higher than the surrounding easily-flooded coastal areas, and the soil of the built-up berms was probably easier to dig than undisturbed ground.

In the Kaka‘ako area between Punchbowl Street and Pi‘ikoi Street, there are four historic cemeteries: Ka‘ākaukukui Cemetery (SIHP # 50-80-14-2918, 8 burials recorded, 5-8 disinterred), possibly utilized from the 1700s to the early 1800s; the Honuakaha Smallpox Cemetery (SIHP # -3712, 87 burials recorded, 62 disinterred), used from 1853-1854; a portion of Kawaiaha‘o Cemetery (SIHP # -4534, 129 burials recorded, 116 disinterred), used from 1875-1920, and the King Street Roman Catholic Cemetery (SIHP # -5455, 33 burials estimated, three disinterred), used from the mid-1800s to the 1920s. The full extent of these cemeteries has not been determined, and there are likely hundreds of burials remaining in these cemeteries, within the modern cemetery boundaries or under modern structures.

The burial at SIHP # -4532 is a known historic burial. At least 2 of the 9 burials in the Kaka‘ako ID-3 area (SIHP # -5280) were historic (one coffin and one with historic grave goods). There is no historic documentation on this small historic burial area and its extent and time of use is unknown.

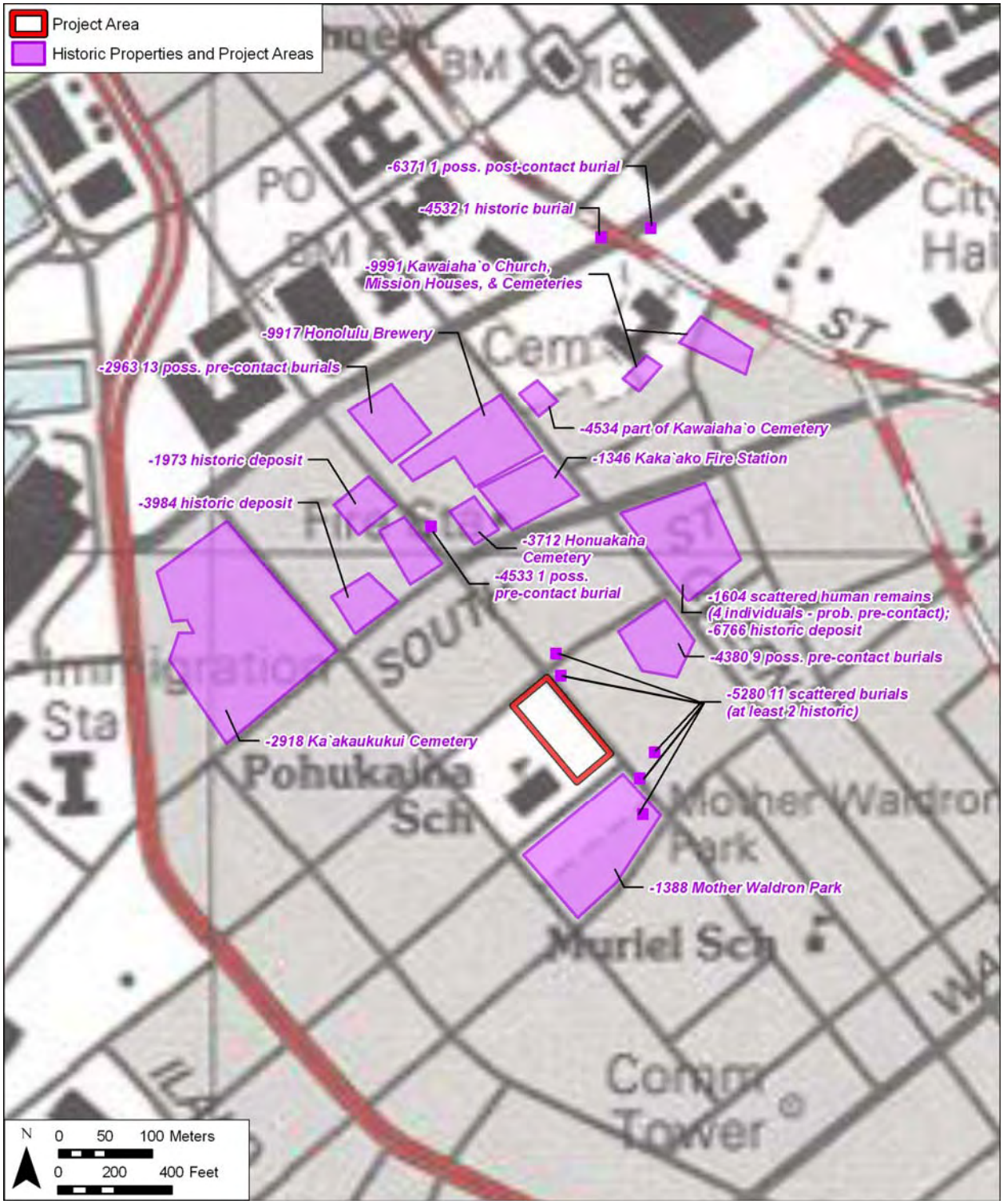

Figure 41. U.S. Geological Survey 7.5-Minute Series Topographic Map, Honolulu Quadrangle (1998), showing previously identified historic properties in the Kaka‘ako area west of Ward Avenue

Table 3. Summary of Burial Finds in the western Kaka‘ako area

SIHP *	Report Description and Findings	Reference
-1604	Queen Emmalani project; 1 human skull and 1 femur reported from a back-dirt pile in 1991. Two isolated human bones reported in 2005 and 2 additional isolated elements reported in 2007; unknown interment date; probably 4 individuals represented	Kawachi 1991; Perzinski et al. 2005; Hazlett et al. 2007a, b
-2918	Ka‘ākaukukui Cemetery (Honolulu Iron Works); 5 burials recorded in 1985; possibly 3 additional burials reported in 1987; probably early post-contact	Yent 1985; Griffin et al. 1987
-2963	State Office Bldg: 6 partial burial sets reported in 1982; Makai Parking Garage: 7 burials recorded in 1987; probably pre-1850 interments	Ota & Kam 1982; Clark 1987
-3712	Honuakaha Smallpox Cemetery (used during 1853-1854); 87 burials have been recorded during archaeological projects and 62 have been disinterred; see Table 4	Pfeffer et al. 1993; Avery & Kennedy 1993a,b; Hammatt & Pfeffer; Winieski et al. 1996
-4380	Pohulani Housing area: 9 burials found	Winieski & Hammatt 2000; Douglas 1991a, b;
-4532	1 historic burial from Punchbowl St.	Pfeffer et al. 1993
- 4533	1 possibly pre-contact burial from Halekauwila St.	Pfeffer et al. 1993
-4534	Kawaiaha‘o Cemetery (used from 1825-1920): 116 historic burials disinterred from Queen St. in 1993; 13 burial pits near Queen Street recorded in 2006, but not disinterred	Pfeffer et al. 1993; Tulchin & Hammatt 2006
-5280	Kaka‘ako ID-3 area: 11 human burials found along streets; most are probably early post-contact (pre-1850)	Winieski & Hammatt 2000
-5455	Roman Catholic King Street Church Cemetery: 1 historic human burial was disinterred during an archaeological project on the west side of the church on King St. in 1995/1996. During a 2006 inventory survey, 2 historic coffin burials were disinterred on the south side of the cemetery on King St. There are a minimum of 30 historic human burials still in situ within the cemetery.	Anderson 1995, 1997a, 1997b; Kapeliela 1996
-6371	King St. Alignment; 1 burial found, post-contact due to presence of historic artifact.	Mann & Hammatt 2002

*SIHP=State Inventory of Historic Properites; all SIHP numbers begin with 50-80-14-

The remaining 37 burials found in the Kaka‘ako area west of Ward Avenue, at SIHP #s -1604 (4 individuals), -2963 (13), -4380 (9), 4533 (1), -5280 (7), and 6371 (1) were not interred in coffins, do not have associated historic grave goods, or consist of partial, previously disturbed, burials. Some burials were found in a flexed position, a traditional Hawaiian burial practice. These may date to the pre-contact period or the early post-contact period (before the mid-nineteenth century), when most Hawaiians adopted Western style burial practices (usually extended within a coffin). Most of these burials cannot be assigned to a specific time period.

The main early (nineteenth century) historic habitation area in the Kaka‘ako area was within Honuakaha Village on both sides of Punchbowl Street at the junction with Queen Street. There was a second cluster of houselots near LCA 982 and the Pu‘unui lot to Queen Emma. No intact early post-contact cultural layers have been recorded in these areas, due to extensive disturbance, but possible pre-contact/early post-contact burials are concentrated in these two areas.

Also found within the Kaka‘ako area west of Ward Avenue were historic deposits/ trash pits (SIHP # -1973, -3984, -6766, -9917, and -9991), which usually date around the last decades of the nineteenth to the early decades of the twentieth century. There are also several historic structures/properties with SIHP numbers, such as Kawaiaha‘o Church and Mission grounds (SIHP # -9991), the Royal Brewery (SIHP # -9917), Mother Waldron Park (SIHP # -1388) and the old Kaka‘ako Fire Station (SIHP # -1346).

3.2.7 Previous Archaeological Work in the Current Project Area and Immediate Vicinity

A review of reports currently on file at the State Historic Preservation Division (SHPD) indicates that no comprehensive archaeological studies of any portion of the current project area have been completed. However, in 1991 and 1992, during excavations for infrastructure improvements associated with the Hawai‘i Community Development Agency project in Kaka‘ako, eleven human burials were inadvertently exposed in the immediate vicinity of the project area. The improvements included installation of a storm drain along Halekauwila Street, and installation of electric lines on Keawe Street and at the intersection of Halekauwila and Cooke streets. The fact that six of the burials were flexed (the position of 4 could not be determined and one was in an extended position) and the general absence of historic artifacts suggest that most (or all) of the burials were of a pre-contact date.

Following consultation with the SHPD, all the burials were disinterred and curated by Cultural Surveys Hawai‘i until they were returned to the SHPD in July of 1993. Subsequently, the burials were reinterred a specially-constructed site at the corner of Halekauwila and Cooke streets; the reinterment was coordinated by the burial administrator of the SHPD.

According to a memorandum of July 2, 1993 from the HCDA to the SHPD burial administrator, the reinterment site at the corner of Halekauwila and Cooke streets comprised “site A [to] be utilized for Improvement Districts 1 and 3 burials.” The memorandum also designates the corner of Cooke and Pohukaina streets, as “site B [which] will be reserved for future reinterments.”

3.3 Background Summary and Predictive Model

Background research indicates a low intensity of use in the vicinity of the current project area in pre-contact and early post contact times. Adjacent areas to the west were marshy into the 1880s and this may have restricted the early use and development of Kaka‘ako to areas to the north and east of the current project area. Coral Street, forming the southeast side of the project area, was slowly established as a major *mauka/makai* artery for Kaka‘ako in the mid 1880s and 1890s. Kaka‘ako grew rapidly in the first decades of the twentieth century. The large Pohukaina School was re-established on a new campus just seaward of the current project area in 1913. A variety of “dwellings” were present on the *mauka* side of the project area by 1914. By 1927, Pohukaina School had expanded into the project area and covered the entire block by 1950. Classroom buildings were aligned along Keawe, Coral, and Halekauwila streets, arranged around the perimeter of the current project area. Structures then present within the present project area included seven classrooms, a cafeteria and a couple of small storage structures. The school continued to dominate the project area until it was demolished in 1980. Since then, the current project area has been used as a public parking lot.

The historic record would suggest only remnants of turn of the twentieth century habitation and school related finds in the time frame of 1913 to 1980. However, the archaeological record suggests a somewhat different picture. The identification of three burials near the intersection of Halekauwila and Keawe streets and 8 burials near the intersection of Coral and Halekauwila streets (both addressed in Winieski and Hammatt 2000), clearly suggests a pattern of pre-contact human interment in the vicinity.

Section 4 Results of Fieldwork

4.1 Survey Findings

The project area is almost entirely asphalt-paved and is currently used as a parking lot (Figure 42). No surface struructures are present within the project area, with the exception of a modern portable trailer used by the Honolulu Police Department as a substation.

4.2 Test Excavation Findings

Subsurface testing consisted of the excavation of 18 test trenches within the project area (Figure 43 and Figure 44). Test trenches were distributed throughout the project area to provide representative coverage and assess the stratigraphy and potential for subsurface cultural resources. Test trenches generally measured 6 m long and were excavated approximately 2 m deep, terminating at the surface of the coral shelf.

The stratigraphic sequence generally consisted of three to five layers (i.e. Stratum I and Stratum II) of historic and modern fill material beneath the modern asphalt pavement and gravel base course. The natural sediment layers (Stratum III) were generally encountered at depths approximately 0.9-1.3 m below the current land surface, within approximately 0.5-1.0 m of the water table.

Stratum I includes historic and modern fill materials, subdivided into sub-strata based on differences in soil composition. Stratum I generally consisted of mixed terrigenous fill material in the upper sub-strata, and crushed-coral fill material in the lower sub-strata. Construction debris and abandoned utilities were observed within Stratum I. Excavation features were observed in the upper fill layers of Trenches 1-3, 8, 9, 11, and 15. The features consist mainly of a mix of fill strata with utility and foundation remnants, and are likely related to historic and modern construction/demolition events of the former Pohukaina School. Stratum II includes a layer of ash and burnt garbage, and layers of sandy clay fill material. The layer of burnt garbage and ash is interpreted to be fill material generated by the city’s municipal garbage incinerator that was formerly located in the Kaka‘ako area. Diagnostic artifacts, consisting primarily of glass bottles, were analyzed (see Section 5: Results of Laboratory Analysis), dating the layer to the late 1800s and early 1900s. The sandy clay layers are interpreted to be fill material generated by the dredging of Honolulu Harbor and other coastal areas in the vicinity. The dredge material was also used to fill the low-lying marsh areas of Kakaako in the late 1800s and early 1900s (see Section 3.1.16 Early Twentieth Century Land Reclamation Projects). Stratum III includes the natural sandy clay and gleyed clay sediments underlying the historic and modern fill layers. Stratum III generally consisted of a pale brown sandy clay over a gleyed sandy clay. The gleyed sandy clay was located at or near the water table. The Stratum III sediments are typical of a wet, marsh-type environment.

No significant cultural material was observed through the subsurface testing program. Detailed stratigraphic profiles and sediment descriptions for each test trench are provided below.

Figure 42. General view of the project area, view to northwest

Figure 43. Aerial photograph (source: Google Earth 2009), showing the locations of test excavations within the project area

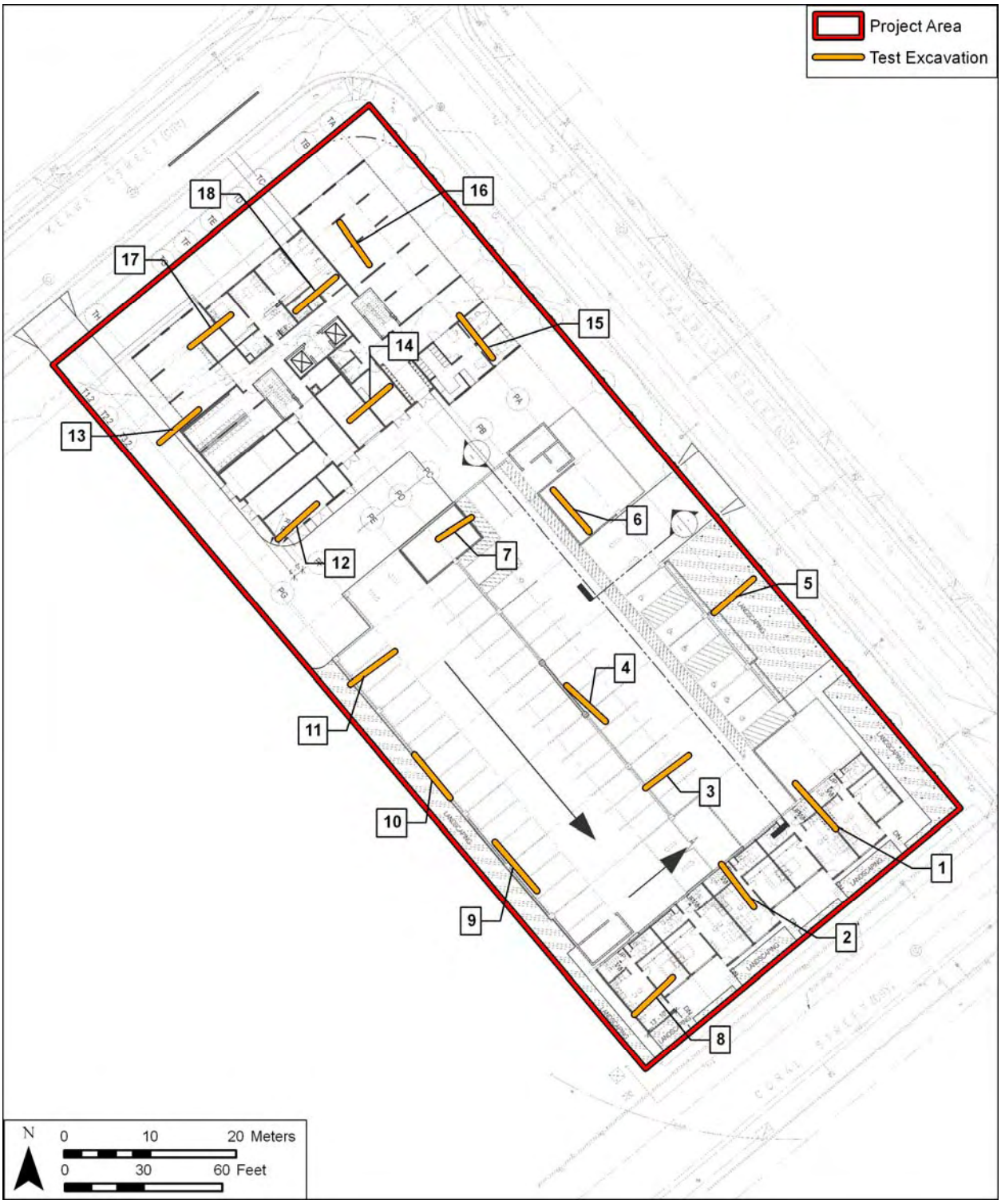

Figure 44. Client-provided site plan, showing the locations of test excavations in relation to the proposed building footprints

4.2.1 Trench 1

Orientation	320° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	1.7 m

Stratum	Depth (cmbs)	Description
Ia	8-42	Fill; 10YR 3/3, dark brown silty clay loam; weak, fine crumb structure; dry, slightly hard consistency; non-plastic; no cementation; terrestrial origin; contains construction debris; Lower Boundary (LB) is very abrupt, smooth.
Ib	37-51	Fill; 10YR 4/3, brown silt loam; moderate, fine crumb structure; dry, slightly hard consistency; non-plastic; no cementation; terrestrial origin; contains roots and rootlets; LB is abrupt, smooth.
Feature A	30-123	Fill; 10YR 6/2, light brownish-gray, silty, sandy mix; structureless; dry, loose consistency; non-plastic; no cementation; mixed origin; LB is very abrupt, irregular. Pit –like feature composed of a mixture of Strata Ib and Ic. Likely associated with utility or foundation/footing structure from previous development.
Ic	42-118	Fill; 10YR 8/2, very pale brown crushed coral and sand; structureless; dry, very hard consistency; non-plastic; no cementation; marine origin; LB is abrupt, smooth.
II	101-155	Fill; 10YR 3/2, very dark, grayish-brown clay and ash; structureless; moist, friable consistency; non-plastic; no cementation; terrestrial origin; contains burnt garbage; LB is very abrupt, smooth.
IIIa	142-168	Gley 2 5/5BG, greenish-gray sandy clay; moderate, fine crumb structure; wet, very sticky consistency; plastic; no cementation; marine origin; LB is abrupt, smooth.
IIIb	158-BOE	10YR 7/1, light gray coral; structureless; dry, extremely hard consistency; non-plastic; indurated; marine origin; Base of Excavation (BOE).

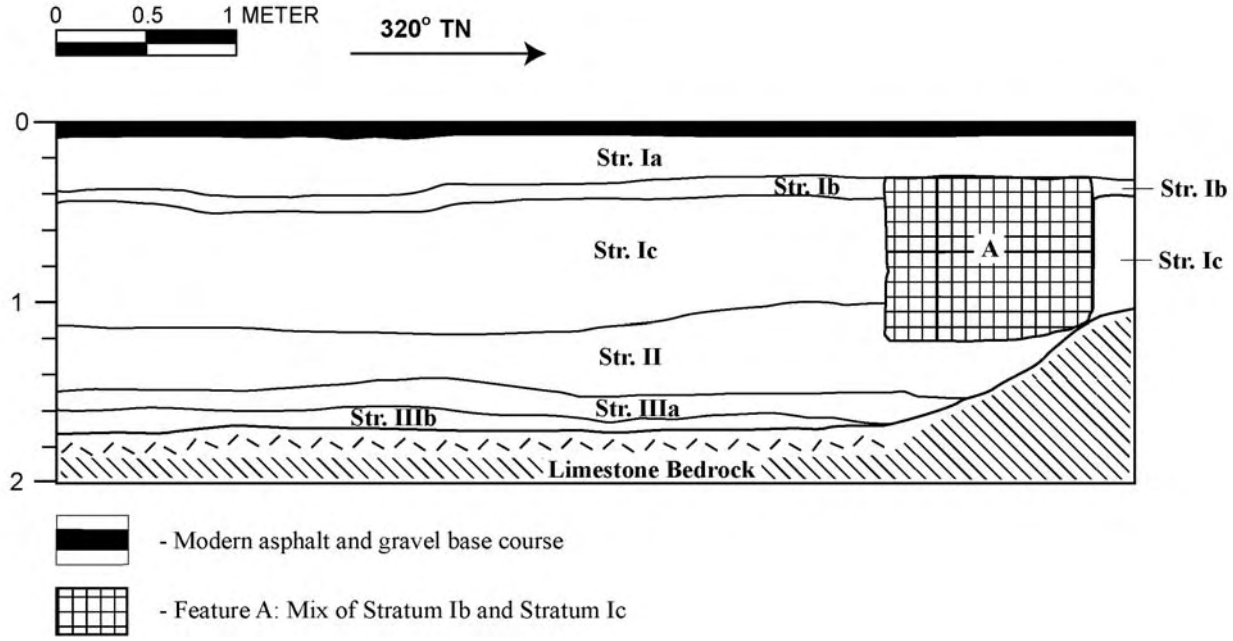

Figure 45. Test Trench 1 photograph (above) and stratigraphic profile (below), southwest wall

4.2.2 Trench 2

Orientation	141° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	1.8 m

Stratum	Depth (cmbs)	Description
Ia	8-39	Fill; 10YR 3/3, dark brown silty clay loam; weak, fine crumb structure; dry, slightly hard consistency; non-plastic; no cementation; terrestrial origin; contains construction debris; Lower Boundary (LB) is very abrupt, smooth.
Ib	29-56	Fill; 10YR 4/3, brown silt loam; moderate, fine crumb structure; dry, slightly hard consistency; non-plastic; no cementation; terrestrial origin; contains roots and rootlets; LB is abrupt, smooth.
Features A & B	32-118	Fill; 10YR 5/2, grayish-brown sandy silt; structureless; dry, loose consistency; non-plastic; no cementation; mixed origin; LB is very abrupt, irregular. Pit –like features composed of a mixture of Strata Ib and Ic. Likely associated with utility or foundation/footing structure from previous development.
Ic	42-119	Fill; 10YR 8/2, very pale brown, coarse, crushed coral and sand; structureless; dry, very hard consistency; non-plastic; no cementation; marine origin; contains historic garbage; LB is abrupt, smooth.
II	111-156	Fill; 10YR 3/2, very dark grayish-brown clay and ash; structureless; moist, friable consistency; non-plastic; no cementation; terrestrial origin; contains burnt garbage; LB is abrupt, smooth.
IIIa	147-175	Gley 2 5/5BG, greenish-gray sandy clay; moderate, fine crumb structure; wet, very sticky consistency; plastic; no cementation; marine origin; LB is abrupt, smooth.
IIIb	170-BOE	10 YR 7/1, light gray coral; structureless; dry, extremely hard consistency; non-plastic; indurated; marine origin; Base of Excavation (BOE).

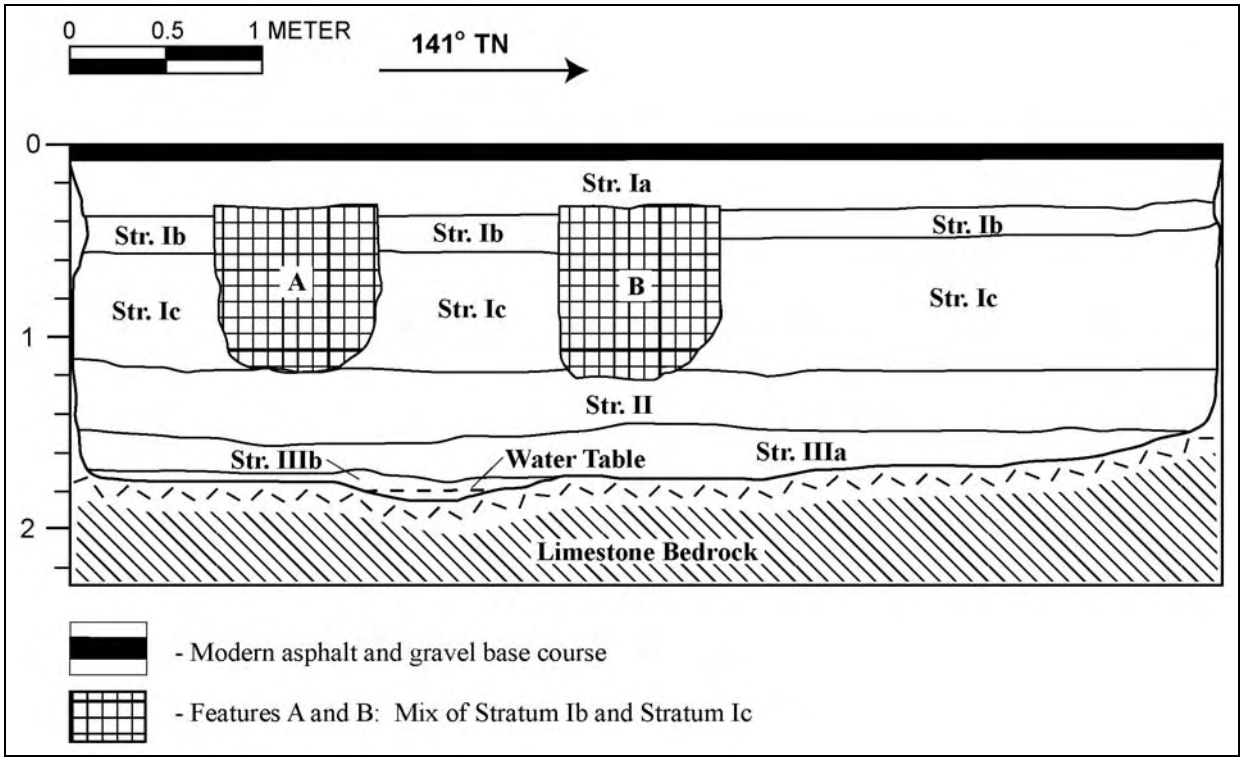

Figure 46. Test Trench 2 photograph (above) and stratigraphic profile (below), northeast wall

4.2.3 Trench 3

Orientation	049° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	2.1 m

Stratum	Depth (cmbs)	Description
Ia	10-45	Fill; 10YR 3/3, dark brown silty clay loam; weak, fine crumb structure; dry, slightly hard consistency; non-plastic; no cementation; terrestrial origin; contains construction debris; Lower Boundary (LB) is very abrupt, smooth.
Ib	36-68	Fill; 10YR 4/3, brown silt loam; moderate, fine crumb structure; dry, slightly hard consistency; non-plastic; no cementation; terrestrial origin; contains roots and rootlets; LB is abrupt, smooth.
Features A & B	31-150	Fill; 10YR 5/2, grayish-brown sandy silt; structureless; dry, loose consistency; non-plastic; no cementation; mixed origin; contains faunal remains, bottles, and garbage; LB is very abrupt, irregular. Pit –like features composed of a mixture of Strata Ib and Ic. Likely associated with utility or foundation/footing structure from previous development.
Ic	56-119	Fill; 10YR 8/2, very pale brown, coarse, crushed coral and sand; structureless; dry, very hard consistency; non-plastic; no cementation; marine origin; LB is abrupt, smooth.
II	90-153	Fill; 10YR 3/2, very dark grayish-brown clay and ash; structureless; moist, friable consistency; non-plastic; terrestrial origin; contains burnt garbage; LB is abrupt, smooth.
IIIa	91-150	10YR 8/2, very pale brown sandy clay; moderate, fine crumb structure; wet, very sticky consistency; plastic; no cementation; marine origin; LB is abrupt, smooth.
IIIb	134-182	Gley 2 5/5BG, greenish-gray sandy clay; moderate, fine crumb structure; wet, very sticky consistency; plastic; no cementation; marine origin; LB is abrupt, smooth.
IIIc	173-BOE	10YR 7/1, light gray coral; structureless; dry, extremely hard consistency; non-plastic; indurated; marine origin; Base of Excavation (BOE).

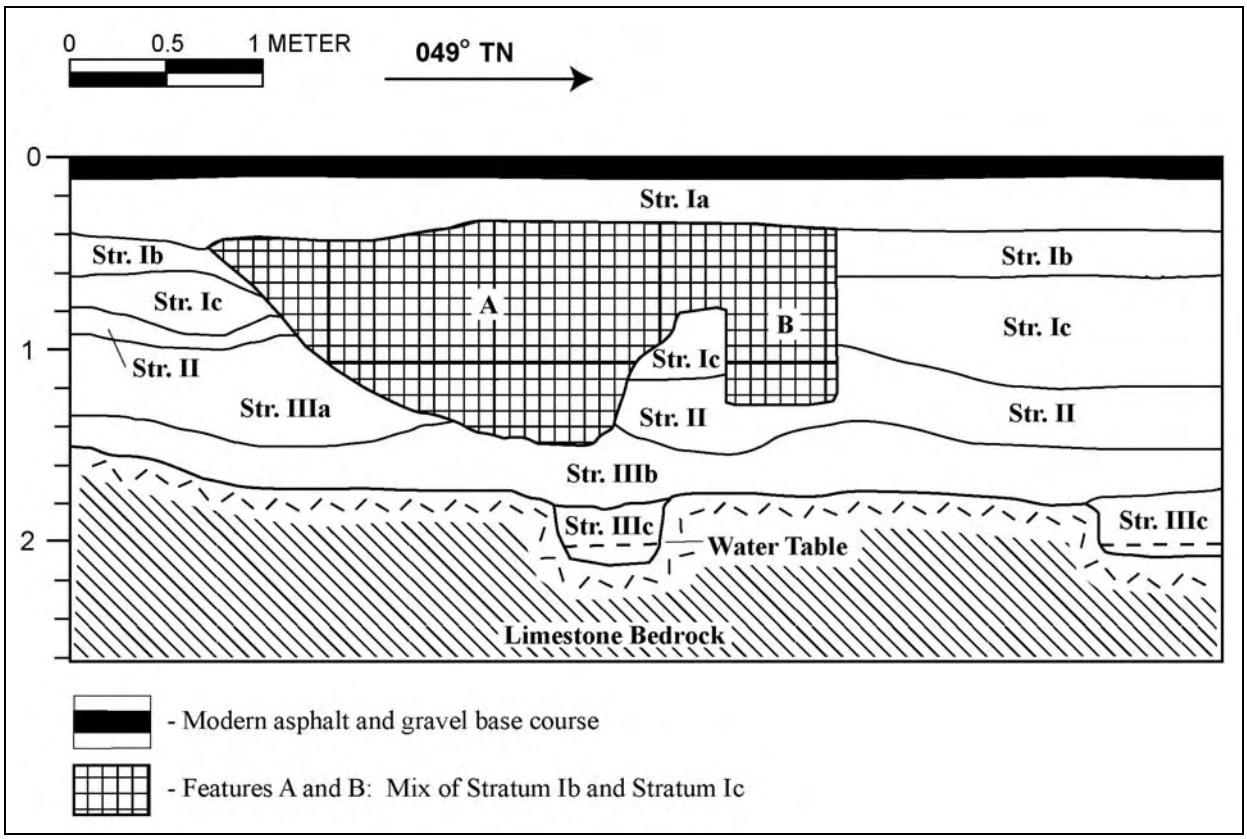

Figure 47. Test Trench 3 photograph (above) and stratigraphic profile (below), northwest wall

4.2.4 Trench 4

Orientation	315° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	1.8 m

Stratum	Depth (cmbs)	Description
Ia	10-41	Fill; 10YR 3/3, dark brown silty clay loam; weak, fine crumb structure; dry, slightly hard consistency; non-plastic; no cementation; terrestrial origin; Lower Boundary (LB) is very abrupt, smooth.
Ib	27-37	Fill ; 10YR 4/3, brown silt loam; moderate, fine crumb structure; dry, slightly hard consistency; non-plastic; no cementation; terrestrial origin; LB is abrupt, smooth.
Ic	27-72	Fill; 10YR 8/2, very pale brown, coarse, crushed coral and sand; structureless; dry, very hard consistency; non-plastic; no cementation; marine origin; contains faunal remains; LB is abrupt, smooth.
Id	65-101	Fill; 10YR 3/3, dark brown silty clay loam; weak, fine crumb structure; dry, slightly hard consistency; non-plastic; no cementation; terrestrial origin; LB is abrupt, smooth.
IIIa	90-149	10YR 8/2, very pale brown sandy clay; moderate, fine crumb structure; wet, very sticky consistency; plastic; no cementation; marine origin; LB is abrupt, smooth.
IIIb	141-174	Gley 2 5/5BG, greenish-gray sandy clay; moderate, fine crumb structure; wet, very sticky consistency; plastic; no cementation; marine origin; LB is abrupt, smooth.
IIIc	167-BOE	10 YR 7/1, light gray coral; structureless; dry, extremely hard consistency; non-plastic; indurated; marine origin; Base of Excavation (BOE).

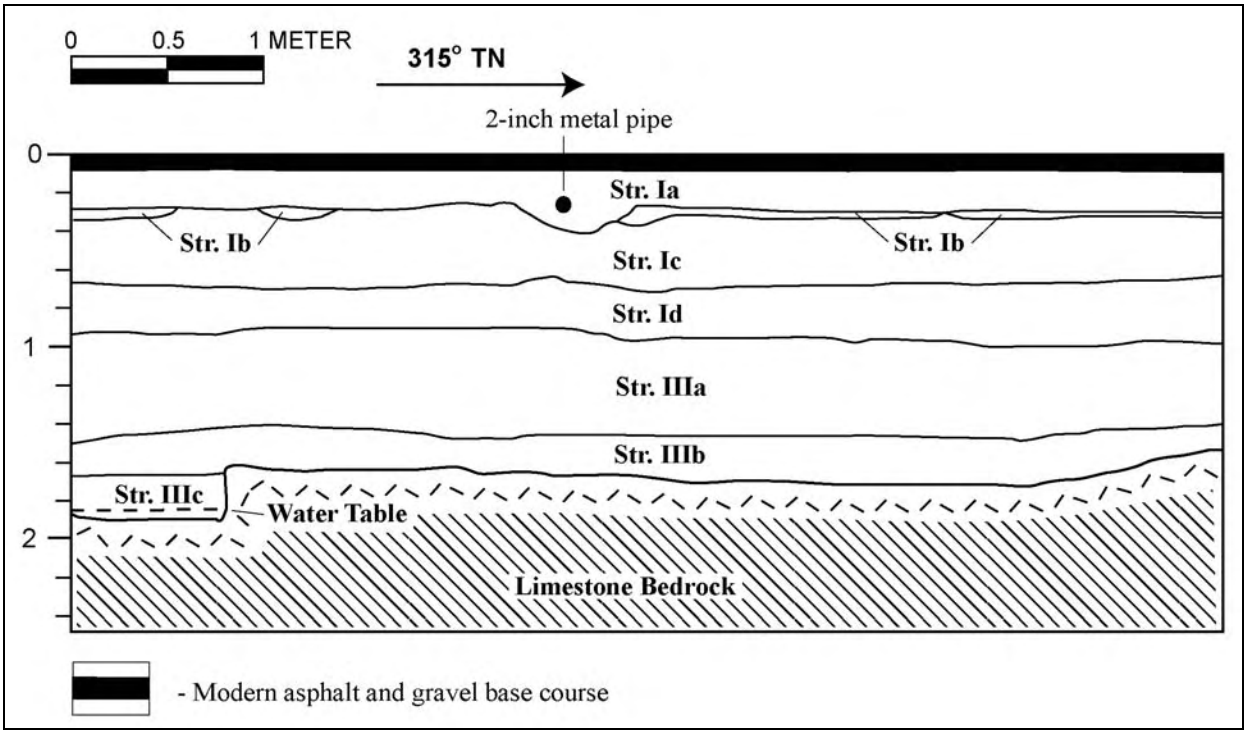

Figure 48. Test Trench 4 photograph (above) and stratigraphic profile (below), southwest wall

4.2.5 Trench 5

Orientation	210° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	1.8 m

Stratum	Depth (cmbs)	Description
Ia	19-45	Fill; 10YR 5/2, grayish-brown silt loam with gravel inclusions; weak, fine crumb structure; dry, loose consistency; non-plastic; no cementation; terrestrial origin; Lower Boundary (LB) is abrupt, smooth.
Ib	34-75	Fill; 7.5YR 3/4, brown silty clay loam with gravel inclusions; moderate, fine crumb structure; moist, friable consistency; non-plastic; no cementation; terrestrial origin; LB is abrupt, smooth.
Ic	51-121	Fill; 10YR 8/2, very pale brown, coarse, crushed coral and sand; structureless; dry, very hard consistency; non-plastic; no cementation; marine origin; LB is abrupt, smooth.
II	43-155	Fill; 10YR 3/2, very dark grayish-brown clay loam and ash; moderate, fine crumb structure; wet, sticky consistency; plastic; no cementation; terrestrial origin; contains burnt garbage; LB is abrupt, wavy.
III	138-BOE	Gley 2 5/5BG, greenish-gray sandy clay with coral gravel; structureless; wet, very sticky consistency; very plastic; no cementation; marine origin; Base of Excavation (BOE).

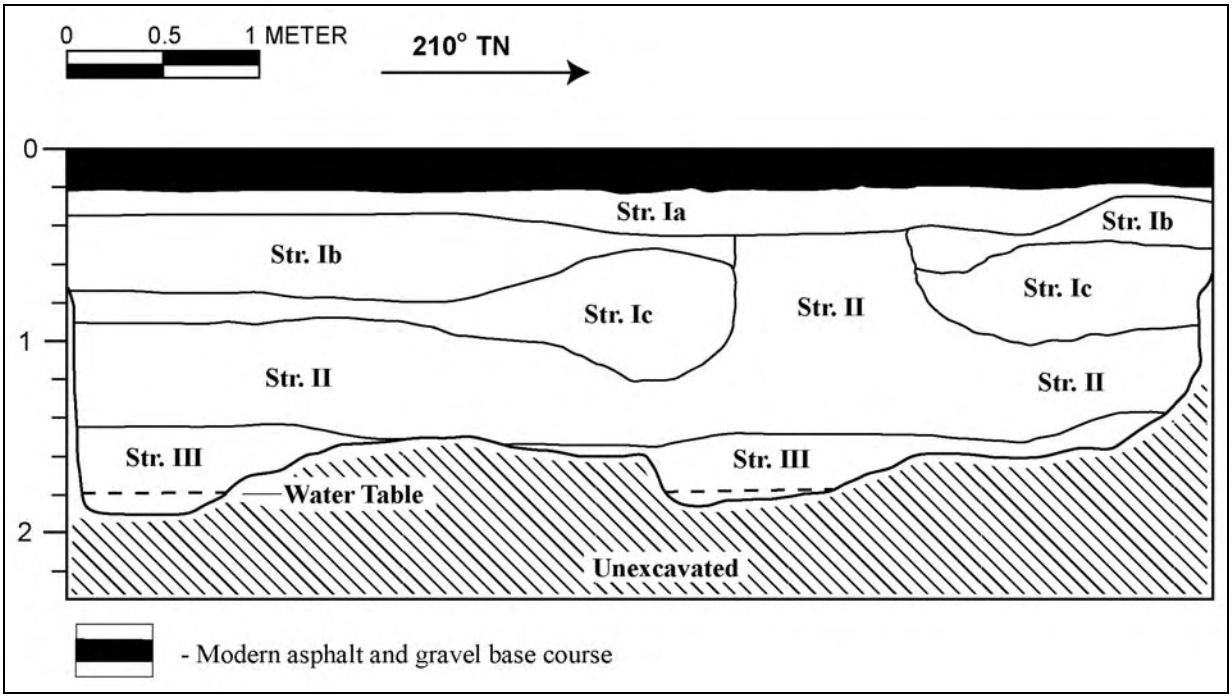

Figure 49. Test Trench 5 photograph (above) and stratigraphic profile (below), southeast wall

4.2.6 Trench 6

Orientation	141° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	2.1 m

Stratum	Depth (cmbs)	Description
Ia	13-32	Fill; 7.5YR 3/2, dark brown clay loam; weak, fine crumb structure; dry, hard consistency; slightly plastic; no cementation; terrestrial origin; contains roots and rootlets; Lower Boundary (LB) is clear, smooth.
Ib	27-50	Fill; 10YR 4/2, dark grayish-brown sandy loam; weak, fine granular structure; dry, slightly hard consistency; non-plastic; no cementation; mixed origin; contains roots and glass fragments; LB is clear, wavy.
Ic	45-88	Fill; 10YR 8/2, very pale brown, coarse, crushed coral and sand; structureless; dry, very hard consistency; non-plastic; no cementation; marine origin; LB is abrupt, smooth.
II	72-106	Fill; 10YR 3/2, very dark grayish-brown clay loam and ash; moderate, fine crumb structure; wet, sticky consistency; plastic; no cementation; terrestrial origin; contains burnt garbage; LB is abrupt, wavy.
IIIa	86-130	10YR 7/3, very pale brown sandy clay; moderate, fine crumb structure; moist, friable consistency; plastic; no cementation; mixed origin; LB is clear, smooth.
IIIb	123-134	10 YR 7/2, light gray clay; weak, fine, crumb structure; moist, friable consistency; very plastic; no cementation; mixed origin; LB is clear, smooth.
IIIc	127-175	Gley 2 7/5PB, light bluish-gray, sandy clay; weak, fine granular structure; wet, sticky consistency; slightly plastic; no cementation; marine origin; LB is diffuse, smooth.
IIId	172-216/BOE	Gley 2 5/5PB, bluish-gray sandy clay; weak, fine, granular structure; wet sticky consistency; non-plastic; no cementation; marine origin; contains coral cobbles and pebbles; Base of Excavation (BOE).

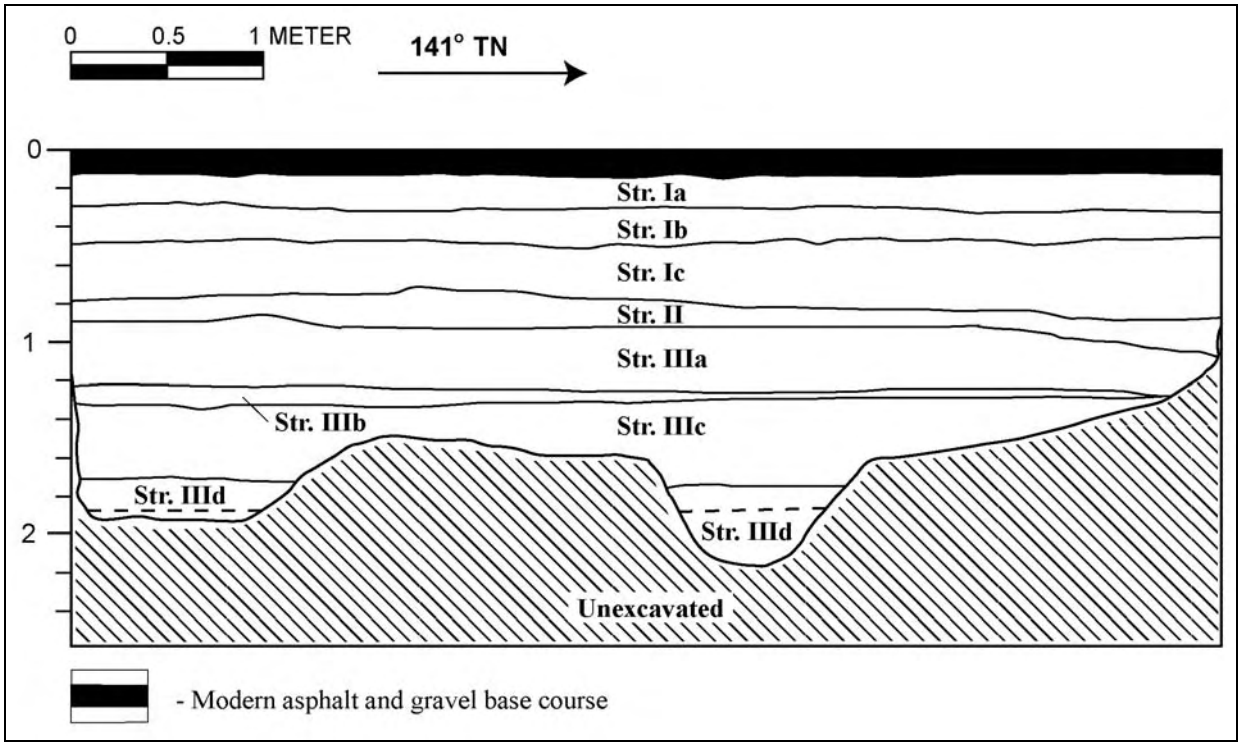

Figure 50. Test Trench 6 photograph (above) and stratigraphic profile (below), northwest wall

4.2.7 Trench 7

Orientation	032° TN
Length	4.0 m
Width	0.8 m
Maximum Depth	1.8 m

Stratum	Depth (cmbs)	Description
Ia	14-28	Fill; 7.5YR 3/2, dark brown clay loam; weak, fine crumb structure; dry, hard consistency; slightly plastic; no cementation; terrestrial origin; contains roots and rootlets; Lower Boundary (LB) is clear, smooth.
Ib	22-54	Fill; 10YR 4/2, dark grayish-brown sandy loam; weak, fine granular structure; dry, slightly hard consistency; non-plastic; no cementation; mixed origin; contains roots and rootlets; LB is clear, smooth.
Ic	32-68	Fill; 10YR 8/2, very pale brown, coarse, crushed coral and sand; structureless; dry, very hard consistency; non-plastic; no cementation; marine origin; LB is abrupt, smooth.
II	50-86	Fill; 10YR 3/2, very dark grayish-brown clay and ash; structureless; moist, friable consistency; non-plastic; terrestrial origin; contains burnt garbage; LB is abrupt, smooth.
IIIa	82-135	10YR 7/3, very pale brown sandy clay; weak, fine granular structure; moist, friable consistency; plastic; no cementation; mixed origin; LB is clear, smooth.
IIIb	131-172	Gley 2 7/5PB, light bluish-gray sandy clay; weak, fine granular structure; wet, sticky consistency; slightly plastic; no cementation; mixed origin; LB is diffuse, smooth.
IIIc	167-BOE	Gley 2 5/5PB, bluish-gray sandy clay; weak, fine granular structure; wet, sticky consistency; non-plastic; no cementation; mixed origin; Base of Excavation (BOE).

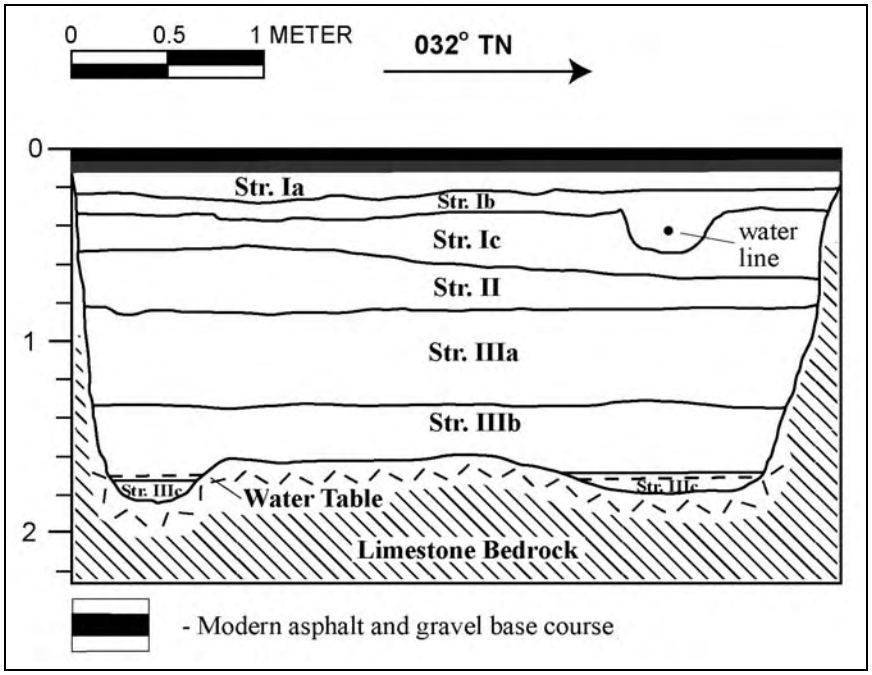

Figure 51. Test Trench 7 photograph (above) and stratigraphic profile (below), northwest wall

4.2.8 Trench 8

Orientation	044° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	2.0 m

Stratum	Depth (cmbs)	Description
Ia	10-43	Fill; 7.5YR 3/2, dark brown clay loam; weak, fine crumb structure; dry, hard consistency; slightly plastic; no cementation; mixed origin; Lower Boundary (LB) is clear, smooth.
Ib	30-60	Fill; 10YR 4/2, dark grayish-brown sandy loam with coral cobbles; weak, fine granular structure; dry, slightly hard consistency; non-plastic; no cementation; mixed origin; LB is clear, smooth.
Ic	46-88	Fill; 10YR 8/2, very pale brown, coarse, crushed coral and sand; structureless; dry, very hard consistency; non-plastic; no cementation; marine origin; LB is abrupt, smooth.
Feature A	10-120	Fill; 10YR 4/2, dark grayish-brown sandy loam; weak, fine granular structure; dry, slightly hard consistency; non-plastic; no cementation; mixed origin; contains utilities; LB is clear, smooth. Appears to be back fill and a combination of strata Ia, Ib, Ic, and II.
II	102-150	Fill; 10YR 3/2, very dark grayish-brown clay and ash; structureless; moist, friable consistency; non-plastic; terrestrial origin; contains burnt garbage; LB is abrupt, smooth.
IIIa	132-163	10 YR 7/3, very pale brown, sandy clay; weak, fine, granular structure; moist, friable consistency; plastic; no cementation; mixed origin; LB is clear, smooth.
IIIb	160-BOE	Gley 2 5/5PB, bluish-gray sandy clay; weak, fine granular structure; wet, non-sticky consistency; non-plastic; no cementation; marine origin; Base of Excavation (BOE).

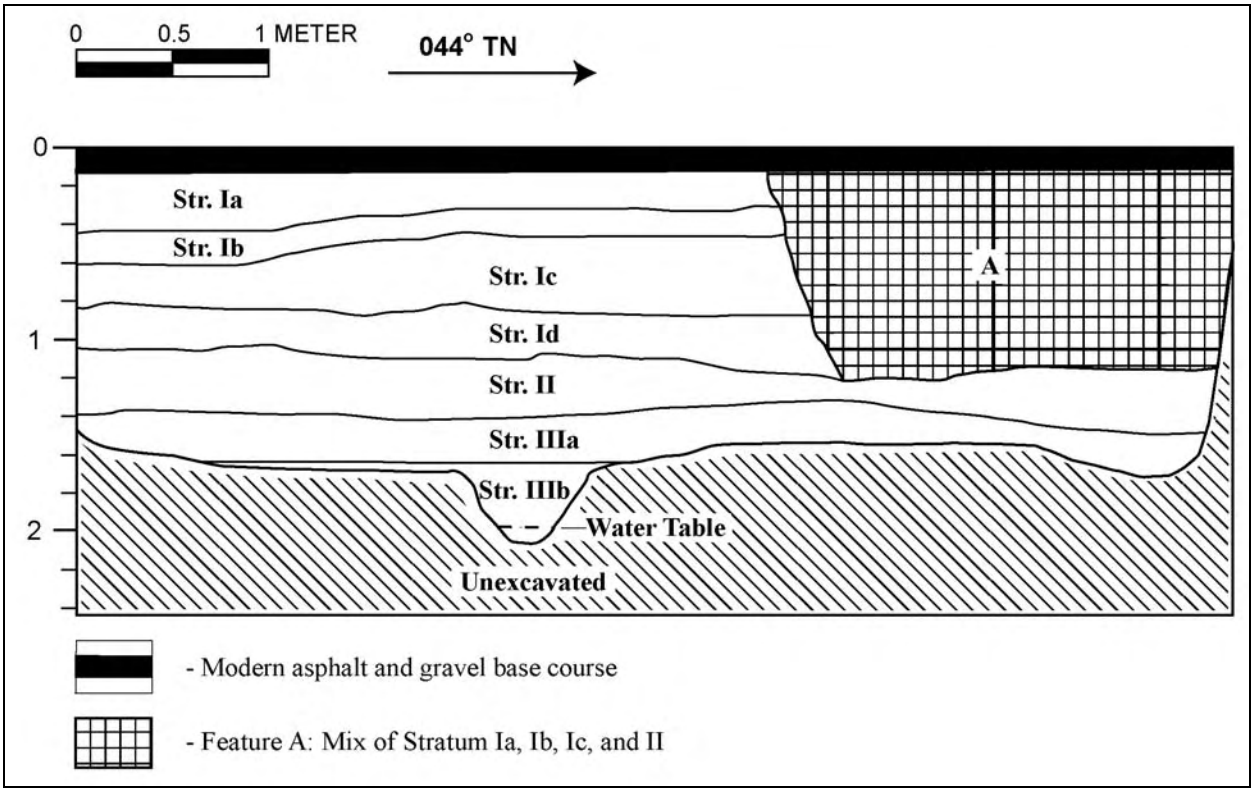

Figure 52. Test Trench 8 photograph (above) and stratigraphic profile (below), northwest wall

4.2.9 Trench 9

Orientation	327° TN
Length	5.6 m
Width	0.8 m
Maximum Depth	2.0 m

Stratum	Depth (cmbs)	Description
Ia	8-14	Fill; 7.5YR 3/2, dark brown clay loam; weak, fine crumb structure; dry, hard consistency; slightly plastic; no cementation; mixed origin; Lower Boundary (LB) is clear, smooth.
Ib	13-35	Fill; 10YR 8/2, very pale brown, coarse, crushed coral and sand; structureless; dry, very hard consistency; non-plastic; no cementation; marine origin; LB is abrupt, smooth.
Feature A	27-157	Fill; 10YR 4/2, dark grayish-brown sandy loam; weak, fine granular structure; dry, slightly hard consistency; non-plastic; no cementation; mixed origin; contains utilities; LB is clear, smooth. Appears to be back fill and a combination of strata Ia, Ib, Ic, and II.
Ic	28-123	Fill; 10YR 5/3, brown clay loam; weak, medium crumb structure; dry, slightly hard consistency; non-plastic; no cementation; terrestrial origin; contains utilities; LB is abrupt, smooth.
IIa	122-132	Fill; Gley 2 6/10G, greenish-gray sandy loam; weak, fine, granular structure; wet, non-sticky consistency; non- plastic; no cementation; marine origin; LB is abrupt, smooth.
IIb	133-136	Fill; 7.5YR 4/1, dark gray sandy clay loam; weak, fine, granular structure; moist, firm consistency; plastic; no cementation; mixed origin; LB is clear, broken.
IIIa	134-165	7.5YR 7/6, reddish-yellow fine sand; structureless; moist, very friable consistency; non-plastic; no cementation; marine origin; LB is clear, smooth.
IIIb	153-BOE	Gley 1 6/5GY, greenish-gray sandy clay; weak, fine granular structure; wet, non-sticky consistency; slightly plastic; no cementation; Base of Excavation (BOE).

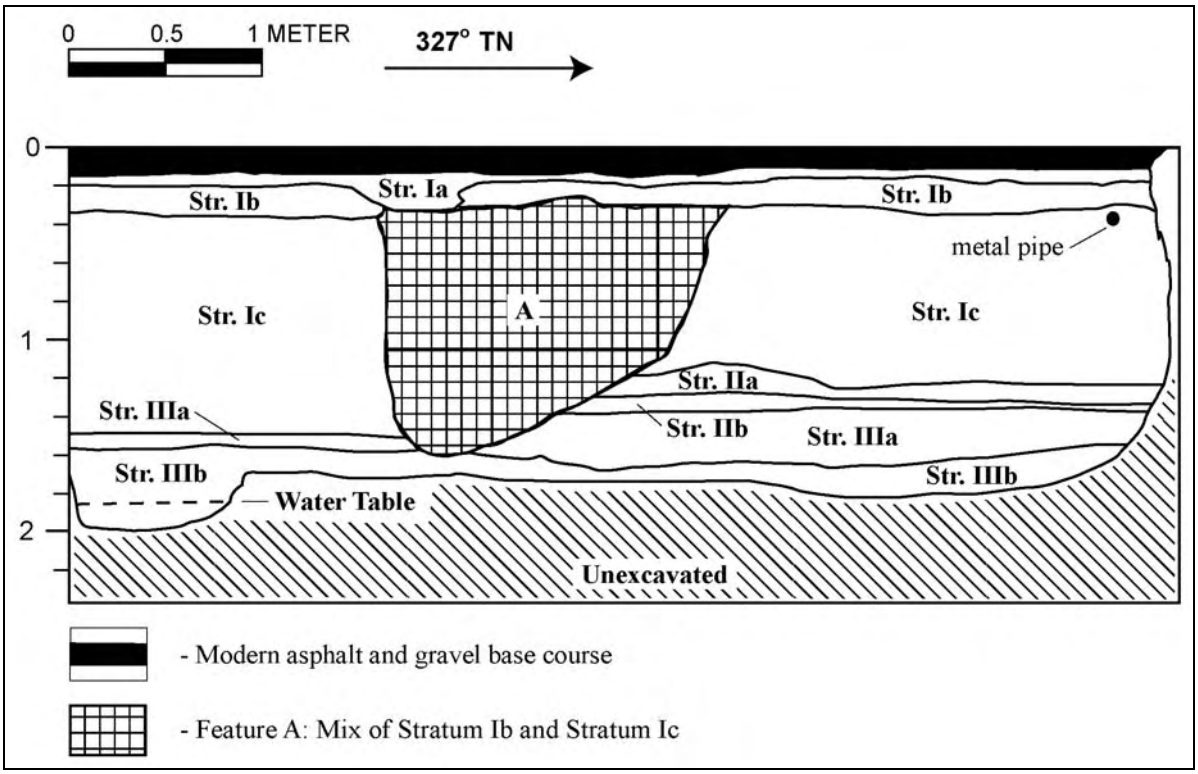

Figure 53. Test Trench 9 photograph (above) and stratigraphic profile (below), southwest wall

4.2.10 Trench 10

Orientation	141° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	1.8 m

Stratum	Depth (cmbs)	Description
Ia	12-45	Fill; 7.5YR 4/6, strong brown silt loam; weak, fine crumb structure; dry, hard consistency; non-plastic; no cementation; terrestrial origin; contains utilities, roots, and rootlets; Lower Boundary (LB) is abrupt boundary, smooth.
Ib	35-42	Fill; Gley 2 4/1, dark bluish-gray medium to coarse basalt sand; structureless; dry, weakly coherent consistency; non-plastic; no cementation; terrestrial origin; LB is abrupt, smooth.
Ic	40-53	Fill; 7.5YR 2.5/2, very dark brown clay loam; weak, fine granular structure; dry, slightly hard consistency; plastic; no cementation; terrestrial origin; LB is clear, smooth.
Id	49-92	Fill; 10YR 3/2, very dark grayish brown gravelly clay loam; weak, fine crumb structure; moist, friable consistency; slightly plastic; no cementation; terrestrial origin; LB is diffuse, smooth.
II	83-135	Fill; 10YR 3/2, very dark grayish-brown clay and ash; structureless; moist, friable consistency; non-plastic; terrestrial origin; contains burnt garbage; LB is abrupt, smooth.
IIIa	124-151	7.5YR 7/1, light gray clay; weak, fine, crumb structure; wet, sticky consistency; very plastic; no cementation; marine origin; LB is clear, smooth.
IIIb	146-BOE	Gley 1 5/10Y, greenish-gray sandy clay; structureless; wet, non-sticky consistency; non-plastic; no cementation; marine origin; Base of Excavation (BOE).

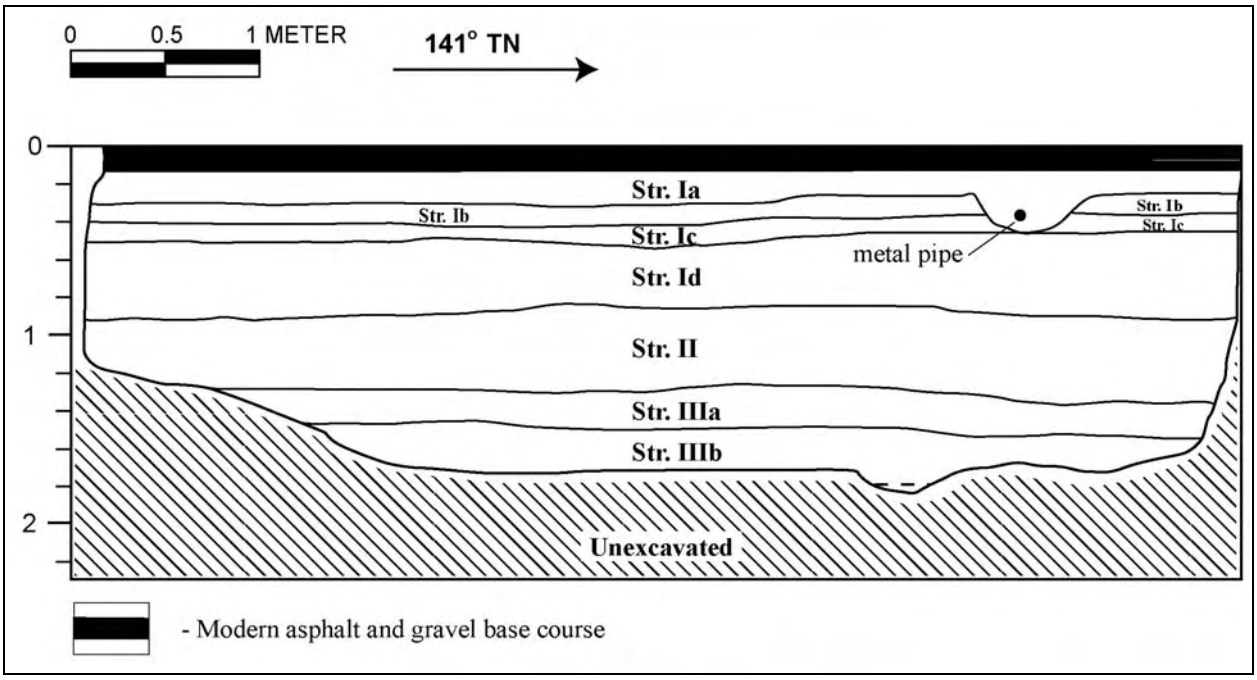

Figure 54. Test Trench 10 photograph (above) and stratigraphic profile (below), northeast wall

4.2.11 Trench 11

Orientation	075° TN
Length	7.0 m
Width	0.8 m
Maximum Depth	2.1 m

Stratum	Depth (cmbs)	Description
Ia	13-34	Fill; 7.5YR 4/6, strong brown silt loam; weak, fine crumb structure; dry, hard consistency; non-plastic; no cementation; terrestrial origin; contains roots and rootlets; Lower Boundary (LB) is abrupt, smooth.
Ib	30-34	Fill; Gley 2 4/1, dark bluish-gray medium to coarse basalt sand; structureless; dry, weakly coherent consistency; non-plastic; no cementation; terrestrial origin; LB is abrupt, smooth.
Ic	39-54	Fill; 10YR 3/2, very dark grayish brown sandy clay loam; weak, fine granular structure; dry, slightly hard consistency; slightly plastic; no cementation; terrestrial origin; LB is clear, broken.
Feature A	39-129	Fill; 7.5YR 3/4, dark brown gravelly clay loam; structureless; dry, slightly hard consistency; slightly plastic; no cementation; mixed origin; LB is diffuse, broken. Backfilled mixture of Strata Ic, Id, Ie, and If; associated with 12-inch sewer pipe installation.
Id	51-63	Fill; Gley 2 4/10B, dark bluish-gray fine to medium basalt sand; structureless; dry, weakly coherent consistency; non-plastic; no cementation; terrestrial origin; LB is abrupt, broken.
Ie	57-110	Fill; 7.5YR 3/2, dark brown sandy clay loam; weak, fine crumb structure; dry, slightly hard consistency; slightly plastic; no cementation; terrestrial origin; LB is diffuse, broken.
If	100-137	Fill; 7.5YR 4/3, brown clay loam; weak, fine crumb structure; moist, friable consistency; plastic; no cementation; mixed origin; LB is clear, smooth.
IIIa	130-158	7.5YR 7/1, light gray clay; weak, fine crumb structure; wet, sticky consistency; plastic; no cementation; marine origin; LB is clear, smooth.
IIIb	150-181	Gley 1 5/10Y, greenish-gray sandy clay; structureless; wet, non-sticky consistency; non-plastic; no cementation; marine origin; LB is diffuse, smooth.
IIIIc	180-BOE	Gley 2 5/5B, bluish-gray sandy clay; structureless; wet, non-sticky consistency; non-plastic; no cementation; marine origin; Base of Excavation (BOE).

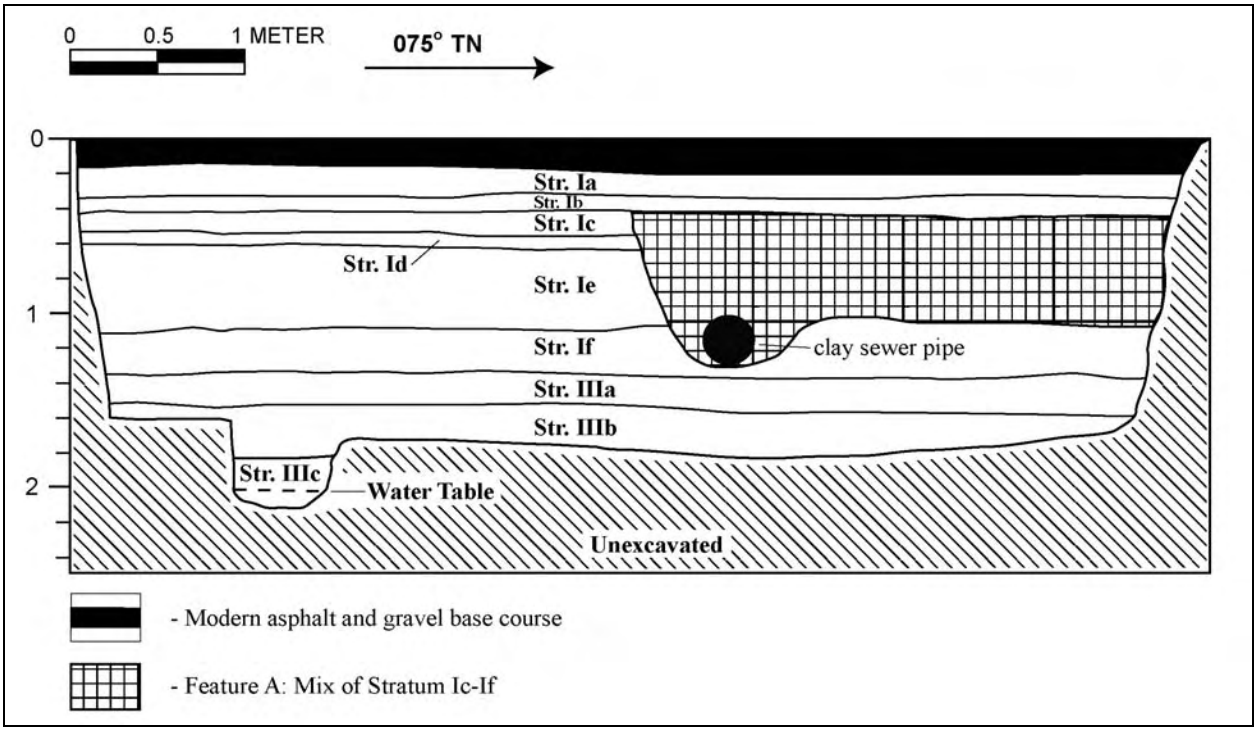

Figure 55. Test Trench 11 photograph (above) and stratigraphic profile (below), northwest wall

4.2.12 Trench 12

Orientation	231° TN
Length	6.2 m
Width	0.8 m
Maximum Depth	2.1 m

Stratum	Depth (cmbs)	Description
Ia	13-40	Fill; 7.5YR 3/3, dark brown silt loam; weak, fine crumb structure; dry, hard consistency; non-plastic; no cementation; terrestrial origin; contains utilities; Lower Boundary (LB) is diffuse, smooth.
Ib	35-70	Fill; 7.5YR 4/3, brown silty clay loam; weak, fine, crumb structure; dry, hard consistency; slightly plastic; no cementation; terrestrial origin; contains utilities, roots and rootlets; LB is diffuse, smooth.
Ic	64-169	Fill; 7.5YR 4/2, brown sandy clay loam; weak, fine crumb structure; moist, friable consistency; plastic; no cementation; mixed origin; contains garbage, coral cobbles and boulders; LB is clear, smooth.
IIIa	153-199	10YR 5/2, grayish-brown sandy clay; structureless; moist, very friable consistency; slightly plastic; no cementation; marine origin; LB is diffuse, smooth.
IIIb	198-BOE	Gley 2 5/10B, bluish-gray sandy clay; structureless; wet, non-sticky consistency; slightly plastic; no cementation; marine origin; Base of Excavation (BOE).

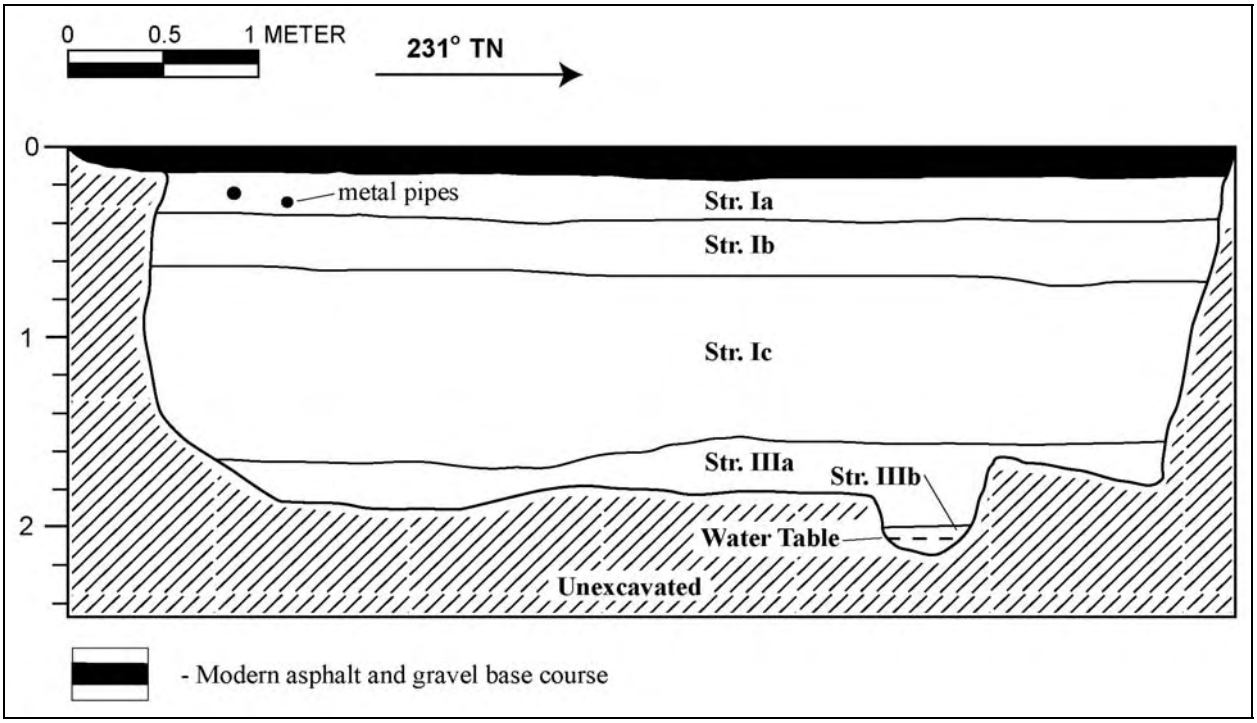

Figure 56. Test Trench 12 photograph (above) and stratigraphic profile (below), southeast wall

4.2.13 Trench 13

Orientation	233° TN
Length	6.1 m
Width	0.8 m
Maximum Depth	1.9 m

Stratum	Depth (cmbs)	Description
Ia	12-32	Fill; 10YR 3/3, dark brown silt loam; weak, fine granular structure; dry, hard consistency; non-plastic; no cementation; terrestrial origin; contains roots and rootlets; Lower Boundary (LB) is clear, smooth.
Ib	31-42	Fill 7.5YR 3/2, dark brown sandy loam; weak, fine granular structure; dry, weakly coherent consistency; non-plastic; no cementation; terrestrial origin; contains utilities; LB is clear, smooth.
Ic	38-70	Fill; 2.5Y 3/2, very dark grayish-brown clay loam; weak, fine crumb structure; moist, friable consistency; plastic; no cementation; mixed origin; LB is abrupt, smooth.
Id	67-90	Fill; 7.5YR 4/3, brown silty clay loam; weak, fine crumb structure; moist, firm consistency; slightly plastic; no cementation; terrestrial origin; LB is diffuse, smooth.
Ie	80-120	Fill; 7.5YR 4/2, brown sandy clay loam; weak, fine, crumb structure; moist, friable consistency; plastic; no cementation; mixed origin; contains garbage, coral cobbles and boulders; LB is clear, smooth.
II	105-137	Fill; 7.5YR 7/1, light gray clay; weak, fine crumb structure; wet, sticky consistency; very plastic; no cementation; marine origin; LB is clear, smooth.
IIIa	132-169	10YR 5/2, grayish-brown sandy clay; structureless; wet, sticky consistency; slightly plastic; no cementation; marine origin; LB is clear, smooth.
IIIb	169-BOE	Gley 2 5/10B, bluish-gray sandy clay; structureless; wet, non-sticky consistency; non-plastic; no cementation; marine origin; Base of Excavation (BOE).

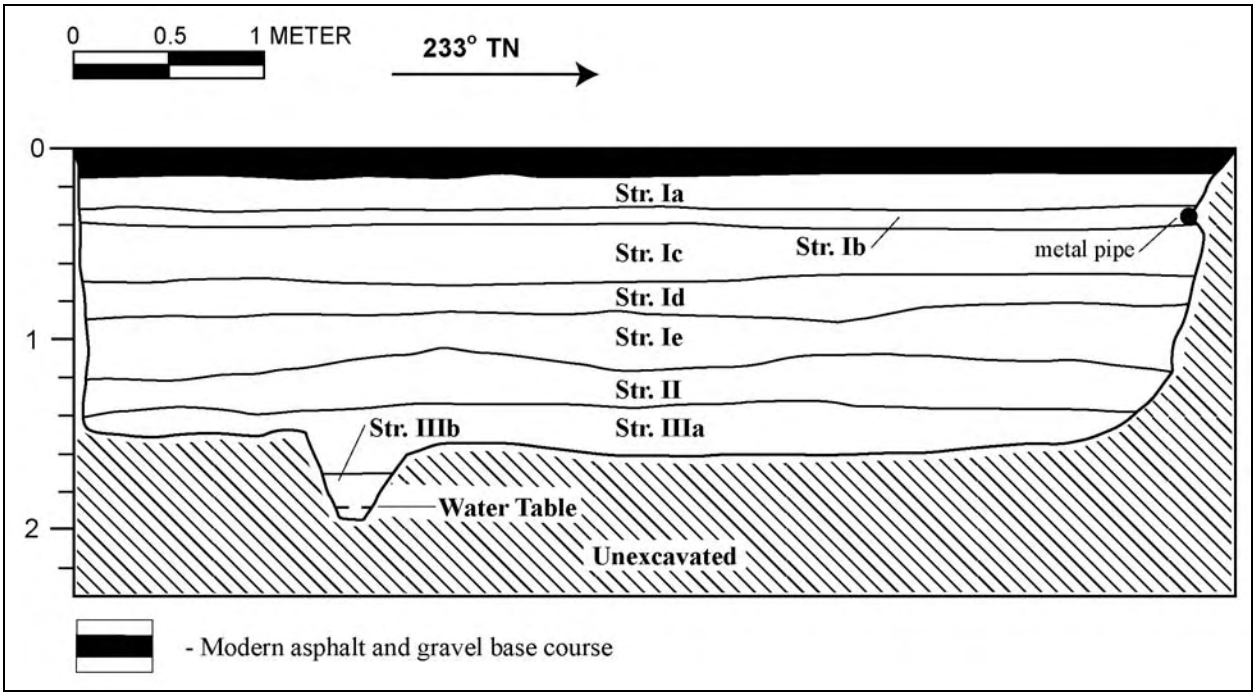

Figure 57. Test Trench 13 photograph (above) and stratigraphic profile (below), southeast wall

4.2.14 Trench 14

Orientation	050° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	1.9 m

Stratum	Depth (cmbs)	Description
Ia	15-30	Fill; 5YR 3/3, dark reddish-brown clay loam; moderate, medium,blocky structure; dry, slightly hard consistency; slightly plastic; no cementation; terrestrial origin; Lower Boundary (LB) is abrupt, smooth.
Ib	28-40	Fill; 7.5YR 4/2, brown sandy loam; weak, fine crumb structure; dry, weakly coherent consistency; non-plastic; no cementation; mixed origin; LB is abrupt, smooth.
Ic	38-58	Fill; 10YR 6/2, light brownish-gray silty sand; weak, fine crumb structure; dry, loose consistency; non-plastic; no cementation; mixed origin; contains crushed coral and utilities; LB is abrupt, smooth.
Id	50-103	Fill; 7.5YR 4/3, brown sandy loam; moderate, fine blocky structure; dry, weakly coherent consistency; non-plastic; no cementation; mixed origin; contains utilities; LB is abrupt, smooth.
IIa	65-130	Fill; 10YR 7/2, light gray sandy clay; weak, fine, crumb structure; moist, friable consistency; plastic; no cementation; marine origin; LB is abrupt, smooth.
IIb	111-137	Fill; 10YR 5/2, grayish-brown silty clay; weak, medium blocky structure; moist, friable consistency; slightly plastic; no cementation; mixed origin; LB is clear boundary, smooth.
IIIa	115-137	10YR 6/4, light yellowish-brown silty sand; weak, fine crumb structure; moist, very friable consistency; non-plastic; no cementation; marine origin; LB is clear, smooth.
IIIb	145-BOE	Gley 2 6/10B, bluish-gray silty sand; structureless; wet, non-sticky consistency; non-plastic; no cementation; marine origin; Base of Excavation (BOE).

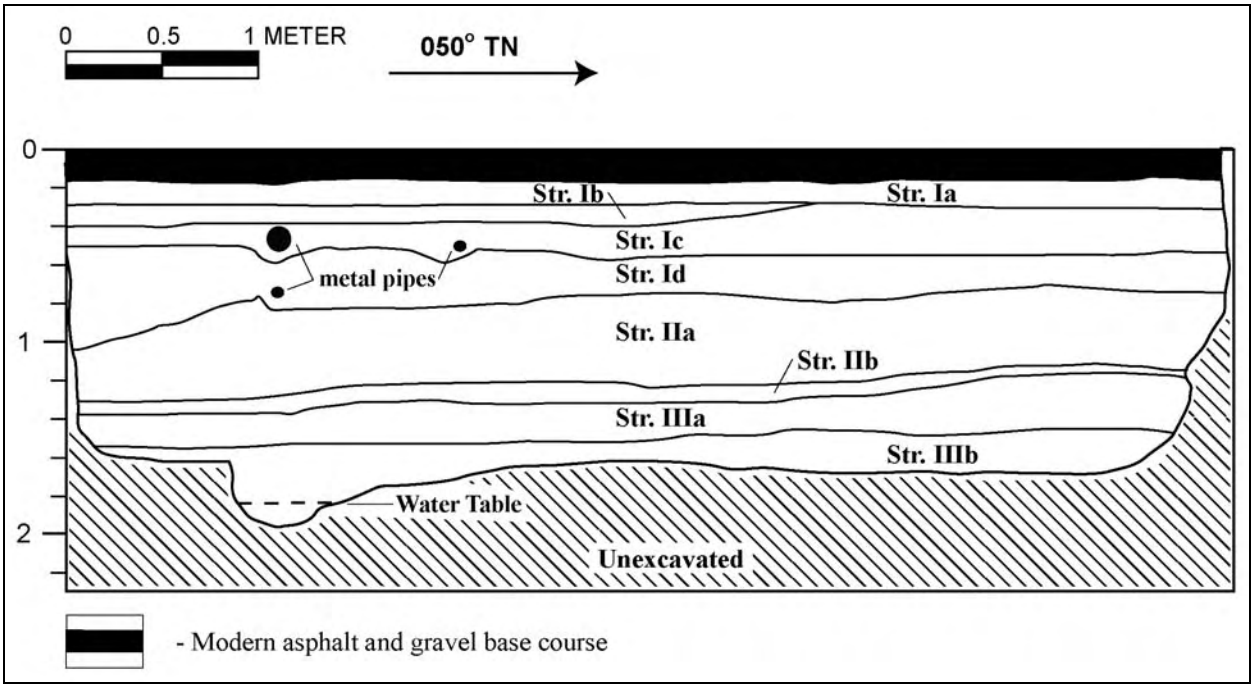

Figure 58. Test Trench 14 photograph (above) and stratigraphic profile (below), northwest wall

4.2.15 Trench 15

Orientation	136° TN
Length	6.1 m
Width	0.8 m
Maximum Depth	2.0 m

Stratum	Depth (cmbs)	Description
Ia	12-48	Fill; 10YR 3/2, very dark grayish-brown silty clay loam; moderate, fine crumb structure; moist, firm consistency; slightly plastic; no cementation; terrestrial origin; Lower Boundary (LB) is very abrupt, smooth.
Feature A	12-130	Fill; 10YR 6/2, light brownish-gray silty clay loam and coral; structureless; moist, firm consistency; non-plastic; no cementation; mixed origin; LB is abrupt, irregular. Pit –like feature composed of a mixture of Strata Ia, Ib, and II.
Ib	45-89	Fill; 10YR 8/2, very pale brown crushed coral and sand; structureless; dry, very hard consistency; non-plastic; no cementation; marine origin; LB is abrupt, smooth.
II	86-140	Fill; 10YR 3/2, very dark, grayish-brown clay and ash; structureless; moist, friable consistency; non-plastic; no cementation; terrestrial origin; contains burnt garbage; LB is very abrupt, smooth.
IIIa	121-155	10YR 4/4, dark yellowish-brown clay; weak, fine crumb structure; moist, friable consistency; plastic; no cementation; marine origin; LB is diffuse, smooth.
IIIb	136-BOE	Gley 2 6/5BG, greenish-gray sandy clay; structureless; moist, loose consistency; non-plastic; no cementation; marine origin; Base of Excavation (BOE).

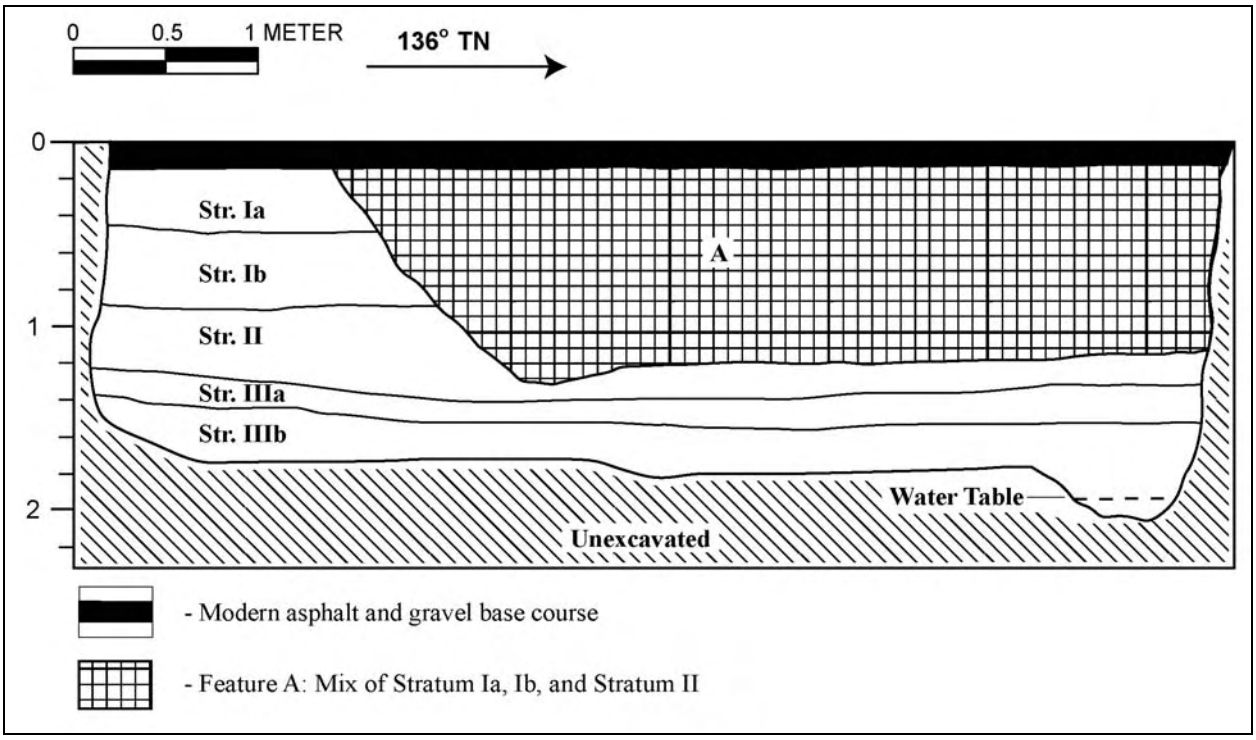

Figure 59. Test Trench 15 photograph (above) and stratigraphic profile (below), northeast wall

4.2.16 Trench 16

Orientation	314° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	1.9 m

Stratum	Depth (cmbs)	Description
Ia	15-65	Fill; 7.5YR 3/1, very dark gray sandy loam; weak, fine crumb structure; dry, hard consistency; non-plastic; no cementation; mixed origin; contains ash, basalt gravel and burnt garbage; Lower Boundary (LB) is abrupt, irregular.
Ib	24-40	Fill; 2.5YR 7/3, pale yellow crushed coral and sand; structureless; dry, slightly hard consistency; non-plastic; no cementation; mixed origin; LB is abrupt, irregular.
II	62-131	Fill; 10YR 6/2, light brownish-gray sandy clay; weak, fine crumb structure; moist, firm consistency; slightly plastic; no cementation; mixed origin; LB is clear, smooth.
IIIa	118-134	10YR 5/2, grayish-brown silty clay; weak, medium blocky structure; moist, friable consistency; slightly plastic; no cementation; mixed origin; LB is clear, smooth.
IIIb	133-BOE	Gley 2 6/10B, bluish-gray sandy clay; structureless; wet, non-sticky consistency; non-plastic; no cementation; marine origin; Base of Excavation (BOE).

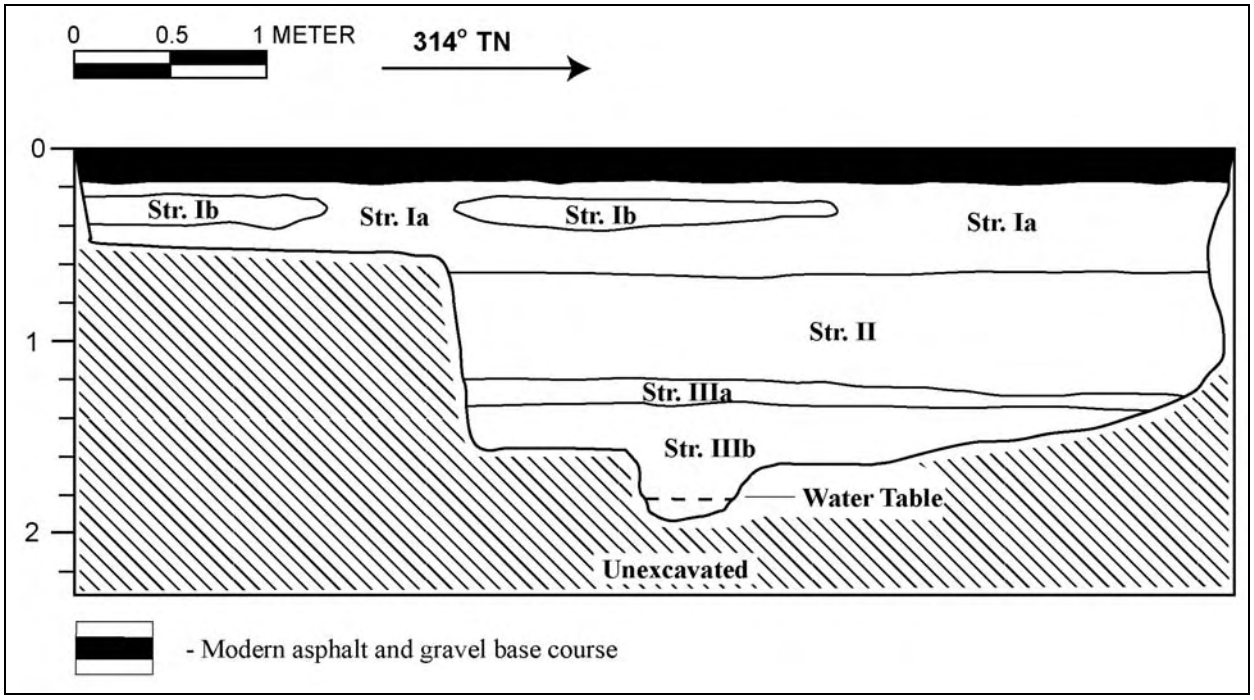

Figure 60. Test Trench 16 photograph (above) and stratigraphic profile (below), southwest wall

4.2.17 Trench 17

Orientation	236° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	1.7 m

Stratum	Depth (cmbs)	Description
Ia	16-40	Fill; 5YR 4/3, reddish-brown clay loam; moderate, medium crumb structure; dry, hard consistency; slightly plastic; no cementation; terrestrial origin; Lower Boundary (LB) is abrupt, wavy.
Ib	32-57	Fill; 7.5YR 4/2, brown sandy loam; weak, fine crumb structure; dry, hard consistency; non-plastic; no cementation; mixed origin; LB is abrupt, wavy.
IIa	52-92	Fill; 10YR 3/2, very dark, grayish-brown clay and ash; structureless; moist, friable consistency; non-plastic; no cementation; terrestrial origin; contains burnt garbage; LB is abrupt, wavy.
IIb	85-131	Fill; 5YR 3/3, dark reddish-brown sandy clay; weak, medium blocky structure; moist, friable consistency; slightly plastic; no cementation; mixed origin; LB is abrupt, smooth.
IIIa	129-143	Gley 1 5/10Y, greenish-gray silty clay; weak, medium blocky structure; moist, friable consistency; plastic; no cementation; mixed origin; LB is clear, smooth.
IIIb	138-BOE	Gley 2 5/5BG, greenish-gray sandy clay; structureless; wet, non-sticky consistency; non-plastic; no cementation; marine origin; Base of Excavation (BOE).

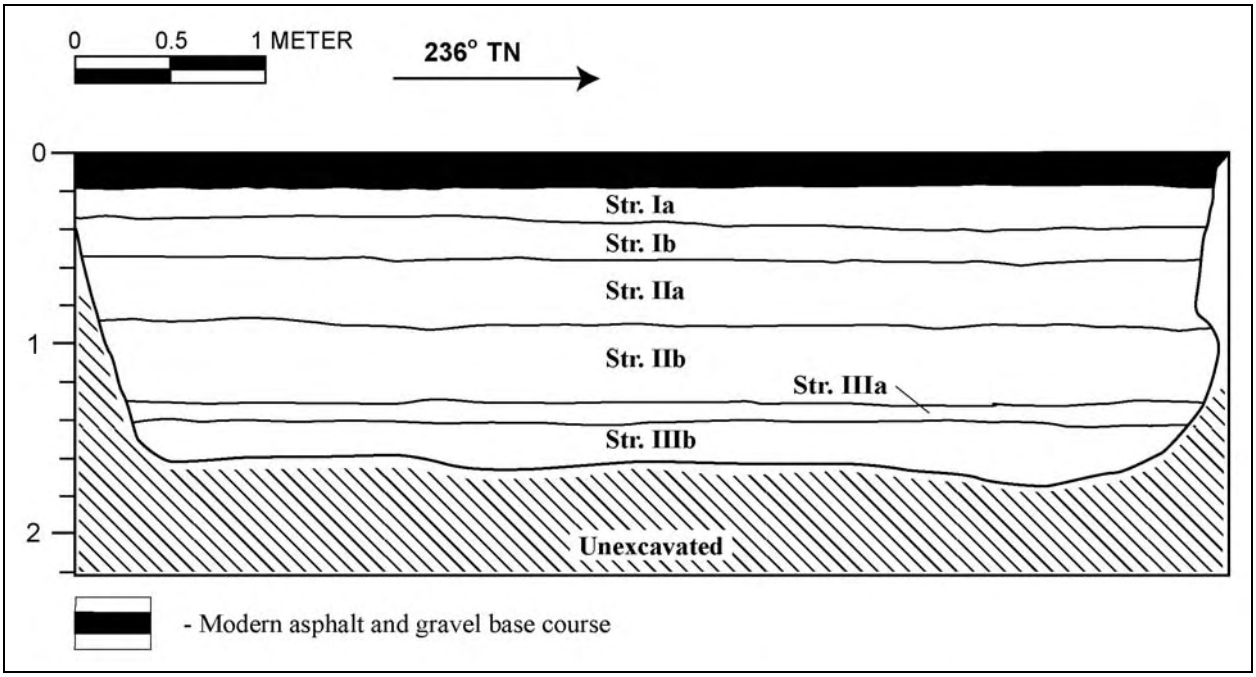

Figure 61. Test Trench 17 photograph (above) and stratigraphic profile (below), southeast wall

4.2.18 Trench 18

Orientation	235° TN
Length	6.0 m
Width	0.8 m
Maximum Depth	1.7 m

Stratum	Depth (cmbs)	Description
Ia	13-30	Fill; 7.5YR 3/1, very dark gray sandy loam; moderate, medium crumb structure; dry, hard consistency; slightly plastic; no cementation; mixed origin; Lower Boundary (LB) is abrupt, smooth.
Ib	28-74	Fill; 7.5YR 4/2, brown silty sand; weak, fine crumb structure; dry, hard consistency; non-plastic; no cementation; mixed origin; contains basalt gravel and cobbles; LB is abrupt, smooth.
IIa	55-104	Fill; 10YR 7/2, light gray sandy clay; weak, medium blocky structure; moist, friable consistency; plastic; no cementation; mixed origin; LB is clear, smooth.
IIb	102-110	Fill; 10YR 5/3, brown clay loam; weak, fine crumb structure; moist, very friable consistency; slightly plastic; no cementation; mixed origin; LB is clear, smooth.
IIIa	108-133	10YR 6/4, light yellowish-brown silty sand; weak, fine, crumb structure; moist, very friable consistency; non-plastic; no cementation; marine origin; LB is clear, smooth.
IIIb	109-BOE	Gley 2 5/5BG, greenish-gray sandy clay; structureless; wet, non-sticky consistency; non-plastic; no cementation; marine origin; Base of Excavation (BOE).

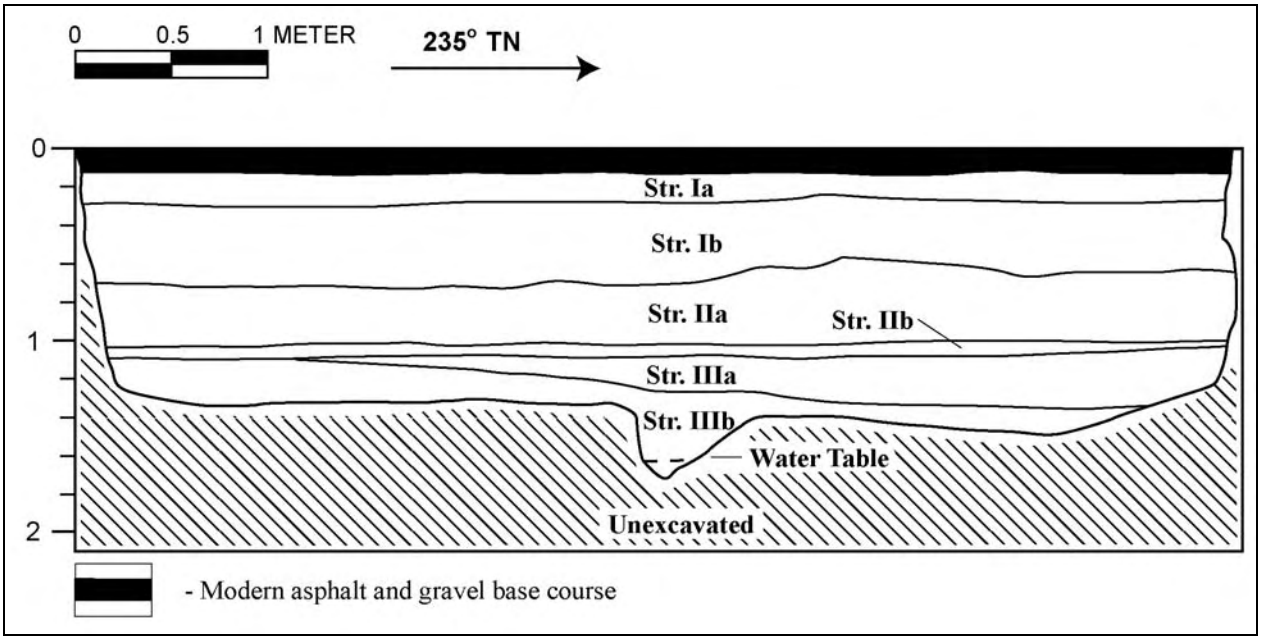

Figure 62. Test Trench 18 photograph (above) and stratigraphic profile (below), southeast wall

Section 5 Results of Laboratory Analysis

5.1 Artifact Analysis

The majority of the artifacts recovered during subsurface testing were bottles or bottle fragments typical of the late 1800s and early 1900s. A catalog of all artifacts collected is included as Appendix B of this report. Recovered bottles included those used for soda water, champagne and wine, whisky and brandy, gin, beer, condiments, perfume, and medicine. Household items recovered include crockery shards of plates, bowls, and vases; rice bowl fragments; a tea cup; and a *sake* glass. Faunal remains were also observed including long bones of cow, pig, and chicken, as well as a few marine shells. Other items recovered include a leather shoe sole, 2 fragments of a leather belt, and miscellaneous pieces of corroded, unidentifiable metal. Overall, the artifact assemblage is typical of household items of the late 19th and early 20th centuries.

5.1.1 Dating Information for Collected Artifacts

The terminology and date ranges used in the following discussion follow the Intermountain Antiquities Computer System (IMACS 1992) manual, as well as the website on bottle identification and dating maintained by the Bureau of Land Management and the Society for Historic Archaeology (http://www.sha.org/bottle/index.htm). Bottle dates can be obtained by analyzing manufacturing techniques, and additional dating information can be obtained from embossing on bottles. Embossing can provide information on the glass manufacturer, the product distributor, or the brand name of the bottled material. The majority of diagnostic bottles were given a date range based on their manufacturing technique.

61 historic artifacts recovered from the inventory survey are diagnostic glass bottles and bottle fragments from incinerator fill (i.e. Stratum II) and associated features in trenches 1, 2, 3, 8, 10, and 15 (Table 4; Figure 63-Figure 73). Of these 61 bottles, over half (37) were used for alcohol. Other diagnostic bottles include 8 soda, 5 medicine, 5 condiment, 1 personal hygiene, 1 storage vessel, and 5 of unknown function. 11 of the bottles have embossing indicating manufacturer and, in some cases, type of use.

The majority of alcohol bottles recovered were manufactured by turn mold where side seams are erased in the firing process (Figure 66). This process was used from the 1870s to the 1920s (IMACS 1992). Of the alcohol bottles recovered where finishes were still intact, 6 of them had finishes that were hand applied; these bottles were likely made slightly earlier (1860s). 6 of the diagnostic alcohol bottles in the assemblage have embossing on their bodies or bases. A complete dark brown bottle is present with “JOHANN HOFF” embossed on the shoulder. Johann Hoff malt extract began production in 1847 and was marketed as a “Beer of Health”; it was introduced to the United States in 1866 (Fike 1987:166). The type of bottle manufacture, turn mold with a tooled lip, indicates it was produced between the 1870s and 1920s (Rock 1981; IMACS 1992).

Figure 63. Representative medicine bottles

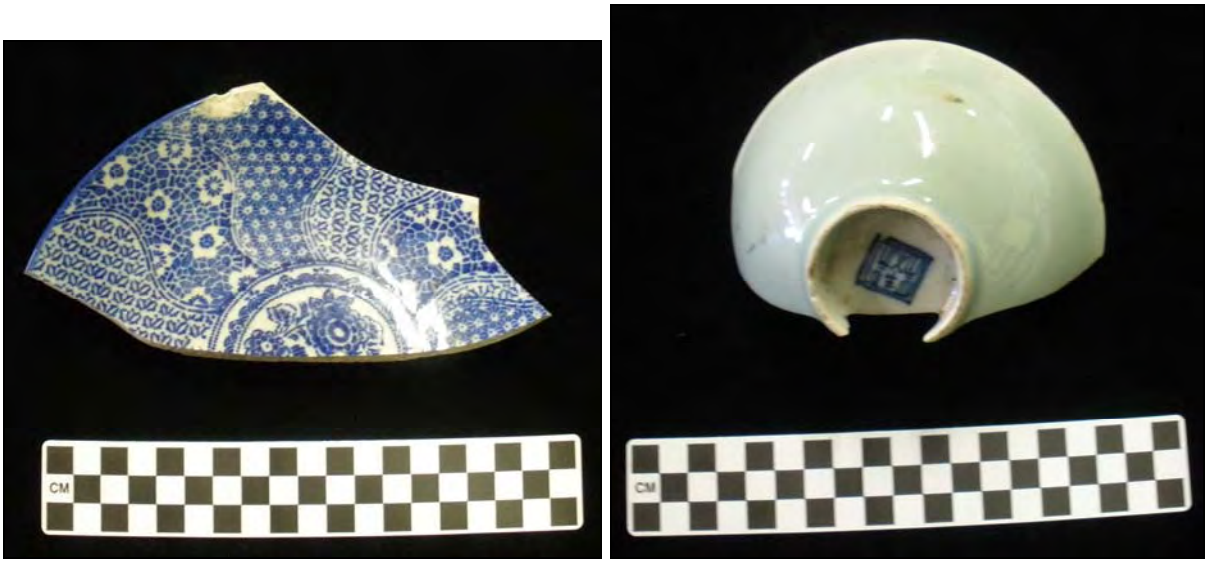

Figure 64. Ceramic bowl fragments

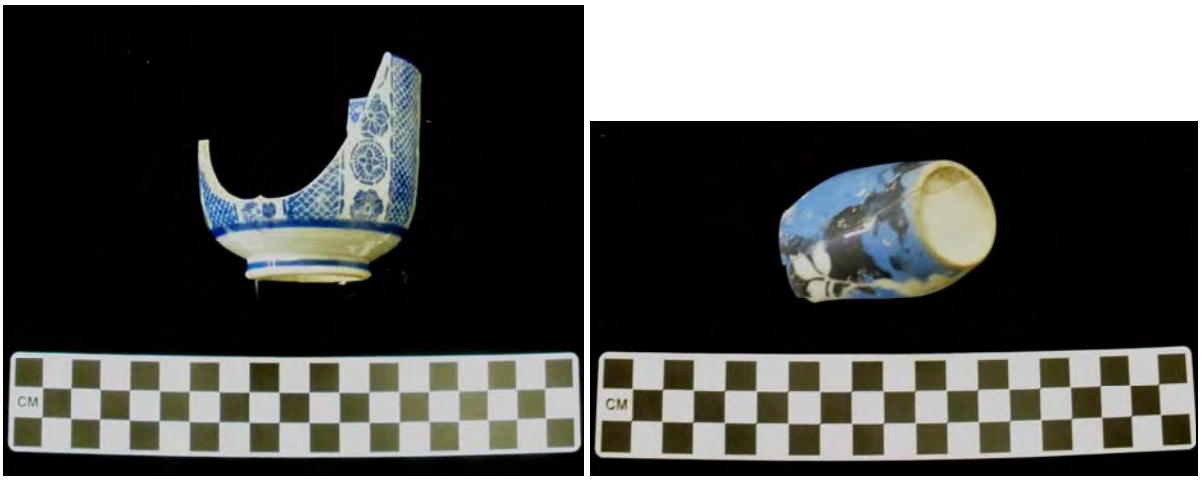

Figure 65. Ceramic Oriental tea cup (left) and sake cup (right)

Figure 66. Representative alcohol bottles present in the artifact assemblage

Two complete and one partial alcohol bottles were recovered with R & CO embossed on the base. This maker’s mark indicates the bottles were manufactured by Roth and Company of San Francisco between 1880 and 1890 (Toulouse 1971: 439). Mold numbers are also present on two of the bottle bases. These bottles likely contained beer.

A partial brown alcohol bottle was recovered with the maker’s mark A B Co/ 9 embossed on its base. The ABC maker’s mark represents the American Bottle Company of Chicago, Illinois. The number 9 likely represents the number for the Streator, Illinois plant. This plant was in operation between approximately 1885 and 1930, indicating the bottle was manufactured sometime during this period. The American Bottling Company had been formed as a result of mergers of the Ohio Bottling Co., the Streator Bottle and Glass Co., and the Adolphus Busch Glass Manufacturing Co. American Bottling Company eventually merged with Owens-Illinois Glass Co., which is still in business today (Toulouse 1971: 31).

The only alcohol bottle of local manufacture present in the artifact assemblage was made by the Honolulu Brewing Company. The bottle is clear and embossed on the body with HONOLULU BREWING AND MALTING CO.LTD/ HONOLULU, T.H. It was manufactured by 3 part mold, has a tooled lip and crown top finish, and is embossed with 2833 and the IPG Co diamond (very faint) underneath. The bottle was produced between 1911 and 1917 (Elliott and Gould 1987: 187). Honolulu Brewing and Malting Company began in 1901 and continued to manufacture beer until Prohibition between 1919 and 1933. Production was restarted in 1934 and continued until 1979 (www.lostvirtualtour.com).

Three soda bottles were recovered which contained local beverages (Figure 67). Of these three bottles, two were manufactured for Hollister Soda Works. The first is a complete aqua bottle embossed with HOLLISTER & CO/HONOLULU on the body and has a Hutchinson style stopper still intact; it was manufactured in the 1880s (Elliott and Gould 1988). The second is similar to the first with the same style of embossing on the body and the same style Hutchinson stopper; the difference is a rounded base which indicates it was manufactured in the 1890s. Hollister Soda Works was one of the first soda producers in Hawai‘i and, in 1863, was originally known as Hollister and Hyland before breaking off to form Hollister Soda Works in 1868. The company expanded to include perfume and tobacco and eventually merged with Tahiti Lemonade Works in 1888 (Sabey 2007: 43).

The last soda bottle present in the assemblage was manufactured for the Honolulu Soda Water Company in 1912 (Elliott and Gould 1988:114). The bottle is light green and made by 4 piece mold with applied lip. The body is embossed with HONOLULU/ SODA WATER Co. LTD/ T.H./ BOTTLE IS NOT SOLD. A maker’s mark of a Maltese cross is present on the base. Honolulu Soda Water Company was founded in 1910 and produced 2 styles of stoppers: the Hutchinson and the BIMAL (Elliott 1971).

A medicine bottle with embossed maker’s mark is also present in the assemblage and consists of an incomplete brown bottle with square Hopkins style base (IMACS 1992). The bottle includes partial shoulders, body, and base (Figure 68 and Figure 69). The base is embossed with REED & CARNRICK/ PHARMACISTS/ N.Y. Reed and Carnrick were manufacturing chemists from 1876 to 1986. In 1899 they relocated from New York to New Jersey, which indicates this bottle was manufactured between 1876 and 1899. The content of the bottle is listed as peptonized cod liver oil and milk (Fike 1987: 1985).

Figure 67. Representative soda bottles present in the artifact assemblage

Figure 68. Reed and Carnrick Pharmacy medicine bottle

Figure 69. Maker’s mark on the base of the Reed and Carnrick Pharmacy medicine bottle

Figure 70. Ed Pinaud perfume bottle fragment

A women’s perfume bottle is also present in the assemblage (Figure 70). The bottle is embossed on the body and base with ED PINAUD and has a Hopkins square base; it was manufactured by ABM. Ed Pinaud began manufacturing perfume in 1810; however the type of manufacture of this bottle indicates it was produced after 1904 (Rock 1981; Fike 1987: 67).

The other embossed vessel present in the diagnostic glass artifact assemblage is a light green, opaque, round jar embossed on the base with C S & CO/ 1185. This maker’s mark identifies Cannington, Shaw and Company of St. Helens, Lancastershire, England. In 1875, Edwin Cannington partnered with John Shaw and opened a glass factory in St. Helens. In 1913, Cannington Shaw merged with United Glass Bottle Manufacturers and the maker’s mark was modified. Hence, this vessel dates between 1875 and 1913. Toulouse mentions these vessels are common food containers found in ghost towns of the west (Toulouse 1971:147-149).

In addition to the diagnostic glass bottles, 1 large stoneware bottle is also present in the assemblage (Figure 72). It consists of a machine made stoneware bottle with handmade handle and is missing the neck and finish. The maker’s mark, BLANKENHEYM & NOLET, is stamped on the shoulder of the vessel. Blankenheym & Nolet were a Netherlands-based company that exported mineral water and case gin in the late 1800s (Perzinski et al. 2000).

One diagnostic ceramic shard is also present in the assemblage. It is a plate base with a Royal Ironstone maker’s mark imprinted (Figure 73). The plate is made of white paste and clear glaze. No decoration was present on the shard. The maker’s mark likely represents E. Challinor & Company, which operated in England between 1842 and 1891 (http://bickler.co.nz.).

Figure 71. Light green storage jar

Figure 72. Blankenheym and Nolet mineral water container

Figure 73. Royal Ironstone china plate fragment with E. Challinor maker’s mark

Table 4. Diagnostic bottles present in the artifact assemblage.

Acc #	Trench	Feature	Stratum	Color	Ht. (cm)	Dia. (cm)	Mfg. Tech.	Lip Finish	Lip Type	Embossing and other comments	Function	Date
5	1		Ia	dark green	11.5	8.6	cup mold	unknown	unknown	none; push-up present on the base	spirits	1870-1910
6	1		Ia	clear	3.2	3	ABM	ABM	flared	NORWESCO embossed on neck	spice bottle	1904-present
13	1		II	dark green	11.6	2.8	unknown	tooled lip	brandy or wine	partial lip and finish of a spirits bottle	spirits	1840-1920
15	1		II	aqua	19.1	3	turn mold	Applied	blob top	HOLLISTER & Co/HONOLULU (body); 2 piece Hutchinson style stopper (portion of wire still inside bottle)	soda	1880s
16	1		II	clear	7.1	4.1	ABM	unknown	unknown	ED PINAUD PARIS (body)/ED PINAUD (base)	perfume	1904-present
17	1		II	light green	29.5	7.5	cup mold	Applied	wine	none; push-up present on the base; cork still present inside	wine	1880s-1910
25	2		Ic	olive green	23.3	7.3	turn mold	tooled lip	blob top	none; no maker’s mark	spirits	pre-1890
27	2		II	olive green	24.3	7.4	turn mold	tooled lip		none	spirits	1870s-1920s
28	2		II	dark green	19	7.4	turn mold	tooled lip		JOHANN HOFF embossed on shoulder; Johann Hoff's malt extract was introduced in 1847 and marked as Beer of Health - introduced in US in 1866 (Fike 1987:166)	spirits	1870s-1920s
29	2		II	amber	23.5	7.5	turn mold	unknown	unknown	none	likely spirits	1870-1910
30	2		II	clear	12.1	4.8	ABM	flat	ABM	concentric circles on shoulder and heel	mustard	pre-1900
31	2		II	amber	22.4	6.2	post mold	unknown	unknown	R & Co; Roth and Company of San Francisco	beer or whiskey	1881-1890
32	2		II	amber	24.1	6.1	turn mold	Applied	beer	none	beer	1870s-1920s

Acc #	Trench	Feature	Stratum	Color	Ht. (cm)	Dia. (cm)	Mfg. Tech.	Lip Finish	Lip Type	Embossing and other comments	Function	Date
41	2		II	aqua	16.4	6.1	side seams present	Applied		no maker’s mark present	spice bottle	1850s-1860s
45	2		II	green	23.1	7.4	turn mold	Applied	blob top	no maker’s mark present	spirits or soda	1870-1910
46	2		II	green	23.5	5.9	turn mold	tooled lip	champaign e	no maker’s mark present; kickup present on base	champagne or wine	1870-1910
51	3			brown	15.1	6.6	post mold	unknown	unknown	ABC/9 embossed on the base	beer or soda	1905-1916
58	3	A/B		light green	13.1	4.6	3 part mold unknown		unknown	slight kick up on base	elixer or medicine	1870-1910
63	3	A/B		cobalt	16.3	3.9	3 part mold unknown	tooled lip	oil or ring	cobalt blue bottle with ring or oil finish and 3 part mold; likely used for medicinal oil	medicinal oil	1870-1910
64	3	A/B		clear	14.1	4.7	3 part mold unknown		prescription	square bottle with prescription finish likely used for medicine; 1232 embossed on the base	medicine bottle	1870-1910
65	3	A/B		clear	12.8	4.4	3 part mold unknown	screw top	screw top	clear glass bottle with screw top and french square base; embossed with I.P. G. CO.83 4 on the heel; 3 part mold; Illionois Pacific Glass Company	likely soda	1902-1925
66	3	A/B		olive green	23.6	6.1	turn mold	tooled lip	champagne	olive green bottle with applied lip, champagne finish, turn mold and slight kickup base; likely a champagne bottle	champagne or wine	1870s-1920s
67	3	A/B		amber	24.1	6.1	3 part mold unknown	tooled lip	ring or oil	embossed on base with R & CO/ 14	whiskey or beer	1879-1888
68	3	A/B		green	16	7.2	turn mold	unknown	unknown	slight push up on base and circle embossed; no other defining characteristics	likely spirits	1870s-1920s
69	3	A/B		clear	23.8	6.3	turn mold	Applied	ring or oil	no maker’s mark or other defining characteristics		1870s-1920s

Acc #	Trench	Feature	Stratum	Color	Ht. (cm)	Dia. (cm)	Mfg. Tech.	Lip Finish	Lip Type	Embossing and other comments	Function	Date
72	3	A/B		amber	21.6	6.4	turn mold	tooled lip	ring or oil	no maker’s mark present	likely beer or spirits	1870s-1920s
74	3	A/B		clear light green	23.2	5.6	4 piece mold	Applied	crown top	clear light green bottle with HONOLULU/ SODA WATER CO .LTD/ T. H./ BOTTLE IS NOT SOLD; maker’s mark of Maltese Cross on base	soda water	1912
75	3	A/B		dark green	31.1	8.6	turn mold	tooled lip	champagne	champagne bottle; no maker’s mark; kick up on base	champagne or wine	1870s-1920s
76	15	A	Ia, Ib, II	light clear green	15.4	7.3	turn mold	unknown	unknown	light clear green bottle fragment consisting of partial body and full base; no maker’s mark, mold number present 42/S	likely spirits or mineral water	1870s-1920s
77	15	A	Ia, Ib, II	dark green	24.1	7.1	turn mold	tooled lip	champagne	dark green bottle complete; applied lip and turn mold seam; no maker’s mark; likely champagne or wine	likely champagne or wine	1870s-1920s
79	15	A	Ia, Ib, II	brown	23.5	6.2	turn mold	Applied	ring or oil	complete brown glass bottle with tooled lip and turn mold; no maker’s mark, slight kickup and stippling on base	beer or whiskey	1870s-1920s
82	15	A	Ia, Ib, II	dark green	11.0	6.5	turn mold	unknown	unknown	partial dark green bottle consisting of partial body and base; turn mold, slight kick up; no maker’s mark	likely champagne or wine	1870s-1920s
83	15	A	Ia, Ib, II	dark green	19.2	6.8	turn mold	unknown	unknown	partial dark green bottle consisting of body and base; turn mold, slight kick up; no maker’s mark	likely champagne or wine	1870s-1920s
85	15	A	Ia, Ib, II	brown	24.4	6.4	turn mold	Applied	double oil or mineral	complete brown glass bottle with tooled lip and turn mold; no maker’s mark, slight kickup and stippling on base	likely beer or whiskey	1870s-1920s
86	15	A	Ia, Ib, II	brown	24.4	6.2	turn mold	Applied	double oil or mineral	complete brown glass bottle with tooled lip and turn mold; no maker’s mark, slight kickup and stippling on base	likely beer or whiskey	1870s-1920s

Acc #	Trench	Feature	Stratum	Color	Ht. (cm)	Dia. (cm)	Mfg. Tech.	Lip Finish	Lip Type	Embossing and other comments	Function	Date
90	8		II	aqua	21.1	2.7	3 part mold unknown	Applied	blob top	1 complete aqua bottle with rounded base, 3 part mold; blob top finishe; embossed with HOLLISTER & CO/HONOLULU; Hutchinson stopper	soda water	1890s
91	8		II	aqua	16.8	5.9	2 piece mold	Applied		1 complete aqua bottle with fluted oblong (variant 1) base, tooled lip; 2 piece hinge mold; likely a 1850s-1860s spice bottle (www.sha.org)	spice bottle	1850s-1860s
92	8		II	green	24	6.6	turn mold	Applied	blob top	1 complete green bottle; turn mold; tooled lip; blob top; part of foil wrapper still present on neck and finish	likley wine or mineral water (IMACS 1992)	1870s-1920s
93	8		II	green	17.4	7.1	turn mold	unknown	unknown	1 partial green bottle consisting of the body and base; turn mold; big kick up	likely champagne or wine	1870s-1920s
94	8		II	green	23.6	6.4	2 piece mold	Applied	oil or ring	1 complete green bottle; 2 piece bottom hinged mold; tooled finish; mold number 618 embossed on the bottom	wine or mineral water	1810-1880
95	8		II	amber	23.6	6.3	turn mold	Applied	oil or ring	1 complete amber bottle; turn mold, tooled lip; some foil still visible on neck	beer	1860s-1920s
101	10		II	dark aqua	26.0	6.4	turn mold	unknown	unknown	1 partial dark green bottle; base is broken and missing part of neck and finish; glass is very bubbly and appears crude; turn mold	unknown	1870s-1920s
102	10		II	clear	15.4	5.1	3 part mold unknown	flat	prescription	1 complete clear glass prescription medicine bottle; 3 piece mold; flat prescription lip; ringed collar; O embossed on the base; Blake (variant 1) style base; flat side panels no maker’s mark	medicine bottle	1870-1910

Acc #	Trench	Feature	Stratum	Color	Ht. (cm)	Dia. (cm)	Mfg. Tech.	Lip Finish	Lip Type	Embossing and other comments	Function	Date
103	10		II	aqua	15.5	5.3	4 part mold unknown	flat	prescription	1 complete aqua glass prescription medicine bottle; 3 piece mold; flat prescription lip; Blake (variant 1) style base; flat side panels no maker's mark	medicine bottle	1870-1910
105	10		II	clear	30.1	7.4	3 part mold unknown	tooled lip	crown top	1 complete clear glass bottle embossed on side with HONOLULU BREWING AND MALTING CO.LTD/ HONOLULU, T.H.; 3 part mold; tooled lip; crown top finish; embossed with 2833 and the IPG Co diamond (very faint) underneath.	beer	1911-1917
107	10		II	brown	26.0	7.9	turn mold	unknown	unknown	1 partial brown glass bottle missing neck and finish; turn mold; kick up present on base; no other identifiable characteristics	beer	1870s-1920s
108	5		Ic, II	brown	18.3	6.3	turn mold	unknown	unknown	2 partial brown glass bottle missing neck and finish; turn mold; kick up present on base; no other identifiable characteristics	beer	1870s-1920s
109	5		Ic, II	green	11.0	3.1	unknown	Applied	2 piece possibly grooved ring	1 green glass bottle fragment consisting of partial shoulders, neck, and finish; hand tooled 2 piece finish with uneven lip and a good amount of slop over; no other defining characteristics	champagne or wine	1840-1860
110	5		Ic, II	amber	11.5	5.7	unknown	unknown	unknown	1 partial brown glass square medicine bottle consisting of partial shoulders, body, and base; basew embossed with REED & CARNRICK/ PHARMACISTS/ N.Y.	Peptonized Cod Liver Oil and Milk	1876-1899

Acc #	Trench	Feature	Stratum	Color	Ht. (cm)	Dia. (cm)	Mfg. Tech.	Lip Finish	Lip Type	Embossing and other comments	Function	Date
112	5		Ic, II	green	23.3	7.3	turn mold	Applied	blob top	1 complete green glass bottle; turn mold; hand tooled blob top finish; round suction scar on base.		1860s-1920s
113	5		Ic, II	green	25.4	7	turn mold	tooled lip	champagne	1 complete green champagne or wine bottle; turn mold, applied lip; kick up on base	champagne or wine	1870s-1920s
115	5		Ic, II	green	23.5	7.1	turn mold	Applied	blob top	1 complete green glass bottle; turn mold; hand tooled blob top finish; round suction scar on base.		1860s-1920s
116	5		Ic, II	brown	19.8	6.6	turn mold	unknown	unknown	1 partial brown bottle missing part of neck and finish; turn mold; no other defining characteristics	whiskey or beer	1870s-1920s
117	5		Ic, II	brown	21.0	7.5	3 part mold unknown	unknown	unknown	1 partial brown bottle missing part of neck and finish; turn mold; embossed with R & CO/ 17 on base	whiskey or beer	1879-1888
118	5		Ic, II	brown	20.4	7.5	turn mold	unknown	unknown	1 partial brown bottle missing part of neck and finish; turn mold; no other defining characteristics	whiskey or beer	1870s-1920s
119	5		Ic, II		28.1	7.8	turn mold	Applied	2 piece	1 complete green glass bottle; turn mold; 2 piece lip; no other defining characteristics		1840-1860
120	5		Ic, II	green	23.4	8.9	turn mold	unknown	unknown	1 partial green champagne bottle with deep kick up, missing neck and finish; turn mold	champagne	1870s-1920s
121	5		Ic, II	green	29.3	8.9	turn mold	unknown	unknown	1 partial green champagne bottle with deep kick up, missing partial neck and finish; some glue residue still present from label on neck; turn mold	champagne	1870s-1920s
122	5		Ic, II	brown	36.0	7.4	turn mold	Applied	2 piece	1 complete brown bottle; glue residue and part of the metal stopper mechanism still present on the neck and finish; 2 piece finish; turn mold; slight kick up	whiskey or beer	1860s-1920s

Acc #	Trench	Feature	Stratum	Color	Ht. (cm)	Dia. (cm)	Mfg. Tech.	Lip Finish	Lip Type	Embossing and other comments	Function	Date
123	5		Ic, II	green	29.1	8.7	turn mold	Applied	3 piece	1 complete green champagne bottle; turn mold; champagne lip; kick up on base	champagne	1860s-1920s
130	8		II	green	16.8	9.3	unknown	tooled lip	large blob top	1 light green, opaque, round jar embossed on the bottom with C S & CO/ 1185	storage vessel	1875-1913

Section 6 Summary and Interpretation

The current project area is located in Ka‘ākaukukui ‘Ili, within the greater area now known as Kaka‘ako. Background research indicates a low intensity of use in the vicinity of the current project area in pre-contact and early post contact times. The area was generally low-lying and marshy. Kaka‘ako was considered outside the Honolulu town boundary and was used in the mid to late 1800s as a place for cemeteries, burial grounds, and for the quarantine of contagious patients. From pre-contact times into the early 1900s, the land in Ka‘ākaukukui was also used to produce salt. Major land reclamation projects of the late 1800s and early 1900s transformed the low-lying marsh lands into dry land for the expanding urban Honolulu area.

Kaka‘ako grew rapidly in the first decades of the twentieth century. Development in the immediate vicinity of the current project area began circa 1913, with the construction of the Pohukaina School. A variety of residential “dwellings” were present within the project area by 1914. By 1927, Pohukaina School had expanded into the project area and covered the entire block by 1950. Classroom buildings were aligned along Keawe, Coral, and Halekauwila streets, arranged around the perimeter of the current project area. Pohukaina School was present within the project area until it was demolished in 1980. Following the demolition of the school, the project area was paved over and has been used as a public parking lot.

The findings of the current archaeological assessment study are consistent with expectations based on background research. No surface structures are present within the project area. Subsurface testing revealed several historic and modern fill layers overlying the natural sediments. The natural sandy clay sediments are typical of a wet, marsh-type environment. Fill layers overlying the natural sediments included a layer of ash and burnt garbage, interpreted to be fill material generated by the city’s municipal garbage incinerator, and layers of sandy clay, interpreted to be fill material generated by the dredging of Honolulu Harbor and other coastal areas in the vicinity. The presence of the dredge fill material and incinerator fill material is consistent with background research of Kaka‘ako land reclamation projects in the late 1800s and early 1900s. The upper terrigenous fill layers included construction debris and abandoned utilities, evidence of the former Pohukaina School.

No significant cultural material was encountered through the subsurface tesing program. However, the archaeological record, including the identification of three burials near the intersection of Halekauwila and Keawe streets and 8 burials near the intersection of Coral and Halekauwila streets (both addressed in Winieski and Hammatt 2000), clearly suggests a pattern of pre-contact human interment in the vicinity.

Section 7 Project Effect and Mitigation Recommendations

The following project effect discussion and cultural resource management recommendations are intended to facilitate project planning and support the project’s required historic preservation consultation. This discussion is based on the results of this archaeological assessment and CSH’s communication with agents for the project proponents regarding the project’s potential impacts to historic properties.

7.1 Project Effect

The proposed Halekauwila Place Project consists of development of a mixed-income urban housing community, including: a 19-story residential tower with ground-level retail and meeting spaces; condominium townhomes; and a multi-level parking garage with ground-level retail spaces. Minimally, land disturbing activities would include: grubbing and grading; excavations for building foundations and subsurface utilities; and associated infrastructure improvements. The proposed project’s area of potential effect (APE) is defined as the entire 1.25-acre project area.

No historic properties were identified during the current archaeological assessment study. However, based on background research, including the previous identification of human skeletal remains in the immediate vicinity of the project area, there is potential for encountering human skeletal remains within the natural sandy clay-type sediments underlying fill material in the project area. Due to the potential adverse effect on significant historic properties within the project’s APE, specifically inadvertent burial discoveries, CSH’s project-specific effect recommendation is “effect, with proposed mitigation commitments.” The recommended mitigation measures will reduce the project’s potential adverse effect to significant historic properties.

7.2 Mitigation Recommendations

To reduce the proposed project’s potential adverse effect on significant historic properties, the following mitigation measures are recommended. The mitigation measures should be completed prior to any land disturbing activities associated with the proposed Halekauwila Place Project.

1. Archaeological monitoring is recommended during all land disturbing activities within the project area. Archaeological monitoring will ensure proper treatment and documentation should any historic properties be discovered during project-related construction activities.
2. An archaeological monitoring plan should be prepared for review and approval of the State Historic Preservation Divison (SHPD) prior to project construction. In accordance with HAR 13-279, the monitoring plan should detail specific archaeological monitoring provisions.

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Appendix A SHPD Acceptance of Archaeological Inventory Survey Plan

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RUSSELL Y. TSUJI
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KEN C. KAWAHARA
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
601 KAMOKILA BOULEVARD, ROOM 555
KAPOLEI, HAWAII 96707

August 12, 2008

David Shideler
Cultural Surveys Hawai`i, Inc.
P.O. Box 1114
Kailua Hawai`i 96734

LOG NO: 2008.2059
DOC NO: 0808LM05
Archaeology

Dear Mr. Shideler:

SUBJECT: Chapter 6E-8 Historic Preservation Review –
Archaeological Inventory Survey Plan for the Proposed Halekauwila Place Project
Kaka`ako Ahupua‘a, Kona District, Island of O‘ahu
TMK: (1) 2-1-051:008 & 009 por.

Thank you for the opportunity to review the aforementioned revised plan (Hammatt, and Shideler 2008), which we received on June 2, 2008. We apologize for the delay in our review. The plan details the program of subsurface archaeological testing to be conducted for the proposed Halekauwila Place Project. Eighteen trenches utilizing a combination of mechanical and manual excavation will be excavated across the parcel in order to identify any buried cultural deposits and/or human burials. If the project demonstrates intact cultural deposits more excavations may be warranted in order to further define the nature and extent of the deposits. If human burials are identified additional testing in the direct vicinity of the burials may be warranted as well. This testing may be in the form of additional trenches and/or block excavations around the identified feature(s).

The revisions requested in our previous review letter, Log No. 2007.2277 Doc No. 0804ED23, have been incorporated into the revised plan. This plan is now accepted as satisfying the requirements of Hawai`i Administrative Rules (HAR) Chapter 13-275-5(c).

Please contact Lauren Morawski (O‘ahu Archaeologist) at (808) 692-8015 if you have any questions or concerns regarding this letter.

Aloha,

Nancy McMahon

Nancy McMahon, Archaeology and Historic Preservation Manager
State Historic Preservation Division

Appendix B Master Artifact Accession Table

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
1	historic	metal	unknown		1	Ia	8-42	1	23	4.2	metal is flat with bulbous-like end; corroded; unknown function
2	shell - rough periwinkle (*Littoraria scabra*)	marine	shell fish of the family Littorinidae		1	Ia	8-42	1	3.1	2.2	complete specimen
3	faunal	bone	pig bone		1	Ia	8-42	1	7.1	0.9	fragment of pig long bone with cut marks on dorsal side and some evidence of burning
4	historic	glass	plate glass		1	Ia	8-42	1	7.5	7.7	fragment of fairly thick glass plate; patena on both sides
5	historic	glass	bottle		1	Ia	8-42	1	11.5	8.6	partial body and full base of a green glass bottle with push up and air bubbles; seam molds are present around the base.
6	historic	glass	medicine bottle		1	Ia	8-42	1	5.5	4.3	lip and partial shoulder of a clear glass bottle with NORWESCO embosssed on the neck; side seams present on both sides through the lip; lip is slightly flared, prescription; bottle is ABM
7	historic	ceramic	bowl		1	Ia	8-42	2	18	10.3	2 pieces, refit, of a ceramic bowl with white paste, clear glaze and painted blue and brown stripes.
8	historic	ceramic	bowl		1	Ia	8-42	1	6.1	5.6	1 ceramic sherd consisting of partial body and base of a bowl with white paste and clear glaze. Same painted stripes as # 8.
9	historic	ceramic	unknown		1	Ia	8-42	1	6.4	4.3	1 ceramic sherd consisting of partial body of a bowl with white paste and clear glaze. Hand painted blue stripe around rim and star pattern of blue, black, and green on body.
10	historic	crockery	bowl		1	II	101-155	1	8.9	8.9	1 crockery sherd with gold paste and clear glaze; decorative pattern of blue stripes and fern imprint on exterior.

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
11	historic	ceramic	plate		1	II	101-155	1	11	8.7	1 ceramic sherd of a plate base with Royal Ironstone china maker’s mark on base. Ceramic is white paste with clear glaze, no decoration. E. Challinor & Co 1842-1891(http://bickler.co.nz)
12	historic	crockery	bowl		1	II	101-155	1	10	6.8	1 crockery sherd of partial base and body, with white paste and clear crackle glaze; no maker’s mark
13	historic	glass	bottle		1	II	101-155	1	11.6	2.8	partial neck and full finish of dark green bottle; likely for spirits
14	historic	glass	cup		1	II	101-155	1	9.2	6	clear glass cup; fragmented; no maker’s mark
15	historic	glass	bottle		1	II	101-155	1	19.1	3	complete aqua glass Hollister Soda bottle; 1880s
16	historic	glass	bottle		1	II	101-155	1	7.1	4.1	clear glass perfume bottle; Ed Pinaud Perfumery since 1810 through at least 1984 (Fike 1987: 67).
17	historic	glass	bottle		1	II	101-155	1	29.5	7.5	light green glass wine bottle with push up base
18	historic	glass	bottle		1	II	101-155	2	20	6.2	aqua glass drugstore bottle with rectangular base and flat lip
19	historic	ceramic	saucer - partial		2	Ia	8-39	1	5.8	3.3	partial ceramic saucer with white paste and clear glaze; metal rust staining present; no maker’s mark
20	historic	stoneware	bowl		2	Ia	8-39	1	6.1	4.5	fragment of ceramic crockery, possibly a bowl, with tan paste and clear glaze; imprinted decoration present as a series of circles forming a line, present on a portion of the dorsal edge
21	historic	stoneware	vase		2	Ia	8-39	2			2 fragments of thick crockery, likely a vase, with white paste, coarse temper and clear green glaze; imprinted decoration; no maker’s mark
22	historic	glass	bottle		2	Ic	42-119	1	10.2	2.6	partial neck and full finish of dark green bottle; tooled lip; likely for spirits
23	marine	cowry shell	shell fish		2	Ic	42-119	1	1.2	1.9	small cowry shell
24	historic	ceramic	building material		2	Ic	42-119	1	5.2	3.6	possible bathroom molding or tile; white paste, clear glaze

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
25	historic	glass	bottle		2	Ic	42-119	1	23.3	7.3	dark green bottle with blob top and turn mold seams; no maker’s mark
26	marine	oyster	shell fish		2	II	111-156	1	9	5.3	oyster shell
27	historic	glass	bottle		2	II	111-156	1	24.3	7.4	complete olive green bottle; tooled lip and turn mold seam; no maker’s mark
28	historic	glass	bottle		2	II	111-156	1	19	7.4	dark green bottle complete; tooled lip and turn mold seam; JOHANN HOFF embossed on shoulder
29	historic	glass	bottle		2	II	111-156	1	23.5	7.5	amber glass bottle missing most of neck and finish; no maker’s mark
30	historic	glass	jar		2	II	111-156	1	12.1	4.8	clear glass small barrel jar with concentric rings embossed on shoulders and heel; likely for mustard (Putnam 1965: 198)
31	historic	glass	bottle		2	II	111-156	1	22.4	6.2	amber glass bottle missing finish; embossed with maker’s mark on base R & CO/ 28
32	historic	glass	bottle		2	II	111-156	1	24.1	6.1	amber beer bottle; turn mold; applied finish
33	historic	glass	window		2	II	111-156	1	13.3	12	clear plate glass
34	historic	stoneware	bowl		2	II	111-156	1	8.3	5.5	1 ceramic rim shard of crockery, likely a bowl; gold paste, clear glaze; painted design on exterior surface similar to #10
35	historic	ceramic	bowl		2	II	111-156	1	8.1	6.7	1 ceramic rim shard, likely a bowl;white paste, clear glaze; painted floral design on extereior, red line painted just below rim
36	historic	stoneware	bowl		2	II	111-156	2	17.6	12.4	2 shards of crockery -1 partial base and 1 body; likely parts of a bowl; white paste, coarse temper, clear glaze; no decoration
37	historic	ceramic	crockery		2	II	111-156	1	19.6	10.4	1 fragment of a mineral water container, cylindrical in shape; beige paste, coarse temper, clear glaze, no decoration or maker’s mark; looks similar in form to the other complete mineral water container in this collection
38	historic	china	saucer - partial		2	II	111-156	1	11.3	5.7	1 fragment (half) of a saucer with white paste and clear glaze; black floral print decoration is present on the anterior portion of the saucer as

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
											well as a hash-like incised pattern arranged in a circular pattern. Half of a maker’s mark is present on the base. China appears to be made in England, however there is insuffucient mark on the base to positively identify.
39	historic	glass	bottle		2	II	111-156	1	6.2	1.4	1 complete clear glass medicine bottle with prescription lip and side seams; no maker’s mark -sold as homeopathic tube vials (Putnam 1965)
40	historic	ceramic	bowl		2	II	111-156	1	16.5	8.8	1 fragment of a large bowl with white paste, clear glaze, and blue floral decoration; no maker’s mark.
41	historic	glass	bottle		2	II	111-156	1	16.4	6.1	aqua glass bottle with air bubbles present in glass; fluted oblong (variant 1) base (IMACS 2001); likely a spice bottle
42	historic	glass	bottle		2	II	111-156	1	7.9	4.5	light green glass bottle fragment consisting of partial body and full base with mold number 271 embossed on the bottom. Bottle has an interior, vertically elongated air blister; likely a condiment bottle or a very small soda bottle
43	historic	glass	bottle		2	II	111-156	1	6.6	6.5	Light green fragment of a rectangular bottle with elixer or handy style base (IMACS 2001) and 2929 embossed on the base. Side seams indicated ABM. The glass of the body 0.8 cm thick.
44	historic	glass	bottle		2	II	111-156	1	3.3	3.3	approximately 1/2 of a clear bottle finish; appears to be tooled
45	historic	glass	bottle		2	II	111-156	1	23.1	7.4	green glass bottle with cup mold base and hand applied lip; no maker’s mark
46	historic	glass	bottle		2	II	111-156	1	18.2	6.3	portion of a dark green bottle -missing neck and finish; turn mold, stippled base
47	historic	glass	bottle		2	II	111-156	1	2.3.5	5.9	complete green bottle with portion of closing mechanism still present on the finish and neck. Small kickup present on base indicating contents of either champaigne or wine.

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
48	historic	faunal	pig long bone and vertabrae		2	Ic/II	111-156	3			3 pieces of faunal bone including 2 pieces of long bone and 1 vertabrae -likely pig
49	historic	faunal	pig, cow, chicken, and fish		3	Ib & Ic		35+			Over 35 fragments of faunal bone including pig, cow, chicken, and 1 large fish vertebrae
50	historic	faunal	pig		4	Ic		1			1 long bone, likely pig
51	historic	glass	bottle	A/B	3		31-150	1	15.1	6.6	amber bottle fragment consisting of body and base with post mold seams and ABC/9 embossed on the base
52	historic	glass	mug	A/B	3		31-150	1	2.9	6.9	clear glass mug base molded decoration; no maker’s mark
53	historic	glass	dish with pedestal	A/B	3		31-150	1	7.1	6.5	partial clear glass dish with pedestal type foot; no maker’s mark; 1 side seam present
54	marine	shell	rough periwinkle (*Littoraria scabra*)	A/B	3		31-150	1	2.5	2.3	complete shell
55	historic	ceramic	bowl	A/B	3		31-150	1	11.3	8.6	partial crockery bowl with white paste, coarse temper, clear glaze and gray floral imprint; no maker’s mark or defining characteristics
56	historic	glass	bottle	A/B	3		31-150	1	17.1	7.1	partial green glass bottle consisting of body and base; turn mold; no maker’s mark
57	historic	glass	bottle	A/B	3		31-150	1	11.8	2.6	partial green glass bottle consisting of shoulders, neck, and finish; grooved ring, tooled finish; elongated bubbles present in the glass indicate it could be hand blown
58	historic	glass	bottle	A/B	3		31-150	1	13.1	4.6	light green partial bottle consisting of partial neck, shoulders, body and base; 3 part mold seam and slight kick up on base 1870-1910 (Rock 1981)
59	historic	glass	bottle	A/B	3		31-150	1	5.4	4.6	partial amber bottle consisting of shoulders, neck, and finish; seams present on neck; prescription finish
60	historic	glass	bottle	A/B	3		31-150	1	11.6	2.7	partial light green bottle consisting of

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
											shoulders, neck and finish; tooled champagne finish
61	historic	glass	bottle	A/B	3		31-150	1	7.5	5.2	clear ink well with screw top finish and part of body and base missing; seam present on one side.
62	historic	glass	bottle	A/B	3		31-150	1	9.5	4.3	rectangular body and base of a clear glass bottle; embossed with CASTO on one side and CHAs.H. FLE on the other. -Chas. H. Fletcher/ Castoria, 1890s (Fike 1987: 162). Vegetable based oil used for regulating the stomach in infants and children
63	historic	glass	bottle	A/B	3		31-150	1	16.3	3.9	cobalt blue bottle with ring or oil finish and 3 part mold; likely used for medicinal oil
64	historic	glass	bottle	A/B	3		31-150	1	14.1	4.7	clear glass, square bottle with prescription finish likely used for medicine; 1232 embossed on the base
65	historic	glass	bottle	A/B	3		31-150	1	12.8	4.4	clear glass bottle with screw top and French square base; embossed with I.P. C. CO.83 4 on the heel; 3 part mold
66	historic	glass	bottle	A/B	3		31-150	1	23.6	6.1	olive green bottle with tooled lip, champagne finish, turn mold and slight kickup base; likely a champagne bottle
67	historic	glass	bottle	A/B	3		31-150	1	24.1	6.1	amber bottle with 3 part mold, tooled lip and embossed on base with R & CO/ 14
68	historic	glass	bottle	A/B	3		31-150	1	16	7.2	partial green glass bottle missing neck and finish; turn mold with slight push up on base and circular mark on base. No other defining characteristics.
69	historic	glass	bottle	A/B	3		31-150	1	23.8	6.3	clear glass bottle, with hand applied lip and turn mold; no maker’s mark
70	historic	stoneware	jug	A/B	3		31-150	1	28.2	11.9	large ceramic bottle missing neck and finish; tan paste, coarse temper, clear glaze; stamped with BLANKENHEYM & NOLET on the body; used for mineral water; late 1800s (Perzinski et al 1999)

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
71	historic	glass	jug	A/B	3		31-150	1	5.6	14.3	aqua glass jug base with large blisters in glass; possible 3 part mold; no maker’s mark or other definig characteristics
72	historic	glass	bottle	A/B	3		31-150	1	21.6	6.4	Complete amber glass bottle with turn mold and tooled lip; likely used for beer
73	historic	glass	bottle	A/B	3		31-150	1	21		clear glass bottle missing partial lip and base; shaped like a gin bottle but body has interior curve; 2 mold seams present on shoulders but disappear on body; lip is applied.
74	historic	glass	bottle	A/B	3		31-150	1	23.2	5.6	clear light green Honolulu bottle with HONOLULU/ SODA WATER CO .LTD/ T. H./ BOTTLE IS NOT SOLD/ ; maker’s mark on base
75	historic	glass	bottle	A/B	3		31-150	1	31.1	8.6	champagne bottle; no maker’s mark; kick up on base
76	historic	glass	bottle	A	15	Ia, Ib, II	80-140	1	15.4	7.3	light clear green bottle fragment consisting of partial body and full base; no maker’s mark, mold number present 42/S
77	historic	glass	bottle	A	15	Ia, Ib, II	80-140	1	24.1	7.1	dark green bottle complete; tooled lip and turn mold seam; no maker’s mark; likely champagne or wine
78	historic	stoneware	bowl or vase	A	15	Ia, Ib, II	80-140	1	7.1	5.0	stoneware shard of white paste, coarse temper, clear glaze; temper contains blue flecks; intereior incised decorative lines; no maker’s mark
79	historic	glass	bottle	A	15	Ia, Ib, II	80-140	1	23.5	6.2	complete brown glass bottle with applied lip and turn mold; no maker’s mark, slight kickup and stippling on base
80	historic	ceramic	bowl	A	15	Ia, Ib, II	80-140	1	8.3	13.4	partial ceramic rice bowl with white paste and celadon glaze; no decoration; oriental maker’s mark on base; most likely late 19th century Chinese rice bowl -"Wintergreen" pottery (Lister and Lister 1989: 50: Costello and Maniery 1988: 34-35)
81	historic	ceramic	bowl	A	15	Ia, Ib, II	80-140	1	7.3	14.0	partial ceramic rice bowl with gray paste, clear

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
											glaze and painted gray floral decoration on exterior; interior decorated with 2 gray concentric circles; no maker’s mark
82	historic	glass	bottle	A	15	Ia, Ib, II	80-140	1	11.0	6.5	partial dark green bottle consisting of partial body and base; turn mold, slight kick up; no maker’s mark
83	historic	glass	bottle	A	15	Ia, Ib, II	80-140	1	19.2	6.8	partial dark green bottle consisting of body and base; turn mold, slight kick up; no maker’s mark
84	historic	glass	bottle	A	15	Ia, Ib, II	80-140	1	4.7	3.1	partial light aqua square bottle consisting of shoulders, neck, and finish; prescription lip; partial embosssing on shoulders of FRANK
85	historic	glass	bottle	A	15	Ia, Ib, II	80-140	1	24.4	6.4	complete brown glass bottle with applied lip and turn mold; no maker’s mark, slight kickup and stippling on base
86	historic	glass	bottle	A	15	Ia, Ib, II	80-140	1	24.4	6.2	complete brown glass bottle with applied lip and turn mold; no maker’s mark, slight kickup and stippling on base
87	historic	copper	utensil	A	15	Ia, Ib, II	80-140	1	17.7	8.8	fragment of a copper cooking utensil, likely a flat spoon or possibly a very small pan
88	historic	ceramic	bowl	A	15	Ia, Ib, II	80-140	2	7.9	6.0	2 fragments of a ceramic bowl; white temper; clear glaze, copper paint; imprinted with stone pattern; no maker’s mark
89	historic	stoneware	plate	A	15	Ia, Ib, II	80-140	1	19.2	9.2	1 fragment of a stoneware plate; white paste, coarse temper; clear glaze, and blue transfer print pattern on interior; exterior also has a blue transfer print pattern of concentric circles on the body and a different swirl patter near the rim; no maker’s mark
90	historic	glass	bottle		8	II	Incinerator Fill	1	21.1	2.7	1 complete aqua bottle with rounded base, 3 part mold; blob top finish; embossed with HOLLISTER & CO/HONOLULU; Hutchinson stopper
9l	historic	glass	bottle		8	II	Incinerator Fill	1	16.8	5.9	1 complete aqua bottle with fluted oblong (variant 1) base, applied lip; 2 piece hinge

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
											mold; likely a 1850s-1860s spice bottle (www.sha.org)
92	historic	glass	bottle		8	II	Incinerator Fill	1	24	6.6	1 complete green bottle; turn mold; applied lip; blob top; part of foil wrapper still present on neck and finish
93	historic	glass	bottle		8	II	Incinerator Fill	1	17.4	7.1	1 partial green bottle consisting of the body and base; turn mold; big kick up; likely champagne or wine
94	historic	glass	bottle		8	II	Incinerator Fill	1	23.6	6.4	1 complete green bottle; 2 piece mold; applied finish; mold number 618 embossed on the bottom
95	historic	glass	bottle		8	II	Incinerator Fill	1	23.6	6.3	1 complete amber bottle; turn mold, applied lip; some foil still visible on neck
96	historic	ceramic	sake glass		8	II	Incinerator Fill	2	5.9	3.5	2 pieces (refit) of a ceramic sake glass with white paste, clear glaze; painted blue with clear floral design; no maker’s mark
97	historic	ceramic	tea cup		8	II	Incinerator Fill	1	6.3	3.7	1 partial ceramic glass likely used for tea; white paste, coarse temper; clear glaze; painted with a dark blue pattern and blue line around the rim, heal, and base of the cup; no maker’s mark
98	historic	ceramic	bowl		10	II		1	4.0	6.9	1 partial ceramic bowl made of white paste and clear glaze with a distinctive painted floral pattern interior and exterior; no maker’s mark
99	historic	clay	sewer pipe		10	II		1	11.4	7.1	1 fragment of red clay sewer pipe
100	historic	glass	bottle		10	II		1	10.2	5.5	1 fragment of a light green bottle, likely the neck and portion of shoulder to a Codd Marble Stopper style
101	historic	glass	bottle		10	II		1	26.0	6.4	1 partial dark green bottle; base is broken and missing part of neck and finish; glass is very bubbly and appears crude; turn mold
102	historic	glass	bottle		10	II		1	15.4	5.1	1 complete clear glass prescription medicine bottle; 3 piece mold; flat prescription lip; ringed collar; O embossed on the base; Blake (variant 1) style base; flat side panels no

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
											maker’s mark
103	historic	glass	bottle		10	II		1	15.5	5.3	1 complete aqua glass prescription medicine bottle; 3 piece mold; flat prescription lip; Blake (variant 1) style base; flat side panels no maker’s mark
104	historic	glass	bottle		10	II		1	12.7	6.5	1 partial brown glass bottle, burned, consisting of partial body and full base; base embossed with maker’s mark resembling C, likely a mold letter; bottle has been burned with high heat and is discolored, seams are indistinguishable
105	historic	glass	bottle		10	II		1	30.1	7.4	1 complete clear glass bottle embossed on side with HONOLULU BREWING AND MALTING CO.LTD/ HONOLULU, T.H.; 3 part mold; tooled lip; screw top finish; embossed with 2833 and the IPG Co diamond (very faint) underneath.
106	historic	glass	bottle		10	II		1	6.0	3.3	1 partial clear glass medicine bottle consisting of lip, neck and partial shoulders; prescription lip; 2 seams visible, no other identifiable characheristics
107	historic	glass	bottle		10	II		1	26.0	7.9	1 partial brown glass bottle missing neck and finish; turn mold; kick up present on base; no other identifiable characteristics
108	historic	glass	bottle		5			1	18.3	6.3	1 partial brown glass bottle missing neck and finish; turn mold; kick up present on base; no other identifiable characteristics
109	historic	glass	bottle		5			1	11.0c	3.1	1 green glass bottle fragment consisting of partial shoulders, neck, and finish; hand applied 2 piece finish with uneven lip and a good amount of slop over; no other defining characteristics
110	historic	glass	bottle		5			1	11.5	5.7	1 partial brown glass square medicine bottle consisting of partial shoulders, body, and base; basew embossed with REED & GARNRICK/ PHARMACISTS/ N.Y.

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
111	historic	glass	bottle		5			1	7.0	7.4	1 partial aqua glass rectangular, side panel, medicine bottle fragment consisting of partial body and base; embossed on all sides PARILLA/ RIES/ Co/ 93
112	historic	glass	bottle		5			1	23.3	7.3	1 complete green glass bottle; turn mold; hand applied blob top finish; round suction scar on base.
113	historic	glass	bottle		5			1	25.4	7	1 complete green champagne or wine bottle; turn mold, tooled lip; kick up on base
114	historic	glass	bottle		5			1		7.5	1 light green, round bottle base with embossed star; seam on heel
115	historic	glass	bottle		5			1	23.5	7.1	1 complete green glass bottle; turn mold; hand applied blob top finish; round suction scar on base.
116	historic	glass	bottle		5			1	19.8	6.6	1 partial brown bottle missing part of neck and finish; turn mold; no other defining characteristics
117	historic	glass	bottle		5			1	21.0	7.5	1 partial brown bottle missing part of neck and finish; turn mold; embossed with R & CO/ 17 on base
118	historic	glass	bottle		5			1	20.4	7.5	1 partial brown bottle missing part of neck and finish; turn mold; no other defining characteristics
119	historic	glass	bottle		5			1	28.1	7.8	1 complete green glass bottle; turn mold; 2 piece tooled lip; no other defining characteristics
120	historic	glass	bottle		5			1	23.4	8.9	1 partial green champagne bottle with deep kick up, missing neck and finish; turn mold
121	historic	glass	bottle		5			1	29.3	8.9	1 partial green champagne bottle with deep kick up, missing partial neck and finish; some glue residue still present from label on neck; turn mold
123	historic	glass	bottle		5			1	36.0	7.4	1 complete brown bottle; glue residue and part of the metal stopper mechanism still present on the neck and finish; 2 piece tooled finish; turn

Acc. #	Artifact Type	Material Type	Function	Feature	Trench	Stratum	Depth (cmbs)	# of Pieces	Length (cm)	Width (cm)	Comments
											mold; slight kick up
124	historic	glass	bottle		5			1	29.1	8.7	1 complete green champagne bottle; turn mold; champagne lip; kick up on base
125	historic	leather	belt		5			2	30	2.6	2 pieces of a hand tooled leather belt, burned
126	historic	metal	strapping		5			1	18	2.3	1 fragment of corroded metal strapping
127	historic	glass	stopper		6	Ib		1	3.2	2.9	1 clear glass bottle stopper; no other defining characteristics
128	historic	leather	shoe sole		8	II	Incinerator Fill	1	10.3	5.5	1 piece of leather shoe sole
129	historic	faunal	pig long bone		8	II	Incinerator Fill	1			1 long bone fragment; likely pig
130	historic	glass	jar		8	II	Incinerator Fill	1	16.8	9.3	1 light green, opaque, round jar embossed on the bottom with C S & CO/ 1185
131	historic	faunal	pig bones		6	II	130-150	11			rib and long pig bones
131	historic	marine	cowry shell		6	II	130-150	1			1 cowry shell
132	historic	faunal	cow		17	Ic	55-92	7			cow rib bones
133	historic	faunal	cow		13	Ic & Id		2			butchered cow rib bones
134	historic	glass	bottle		13	Ic & Id		1	11.7	4.3	1 complete clear glass oriental medicine bottle with oriental characters embossed on 1 side panel; 2 piece mold; prescription finish; no maker’s mark
135	historic	soil	soil sample		14	II	111-137				soil sample
136	historic	soil	soil sample		15	III					soil sample

Traffic Impact Report

Halekauwila Place

Prepared for:
Halekauwila Partners, LLC

Prepared by:
Wilson Okamoto Corporation

October 2009

TRAFFIC IMPACT REPORT

FOR

HALEKAUWILA PLACE

Prepared for:

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I. INTRODUCTION

A. Purpose of Study

The purpose of this study is to identify and assess the traffic impacts resulting from a proposed affordable multi-family residential development in Kakaako on the island of Oahu. Halekauwila Place will include approximately 204 rental units, a parking garage, and amenities.

B. Scope of Study

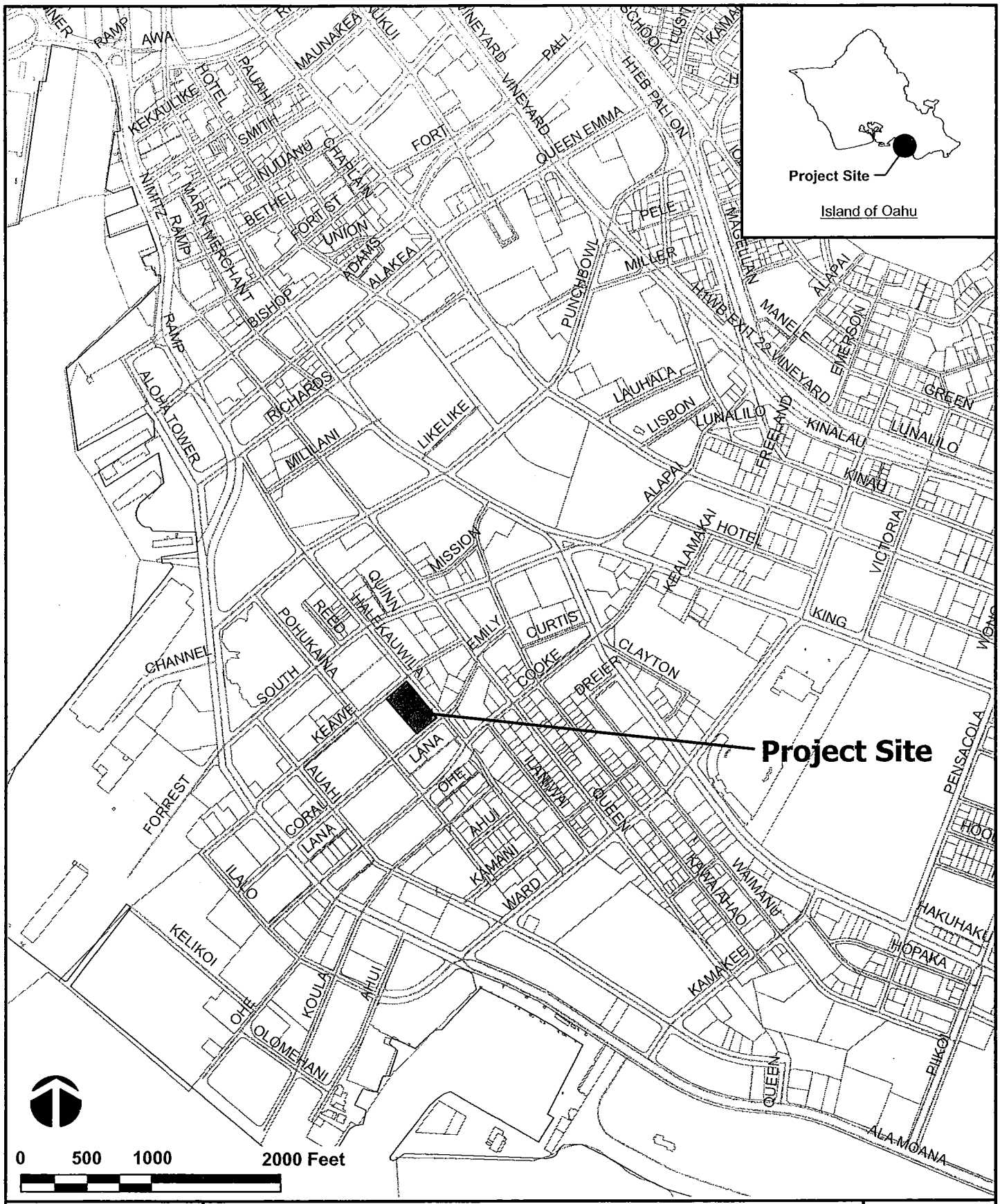
This report presents the findings and conclusions of the traffic study, the scope of which includes:

1. Description of the proposed project.
2. Evaluation of existing roadway and traffic operations in the vicinity.
3. Analysis of future roadway and traffic conditions without the proposed project.
4. Analysis and development of trip generation characteristics for the proposed project.
5. Superimposing site-generated traffic over future traffic conditions.
6. The identification and analysis of traffic impacts resulting from the proposed project.
7. Recommendations of improvements, if appropriate, that would mitigate the traffic impacts resulting from the proposed project.

II. PROJECT DESCRIPTION

A. Location

The proposed site is located adjacent to Halekauwila Street in Kakaako on the island of Oahu (see Figure 1) and is further identified as Tax Map Key: 2-1-051: por. 009. The site is bounded by Halekauwila Street to the north, Keawe Street to the west, a surface parking lot to the south, and Mother Waldren Park to the east. Primary access to the residential development will be provided via driveways off Halekauwila Street with a secondary driveway providing access to a loading area off Keawe Street.



WILSON OKAMOTO CORPORATION ENGINEERS - PLANNERS	HALEKAUWILA PLACE	FIGURE
	LOCATION AND VICINITY MAP	1

B. Project Characteristics

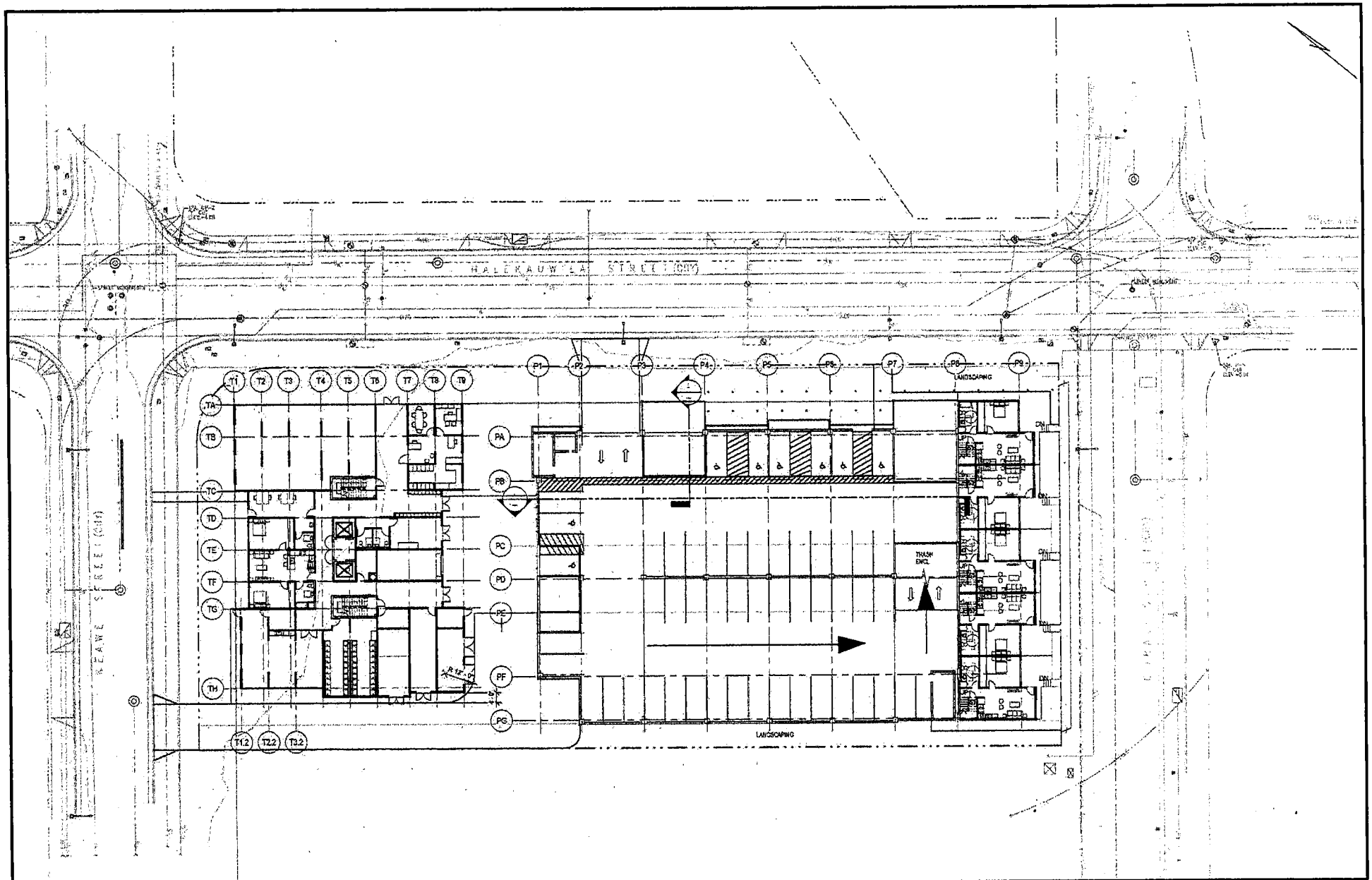
The proposed Halekauwila Place development will be located on a 1.25-acre parcel adjacent to Halekauwila Street that is currently utilized as a surface parking lot. The Honolulu Police Department (HPD) has a portable trailer stationed within the parking lot that serves as an office for HPD staff. The proposed project entails the construction of an 18-story residential tower with approximately 204 affordable rental units, a 4-story parking garage, office space for HPD staff, approximately 3,000 square feet of retail space, and amenities such as recreational and storage areas. Primary access will be provided via a new driveway off Halekauwila Street with secondary access provided off Keawe Street for a loading area. The proposed development is expected to be completed and occupied by the Year 2012. Figure 2 shows the proposed project site plan.

III. EXISTING TRAFFIC CONDITIONS

A. Area Roadway System

The proposed project site is located adjacent to Halekauwila Street in Kakaako. Halekauwila Street originates at Nimitz Highway as a one-lane, one-way (eastbound) roadway that transitions to a two-lane, two-way roadway at Punchbowl Street and terminates at Ward Avenue. At the northwest corner of the project site, Halekauwila Street intersects Keawe Street. At this all-way stop intersection, both approaches of Halekauwila Street have one lane that serves all traffic movements. Keawe Street is a predominantly two-lane, two-way roadway generally oriented in the north-south direction between Ilalo Street and Queen Street. At the intersection with Halekauwila Street, the Keawe Street approaches have one lane that serves all traffic movements.

East of the intersection with Keawe Street, Halekauwila Street intersects Coral Street. At this uncontrolled T-intersection, the eastbound approach of Halekauwila Street has one lane that serves left-turn and through traffic movements while the westbound approach has one lane that serves through and right-turn traffic movements. Coral Street is a predominantly two-lane, two-way roadway generally oriented in the north-south direction. The northern segment of Coral Street extends between Queen Street and Halekauwila Street while the southern segment extends



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HALEKAUWILA PLACE

PROPOSED SITE PLAN

FIGURE 2

between Pohukaina Street and Ala Moana Boulevard. At the intersection with Halekauwila Street, the Coral Street approach has one stop-controlled lane that serves left-turn and right-turn traffic movements.

Further east, Halekauwila Street intersects Cooke Street. At this all-way stop intersection, both approaches of Halekauwila Street have one lane that serves all traffic movements. Cooke Street originates at Ilalo Street as a two-lane, two-way roadway, transitions to a four-lane roadway between Ala Moana Boulevard and Kapiolani Boulevard, then returns to a two-lane roadway until its terminus at South King Street. At the intersection with Halekauwila Street, both approaches of Cooke Street have a shared left-turn and through lane and a shared through and right-turn lane.

South of the intersection with Halekauwila Street, Keawe Street intersects Pohukaina Street. At this all-way stop intersection, both approaches of Keawe Street have one lane that serves all traffic movements. Pohukaina Street is a two-lane, two-way roadway generally oriented in the east-west direction between Punchbowl Street and Kamani Street. At the intersection with Keawe Street, both approaches of Pohukaina Street have one lane that serves all traffic movements.

East of the intersection with Keawe Street, Pohukaina Street intersects Coral Street. At this uncontrolled T-intersection, the eastbound approach of Pohukaina Street has one lane that serves through and right-turn traffic movements while the westbound approach has one lane that serves left-turn and through traffic movements. The Coral Street approach has one stop-controlled lane that serves left-turn and right-turn traffic movements.

Further east, Pohukaina Street intersects Cooke Street. At this all-way stop intersection, both approaches of Pohukaina Street have one lane that serves all traffic movements while both approaches of Cooke Street have a shared left-turn and through lane and a shared through and right-turn lane.

B. Traffic Volumes and Conditions

1. General

a. Field Investigation

Field investigations were conducted on July 28-30, 2009 and consisted of manual turning movement count surveys and traffic flow assessments during the morning peak hours between 6:00 AM and 9:00 AM, and the afternoon peak hours between 3:00 PM and 6:00 PM at the following intersections:

- Halekauwila Street and Keawe Street
- Halekauwila Street and Coral Street
- Halekauwila Street and Cooke Street
- Pohukaina Street and Keawe Street
- Pohukaina Street and Coral Street
- Pohukaina Street and Cooke Street

The proposed project site is not located within close proximity of schools and traffic along the adjacent roadways is primarily local, business-related traffic rather than regional traffic. In addition, the collected data was similar to historical traffic data collected by the State Department of Transportation in the project vicinity. As such, no adjustments were made to the collected data to account for seasonal variations. Appendix A includes the existing traffic count data.

b. Capacity Analysis Methodology

The highway capacity analysis performed in this study is based upon procedures presented in the "Highway Capacity Manual", Transportation Research Board, 2000, and the "Highway Capacity Software", developed by the Federal Highway Administration. The analysis is based on the concept of Level of Service (LOS) to identify the traffic impacts associated with traffic demands during the peak periods of traffic.

LOS is a quantitative and qualitative assessment of traffic operations. Levels of Service are defined by LOS "A" through "F"; LOS "A" representing ideal or free-flow traffic operating conditions

and LOS "F" unacceptable or potentially congested traffic operating conditions.

"Volume-to-Capacity" (v/c) ratio is another measure indicating the relative traffic demand to the road carrying capacity. A v/c ratio of one (1.00) indicates that the roadway is operating at or near capacity. A v/c ratio of greater than 1.00 indicates that the traffic demand exceeds the road's carrying capacity. The LOS definitions are included in Appendix B.

2. Existing Peak Hour Traffic

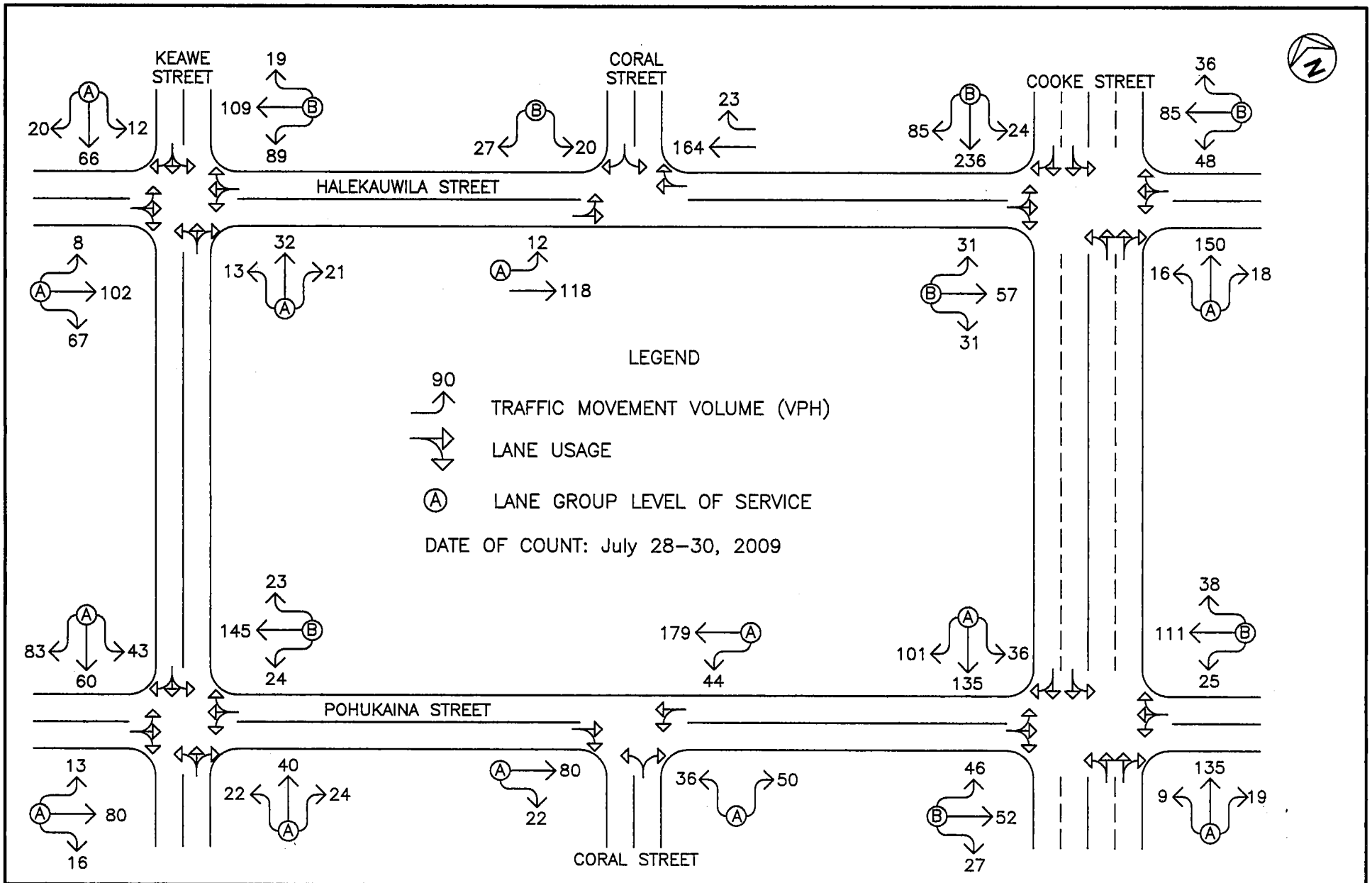
a. General

Figures 3 and 4 show the existing AM and PM peak period traffic volumes and operating conditions. The AM peak hour of traffic generally occurs between 7:30 AM and 8:30 AM in the vicinity of the hospital. In the afternoon, the PM peak hour of traffic generally occurs between the hours of 4:30 PM and 5:30 PM. The analysis is based on these peak hour time periods for each intersection to identify the traffic impacts resulting from the proposed project. LOS calculations are included in Appendix C.

b. Halekauwila Street and Keawe Street

At the intersection with Keawe Street, Halekauwila Street carries 177 vehicles eastbound and 217 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is slightly higher with 290 vehicles traveling eastbound and 136 vehicles traveling westbound. The eastbound approach of Halekauwila Street operates at LOS "A" and LOS "B" during the AM and PM peak periods, respectively, while the westbound approach operates at LOS "B" and LOS "A" during the AM and PM peak periods, respectively.

The Keawe Street approaches of the intersection carry 66 vehicles northbound and 98 vehicles southbound during the AM peak



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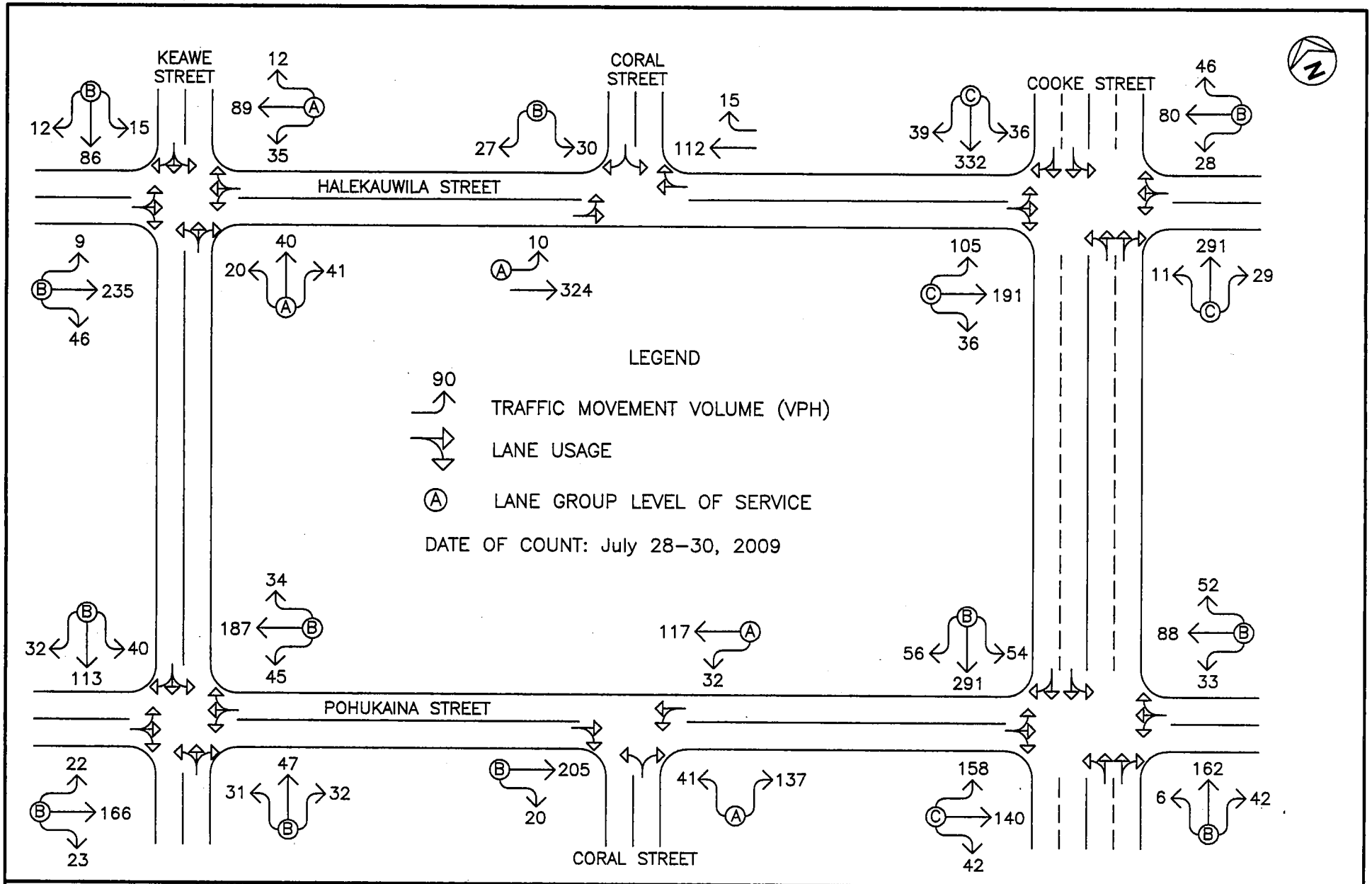
HALEKAUWILA PLACE

EXISTING AM PEAK HOUR OF TRAFFIC

FIGURE 3



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EXISTING PM PEAK HOUR OF TRAFFIC

FIGURE 4

period. During the PM peak period, traffic volumes are higher with 101 vehicles traveling northbound and 113 vehicles traveling southbound. The northbound approach of Keawe Street operates at LOS "A" during both peak periods while the southbound approach operates at LOS "A" and LOS "B" during the AM and PM peak periods, respectively.

c. Halekauwila Street and Coral Street

At the intersection with Coral Street, Halekauwila Street carries 130 vehicles eastbound and 187 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is slightly higher with 334 vehicles traveling eastbound and 127 vehicles traveling westbound. The critical traffic movement on the Halekauwila Street approaches is the eastbound approach which operates at LOS "A" during both peak periods.

The Coral Street approach of the intersection carries 57 vehicles and 47 vehicles southbound during the AM and PM peak periods, respectively. This approach operates at LOS "B" during both peak periods.

d. Halekauwila Street and Cooke Street

At the intersection with Cooke Street, Halekauwila Street carries 119 vehicles eastbound and 169 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is slightly higher with 332 vehicles traveling eastbound and 154 vehicles traveling westbound. Both approaches of Halekauwila Street operate at LOS "B" during both peak periods.

The Cooke Street approaches of the intersection carry 184 vehicles northbound and 345 vehicles southbound during the AM peak period. During the PM peak period, traffic volumes are higher with 331 vehicles traveling northbound and 407 vehicles traveling southbound. The northbound approach of Cooke Street operates at LOS "A" and LOS "C" during the AM and PM peak periods,

respectively, while the southbound approach operates at LOS "B" and LOS "B" during the AM and PM peak periods, respectively.

e. Pohukaina Street and Keawe Street

At the intersection with Keawe Street, Pohukaina Street carries 109 vehicles eastbound and 192 vehicles westbound during the AM peak period. During the PM peak period, traffic volumes are higher with 211 vehicles traveling eastbound and 266 vehicles traveling westbound. The eastbound approach of Pohukaina Street operates at LOS "A" and LOS "B" during the AM and PM peak periods, respectively, while the westbound approach operates at LOS "B" during both peak periods.

The Keawe Street approaches of the intersection carry 86 vehicles northbound and 186 vehicles southbound during the AM peak period. During the PM peak period, the overall traffic volume is slightly higher with 110 vehicles traveling northbound and 185 vehicles traveling southbound. Both approaches of Keawe Street operate at LOS "A" and LOS "B" during the AM and PM peak periods, respectively.

f. Pohukaina Street and Coral Street

At the intersection with Coral Street, Pohukaina Street carries 102 vehicles eastbound and 223 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is slightly higher with 225 vehicles traveling eastbound and 149 vehicles traveling westbound. The eastbound approach of Pohukaina Street operates at LOS "A" and LOS "B" during the AM and PM peak periods, respectively, while the westbound approach operates at LOS "A" during both peak periods.

The Coral Street approach of the intersection carries 86 vehicles and 178 vehicles northbound during the AM and PM peak periods, respectively. This approach operates at LOS "A" during both peak periods.

g. Pohukaina Street and Cooke Street

At the intersection with Cooke Street, Pohukaina Street carries 125 vehicles eastbound and 174 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is slightly higher with 340 vehicles traveling eastbound and 173 vehicles traveling westbound. The eastbound approach of Halekauwila Street operates at LOS "B" and LOS "C" during the AM and PM peak periods, respectively, while the westbound approach operates at LOS "B" during both peak periods.

The Cooke Street approaches of the intersection carry 163 vehicles northbound and 272 vehicles southbound during the AM peak period. During the PM peak period, traffic volumes are higher with 210 vehicles traveling northbound and 401 vehicles traveling southbound. Both approaches of Cooke Street operate at LOS "A" and LOS "B" during the AM and PM peak periods, respectively.

IV. PROJECTED TRAFFIC CONDITIONS

A. Site-Generated Traffic

1. Trip Generation Methodology

The trip generation methodology used in this study is based upon generally accepted techniques developed by the Institute of Transportation Engineers (ITE) and published in "Trip Generation, 8th Edition," 2008. The ITE trip generation rates are developed empirically by correlating the vehicle trip generation data with various land use characteristics such as the number of vehicle trips generated per dwelling unit. The proposed retail space within the development is expected to be a neighborhood market that will serve the project's residents and is therefore considered an amenity for the building. Table 1 summarizes the project site trip generation characteristics applied to the AM and PM peak periods of traffic.

Table 1: Peak Hour Trip Generation

HIGH-RISE APARTMENT INDEPENDENT VARIABLE: # of dwelling units = 202		
		PROJECTED TRIP ENDS
AM PEAK	ENTER	15
	EXIT	47
	TOTAL	62
PM PEAK	ENTER	48
	EXIT	30
	TOTAL	78

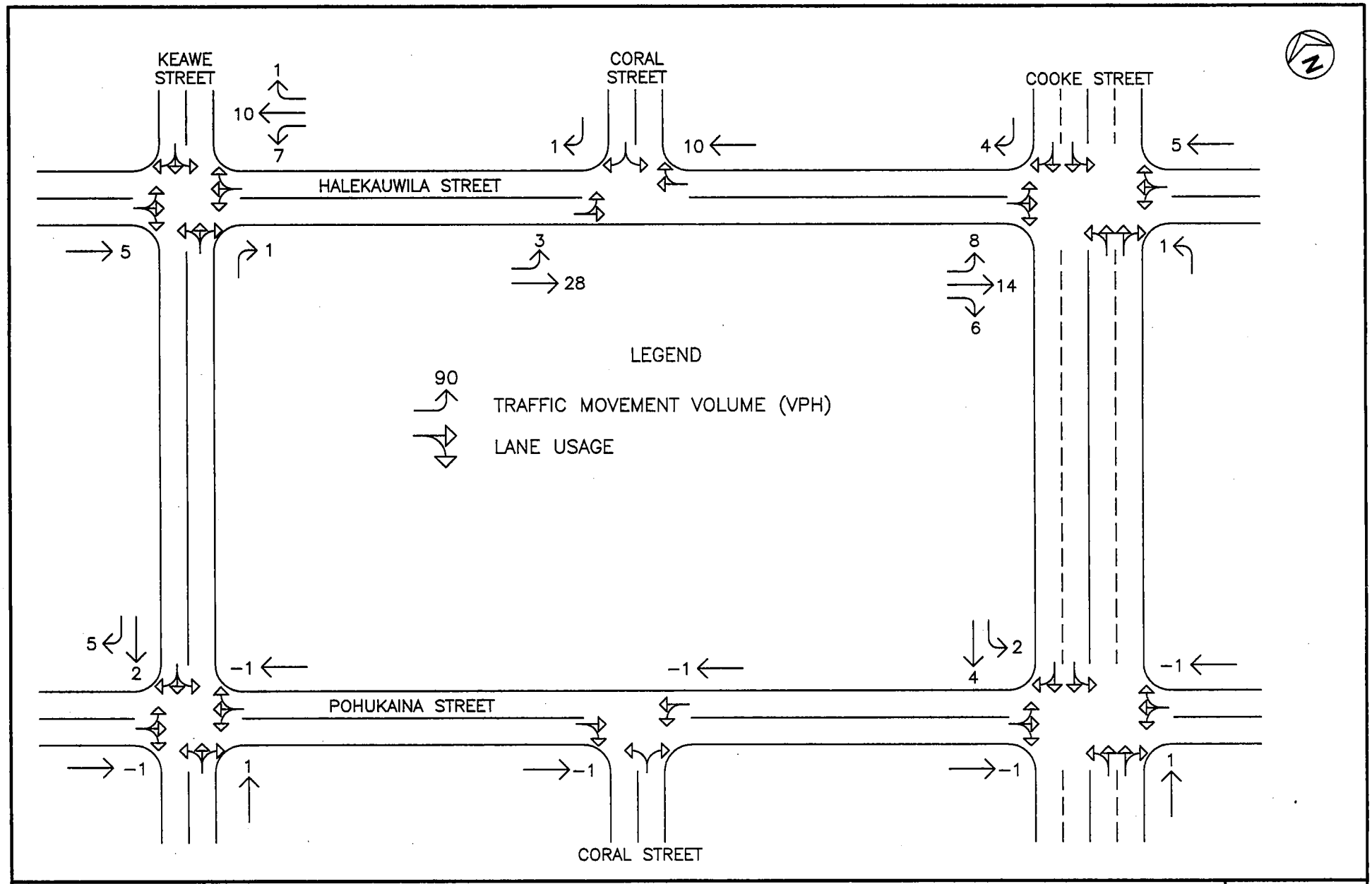
2. Trip Distribution

a. General

Figures 5 and 6 show the distribution of site-generated traffic during the AM and PM peak periods. Primary access to Halekauwila Place will be provided via a new driveway off Halekauwila Street. Site-generated traffic is comprised of new trips generated by the proposed residential dwellings and existing HPD-related trips that are currently utilizing a driveway off Pohukaina Street between Keawe Street and Coral Street.

b. Distribution of New Trips

The directional distribution of new site-generated vehicles was based upon the relative directional distribution of traffic between Cooke Street and Keawe Street. As such, 63.4% of the vehicles were assumed to be traveling to/from Cooke Street during the AM peak period while 36.6% were assumed to be traveling to/from Keawe Street. During the PM peak period, 73.1% were assumed to be traveling to/from Cooke Street while 26.9% were assumed to be traveling to/from Keawe Street. At study intersection, the directional distribution of traffic was assumed to remain similar to existing conditions with the exception of vehicles utilizing Pohukaina Street between Keawe Street and Cooke Street. These vehicles were assumed to utilize a more direct route to the project site instead.



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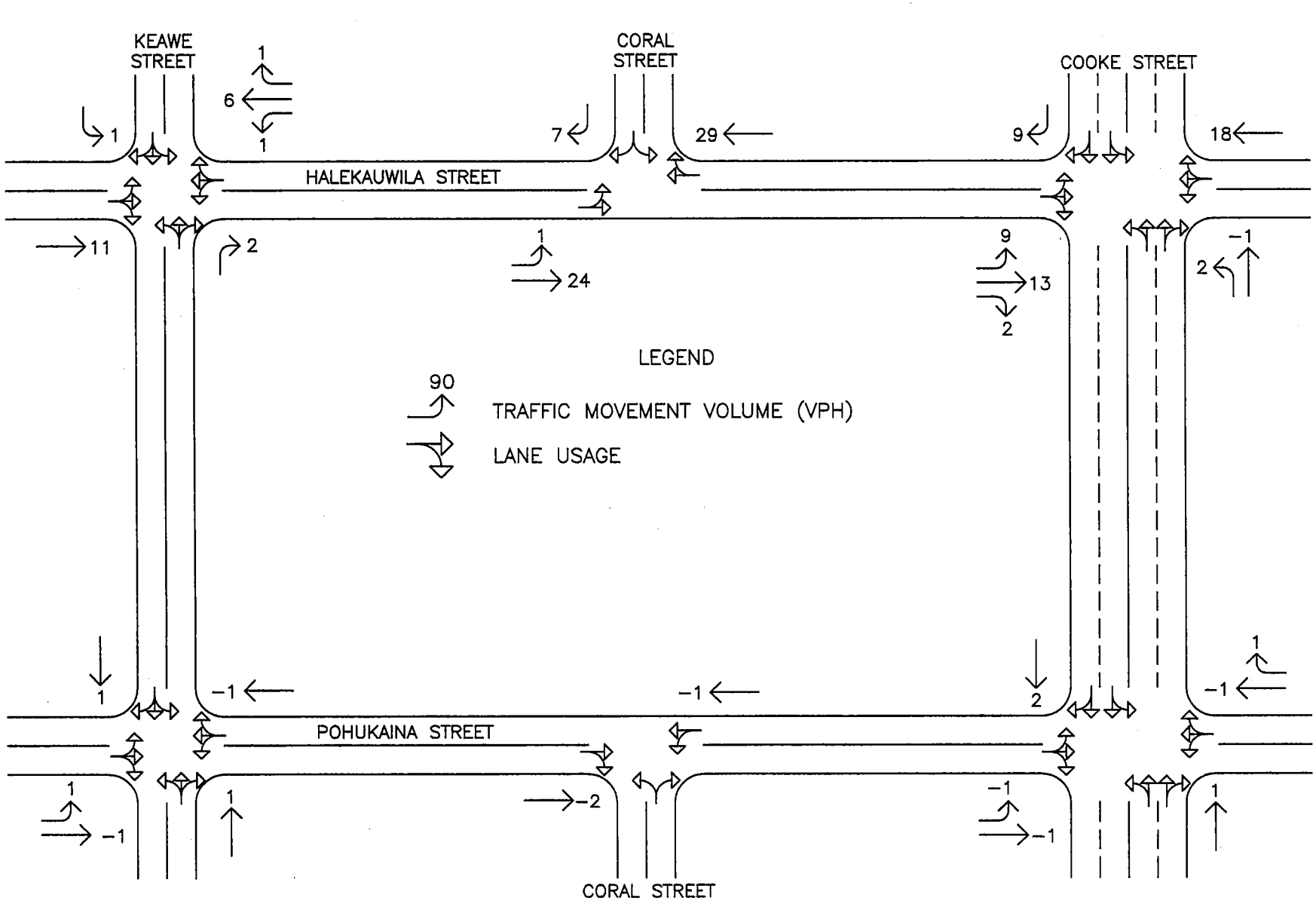
DISTRIBUTION OF SITE-GENERATED VEHICLES
AM PEAK HOUR OF TRAFFIC

FIGURE
5



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HALEKAUWILA PLACE

DISTRIBUTION OF SITE-GENERATED VEHICLES
PM PEAK HOUR OF TRAFFIC

FIGURE 6

c. Trip Reassignment

There is a portable trailer currently located on the project site that is utilized by HPD staff as an office. HPD-related vehicles are currently utilizing a driveway off Pohukaina Street between Keawe Street and Coral Street to access this trailer. The proposed project includes office space for the HPD to replace the portable trailer. As such, the HPD-related vehicles currently utilizing Pohukaina Street to access the trailer were reassigned to Halekauwila Street.

B. Through Traffic Forecasting Methodology

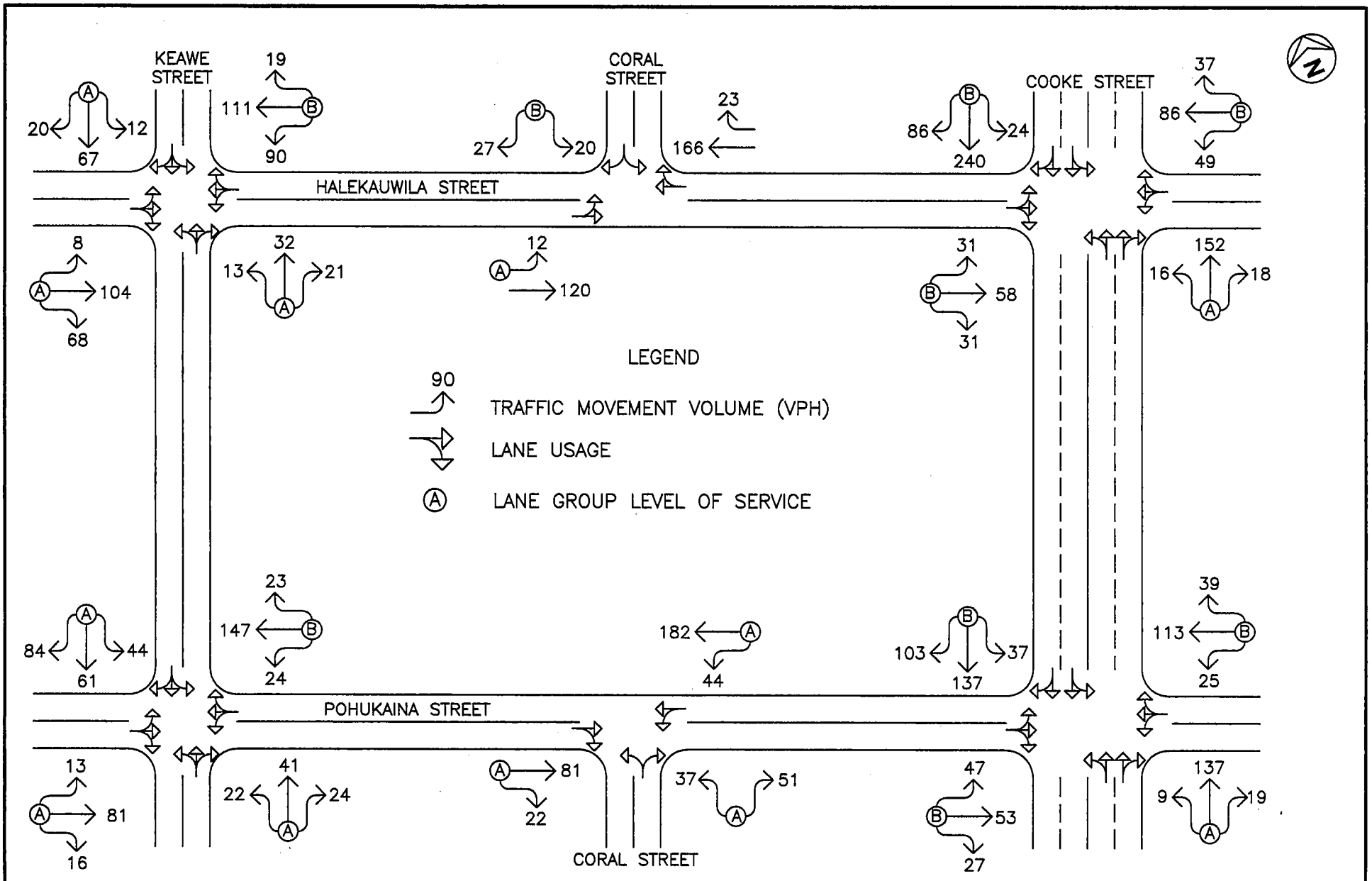
The travel forecast is based upon historical traffic count data obtained from the State DOT, Highways Division at survey stations located in the vicinity of the project site. The historical data indicates a stable or declining growth in traffic and, as such, an annual traffic growth rate of approximately 0.5% was conservatively assumed in the project vicinity. As such, using 2009 as the Base Year, a growth rate factor of 1.015 was applied to the existing traffic demands in the project vicinity to achieve the projected Year 2012 traffic demands.

C. Total Traffic Volumes Without Project

The projected Year 2012 AM and PM peak period traffic volumes and operating conditions without the proposed Halekauwila Place development are shown in Figures 7 and 8, and summarized in Table 2. The existing levels of service are provided for comparison purposes. LOS calculations are included in Appendix D.

Table 2: Existing and Projected Year 2012 (Without Project) LOS Traffic Operating Conditions

Intersection	Critical Traffic Movement		AM		PM	
			Exist	Year 2012 w/out Proj	Exist	Year 2012 w/out Proj
Halekauwila St/ Keawe St	Eastbound	LT-TH-RT	A	A	B	B
	Westbound	LT-TH-RT	B	B	A	A
	Northbound	LT-TH-RT	A	A	A	A
	Southbound	LT-TH-RT	A	A	B	B



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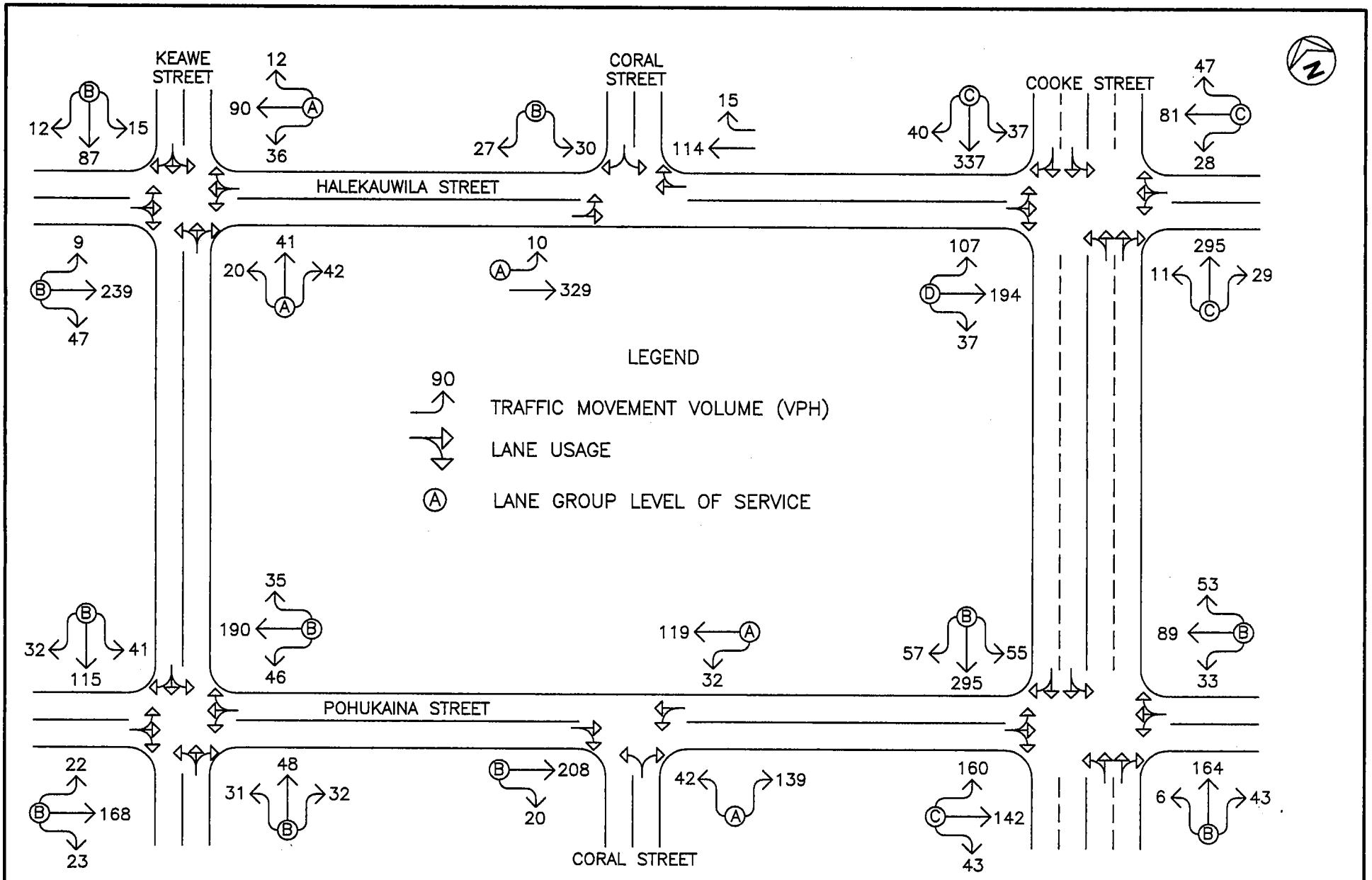
HALEKAUWILA PLACE

YEAR 2012 AM PEAK HOUR OF TRAFFIC WITHOUT PROJECT

FIGURE 7



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HALEKAUWILA PLACE

YEAR 2012 PM PEAK HOUR OF TRAFFIC WITHOUT PROJECT

FIGURE 8

Table 2: Existing and Projected Year 2012 (Without Project) LOS Traffic Operating Conditions (Cont'd)

Intersection	Critical Traffic Movement		AM		PM	
			Exist	Year 2012 w/out Proj	Exist	Year 2012 w/out Proj
Halekauwila St/ Coral St	Eastbound	LT-TH	A	A	A	A
	Southbound	LT-RT	B	B	B	B
Halekauwila St/ Cooke St	Eastbound	LT-TH-RT	B	B	C	D
	Westbound	LT-TH-RT	B	B	B	C
	Northbound	LT-TH-RT	A	A	C	C
	Southbound	LT-TH-RT	B	B	C	C
Pohukaina St/ Keawe St	Eastbound	LT-TH-RT	A	A	B	B
	Westbound	LT-TH-RT	B	B	B	B
	Northbound	LT-TH-RT	A	A	B	B
	Southbound	LT-TH-RT	A	A	B	B
Pohukaina St/ Coral St	Eastbound	TH-RT	A	A	B	B
	Westbound	LT-TH	A	A	A	A
	Northbound	LT-RT	A	A	A	A
Pohukaina St/ Cooke St	Eastbound	LT-TH-RT	B	B	C	C
	Westbound	LT-TH-RT	B	B	B	B
	Northbound	LT-TH-RT	A	A	B	B
	Southbound	LT-TH-RT	A	B	B	B

Traffic operations under Year 2012 without project conditions are expected to deteriorate slightly from existing conditions. During the AM peak period, the southbound approach of Cooke Street at the intersection with Pohukaina Street is expected to deteriorate from LOS "A" to LOS "B." Similarly, the eastbound approach of Halekauwila Street at the intersection with Cooke Street is expected to deteriorate from LOS "C" to LOS "D" during the PM peak period while the westbound approach of that intersection is expected to deteriorate from LOS "B" to LOS "C" during that peak period. The remaining critical traffic movements at these intersections, as well as, the other study intersections are expected to continue operating at levels of service similar to existing conditions.

D. Total Traffic Volumes With Project

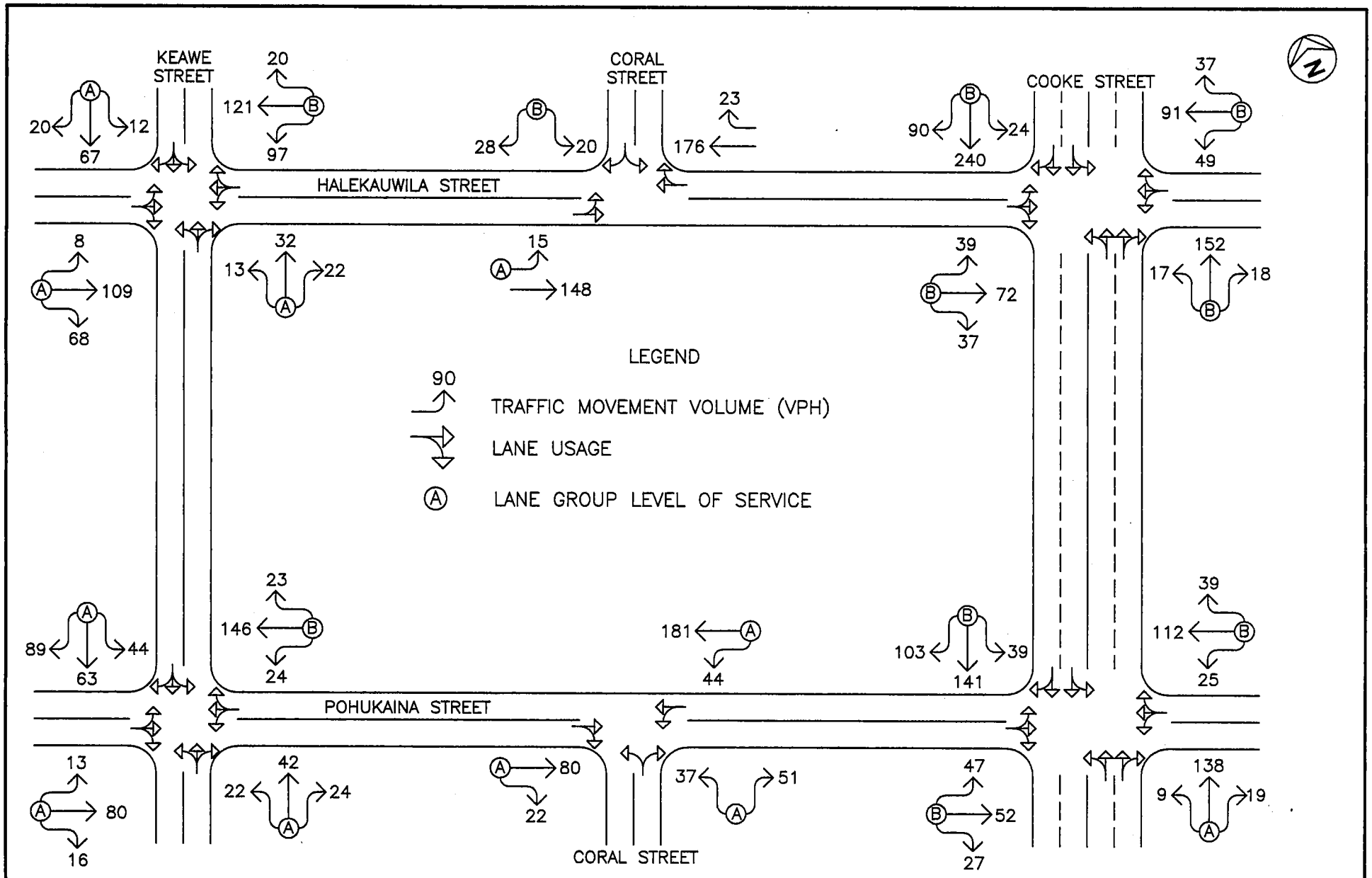
Figures 9 and 10 show the Year 2012 cumulative AM and PM peak hour traffic conditions resulting from the projected external traffic and the proposed Halekauwila Place development. The cumulative volumes consist of site- generated traffic superimposed over Year 2012 projected traffic demands. The traffic impacts resulting from the proposed project are addressed in the following section.

V. TRAFFIC IMPACT ANALYSIS

The Year 2012 cumulative AM and PM peak hour traffic conditions with the Halekauwila Place development are summarized in Table 3. The existing and projected Year 2010 (Without Project) operating conditions are provided for comparison purposes. LOS calculations are included in Appendix E.

Table 3: Existing and Projected Year 2012 (Without and With Project) LOS Traffic Operating Conditions

Intersection	Critical Traffic Movement		AM			PM		
			Exist	Year 2012		Exist	Year 2012	
				w/out Proj	w/ Proj		w/out Proj	w/ Proj
Halekauwila St/ Keawe St	Eastbound Westbound	LT-TH-RT	A	A	A	B	B	B
		LT-TH-RT	B	B	B	A	A	B
	Northbound	LT-TH-RT	A	A	A	A	A	B
	Southbound	LT-TH-RT	A	A	A	B	B	B
Halekauwila St/ Coral St	Eastbound	LT-TH	A	A	A	A	A	A
	Southbound	LT-RT	B	B	B	B	B	B
Halekauwila St/ Cooke St	Eastbound	LT-TH-RT	B	B	B	C	D	D
	Westbound	LT-TH-RT	B	B	B	B	C	C
	Northbound	LT-TH-RT	A	A	B	C	C	C
	Southbound	LT-TH-RT	B	B	B	C	C	C
Pohukaina St/ Keawe St	Eastbound	LT-TH-RT	A	A	A	B	B	B
	Westbound	LT-TH-RT	B	B	B	B	B	B
	Northbound	LT-TH-RT	A	A	A	B	B	B
	Southbound	LT-TH-RT	A	A	A	B	B	B
Pohukaina St/ Coral St	Eastbound	TH-RT	A	A	A	B	B	B
	Westbound	LT-TH	A	A	A	A	A	A
	Northbound	LT-RT	A	A	A	A	A	A



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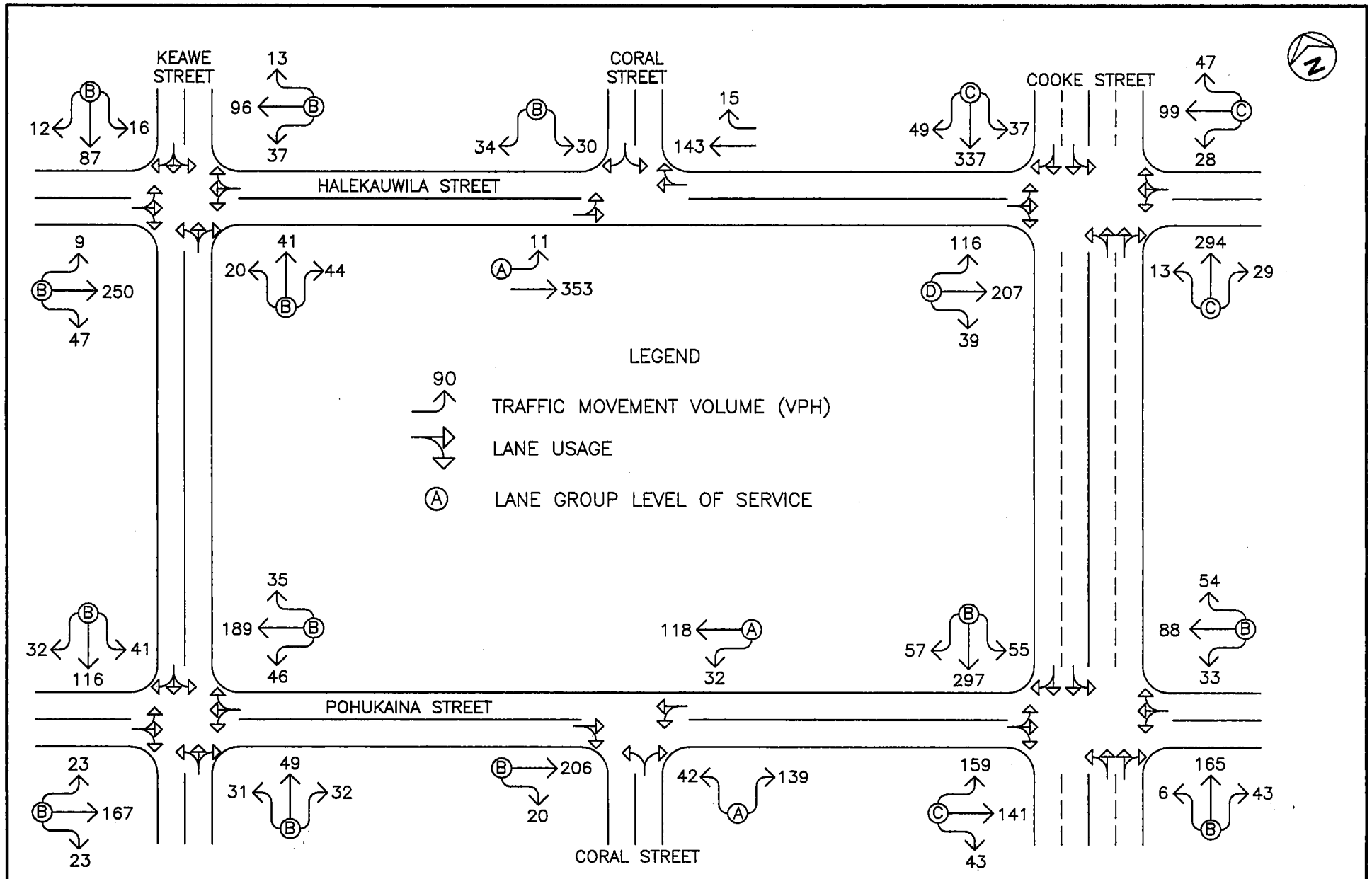
HALEKAUWILA PLACE

YEAR 2012 AM PEAK HOUR OF TRAFFIC WITH PROJECT

FIGURE 9



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HALEKAUWILA PLACE

YEAR 2012 PM PEAK HOUR OF TRAFFIC WITH PROJECT

FIGURE 10

Table 3: Existing and Projected Year 2012 (Without and With Project) LOS Traffic Operating Conditions (Cont'd)

Intersection	Critical Traffic Movement		AM			PM		
			Exist	Year 2012		Exist	Year 2012	
				w/out Proj	w/ Proj		w/out Proj	w/ Proj
Pohukaina St/ Cooke St	Eastbound	LT-TH-RT	B	B	B	C	C	C
	Westbound	LT-TH-RT	B	B	B	B	B	B
	Northbound	LT-TH-RT	A	A	A	B	B	B
	Southbound	LT-TH-RT	A	B	B	B	B	B

Traffic operations in the vicinity of the Halekauwila Place development are expected to remain similar to Year 2012 without project conditions. Along Halekauwila Street, the northbound approach of the intersection with Cooke Street is expected to operate at a slightly lower LOS "B" during the AM peak period while the westbound and northbound approaches of the intersection with Keawe Street are expected to operate at a slightly lower LOS "B" during the PM peak period. The remaining critical traffic movements at these intersections, as well as, the other study intersections are expected to continue operating at levels of service similar to without project conditions.

VI. RECOMMENDATIONS

Based on the analysis of the traffic data, the following are the recommendations of this study to be incorporated in the project design.

1. Maintain sufficient sight distance for motorists to safely enter and exit all project driveways. Parking along Halekauwila Street and Keawe Street fronting the project site may need to be restricted to ensure that sufficient sight distances are maintained.

2. Provide adequate on-site loading and off-loading service areas and prohibit off-site loading operations.

3. Provide adequate turn-around area for service, delivery, and refuse collection vehicles to maneuver on the project site to avoid vehicle-reversing maneuvers onto public roadways.

4. Provide sufficient turning radii at all project driveways to avoid or minimize vehicle encroachments to oncoming traffic lanes.

5. Provide sufficient storage for entering vehicles at the parking garage access control (i.e., automatic gate, etc.) to ensure that queues do not extend onto the adjacent public roadway.

VII. CONCLUSION

The proposed Halekauwila Place development includes approximately 204 affordable rental units with a parking garage and amenities. In addition, the development will include some office space for Honolulu Police Department staff to replace the existing portable trailer they are currently utilizing within the project site. Despite the anticipated increases in traffic along the surrounding roadways due to the proposed project, the traffic movements at the study intersections are anticipated to continue operating at levels-of-service similar to without project conditions during both peak periods. As such, with the implementation of the aforementioned recommendations, the proposed Halekauwila Place development is not expected to have a significant impact on traffic operations in the vicinity.

APPENDIX A

EXISTING TRAFFIC COUNT DATA

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:D4-3889, D4-5672
Counted By:JY, DY
Weather:Clear

File Name : HalKea AM
Site Code : 00000001
Start Date : 7/28/2009
Page No : 1

Groups Printed- Unshifted

	Keawe Street Southbound				Halekauwila Street Westbound				Keawe Street Northbound				Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
06:00 AM	0	7	2	9	1	5	1	7	0	0	0	0	0	11	6	17	33
06:15 AM	2	8	3	13	6	3	2	11	1	4	5	10	0	16	4	20	54
06:30 AM	3	8	2	13	8	10	0	18	3	4	4	11	0	21	8	29	71
06:45 AM	0	11	0	11	22	12	0	34	0	4	1	5	3	19	10	32	82
Total	5	34	7	46	37	30	3	70	4	12	10	26	3	67	28	98	240
07:00 AM	5	17	5	27	10	34	6	50	6	4	2	12	2	18	13	33	122
07:15 AM	2	17	4	23	11	26	5	42	6	11	4	21	3	25	19	47	133
07:30 AM	4	22	1	27	27	23	1	51	1	12	1	14	3	26	11	40	132
07:45 AM	2	17	2	21	25	33	6	64	4	9	8	21	3	25	24	52	158
Total	13	73	12	98	73	116	18	207	17	36	15	68	11	94	67	172	545
08:00 AM	3	14	14	31	14	30	6	50	3	6	8	17	1	22	15	38	136
08:15 AM	3	13	3	19	23	23	6	52	5	5	4	14	1	29	17	47	132
08:30 AM	3	11	6	20	11	27	2	40	6	2	8	16	2	28	12	42	118
08:45 AM	4	18	2	24	8	21	3	32	2	7	7	16	1	26	7	34	106
Total	13	56	25	94	56	101	17	174	16	20	27	63	5	105	51	161	492
Grand Total	31	163	44	238	166	247	38	451	37	68	52	157	19	266	146	431	1277
Apprch %	13	68.5	18.5		36.8	54.8	8.4		23.6	43.3	33.1		4.4	61.7	33.9		
Total %	2.4	12.8	3.4	18.6	13	19.3	3	35.3	2.9	5.3	4.1	12.3	1.5	20.8	11.4	33.8	

	Keawe Street Southbound				Halekauwila Street Westbound				Keawe Street Northbound				Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	2	17	4	23	11	26	5	42	**6**	11	4	**21**	**3**	25	19	47	133
07:30 AM	**4**	**22**	1	27	**27**	23	1	51	1	**12**	1	14	3	**26**	11	40	132
07:45 AM	2	17	2	21	25	**33**	**6**	**64**	4	9	**8**	21	3	25	**24**	**52**	**158**
08:00 AM	3	14	**14**	**31**	14	30	6	50	3	6	8	17	1	22	15	38	136
Total Volume	11	70	21	102	77	112	18	207	14	38	21	73	10	98	69	177	559
% App. Total	10.8	68.6	20.6		37.2	54.1	8.7		19.2	52.1	28.8		5.6	55.4	39		
PHF	.688	.795	.375	.823	.713	.848	.750	.809	.583	.792	.656	.869	.833	.942	.719	.851	.884

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:D4-5672, D4-3889
Counted By:DY, JY
Weather:Clear

File Name : HalKea PM
Site Code : 00000001
Start Date : 7/28/2009
Page No : 1

Groups Printed- Unshifted

	Keawe Street Southbound				Halekauwila Street Westbound				Keawe Street Northbound				Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
03:00 PM	3	12	1	16	10	13	2	25	9	9	4	22	2	27	10	39	102
03:15 PM	4	13	1	18	10	21	4	35	2	8	5	15	4	36	8	48	116
03:30 PM	7	10	3	20	6	23	7	36	5	3	4	12	2	33	11	46	114
03:45 PM	4	9	5	18	10	22	4	36	4	9	2	15	2	42	10	54	123
Total	18	44	10	72	36	79	17	132	20	29	15	64	10	138	39	187	455
04:00 PM	6	10	5	21	12	24	5	41	6	5	9	20	6	52	15	73	155
04:15 PM	6	15	4	25	10	26	6	42	5	11	5	21	1	45	8	54	142
04:30 PM	4	32	7	43	7	24	5	36	4	6	12	22	4	69	19	92	193
04:45 PM	3	14	1	18	8	18	2	28	2	7	8	17	0	50	13	63	126
Total	19	71	17	107	37	92	18	147	17	29	34	80	11	216	55	282	616
05:00 PM	7	26	4	37	14	25	2	41	10	15	9	34	2	65	8	75	187
05:15 PM	1	14	0	15	6	22	3	31	4	12	12	28	3	51	6	60	134
05:30 PM	4	13	1	18	2	23	1	26	4	9	11	24	2	41	6	49	117
05:45 PM	1	7	0	8	5	16	0	21	6	8	4	18	2	36	5	43	90
Total	13	60	5	78	27	86	6	119	24	44	36	104	9	193	25	227	528
Grand Total	50	175	32	257	100	257	41	398	61	102	85	248	30	547	119	696	1599
Apprch %	19.5	68.1	12.5		25.1	64.6	10.3		24.6	41.1	34.3		4.3	78.6	17.1		
Total %	3.1	10.9	2	16.1	6.3	16.1	2.6	24.9	3.8	6.4	5.3	15.5	1.9	34.2	7.4	43.5	

	Keawe Street Southbound				Halekauwila Street Westbound				Keawe Street Northbound				Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:15 PM																	
04:15 PM	6	15	4	25	10	**26**	**6**	**42**	5	11	5	21	1	45	8	54	142
04:30 PM	4	**32**	**7**	**43**	7	24	5	36	4	6	**12**	22	**4**	**69**	**19**	**92**	**193**
04:45 PM	3	14	1	18	8	18	2	28	2	7	8	17	0	50	13	63	126
05:00 PM	**7**	26	4	37	**14**	25	2	41	**10**	**15**	9	**34**	2	65	8	75	187
Total Volume	20	87	16	123	39	93	15	147	21	39	34	94	7	229	48	284	648
% App. Total	16.3	70.7	13		26.5	63.3	10.2		22.3	41.5	36.2		2.5	80.6	16.9		
PHF	.714	.680	.571	.715	.696	.894	.625	.875	.525	.650	.708	.691	.438	.830	.632	.772	.839

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:T-1839, D4-5675
Counted By:Kp, TO
Weather:Clear

File Name : HalCor AM
Site Code : 00000001
Start Date : 7/30/2009
Page No : 1

Groups Printed- Unshifted

	Coral Street Southbound				Halekauwila Street Westbound				Northbound	Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
06:00 AM	1	0	2	3	0	12	3	15	0	3	13	0	16	34
06:15 AM	4	0	2	6	0	13	2	15	0	2	16	0	18	39
06:30 AM	2	0	2	4	0	19	0	19	0	7	14	0	21	44
06:45 AM	3	0	3	6	0	26	1	27	0	1	24	0	25	58
Total	10	0	9	19	0	70	6	76	0	13	67	0	80	175
07:00 AM	3	0	8	11	0	51	4	55	0	2	31	0	33	99
07:15 AM	6	0	6	12	0	20	1	21	0	2	29	0	31	64
07:30 AM	5	0	4	9	0	48	3	51	0	3	28	0	31	91
07:45 AM	5	0	4	9	0	35	7	42	0	3	39	0	42	93
Total	19	0	22	41	0	154	15	169	0	10	127	0	137	347
08:00 AM	4	0	9	13	0	43	6	49	0	3	26	0	29	91
08:15 AM	6	0	10	16	0	38	7	45	0	3	25	0	28	89
08:30 AM	8	0	3	11	0	28	5	33	0	2	31	0	33	77
08:45 AM	7	1	7	15	0	25	4	29	0	7	26	0	33	77
Total	25	1	29	55	0	134	22	156	0	15	108	0	123	334
Grand Total	54	1	60	115	0	358	43	401	0	38	302	0	340	856
Apprch %	47	0.9	52.2		0	89.3	10.7			11.2	88.8	0		
Total %	6.3	0.1	7	13.4	0	41.8	5	46.8	0	4.4	35.3	0	39.7	

	Coral Street Southbound				Halekauwila Street Westbound				Northbound	Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 07:30 AM														
07:30 AM	5	0	4	9	0	**48**	3	**51**	0	**3**	28	0	31	91
07:45 AM	5	0	4	9	0	35	**7**	42	0	3	**39**	0	**42**	**93**
08:00 AM	4	0	9	13	0	43	6	49	0	3	26	0	29	91
08:15 AM	**6**	0	**10**	**16**	0	38	7	45	0	3	25	0	28	89
Total Volume	20	0	27	47	0	164	23	187	0	12	118	0	130	364
% App. Total	42.6	0	57.4		0	87.7	12.3			9.2	90.8	0		
PHF	.833	.000	.675	.734	.000	.854	.821	.917	.000	1.000	.756	.000	.774	.978

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:T-1839, D4-5675
Counted By:KP, TO
Weather:Clear

File Name : HalCor PM
Site Code : 00000001
Start Date : 7/30/2009
Page No : 1

Groups Printed- Unshifted

	Coral Street Southbound				Halekauwila Street Westbound				Northbound	Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
03:00 PM	12	0	8	20	0	17	2	19	0	4	40	0	44	83
03:15 PM	6	0	6	12	0	25	2	27	0	4	31	0	35	74
03:30 PM	7	0	9	16	0	23	5	28	0	3	45	0	48	92
03:45 PM	4	0	9	13	0	22	2	24	0	2	39	0	41	78
Total	29	0	32	61	0	87	11	98	0	13	155	0	168	327
04:00 PM	7	0	12	19	0	28	4	32	0	4	68	0	72	123
04:15 PM	8	0	3	11	0	24	6	30	0	4	68	0	72	113
04:30 PM	7	0	7	14	0	30	3	33	0	4	87	0	91	138
04:45 PM	9	0	10	19	0	27	5	32	0	3	73	0	76	127
Total	31	0	32	63	0	109	18	127	0	15	296	0	311	501
05:00 PM	6	0	7	13	0	28	2	30	0	3	77	0	80	123
05:15 PM	8	0	3	11	0	27	5	32	0	0	87	0	87	130
05:30 PM	2	0	8	10	0	18	1	19	0	0	52	0	52	81
05:45 PM	2	0	2	4	0	22	2	24	0	2	53	0	55	83
Total	18	0	20	38	0	95	10	105	0	5	269	0	274	417
Grand Total	78	0	84	162	0	291	39	330	0	33	720	0	753	1245
Apprch %	48.1	0	51.9		0	88.2	11.8			4.4	95.6	0		
Total %	6.3	0	6.7	13	0	23.4	3.1	26.5	0	2.7	57.8	0	60.5	

	Coral Street Southbound				Halekauwila Street Westbound				Northbound	Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 04:30 PM														
04:30 PM	7	0	7	14	0	**30**	3	**33**	0	**4**	**87**	0	**91**	**138**
04:45 PM	**9**	0	**10**	**19**	0	27	**5**	32	0	3	73	0	76	127
05:00 PM	6	0	7	13	0	28	2	30	0	3	77	0	80	123
05:15 PM	8	0	3	11	0	27	5	32	0	0	87	0	87	130
Total Volume	30	0	27	57	0	112	15	127	0	10	324	0	334	518
% App. Total	52.6	0	47.4		0	88.2	11.8			3	97	0		
PHF	.833	.000	.675	.750	.000	.933	.750	.962	.000	.625	.931	.000	.918	.938

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:D4-3888, D4-3890
Counted By:JY, DY
Weather:Clear

File Name : HalCoo AM
Site Code : 00000001
Start Date : 7/30/2009
Page No : 1

Groups Printed- Unshifted

	Cooke Street Southbound				Halekauwila Street Westbound				Cooke Street Northbound				Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
06:00 AM	3	15	5	23	2	7	3	12	4	15	1	20	4	8	2	14	69
06:15 AM	3	20	4	27	5	7	1	13	4	17	7	28	7	12	1	20	88
06:30 AM	5	34	8	47	5	10	1	16	1	25	3	29	4	7	3	14	106
06:45 AM	4	29	12	45	4	15	8	27	0	25	6	31	10	11	7	28	131
Total	15	98	29	142	16	39	13	68	9	82	17	108	25	38	13	76	394
07:00 AM	14	35	16	65	8	30	6	44	4	30	4	38	11	19	4	34	181
07:15 AM	11	49	11	71	13	8	7	28	1	41	4	46	4	21	8	33	178
07:30 AM	5	60	29	94	14	18	6	38	4	39	5	48	8	12	8	28	208
07:45 AM	10	62	17	89	12	24	11	47	2	31	7	40	9	17	9	35	211
Total	40	206	73	319	47	80	30	157	11	141	20	172	32	69	29	130	778
08:00 AM	5	51	18	74	13	25	8	46	5	43	5	53	11	9	9	29	202
08:15 AM	4	63	21	88	9	18	11	38	5	37	1	43	3	19	5	27	196
08:30 AM	6	53	15	74	4	14	7	25	3	40	1	44	12	14	6	32	175
08:45 AM	15	43	10	68	14	15	12	41	3	34	7	44	9	9	7	25	178
Total	30	210	64	304	40	72	38	150	16	154	14	184	35	51	27	113	751
Grand Total	85	514	166	765	103	191	81	375	36	377	51	464	92	158	69	319	1923
Apprch %	11.1	67.2	21.7		27.5	50.9	21.6		7.8	81.2	11		28.8	49.5	21.6		
Total %	4.4	26.7	8.6	39.8	5.4	9.9	4.2	19.5	1.9	19.6	2.7	24.1	4.8	8.2	3.6	16.6	

	Cooke Street Southbound				Halekauwila Street Westbound				Cooke Street Northbound				Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	5	60	**29**	**94**	**14**	18	6	38	4	39	5	48	8	12	8	28	208
07:45 AM	**10**	62	17	89	12	24	**11**	**47**	2	31	**7**	40	9	17	**9**	**35**	**211**
08:00 AM	5	51	18	74	13	**25**	8	46	**5**	**43**	5	**53**	**11**	9	9	29	202
08:15 AM	4	**63**	21	88	9	18	11	38	5	37	1	43	3	**19**	5	27	196
Total Volume	24	236	85	345	48	85	36	169	16	150	18	184	31	57	31	119	817
% App. Total	7	68.4	24.6		28.4	50.3	21.3		8.7	81.5	9.8		26.1	47.9	26.1		
PHF	.600	.937	.733	.918	.857	.850	.818	.899	.800	.872	.643	.868	.705	.750	.861	.850	.968

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:T-1839, D4-5675
Counted By:DY, JY
Weather:Clear

File Name : HalCoo PM
Site Code : 00000001
Start Date : 7/30/2009
Page No : 1

Groups Printed- Unshifted

	Cooke Street Southbound				Halekauwila Street Westbound				Cooke Street Northbound				Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
03:00 PM	8	61	9	78	6	6	9	21	4	56	4	64	16	16	18	50	213
03:15 PM	3	63	13	79	8	11	11	30	3	74	8	85	15	15	11	41	235
03:30 PM	8	89	9	106	10	15	10	35	3	50	8	61	21	14	12	47	249
03:45 PM	2	77	7	86	7	14	13	34	5	42	12	59	8	31	7	46	225
Total	21	290	38	349	31	46	43	120	15	222	32	269	60	76	48	184	922
04:00 PM	7	89	10	106	12	22	17	51	3	51	4	58	24	41	7	72	287
04:15 PM	6	86	13	105	11	11	8	30	4	70	2	76	17	35	9	61	272
04:30 PM	9	86	9	104	9	24	14	47	1	86	12	99	26	49	9	84	334
04:45 PM	8	94	11	113	6	18	12	36	3	71	8	82	26	41	10	77	308
Total	30	355	43	428	38	75	51	164	11	278	26	315	93	166	35	294	1201
05:00 PM	6	83	6	95	10	21	10	41	5	71	6	82	24	51	5	80	298
05:15 PM	13	69	13	95	3	17	10	30	2	63	3	68	29	50	12	91	284
05:30 PM	5	50	8	63	4	12	14	30	1	59	3	63	20	34	4	58	214
05:45 PM	5	49	4	58	7	15	5	27	6	50	6	62	8	31	8	47	194
Total	29	251	31	311	24	65	39	128	14	243	18	275	81	166	29	276	990
Grand Total	80	896	112	1088	93	186	133	412	40	743	76	859	234	408	112	754	3113
Apprch %	7.4	82.4	10.3		22.6	45.1	32.3		4.7	86.5	8.8		31	54.1	14.9		
Total %	2.6	28.8	3.6	35	3	6	4.3	13.2	1.3	23.9	2.4	27.6	7.5	13.1	3.6	24.2	

	Cooke Street Southbound				Halekauwila Street Westbound				Cooke Street Northbound				Halekauwila Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:30 PM																	
04:30 PM	9	86	9	104	9	**24**	**14**	**47**	1	**86**	**12**	**99**	26	49	9	84	**334**
04:45 PM	8	**94**	11	**113**	6	18	12	36	3	71	8	82	26	41	10	77	308
05:00 PM	6	83	6	95	**10**	21	10	41	**5**	71	6	82	24	**51**	5	80	298
05:15 PM	**13**	69	**13**	95	3	17	10	30	2	63	3	68	**29**	50	**12**	**91**	284
Total Volume	36	332	39	407	28	80	46	154	11	291	29	331	105	191	36	332	1224
% App. Total	8.8	81.6	9.6		18.2	51.9	29.9		3.3	87.9	8.8		31.6	57.5	10.8		
PHF	.692	.883	.750	.900	.700	.833	.821	.819	.550	.846	.604	.836	.905	.936	.750	.912	.916

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:D4-5674, D4-5677
Counted By:KP, TO
Weather:Clear

File Name : PohKea AM
Site Code : 00000001
Start Date : 7/28/2009
Page No : 1

Groups Printed- Unshifted

	Keawe Street Southbound				Pohukaina Street Westbound				Keawe Street Northbound				Pohukaina Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
06:00 AM	6	5	2	13	2	3	0	5	3	1	6	10	0	11	4	15	43
06:15 AM	3	8	2	13	5	8	1	14	4	10	5	19	1	11	2	14	60
06:30 AM	5	4	6	15	1	14	3	18	5	6	5	16	2	12	6	20	69
06:45 AM	12	11	12	35	2	22	3	27	8	4	5	17	2	17	1	20	99
Total	26	28	22	76	10	47	7	64	20	21	21	62	5	51	13	69	271
07:00 AM	10	8	11	29	3	32	6	41	2	11	5	18	1	12	2	15	103
07:15 AM	9	8	17	34	1	40	1	42	2	15	3	20	4	18	3	25	121
07:30 AM	12	15	22	49	3	39	4	46	5	6	6	17	3	19	3	25	137
07:45 AM	9	16	28	53	7	43	7	57	5	18	10	33	2	17	4	23	166
Total	40	47	78	165	14	154	18	186	14	50	24	88	10	66	12	88	527
08:00 AM	8	14	16	38	5	32	8	45	3	10	5	18	3	21	3	27	128
08:15 AM	14	15	17	46	9	31	4	44	9	6	3	18	5	23	6	34	142
08:30 AM	9	14	9	32	1	27	8	36	7	7	4	18	2	25	11	38	124
08:45 AM	6	13	7	26	8	28	3	39	8	8	7	23	7	31	8	46	134
Total	37	56	49	142	23	118	23	164	27	31	19	77	17	100	28	145	528
Grand Total	103	131	149	383	47	319	48	414	61	102	64	227	32	217	53	302	1326
Apprch %	26.9	34.2	38.9		11.4	77.1	11.6		26.9	44.9	28.2		10.6	71.9	17.5		
Total %	7.8	9.9	11.2	28.9	3.5	24.1	3.6	31.2	4.6	7.7	4.8	17.1	2.4	16.4	4	22.8	

	Keawe Street Southbound				Pohukaina Street Westbound				Keawe Street Northbound				Pohukaina Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	12	15	22	49	3	39	4	46	5	6	6	17	3	19	3	25	137
07:45 AM	9	**16**	**28**	**53**	7	**43**	7	**57**	5	**18**	**10**	**33**	2	17	4	23	**166**
08:00 AM	8	14	16	38	5	32	**8**	45	3	10	5	18	3	21	3	27	128
08:15 AM	**14**	15	17	46	**9**	31	4	44	**9**	6	3	18	**5**	**23**	**6**	**34**	142
Total Volume	43	60	83	186	24	145	23	192	22	40	24	86	13	80	16	109	573
% App. Total	23.1	32.3	44.6		12.5	75.5	12		25.6	46.5	27.9		11.9	73.4	14.7		
PHF	.768	.938	.741	.877	.667	.843	.719	.842	.611	.556	.600	.652	.650	.870	.667	.801	.863

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:D4-5674, D4-5677
Counted By:KP, TO
Weather: Clear

File Name : PohKea PM
Site Code : 00000001
Start Date : 7/28/2009
Page No : 1

Groups Printed- Unshifted

	Keawe Street Southbound				Pohukaina Street Westbound				Keawe Street Northbound				Pohukaina Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
03:00 PM	7	13	11	31	15	28	10	53	9	10	10	29	3	31	11	45	158
03:15 PM	6	15	8	29	8	33	5	46	6	7	5	18	4	30	7	41	134
03:30 PM	6	17	6	29	11	40	8	59	13	5	8	26	3	21	12	36	150
03:45 PM	8	18	10	36	12	43	5	60	4	11	10	25	1	30	7	38	159
Total	27	63	35	125	46	144	28	218	32	33	33	98	11	112	37	160	601
04:00 PM	3	21	11	35	10	42	7	59	10	9	2	21	3	20	9	32	147
04:15 PM	5	22	12	39	13	48	7	68	3	12	4	19	2	28	3	33	159
04:30 PM	11	46	12	69	13	45	5	63	13	15	11	39	4	37	4	45	216
04:45 PM	7	20	8	35	12	48	7	67	6	8	7	21	5	49	2	56	179
Total	26	109	43	178	48	183	26	257	32	44	24	100	14	134	18	166	701
05:00 PM	14	28	7	49	10	52	13	75	7	13	10	30	3	41	6	50	204
05:15 PM	8	19	5	32	10	42	9	61	5	11	4	20	10	39	11	60	173
05:30 PM	2	19	6	27	5	45	3	53	6	10	8	24	3	36	8	47	151
05:45 PM	3	11	4	18	9	31	4	44	1	6	6	13	4	20	7	31	106
Total	27	77	22	126	34	170	29	233	19	40	28	87	20	136	32	188	634
Grand Total	80	249	100	429	128	497	83	708	83	117	85	285	45	382	87	514	1936
Apprch %	18.6	58	23.3		18.1	70.2	11.7		29.1	41.1	29.8		8.8	74.3	16.9		
Total %	4.1	12.9	5.2	22.2	6.6	25.7	4.3	36.6	4.3	6	4.4	14.7	2.3	19.7	4.5	26.5	

	Keawe Street Southbound				Pohukaina Street Westbound				Keawe Street Northbound				Pohukaina Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:30 PM																	
04:30 PM	11	**46**	**12**	**69**	**13**	45	5	63	**13**	**15**	**11**	**39**	4	37	4	45	**216**
04:45 PM	7	20	8	35	12	48	7	67	6	8	7	21	5	**49**	2	56	179
05:00 PM	**14**	28	7	49	10	**52**	**13**	**75**	7	13	10	30	3	41	6	50	204
05:15 PM	8	19	5	32	10	42	9	61	5	11	4	20	**10**	39	**11**	**60**	173
Total Volume	40	113	32	185	45	187	34	266	31	47	32	110	22	166	23	211	772
% App. Total	21.6	61.1	17.3		16.9	70.3	12.8		28.2	42.7	29.1		10.4	78.7	10.9		
PHF	.714	.614	.667	.670	.865	.899	.654	.887	.596	.783	.727	.705	.550	.847	.523	.879	.894

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:D4-5671
Counted By:TO
Weather:Clear

File Name : HPD Movements AM
Site Code : 00000001
Start Date : 7/29/2009
Page No : 1

Groups Printed- Unshifted

	Driveway To/From Police Sub-Station Southbound				Pohukaina Street Westbound				Northbound	Pohukaina Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
06:00 AM	1	0	0	1	0	0	1	1	0	0	0	0	0	2
06:15 AM	2	0	0	2	0	0	0	0	0	0	0	0	0	2
06:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	0	3	0	0	1	1	0	0	0	0	0	4
07:00 AM	0	0	2	2	0	0	0	0	0	1	0	0	1	3
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	2	2	0	0	0	0	0	1	0	0	1	3
08:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 AM	1	0	1	2	0	0	0	0	0	1	0	0	1	3
08:30 AM	0	0	0	0	0	0	1	1	0	0	0	0	0	1
08:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	2	0	0	1	1	0	1	0	0	1	4
Grand Total	4	0	3	7	0	0	2	2	0	2	0	0	2	11
Apprch %	57.1	0	42.9		0	0	100			100	0	0		
Total %	36.4	0	27.3	63.6	0	0	18.2	18.2	0	18.2	0	0	18.2	

	Driveway To/From Police Sub-Station Southbound				Pohukaina Street Westbound				Northbound	Pohukaina Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 06:15 AM														
06:15 AM	**2**	0	0	**2**	0	0	0	0	0	0	0	0	0	2
06:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 AM	0	0	**2**	2	0	0	0	0	0	**1**	0	0	**1**	**3**
Total Volume	2	0	2	4	0	0	0	0	0	1	0	0	1	5
% App. Total	50	0	50		0	0	0			100	0	0		
PHF	.250	.000	.250	.500	.000	.000	.000	.000	.000	.250	.000	.000	.250	.417

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:D4-5671
Counted By:TO
Weather:Clear

File Name : HPD Movements PM
Site Code : 00000001
Start Date : 7/29/2009
Page No : 1

Groups Printed- Unshifted

	Driveway To/From Police Sub-Station Southbound				Pohukaina Street Westbound				Northbound	Pohukaina Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
03:00 PM	1	0	2	3	0	0	0	0	0	0	0	0	0	3
03:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:30 PM	0	0	1	1	0	0	0	0	0	0	0	0	0	1
03:45 PM	2	0	1	3	0	0	0	0	0	0	0	0	0	3
Total	3	0	4	7	0	0	0	0	0	0	0	0	0	7
04:00 PM	1	0	0	1	0	0	1	1	0	1	0	0	1	3
04:15 PM	0	0	0	0	0	0	0	0	0	2	0	0	2	2
04:30 PM	1	0	0	1	0	0	0	0	0	0	0	0	0	1
04:45 PM	0	0	0	0	0	0	1	1	0	0	0	0	0	1
Total	2	0	0	2	0	0	2	2	0	3	0	0	3	7
05:00 PM	0	0	1	1	0	0	0	0	0	0	0	0	0	1
05:15 PM	1	0	0	1	0	0	0	0	0	1	0	0	1	2
05:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	2	0	0	0	0	0	1	0	0	1	3
Grand Total	6	0	5	11	0	0	2	2	0	4	0	0	4	17
Apprch %	54.5	0	45.5		0	0	100			100	0	0		
Total %	35.3	0	29.4	64.7	0	0	11.8	11.8	0	23.5	0	0	23.5	

	Driveway To/From Police Sub-Station Southbound				Pohukaina Street Westbound				Northbound	Pohukaina Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:30 PM														
03:30 PM	0	0	**1**	1	0	0	0	0	0	0	0	0	0	1
03:45 PM	**2**	0	1	**3**	0	0	0	0	0	0	0	0	0	**3**
04:00 PM	1	0	0	1	0	0	**1**	**1**	0	1	0	0	1	3
04:15 PM	0	0	0	0	0	0	0	0	0	**2**	0	0	**2**	2
Total Volume	3	0	2	5	0	0	1	1	0	3	0	0	3	9
% App. Total	60	0	40		0	0	100			100	0	0		
PHF	.375	.000	.500	.417	.000	.000	.250	.250	.000	.375	.000	.000	.375	.750

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:D4-5674, D4-5677
Counted By:KP, TO
Weather:Clear

File Name : PohCor AM
Site Code : 00000001
Start Date : 7/29/2009
Page No : 1

Groups Printed- Unshifted

	Southbound	Pohukaina Street Westbound				Coral Street Northbound				Pohukaina Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
06:00 AM	0	3	15	0	18	0	0	2	2	0	9	6	15	35
06:15 AM	0	3	9	0	12	1	0	2	3	0	10	4	14	29
06:30 AM	0	5	18	0	23	2	0	2	4	0	10	5	15	42
06:45 AM	0	9	23	0	32	2	0	4	6	0	17	4	21	59
Total	0	20	65	0	85	5	0	10	15	0	46	19	65	165
07:00 AM	0	8	39	0	47	6	0	5	11	0	24	5	29	87
07:15 AM	0	7	59	0	66	10	0	6	16	0	15	9	24	106
07:30 AM	0	11	40	0	51	8	0	5	13	0	13	2	15	79
07:45 AM	0	8	49	0	57	14	0	10	24	0	25	5	30	111
Total	0	34	187	0	221	38	0	26	64	0	77	21	98	383
08:00 AM	0	11	49	0	60	9	0	23	32	0	22	7	29	121
08:15 AM	0	14	41	0	55	5	0	12	17	0	20	8	28	100
08:30 AM	0	4	42	0	46	11	0	10	21	0	22	4	26	93
08:45 AM	0	8	33	0	41	11	0	14	25	0	23	5	28	94
Total	0	37	165	0	202	36	0	59	95	0	87	24	111	408
Grand Total	0	91	417	0	508	79	0	95	174	0	210	64	274	956
Apprch %		17.9	82.1	0		45.4	0	54.6		0	76.6	23.4		
Total %	0	9.5	43.6	0	53.1	8.3	0	9.9	18.2	0	22	6.7	28.7	

	Southbound	Pohukaina Street Westbound				Coral Street Northbound				Pohukaina Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 07:45 AM														
07:45 AM	0	8	**49**	0	57	**14**	0	10	24	0	**25**	5	**30**	111
08:00 AM	0	11	49	0	**60**	9	0	**23**	**32**	0	22	7	29	**121**
08:15 AM	0	**14**	41	0	55	5	0	12	17	0	20	**8**	28	100
08:30 AM	0	4	42	0	46	11	0	10	21	0	22	4	26	93
Total Volume	0	37	181	0	218	39	0	55	94	0	89	24	113	425
% App. Total		17	83	0		41.5	0	58.5		0	78.8	21.2		
PHF	.000	.661	.923	.000	.908	.696	.000	.598	.734	.000	.890	.750	.942	.878

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:T-1839, D4-5675
Counted By:KP, TO
Weather:Clear

File Name : PohCor PM
Site Code : 00000001
Start Date : 7/29/2009
Page No : 1

Groups Printed- Unshifted

	Southbound	Pohukaina Street Westbound				Coral Street Northbound				Pohukaina Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
03:00 PM	0	15	40	0	55	9	0	22	31	0	48	6	54	140
03:15 PM	0	13	35	0	48	10	0	31	41	0	44	8	52	141
03:30 PM	0	7	57	0	64	14	0	36	50	7	40	3	50	164
03:45 PM	0	14	39	1	54	8	0	35	43	0	45	11	56	153
Total	0	49	171	1	221	41	0	124	165	7	177	28	212	598
04:00 PM	0	8	34	1	43	15	0	25	40	0	44	13	57	140
04:15 PM	0	14	39	0	53	17	0	24	41	1	43	4	48	142
04:30 PM	0	11	32	0	43	13	0	39	52	0	62	7	69	164
04:45 PM	0	3	26	1	30	9	0	36	45	0	46	8	54	129
Total	0	36	131	2	169	54	0	124	178	1	195	32	228	575
05:00 PM	0	10	35	0	45	11	1	35	47	0	52	1	53	145
05:15 PM	0	8	24	0	32	8	0	27	35	0	45	4	49	116
05:30 PM	0	7	17	0	24	19	0	33	52	0	33	3	36	112
05:45 PM	0	7	18	0	25	13	0	26	39	0	40	7	47	111
Total	0	32	94	0	126	51	1	121	173	0	170	15	185	484
Grand Total	0	117	396	3	516	146	1	369	516	8	542	75	625	1657
Apprch %		22.7	76.7	0.6		28.3	0.2	71.5		1.3	86.7	12		
Total %	0	7.1	23.9	0.2	31.1	8.8	0.1	22.3	31.1	0.5	32.7	4.5	37.7	

	Southbound	Pohukaina Street Westbound				Coral Street Northbound				Pohukaina Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:30 PM														
03:30 PM	0	7	**57**	0	**64**	14	0	**36**	**50**	**7**	40	3	50	**164**
03:45 PM	0	**14**	39	**1**	54	8	0	35	43	0	**45**	11	56	153
04:00 PM	0	8	34	1	43	15	0	25	40	0	44	**13**	**57**	140
04:15 PM	0	14	39	0	53	**17**	0	24	41	1	43	4	48	142
Total Volume	0	43	169	2	214	54	0	120	174	8	172	31	211	599
% App. Total		20.1	79	0.9		31	0	69		3.8	81.5	14.7		
PHF	.000	.768	.741	.500	.836	.794	.000	.833	.870	.286	.956	.596	.925	.913

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:D4-3888, D4-5671
Counted By:DY, JY
Weather:Clear

File Name : CooPoh AM
Site Code : 00000001
Start Date : 7/29/2009
Page No : 1

Groups Printed- Unshifted

	Cooke Street Southbound				Pohukaina Street Westbound				Cooke Street Northbound				Pohukaina Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
06:00 AM	2	5	8	15	1	6	5	12	1	15	4	20	5	5	1	11	58
06:15 AM	1	10	10	21	1	5	1	7	0	13	4	17	7	5	1	13	58
06:30 AM	5	12	6	23	3	15	7	25	1	17	6	24	6	8	2	16	88
06:45 AM	4	22	17	43	6	11	3	20	4	21	9	34	1	18	1	20	117
Total	12	49	41	102	11	37	16	64	6	66	23	95	19	36	5	60	321
07:00 AM	10	27	23	60	8	23	11	42	3	36	7	46	8	16	5	29	177
07:15 AM	8	21	31	60	10	34	9	53	1	21	4	26	6	12	3	21	160
07:30 AM	10	32	15	57	7	27	7	41	5	33	5	43	6	7	2	15	156
07:45 AM	6	35	30	71	9	25	10	44	2	30	3	35	9	17	9	35	185
Total	34	115	99	248	34	109	37	180	11	120	19	150	29	52	19	100	678
08:00 AM	12	31	28	71	6	30	11	47	1	36	4	41	15	19	8	42	201
08:15 AM	8	37	28	73	3	29	10	42	1	36	7	44	16	9	8	33	192
08:30 AM	8	33	17	58	7	27	15	49	2	22	4	28	10	12	4	26	161
08:45 AM	9	36	27	72	5	14	12	31	0	27	4	31	12	21	8	41	175
Total	37	137	100	274	21	100	48	169	4	121	19	144	53	61	28	142	729
Grand Total	83	301	240	624	66	246	101	413	21	307	61	389	101	149	52	302	1728
Apprch %	13.3	48.2	38.5		16	59.6	24.5		5.4	78.9	15.7		33.4	49.3	17.2		
Total %	4.8	17.4	13.9	36.1	3.8	14.2	5.8	23.9	1.2	17.8	3.5	22.5	5.8	8.6	3	17.5	

	Cooke Street Southbound				Pohukaina Street Westbound				Cooke Street Northbound				Pohukaina Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:45 AM																	
07:45 AM	6	35	**30**	71	**9**	25	10	44	**2**	30	3	35	9	17	**9**	35	185
08:00 AM	**12**	31	28	71	6	**30**	11	47	1	**36**	4	41	15	**19**	8	**42**	**201**
08:15 AM	8	**37**	28	**73**	3	29	10	42	1	36	**7**	**44**	**16**	9	8	33	192
08:30 AM	8	33	17	58	7	27	**15**	**49**	2	22	4	28	10	12	4	26	161
Total Volume	34	136	103	273	25	111	46	182	6	124	18	148	50	57	29	136	739
% App. Total	12.5	49.8	37.7		13.7	61	25.3		4.1	83.8	12.2		36.8	41.9	21.3		
PHF	.708	.919	.858	.935	.694	.925	.767	.929	.750	.861	.643	.841	.781	.750	.806	.810	.919

APPENDIX B

LEVEL OF SERVICE DEFINITIONS

LEVEL OF SERVICE DEFINITIONS

LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS

Level of Service (LOS) criteria are given in Table 1. As used here, control delay is defined as the total elapsed time from the time a vehicle stops at the end of the queue to the time required for the vehicle to travel from the last-in-queue position to the first-in-queue position, including deceleration of vehicles from free-flow speed to the speed of vehicles in the queue.

The average total delay for any particular minor movement is a function of the service rate or capacity of the approach and the degree of saturation. If the degree of saturation is greater than about 0.9, average control delay is significantly affected by the length of the analysis period.

Table 1: Level-of-Service Criteria for Unsignalized Intersections

Level of Service	Average Control Delay (Sec/Veh)
A	≤10.0
B	>10.0 and ≤15.0
C	>15.0 and ≤25.0
D	>25.0 and ≤35.0
E	>35.0 and ≤50.0
F	>50.0

"Highway Capacity Manual," Transportation Research Board, 2000.

APPENDIX C

CAPACITY ANALYSIS CALCULATIONS
EXISTING PEAK PERIOD TRAFFIC ANALYSIS

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Halekauwila
North/South Street: Keawe

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	8	102	67	89	109	19	13	32	21	12	66	20

% Thrus Left Lane

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.85		0.85		0.79		0.79	
Flow Rate	206		254		82		123	
% Heavy Veh	2		2		2		2	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	206		254		82		123	
Left-Turn	9		104		16		15	
Right-Turn	78		22		26		25	
Prop. Left-Turns	0.0		0.4		0.2		0.1	
Prop. Right-Turns	0.4		0.1		0.3		0.2	

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0
Geometry Group	1	1	1	1
Adjustments Exhibit 17-33:				
hLT-adj	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7
hadj, computed	-0.2	0.1	-0.1	-0.1

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	206		254		82		123	
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.18		0.23		0.07		0.11	
hd, final value	4.59		4.77		5.09		5.07	
x, final value	0.26		0.34		0.12		0.17	
Move-up time, m	2.0		2.0		2.0		2.0	
Service Time	2.6		2.8		3.1		3.1	

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	206		254		82		123	
Service Time	2.6		2.8		3.1		3.1	
Utilization, x	0.26		0.34		0.12		0.17	
Dep. headway, hd	4.59		4.77		5.09		5.07	
Capacity	456		504		332		373	
Delay	9.22		10.18		8.75		9.14	
LOS	A		B		A		A	
Approach:								
Delay	9.22		10.18		8.75		9.14	
LOS	A		B		A		A	

Intersection Delay 9.51 Intersection LOS A

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Halekauwila
North/South Street: Keawe

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	9	235	46	35	89	12	20	40	41	15	86	12
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.77		0.88		0.69		0.72	
Flow Rate	375		153		144		155	
% Heavy Veh	2		2		2		2	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	375		153		144		155	
Left-Turn	11		39		28		20	
Right-Turn	59		13		59		16	
Prop. Left-Turns	0.0		0.3		0.2		0.1	
Prop. Right-Turns	0.2		0.1		0.4		0.1	

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0
Geometry Group	1	1	1	1
Adjustments Exhibit 17-33:				
hLT-adj	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7
hadj, computed	-0.1	0.0	-0.2	-0.0

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	375		153		144		155	
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.33		0.14		0.13		0.14	
hd, final value	4.93		5.33		5.38		5.53	
x, final value	0.51		0.23		0.22		0.24	
Move-up time, m	2.0		2.0		2.0		2.0	
Service Time	2.9		3.3		3.4		3.5	

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	375		153		144		155	
Service Time	2.9		3.3		3.4		3.5	
Utilization, x	0.51		0.23		0.22		0.24	
Dep. headway, hd	4.93		5.33		5.38		5.53	
Capacity	625		403		394		405	
Delay	13.11		9.89		9.86		10.25	
LOS	B		A		A		B	
Approach:								
Delay	13.11		9.89		9.86		10.25	
LOS	B		A		A		B	

Intersection Delay 11.41 Intersection LOS B

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Halekauwila
North/South Street: Coral
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	12	118			164	23
Peak-Hour Factor, PHF	0.77	0.77			0.92	0.92
Hourly Flow Rate, HFR	15	153			178	24
Percent Heavy Vehicles	2	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				20		27
Peak Hour Factor, PHF				0.73		0.73
Hourly Flow Rate, HFR				27		36
Percent Heavy Vehicles				2		2
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0		0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	15						63	
C(m) (vph)	1370						735	
v/c	0.01						0.09	
95% queue length	0.03						0.28	
Control Delay	7.7						10.4	
LOS	A						B	
Approach Delay							10.4	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Halekauwila
North/South Street: Coral
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	10	324			112	15
Peak-Hour Factor, PHF	0.91	0.91			0.96	0.96
Hourly Flow Rate, HFR	10	356			116	15
Percent Heavy Vehicles	2	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				30		27
Peak Hour Factor, PHF				0.75		0.75
Hourly Flow Rate, HFR				40		36
Percent Heavy Vehicles				2		2
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	0	
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	10						76	
C(m) (vph)	1454						662	
v/c	0.01						0.11	
95% queue length	0.02						0.39	
Control Delay	7.5						11.1	
LOS	A						B	
Approach Delay							11.1	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Halekauwila
North/South Street: Cooke

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	31	57	31	48	85	36	16	150	18	24	236	85
% Thrus Left Lane									50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LT	TR	LT	TR
PHF	0.85		0.90		0.87	0.87	0.92	0.92
Flow Rate	139		187		104	106	154	220
% Heavy Veh	2		2		2	2	2	2
No. Lanes	1		1		2		2	
Opposing-Lanes	1		1		2		2	
Conflicting-lanes	2		2		1		1	
Geometry group	2		2		5		5	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	139		187		104	106	154	220
Left-Turn	36		53		18	0	26	0
Right-Turn	36		40		0	20	0	92
Prop. Left-Turns	0.3		0.3		0.2	0.0	0.2	0.0
Prop. Right-Turns	0.3		0.2		0.0	0.2	0.0	0.4

Prop. Heavy Vehicle	0.0		0.0		0.0	0.0	0.0	0.0
Geometry Group	2		2		5		5	
Adjustments Exhibit 17-33:								
hLT-adj	0.2		0.2		0.5		0.5	
hRT-adj	-0.6		-0.6		-0.7		-0.7	
hHV-adj	1.7		1.7		1.7		1.7	
hadj, computed	-0.1		-0.0		0.1	-0.1	0.1	-0.3

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	139		187		104	106	154	220
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.12		0.17		0.09	0.09	0.14	0.20
hd, final value	5.62		5.55		6.09	5.87	5.88	5.50
x, final value	0.22		0.29		0.18	0.17	0.25	0.34
Move-up time, m	2.0		2.0		2.3		2.3	
Service Time	3.6		3.6		3.8	3.6	3.6	3.2

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	139		187		104	106	154	220
Service Time	3.6		3.6		3.8	3.6	3.6	3.2
Utilization, x	0.22		0.29		0.18	0.17	0.25	0.34
Dep. headway, hd	5.62		5.55		6.09	5.87	5.88	5.50
Capacity	389		437		354	356	404	470
Delay	10.17		10.80		10.09	9.79	10.56	10.98
LOS	B		B		B	A	B	B
Approach:								
Delay	10.17		10.80		9.94		10.80	
LOS	B		B		A		B	

Intersection Delay 10.51 Intersection LOS B

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Halekauwila
North/South Street: Cooke

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	105	191	36	28	80	46	11	291	29	36	332	39
% Thrus Left Lane									50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LT	TR	LT	TR
PHF	0.91		0.82		0.84	0.84	0.90	0.90
Flow Rate	363		187		185	207	224	227
% Heavy Veh	2		2		2	2	2	2
No. Lanes	1		1		2		2	
Opposing-Lanes	1		1		2		2	
Conflicting-lanes	2		2		1		1	
Geometry group	2		2		5		5	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	363		187		185	207	224	227
Left-Turn	115		34		13	0	40	0
Right-Turn	39		56		0	34	0	43
Prop. Left-Turns	0.3		0.2		0.1	0.0	0.2	0.0
Prop. Right-Turns	0.1		0.3		0.0	0.2	0.0	0.2

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0	0.0	0.0
Geometry Group	2	2	5		5	
Adjustments Exhibit 17-33:						
hLT-adj	0.2	0.2	0.5		0.5	
hRT-adj	-0.6	-0.6	-0.7		-0.7	
hHV-adj	1.7	1.7	1.7		1.7	
hadj, computed	0.0	-0.1	0.1	-0.1	0.1	-0.1

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	363		187		185	207	224	227
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.32		0.17		0.16	0.18	0.20	0.20
hd, final value	6.85		7.28		7.55	7.39	7.50	7.27
x, final value	0.69		0.38		0.39	0.43	0.47	0.46
Move-up time, m	2.0		2.0		2.3		2.3	
Service Time	4.8		5.3		5.2	5.1	5.2	5.0

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	363		187		185	207	224	227
Service Time	4.8		5.3		5.2	5.1	5.2	5.0
Utilization, x	0.69		0.38		0.39	0.43	0.47	0.46
Dep. headway, hd	6.85		7.28		7.55	7.39	7.50	7.27
Capacity	505		437		435	457	460	474
Delay	24.73		14.70		15.01	15.53	16.72	16.09
LOS	C		B		C	C	C	C
Approach:								
Delay	24.73		14.70		15.29		16.41	
LOS	C		B		C		C	

Intersection Delay 18.03 Intersection LOS C

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Pohukaina
North/South Street: Keawe

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	13	80	16	24	145	23	22	40	24	43	60	83
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.80		0.84		0.65		0.88	
Flow Rate	134		227		130		210	
% Heavy Veh	2		2		2		2	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	134		227		130		210	
Left-Turn	16		28		33		48	
Right-Turn	19		27		36		94	
Prop. Left-Turns	0.1		0.1		0.3		0.2	
Prop. Right-Turns	0.1		0.1		0.3		0.4	

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0
Geometry Group	1	1	1	1
Adjustments Exhibit 17-33:				
hLT-adj	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7
hadj, computed	-0.0	-0.0	-0.1	-0.2

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	134		227		130		210	
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.12		0.20		0.12		0.19	
hd, final value	5.08		4.96		5.06		4.84	
x, final value	0.19		0.31		0.18		0.28	
Move-up time, m	2.0		2.0		2.0		2.0	
Service Time	3.1		3.0		3.1		2.8	

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	134		227		130		210	
Service Time	3.1		3.0		3.1		2.8	
Utilization, x	0.19		0.31		0.18		0.28	
Dep. headway, hd	5.08		4.96		5.06		4.84	
Capacity	384		477		380		460	
Delay	9.26		10.21		9.20		9.75	
LOS	A		B		A		A	
Approach:								
Delay	9.26		10.21		9.20		9.75	
LOS	A		B		A		A	

Intersection Delay 9.70 Intersection LOS A

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Pohukaina
North/South Street: Keawe

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	22	166	23	45	187	34	31	47	32	40	113	32
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.88		0.89		0.71		0.67	
Flow Rate	239		298		154		274	
% Heavy Veh	2		2		2		2	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	239		298		154		274	
Left-Turn	25		50		43		59	
Right-Turn	26		38		45		47	
Prop. Left-Turns	0.1		0.2		0.3		0.2	
Prop. Right-Turns	0.1		0.1		0.3		0.2	

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0
Geometry Group	1	1	1	1
Adjustments Exhibit 17-33:				
hLT-adj	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7
hadj, computed	-0.0	-0.0	-0.1	-0.0

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	239		298		154		274	
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.21		0.26		0.14		0.24	
hd, final value	5.73		5.63		5.94		5.75	
x, final value	0.38		0.47		0.25		0.44	
Move-up time, m	2.0		2.0		2.0		2.0	
Service Time	3.7		3.6		3.9		3.7	

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	239		298		154		274	
Service Time	3.7		3.6		3.9		3.7	
Utilization, x	0.38		0.47		0.25		0.44	
Dep. headway, hd	5.73		5.63		5.94		5.75	
Capacity	489		548		404		524	
Delay	12.25		13.52		10.96		13.19	
LOS	B		B		B		B	
Approach:								
Delay	12.25		13.52		10.96		13.19	
LOS	B		B		B		B	

Intersection Delay 12.70 Intersection LOS B

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Pohukaina
North/South Street: Coral

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	0	80	22	44	179	0	36	0	50	0	0	0
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	TR		LT		LR			
PHF	0.85		0.93		0.67			
Flow Rate	119		239		127			
% Heavy Veh	2		2		2			
No. Lanes	1		1		1			
Opposing-Lanes	1		1		0			
Conflicting-lanes	1		1		1			
Geometry group	1		1		1			

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	119		239		127			
Left-Turn	0		47		53			
Right-Turn	25		0		74			
Prop. Left-Turns	0.0		0.2		0.4			
Prop. Right-Turns	0.2		0.0		0.6			

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Pohukaina
North/South Street: Coral

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	0	205	20	32	117	0	41	0	137	0	0	0
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	TR		LT		LR			
PHF	0.82		0.83		0.86			
Flow Rate	274		178		206			
% Heavy Veh	2		2		2			
No. Lanes	1		1		1			
Opposing-Lanes	1		1		0			
Conflicting-lanes	1		1		1			
Geometry group	1		1		1			

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	274		178		206			
Left-Turn	0		38		47			
Right-Turn	24		0		159			
Prop. Left-Turns	0.0		0.2		0.2			
Prop. Right-Turns	0.1		0.0		0.8			

Prop. Heavy Vehicle	0.0	0.0	0.0
Geometry Group	1	1	1
Adjustments Exhibit 17-33:			
hLT-adj	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7
hadj, computed	-0.0	0.1	-0.4

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	274		178		206			
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.24		0.16		0.18			
hd, final value	4.62		4.82		4.59			
x, final value	0.35		0.24		0.26			
Move-up time, m	2.0		2.0		2.0			
Service Time	2.6		2.8		2.6			

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	274		178		206			
Service Time	2.6		2.8		2.6			
Utilization, x	0.35		0.24		0.26			
Dep. headway, hd	4.62		4.82		4.59			
Capacity	524		428		456			
Delay	10.12		9.33		9.23			
LOS	B		A		A			
Approach:								
Delay	10.12		9.33		9.23			
LOS	B		A		A			

Intersection Delay 9.63 Intersection LOS A

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Pohukaina
North/South Street: Cooke

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	46	52	27	25	111	38	9	135	19	36	135	101
% Thrus Left Lane									50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LT	TR	LT	TR
PHF	0.74		0.93		0.93	0.93	0.93	0.93
Flow Rate	168		185		81	93	110	181
% Heavy Veh	2		2		2	2	2	2
No. Lanes	1		1		2		2	
Opposing-Lanes	1		1		2		2	
Conflicting-lanes	2		2		1		1	
Geometry group	2		2		5		5	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	168		185		81	93	110	181
Left-Turn	62		26		9	0	38	0
Right-Turn	36		40		0	20	0	108
Prop. Left-Turns	0.4		0.1		0.1	0.0	0.3	0.0
Prop. Right-Turns	0.2		0.2		0.0	0.2	0.0	0.6

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0	0.0	0.0
Geometry Group	2	2	5		5	
Adjustments Exhibit 17-33:						
hLT-adj	0.2	0.2	0.5		0.5	
hRT-adj	-0.6	-0.6	-0.7		-0.7	
hHV-adj	1.7	1.7	1.7		1.7	
hadj, computed	-0.0	-0.1	0.1	-0.1	0.2	-0.4

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	168		185		81	93	110	181
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.15		0.16		0.07	0.08	0.10	0.16
hd, final value	5.36		5.28		5.97	5.77	5.95	5.35
x, final value	0.25		0.27		0.13	0.15	0.18	0.27
Move-up time, m	2.0		2.0		2.3		2.3	
Service Time	3.4		3.3		3.7	3.5	3.6	3.0

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	168		185		81	93	110	181
Service Time	3.4		3.3		3.7	3.5	3.6	3.0
Utilization, x	0.25		0.27		0.13	0.15	0.18	0.27
Dep. headway, hd	5.36		5.28		5.97	5.77	5.95	5.35
Capacity	418		435		331	343	360	431
Delay	10.14		10.25		9.60	9.47	9.96	10.01
LOS	B		B		A	A	A	B
Approach:								
Delay	10.14		10.25		9.53		9.99	
LOS	B		B		A		A	

Intersection Delay 9.98 Intersection LOS A

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: Pohukaina
North/South Street: Cooke

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	158	140	42	33	88	52	6	162	42	54	291	56
% Thrus Left Lane									50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LT	TR	LT	TR
PHF	0.89		0.90		0.89	0.89	0.97	0.97
Flow Rate	381		190		97	138	204	207
% Heavy Veh	2		2		2	2	2	2
No. Lanes	1		1		2		2	
Opposing-Lanes	1		1		2		2	
Conflicting-lanes	2		2		1		1	
Geometry group	2		2		5		5	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	381		190		97	138	204	207
Left-Turn	177		36		6	0	55	0
Right-Turn	47		57		0	47	0	57
Prop. Left-Turns	0.5		0.2		0.1	0.0	0.3	0.0
Prop. Right-Turns	0.1		0.3		0.0	0.3	0.0	0.3

Prop. Heavy Vehicle	0.0		0.0		0.0	0.0	0.0	0.0
Geometry Group	2		2		5		5	
Adjustments Exhibit 17-33:								
hLT-adj	0.2		0.2		0.5		0.5	
hRT-adj	-0.6		-0.6		-0.7		-0.7	
hHV-adj	1.7		1.7		1.7		1.7	
hadj, computed	0.1		-0.1		0.1	-0.2	0.2	-0.2

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	381		190		97	138	204	207
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.34		0.17		0.09	0.12	0.18	0.18
hd, final value	6.23		6.55		7.28	7.01	7.06	6.72
x, final value	0.66		0.35		0.20	0.27	0.40	0.39
Move-up time, m	2.0		2.0		2.3		2.3	
Service Time	4.2		4.5		5.0	4.7	4.8	4.4

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	381		190		97	138	204	207
Service Time	4.2		4.5		5.0	4.7	4.8	4.4
Utilization, x	0.66		0.35		0.20	0.27	0.40	0.39
Dep. headway, hd	6.23		6.55		7.28	7.01	7.06	6.72
Capacity	556		440		347	388	454	457
Delay	21.08		13.00		11.76	12.27	14.45	13.65
LOS	C		B		B	B	B	B
Approach:								
Delay	21.08		13.00		12.06		14.05	
LOS	C		B		B		B	

Intersection Delay 15.70 Intersection LOS C

APPENDIX D

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2012 PEAK PERIOD TRAFFIC
ANALYSIS WITHOUT PROJECT

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/out project
Project ID:
East/West Street: Halekauwila
North/South Street: Keawe

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	8	104	68	90	111	19	13	32	21	12	67	20
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.85		0.85		0.79		0.79	
Flow Rate	210		257		82		124	
% Heavy Veh	2		2		2		2	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	210		257		82		124	
Left-Turn	9		105		16		15	
Right-Turn	79		22		26		25	
Prop. Left-Turns	0.0		0.4		0.2		0.1	
Prop. Right-Turns	0.4		0.1		0.3		0.2	

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0
Geometry Group	1	1	1	1
Adjustments Exhibit 17-33:				
hLT-adj	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7
hadj, computed	-0.2	0.1	-0.1	-0.1

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	210		257		82		124	
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.19		0.23		0.07		0.11	
hd, final value	4.60		4.78		5.11		5.09	
x, final value	0.27		0.34		0.12		0.18	
Move-up time, m	2.0		2.0		2.0		2.0	
Service Time	2.6		2.8		3.1		3.1	

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	210		257		82		124	
Service Time	2.6		2.8		3.1		3.1	
Utilization, x	0.27		0.34		0.12		0.18	
Dep. headway, hd	4.60		4.78		5.11		5.09	
Capacity	460		507		332		374	
Delay	9.29		10.25		8.78		9.18	
LOS	A		B		A		A	
Approach:								
Delay	9.29		10.25		8.78		9.18	
LOS	A		B		A		A	

Intersection Delay 9.57 Intersection LOS A

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/out project
Project ID:
East/West Street: Halekauwila
North/South Street: Keawe

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	9	239	47	36	90	12	20	41	42	15	87	12
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.77		0.88		0.69		0.72	
Flow Rate	382		155		147		156	
% Heavy Veh	2		2		2		2	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	382		155		147		156	
Left-Turn	11		40		28		20	
Right-Turn	61		13		60		16	
Prop. Left-Turns	0.0		0.3		0.2		0.1	
Prop. Right-Turns	0.2		0.1		0.4		0.1	

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0
Geometry Group	1	1	1	1
Adjustments Exhibit 17-33:				
hLT-adj	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7
hadj, computed	-0.1	0.0	-0.2	-0.0

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	382		155		147		156	
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.34		0.14		0.13		0.14	
hd, final value	4.95		5.37		5.42		5.57	
x, final value	0.53		0.23		0.22		0.24	
Move-up time, m	2.0		2.0		2.0		2.0	
Service Time	3.0		3.4		3.4		3.6	

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	382		155		147		156	
Service Time	3.0		3.4		3.4		3.6	
Utilization, x	0.53		0.23		0.22		0.24	
Dep. headway, hd	4.95		5.37		5.42		5.57	
Capacity	632		405		397		406	
Delay	13.41		9.98		9.96		10.34	
LOS	B		A		A		B	
Approach:								
Delay	13.41		9.98		9.96		10.34	
LOS	B		A		A		B	

Intersection Delay 11.60 Intersection LOS B

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/out project
Project ID:
East/West Street: Halekauwila
North/South Street: Coral
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	12	120			166	23
Peak-Hour Factor, PHF	0.77	0.77			0.92	0.92
Hourly Flow Rate, HFR	15	155			180	24
Percent Heavy Vehicles	2	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration		LT				TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				20		27
Peak Hour Factor, PHF				0.73		0.73
Hourly Flow Rate, HFR				27		36
Percent Heavy Vehicles				2		2
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	0	
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	15						63	
C(m) (vph)	1368						732	
v/c	0.01						0.09	
95% queue length	0.03						0.28	
Control Delay	7.7						10.4	
LOS	A						B	
Approach Delay							10.4	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/out project
Project ID:
East/West Street: Halekauwila
North/South Street: Coral
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	10	329			114	15
Peak-Hour Factor, PHF	0.91	0.91			0.96	0.96
Hourly Flow Rate, HFR	10	361			118	15
Percent Heavy Vehicles	2	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				30		27
Peak Hour Factor, PHF				0.75		0.75
Hourly Flow Rate, HFR				40		36
Percent Heavy Vehicles				2		2
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	0	
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	10						76	
C(m) (vph)	1452						657	
v/c	0.01						0.12	
95% queue length	0.02						0.39	
Control Delay	7.5						11.2	
LOS	A						B	
Approach Delay							11.2	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/out project
Project ID:
East/West Street: Halekauwila
North/South Street: Cooke

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	31	58	31	49	86	37	16	152	18	24	240	86
% Thrus Left Lane									50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LT	TR	LT	TR
PHF	0.85		0.90		0.87	0.87	0.92	0.92
Flow Rate	140		190		105	107	156	223
% Heavy Veh	2		2		2	2	2	2
No. Lanes	1		1		2		2	
Opposing-Lanes	1		1		2		2	
Conflicting-lanes	2		2		1		1	
Geometry group	2		2		5		5	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	140		190		105	107	156	223
Left-Turn	36		54		18	0	26	0
Right-Turn	36		41		0	20	0	93
Prop. Left-Turns	0.3		0.3		0.2	0.0	0.2	0.0
Prop. Right-Turns	0.3		0.2		0.0	0.2	0.0	0.4

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0	0.0	0.0
Geometry Group	2	2	5		5	
Adjustments Exhibit 17-33:						
hLT-adj	0.2	0.2	0.5		0.5	
hRT-adj	-0.6	-0.6	-0.7		-0.7	
hHV-adj	1.7	1.7	1.7		1.7	
hadj, computed	-0.1	-0.0	0.1	-0.1	0.1	-0.3

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	140		190		105	107	156	223
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.12		0.17		0.09	0.10	0.14	0.20
hd, final value	5.65		5.58		6.12	5.90	5.90	5.52
x, final value	0.22		0.29		0.18	0.18	0.26	0.34
Move-up time, m	2.0		2.0		2.3		2.3	
Service Time	3.6		3.6		3.8	3.6	3.6	3.2

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	140		190		105	107	156	223
Service Time	3.6		3.6		3.8	3.6	3.6	3.2
Utilization, x	0.22		0.29		0.18	0.18	0.26	0.34
Dep. headway, hd	5.65		5.58		6.12	5.90	5.90	5.52
Capacity	390		440		355	357	406	473
Delay	10.24		10.90		10.15	9.85	10.63	11.09
LOS	B		B		B	A	B	B
Approach:								
Delay	10.24		10.90		10.00-		10.90	
LOS	B		B		A		B	

Intersection Delay 10.59 Intersection LOS B

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/out project
Project ID:
East/West Street: Halekauwila
North/South Street: Cooke

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	107	194	37	28	81	47	11	295	29	37	337	40
% Thrus Left Lane									50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LT	TR	LT	TR
PHF	0.91		0.82		0.84	0.84	0.90	0.90
Flow Rate	370		189		188	210	227	231
% Heavy Veh	2		2		2	2	2	2
No. Lanes	1		1		2		2	
Opposing-Lanes	1		1		2		2	
Conflicting-lanes	2		2		1		1	
Geometry group	2		2		5		5	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	370		189		188	210	227	231
Left-Turn	117		34		13	0	41	0
Right-Turn	40		57		0	34	0	44
Prop. Left-Turns	0.3		0.2		0.1	0.0	0.2	0.0
Prop. Right-Turns	0.1		0.3		0.0	0.2	0.0	0.2

Prop. Heavy Vehicle	0.0		0.0		0.0	0.0	0.0	0.0
Geometry Group	2		2		5		5	
Adjustments Exhibit 17-33:								
hLT-adj	0.2		0.2		0.5		0.5	
hRT-adj	-0.6		-0.6		-0.7		-0.7	
hHV-adj	1.7		1.7		1.7		1.7	
hadj, computed	0.0		-0.1		0.1	-0.1	0.1	-0.1

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	370		189		188	210	227	231
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.33		0.17		0.17	0.19	0.20	0.21
hd, final value	6.91		7.38		7.63	7.48	7.58	7.35
x, final value	0.71		0.39		0.40	0.44	0.48	0.47
Move-up time, m	2.0		2.0		2.3		2.3	
Service Time	4.9		5.4		5.3	5.2	5.3	5.1

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	370		189		188	210	227	231
Service Time	4.9		5.4		5.3	5.2	5.3	5.1
Utilization, x	0.71		0.39		0.40	0.44	0.48	0.47
Dep. headway, hd	6.91		7.38		7.63	7.48	7.58	7.35
Capacity	502		438		438	457	456	469
Delay	26.35		15.02		15.37	15.93	17.18	16.58
LOS	D		C		C	C	C	C
Approach:								
Delay	26.35		15.02		15.66		16.88	
LOS	D		C		C		C	

Intersection Delay 18.76 Intersection LOS C

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/out project
Project ID:
East/West Street: Pohukaina
North/South Street: Keawe

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	13	81	16	24	147	23	22	41	24	44	61	84

% Thrus Left Lane

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.80		0.84		0.65		0.88	
Flow Rate	136		230		132		214	
% Heavy Veh	2		2		2		2	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	136		230		132		214	
Left-Turn	16		28		33		50	
Right-Turn	19		27		36		95	
Prop. Left-Turns	0.1		0.1		0.3		0.2	
Prop. Right-Turns	0.1		0.1		0.3		0.4	

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/out project
Project ID:
East/West Street: Pohukaina
North/South Street: Coral

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	0	81	22	45	182	0	37	0	51	0	0	0
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	TR		LT		LR			
PHF	0.85		0.93		0.67			
Flow Rate	120		243		131			
% Heavy Veh	2		2		2			
No. Lanes	1		1		1			
Opposing-Lanes	1		1		0			
Conflicting-lanes	1		1		1			
Geometry group	1		1		1			

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	120		243		131			
Left-Turn	0		48		55			
Right-Turn	25		0		76			
Prop. Left-Turns	0.0		0.2		0.4			
Prop. Right-Turns	0.2		0.0		0.6			

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/out project
Project ID:
East/West Street: Pohukaina
North/South Street: Coral

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	0	208	20	32	119	0	42	0	139	0	0	0
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	TR		LT		LR			
PHF	0.82		0.83		0.86			
Flow Rate	277		181		209			
% Heavy Veh	2		2		2			
No. Lanes	1		1		1			
Opposing-Lanes	1		1		0			
Conflicting-lanes	1		1		1			
Geometry group	1		1		1			

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	277		181		209			
Left-Turn	0		38		48			
Right-Turn	24		0		161			
Prop. Left-Turns	0.0		0.2		0.2			
Prop. Right-Turns	0.1		0.0		0.8			

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/out project
Project ID:
East/West Street: Pohukaina
North/South Street: Cooke

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	47	53	27	25	113	39	9	137	19	37	137	103
% Thrus Left Lane									50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LT	TR	LT	TR
PHF	0.74		0.93		0.93	0.93	0.93	0.93
Flow Rate	170		188		82	94	112	184
% Heavy Veh	2		2		2	2	2	2
No. Lanes	1		1		2		2	
Opposing-Lanes	1		1		2		2	
Conflicting-lanes	2		2		1		1	
Geometry group	2		2		5		5	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	170		188		82	94	112	184
Left-Turn	63		26		9	0	39	0
Right-Turn	36		41		0	20	0	110
Prop. Left-Turns	0.4		0.1		0.1	0.0	0.3	0.0
Prop. Right-Turns	0.2		0.2		0.0	0.2	0.0	0.6

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/out project
Project ID:
East/West Street: Pohukaina
North/South Street: Cooke

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	160	142	43	33	89	53	6	164	43	55	295	57
% Thrus Left Lane									50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LT	TR	LT	TR
PHF	0.89		0.90		0.89	0.89	0.97	0.97
Flow Rate	386		192		98	140	207	210
% Heavy Veh	2		2		2	2	2	2
No. Lanes	1		1		2		2	
Opposing-Lanes	1		1		2		2	
Conflicting-lanes	2		2		1		1	
Geometry group	2		2		5		5	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	386		192		98	140	207	210
Left-Turn	179		36		6	0	56	0
Right-Turn	48		58		0	48	0	58
Prop. Left-Turns	0.5		0.2		0.1	0.0	0.3	0.0
Prop. Right-Turns	0.1		0.3		0.0	0.3	0.0	0.3

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0	0.0	0.0
Geometry Group	2	2	5		5	
Adjustments Exhibit 17-33:						
hLT-adj	0.2	0.2	0.5		0.5	
hRT-adj	-0.6	-0.6	-0.7		-0.7	
hHV-adj	1.7	1.7	1.7		1.7	
hadj, computed	0.1	-0.1	0.1	-0.2	0.2	-0.2

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	386		192		98	140	207	210
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.34		0.17		0.09	0.12	0.18	0.19
hd, final value	6.27		6.61		7.34	7.06	7.11	6.77
x, final value	0.67		0.35		0.20	0.27	0.41	0.40
Move-up time, m	2.0		2.0		2.3		2.3	
Service Time	4.3		4.6		5.0	4.8	4.8	4.5

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	386		192		98	140	207	210
Service Time	4.3		4.6		5.0	4.8	4.8	4.5
Utilization, x	0.67		0.35		0.20	0.27	0.41	0.40
Dep. headway, hd	6.27		6.61		7.34	7.06	7.11	6.77
Capacity	553		442		348	390	457	460
Delay	21.90		13.19		11.87	12.43	14.71	13.88
LOS	C		B		B	B	B	B
Approach:								
Delay	21.90		13.19		12.20		14.29	
LOS	C		B		B		B	

Intersection Delay 16.10 Intersection LOS C

APPENDIX E

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2012 PEAK PERIOD TRAFFIC
ANALYSIS WITH PROJECT

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/ project
Project ID:
East/West Street: Halekauwila
North/South Street: Keawe

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	8	109	68	97	121	20	13	32	22	12	67	20
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.85		0.85		0.79		0.79	
Flow Rate	216		279		83		124	
% Heavy Veh	2		2		2		2	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	216		279		83		124	
Left-Turn	9		114		16		15	
Right-Turn	79		23		27		25	
Prop. Left-Turns	0.0		0.4		0.2		0.1	
Prop. Right-Turns	0.4		0.1		0.3		0.2	

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0
Geometry Group	1	1	1	1
Adjustments Exhibit 17-33:				
hLT-adj	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7
hadj, computed	-0.2	0.1	-0.1	-0.1

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	216		279		83		124	
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.19		0.25		0.07		0.11	
hd, final value	4.65		4.80		5.19		5.17	
x, final value	0.28		0.37		0.12		0.18	
Move-up time, m	2.0		2.0		2.0		2.0	
Service Time	2.6		2.8		3.2		3.2	

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	216		279		83		124	
Service Time	2.6		2.8		3.2		3.2	
Utilization, x	0.28		0.37		0.12		0.18	
Dep. headway, hd	4.65		4.80		5.19		5.17	
Capacity	466		529		333		374	
Delay	9.44		10.64		8.89		9.30	
LOS	A		B		A		A	
Approach:								
Delay	9.44		10.64		8.89		9.30	
LOS	A		B		A		A	

Intersection Delay 9.83 Intersection LOS A

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/ project
Project ID:
East/West Street: Halekauwila
North/South Street: Keawe

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	9	250	47	37	96	13	20	41	44	16	87	12
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.77		0.88		0.69		0.72	
Flow Rate	396		165		150		158	
% Heavy Veh	2		2		2		2	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	396		165		150		158	
Left-Turn	11		42		28		22	
Right-Turn	61		14		63		16	
Prop. Left-Turns	0.0		0.3		0.2		0.1	
Prop. Right-Turns	0.2		0.1		0.4		0.1	

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0
Geometry Group	1	1	1	1
Adjustments Exhibit 17-33:				
hLT-adj	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7
hadj, computed	-0.1	0.0	-0.2	0.0

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	396		165		150		158	
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.35		0.15		0.13		0.14	
hd, final value	5.01		5.43		5.50		5.66	
x, final value	0.55		0.25		0.23		0.25	
Move-up time, m	2.0		2.0		2.0		2.0	
Service Time	3.0		3.4		3.5		3.7	

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	396		165		150		158	
Service Time	3.0		3.4		3.5		3.7	
Utilization, x	0.55		0.25		0.23		0.25	
Dep. headway, hd	5.01		5.43		5.50		5.66	
Capacity	646		415		400		408	
Delay	14.10		10.22		10.14		10.53	
LOS	B		B		B		B	
Approach:								
Delay	14.10		10.22		10.14		10.53	
LOS	B		B		B		B	

Intersection Delay 12.03 Intersection LOS B

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/ project
Project ID:
East/West Street: Halekauwila
North/South Street: Coral
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	15	148			176	23
Peak-Hour Factor, PHF	0.77	0.77			0.92	0.92
Hourly Flow Rate, HFR	19	192			191	24
Percent Heavy Vehicles	2	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				20		28
Peak Hour Factor, PHF				0.73		0.73
Hourly Flow Rate, HFR				27		38
Percent Heavy Vehicles				2		2
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	0	
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	19						65	
C(m) (vph)	1355						702	
v/c	0.01						0.09	
95% queue length	0.04						0.31	
Control Delay	7.7						10.7	
LOS	A						B	
Approach Delay							10.7	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/ project
Project ID:
East/West Street: Halekauwila
North/South Street: Coral
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	11	353			143	15
Peak-Hour Factor, PHF	0.91	0.91			0.96	0.96
Hourly Flow Rate, HFR	12	387			148	15
Percent Heavy Vehicles	2	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				30		27
Peak Hour Factor, PHF				0.75		0.75
Hourly Flow Rate, HFR				40		36
Percent Heavy Vehicles				2		2
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	0	
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	12						76	
C(m) (vph)	1416						615	
v/c	0.01						0.12	
95% queue length	0.03						0.42	
Control Delay	7.6						11.7	
LOS	A						B	
Approach Delay							11.7	
Approach LOS							B	

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Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/ project
Project ID:
East/West Street: Halekauwila
North/South Street: Cooke

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	39	72	37	49	91	37	17	152	18	24	240	90
% Thrus Left Lane									50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LT	TR	LT	TR
PHF	0.85		0.90		0.87	0.87	0.92	0.92
Flow Rate	172		196		106	107	156	227
% Heavy Veh	2		2		2	2	2	2
No. Lanes	1		1		2		2	
Opposing-Lanes	1		1		2		2	
Conflicting-lanes	2		2		1		1	
Geometry group	2		2		5		5	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	172		196		106	107	156	227
Left-Turn	45		54		19	0	26	0
Right-Turn	43		41		0	20	0	97
Prop. Left-Turns	0.3		0.3		0.2	0.0	0.2	0.0
Prop. Right-Turns	0.3		0.2		0.0	0.2	0.0	0.4

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0	0.0	0.0
Geometry Group	2	2	5		5	
Adjustments Exhibit 17-33:						
hLT-adj	0.2	0.2	0.5		0.5	
hRT-adj	-0.6	-0.6	-0.7		-0.7	
hHV-adj	1.7	1.7	1.7		1.7	
hadj, computed	-0.1	-0.0	0.1	-0.1	0.1	-0.3

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	172		196		106	107	156	227
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.15		0.17		0.09	0.10	0.14	0.20
hd, final value	5.72		5.70		6.29	6.06	6.05	5.67
x, final value	0.27		0.31		0.19	0.18	0.26	0.36
Move-up time, m	2.0		2.0		2.3		2.3	
Service Time	3.7		3.7		4.0	3.8	3.8	3.4

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	172		196		106	107	156	227
Service Time	3.7		3.7		4.0	3.8	3.8	3.4
Utilization, x	0.27		0.31		0.19	0.18	0.26	0.36
Dep. headway, hd	5.72		5.70		6.29	6.06	6.05	5.67
Capacity	422		446		356	357	406	477
Delay	10.87		11.25		10.42	10.10	10.90	11.51
LOS	B		B		B	B	B	B
Approach:								
Delay	10.87		11.25		10.26		11.26	
LOS	B		B		B		B	

Intersection Delay 10.97 Intersection LOS B

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/ project
Project ID:
East/West Street: Halekauwila
North/South Street: Cooke

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	116	207	39	28	99	47	13	294	29	37	337	49
% Thrus Left Lane									50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LT	TR	LT	TR
PHF	0.91		0.82		0.84	0.84	0.90	0.90
Flow Rate	396		211		190	209	227	241
% Heavy Veh	2		2		2	2	2	2
No. Lanes	1		1		2		2	
Opposing-Lanes	1		1		2		2	
Conflicting-lanes	2		2		1		1	
Geometry group	2		2		5		5	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	396		211		190	209	227	241
Left-Turn	127		34		15	0	41	0
Right-Turn	42		57		0	34	0	54
Prop. Left-Turns	0.3		0.2		0.1	0.0	0.2	0.0
Prop. Right-Turns	0.1		0.3		0.0	0.2	0.0	0.2

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0	0.0	0.0
Geometry Group	2	2	5		5	
Adjustments Exhibit 17-33:						
hLT-adj	0.2	0.2	0.5		0.5	
hRT-adj	-0.6	-0.6	-0.7		-0.7	
hHV-adj	1.7	1.7	1.7		1.7	
hadj, computed	0.0	-0.1	0.1	-0.1	0.1	-0.1

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	396		211		190	209	227	241
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.35		0.19		0.17	0.19	0.20	0.21
hd, final value	7.13		7.65		7.97	7.81	7.90	7.65
x, final value	0.78		0.45		0.42	0.45	0.50	0.51
Move-up time, m	2.0		2.0		2.3		2.3	
Service Time	5.1		5.7		5.7	5.5	5.6	5.3

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	396		211		190	209	227	241
Service Time	5.1		5.7		5.7	5.5	5.6	5.3
Utilization, x	0.78		0.45		0.42	0.45	0.50	0.51
Dep. headway, hd	7.13		7.65		7.97	7.81	7.90	7.65
Capacity	491		426		429	437	438	452
Delay	34.55		16.84		16.44	16.96	18.38	18.29
LOS	D		C		C	C	C	C
Approach:								
Delay	34.55		16.84		16.71		18.33	
LOS	D		C		C		C	

Intersection Delay 22.04 Intersection LOS C

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/ project
Project ID:
East/West Street: Pohukaina
North/South Street: Keawe

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	13	80	16	24	146	23	22	42	24	44	63	89
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.80		0.84		0.65		0.88	
Flow Rate	134		228		133		222	
% Heavy Veh	2		2		2		2	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	134		228		133		222	
Left-Turn	16		28		33		50	
Right-Turn	19		27		36		101	
Prop. Left-Turns	0.1		0.1		0.2		0.2	
Prop. Right-Turns	0.1		0.1		0.3		0.5	

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0
Geometry Group	1	1	1	1
Adjustments Exhibit 17-33:				
hLT-adj	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7
hadj, computed	-0.0	-0.0	-0.1	-0.2

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	134		228		133		222	
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.12		0.20		0.12		0.20	
hd, final value	5.13		5.00		5.10		4.86	
x, final value	0.19		0.32		0.19		0.30	
Move-up time, m	2.0		2.0		2.0		2.0	
Service Time	3.1		3.0		3.1		2.9	

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	134		228		133		222	
Service Time	3.1		3.0		3.1		2.9	
Utilization, x	0.19		0.32		0.19		0.30	
Dep. headway, hd	5.13		5.00		5.10		4.86	
Capacity	384		478		383		472	
Delay	9.34		10.32		9.28		9.93	
LOS	A		B		A		A	
Approach:								
Delay	9.34		10.32		9.28		9.93	
LOS	A		B		A		A	

Intersection Delay 9.82 Intersection LOS A

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/ project
Project ID:
East/West Street: Pohukaina
North/South Street: Keawe

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	23	167	23	46	189	35	31	49	32	41	116	32
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.88		0.89		0.71		0.67	
Flow Rate	241		302		157		281	
% Heavy Veh	2		2		2		2	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	241		302		157		281	
Left-Turn	26		51		43		61	
Right-Turn	26		39		45		47	
Prop. Left-Turns	0.1		0.2		0.3		0.2	
Prop. Right-Turns	0.1		0.1		0.3		0.2	

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst: CL
Agency/Co.:
Date Performed: 8/25/2009
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year: Year 2012 w/ project
Project ID:
East/West Street: Pohukaina
North/South Street: Cooke

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	47	52	27	25	112	39	9	138	19	39	141	103
% Thrus Left Lane									50			50

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LT	TR	LT	TR
PHF	0.74		0.93		0.93	0.93	0.93	0.93
Flow Rate	169		187		83	94	116	186
% Heavy Veh	2		2		2	2	2	2
No. Lanes	1		1		2		2	
Opposing-Lanes	1		1		2		2	
Conflicting-lanes	2		2		1		1	
Geometry group	2		2		5		5	

Duration, T 1.00 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	169		187		83	94	116	186
Left-Turn	63		26		9	0	41	0
Right-Turn	36		41		0	20	0	110
Prop. Left-Turns	0.4		0.1		0.1	0.0	0.4	0.0
Prop. Right-Turns	0.2		0.2		0.0	0.2	0.0	0.6

Prop. Heavy Vehicle	0.0	0.0	0.0	0.0	0.0	0.0
Geometry Group	2	2	5		5	
Adjustments Exhibit 17-33:						
hLT-adj	0.2	0.2	0.5		0.5	
hRT-adj	-0.6	-0.6	-0.7		-0.7	
hHV-adj	1.7	1.7	1.7		1.7	
hadj, computed	0.1	-0.1	0.1	-0.2	0.2	-0.2

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	384		193		98	141	208	211
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.34		0.17		0.09	0.13	0.18	0.19
hd, final value	6.28		6.60		7.34	7.07	7.11	6.78
x, final value	0.67		0.35		0.20	0.28	0.41	0.40
Move-up time, m	2.0		2.0		2.3		2.3	
Service Time	4.3		4.6		5.0	4.8	4.8	4.5

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	384		193		98	141	208	211
Service Time	4.3		4.6		5.0	4.8	4.8	4.5
Utilization, x	0.67		0.35		0.20	0.28	0.41	0.40
Dep. headway, hd	6.28		6.60		7.34	7.07	7.11	6.78
Capacity	551		443		348	391	458	461
Delay	21.80		13.21		11.87	12.46	14.75	13.92
LOS	C		B		B	B	B	B
Approach:								
Delay	21.80		13.21		12.22		14.33	
LOS	C		B		B		B	

Intersection Delay 16.07 Intersection LOS C

B.D. NEAL & ASSOCIATES

Applied Meteorology • Air Quality • Computer Science

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November 4, 2008

Taeyong M. Kim
Principal
Environmental Communications, Inc.
1188 Bishop Street, Suite 2210
Honolulu, Hawaii 96813

Subject: Halekauwila Place Development
Air Quality Impact Assessment

Dear Mr. Kim:

In response to your request, we have examined the potential air quality impacts related to the proposed development of Halekauwila Place located in the Kakaako District in Honolulu, Oahu. The results of this examination along with background information related to this issue and recommended mitigation measures are summarized below.

Project Description

Halekauwila Partners, LLC is proposing the Halekauwila Place development in Kakaako on the island of Oahu. The project site includes approximately 1.25 acres of land adjacent to Halekauwila Street that is currently used as a surface parking lot. The proposed development will include the construction of an 18-story residential tower with approximately 204 affordable rental units, a 4-story parking garage, office space for police department staff, approximately 3,000 square feet of retail space, and amenities such as recreational and storage areas. It is expected that the proposed project would be fully developed and occupied by the year 2012.

Ambient Air Quality Standards

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii air quality standards are comparable to the national

standards except those for nitrogen dioxide and carbon monoxide which are more stringent than the national standards.

Regional and Local Climatology

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. Winds are predominantly trade winds which are deviated somewhat from the northeast toward the east or southeast by the local terrain. During winter, occasional storms may generate strong winds from the south (kona winds) for brief periods. When the trade winds or kona winds are weak or absent, landbreeze-seabreeze circulations may develop. Wind speeds are often lower compared to more exposed coastal locations, but the trade winds still provide relatively good ventilation much of the time. Temperatures in the Oahu area leeward of the Koolaus are generally very moderate with average daily temperatures ranging from about 70°F to 84°F. Extreme temperatures range from about 53°F to about 95°F. Rainfall is relatively low with an average of about 22 inches per year.

Existing Air Quality Conditions

Air quality in the vicinity of the project presently is mostly affected by emissions from vehicular sources which emit carbon monoxide, nitrogen oxides, hydrocarbons and other air pollutants. Air quality data from the nearest monitoring stations operated by the Hawaii Department of Health suggest that all state and national air quality standards are currently being met in the downtown Honolulu area.

Air Quality Impacts of Project

Short-term direct and indirect impacts on air quality could potentially occur during project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from soil excavation, aggregate processing and vehicle movement; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term air quality impacts from the disruption of traffic on nearby roadways, from slow-moving construction equipment traveling to and from the project site, and from a temporary increase in local traffic caused by commuting construction workers.

Fugitive dust emissions from construction activities are difficult to estimate accurately because of their elusive nature of emission and because the potential for dust generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The U.S. EPA has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions from project construction would likely be somewhere near this level. In any case, State of Hawaii Air Pollution Control Regulations prohibit visible emissions of fugitive dust from construction activities at the project property line. Thus, an effective dust control plan for the project construction phase should be prepared.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in active construction areas from becoming significant sources of dust. On days without rainfall, construction areas should be watered at least twice during the workday to help keep dust to a minimum. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials likely to give rise to airborne dust. Haul trucks tracking dirt onto paved streets from unpaved areas are oftentimes a significant source of dust in construction areas. Some means to alleviate this problem, such as tire washing or road cleaning, may be appropriate. Dust monitoring could be considered as a means to quantitatively evaluate the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the standard for nitrogen dioxide is set on an annual basis and is not likely to be violated by short-term construction equipment emissions. Carbon monoxide emissions from diesel engines, on the other hand, are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Indirectly, slow-moving construction vehicles on roadways leading to and from the project site could obstruct the normal flow of traffic to such an extent that overall vehicular emissions increase. This impact can be mitigated by moving heavy construction equipment during periods of low traffic volume. Likewise, the schedules of commuting construction workers can be adjusted to avoid peak hours in the project vicinity.

After the period of construction, long-term impacts on air quality from motor vehicle exhausts can potentially occur at or near any project that attracts large volumes of motor vehicle traffic. Carbon monoxide emissions are usually the primary issue, and public areas near traffic-congested intersections are the main concern. Primary access to the project will be provided via driveways off Halekauwila Street between Cooke Street and Keawe Street with a secondary driveway providing access to a loading area off Keawe Street between Halekauwila Street and Pohukaina Street. The project traffic study examined six nearby roadway intersections along Halekauwila Street and Pohukaina Street. These included Halekauwila Street at Cooke Street, Halekauwila Street at Coral Steet, Halekauwila Street at Keawe Street, Pohukaina Street at Keawe Street, Pohukaina Street at Coral Street, and Pohukaina Street at Cooke Street. The project traffic study indicates that with the project, peak-hour traffic volumes at these intersections would likely increase by about 5 percent or less except at the intersection of Coral Street and Halekauwila Street where an increase of about 11 to 12 percent would occur (which is a maximum traffic increase of 61 vehicles per hour during the afternoon peak hour). The traffic study also indicates that traffic level-of-service at these intersections is presently good and that by the year 2012, with or without the project, traffic level-of-service conditions would remain essentially unchanged.

Based on extensive experience in assessing traffic-related air quality impacts, traffic volume increases of less than about 5 percent or less than about 100 vehicles per hour and traffic approach volumes of less than about 1,000 vehicles per hour do not cause any significant impacts on air quality if adequate traffic level-of-service is provided. The project traffic study indicates that traffic volumes in the project area should remain well within these criteria. Considering the small project-related traffic volumes that are expected, traffic from the proposed project should have no measurable long-term impacts on air pollution levels in the project area. Although a detailed air quality modeling study could be performed to quantitatively

predict project impacts, such an analysis is probably unwarranted.

In summary, short-term impacts from fugitive dust during project construction may potentially occur. Because of this, an effective dust control plan for the period of construction should be prepared and implemented. After construction, any long-term impacts on air quality from motor vehicle traffic related to this project will likely be negligible.

Please call me if you have any questions concerning the information presented herein or if you wish to discuss this matter further.

Very truly yours,

Barry D. Neal
Certified Consulting
Meteorologist

ACOUSTIC STUDY FOR THE HALEKAUWILA PLACE PROJECT KAKAAKO, OAHU

Prepared for:

ENVIRONMENTAL COMMUNICATIONS, INC.

Prepared by:

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1126 12th Avenue, Room 305
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OCTOBER 2009

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CHAPTER I. SUMMARY

The existing and future traffic noise levels in the vicinity of the proposed Halekauwila Place project in Kakaako were evaluated for their potential impacts and their relationship to current FHA/HUD noise standards. The traffic noise level increases along the 6 roadways bordering the project site (see FIGURE 1) were calculated. No significant increases in traffic noise are predicted to occur as a result of project plus non-project traffic following project build-out by CY 2012.

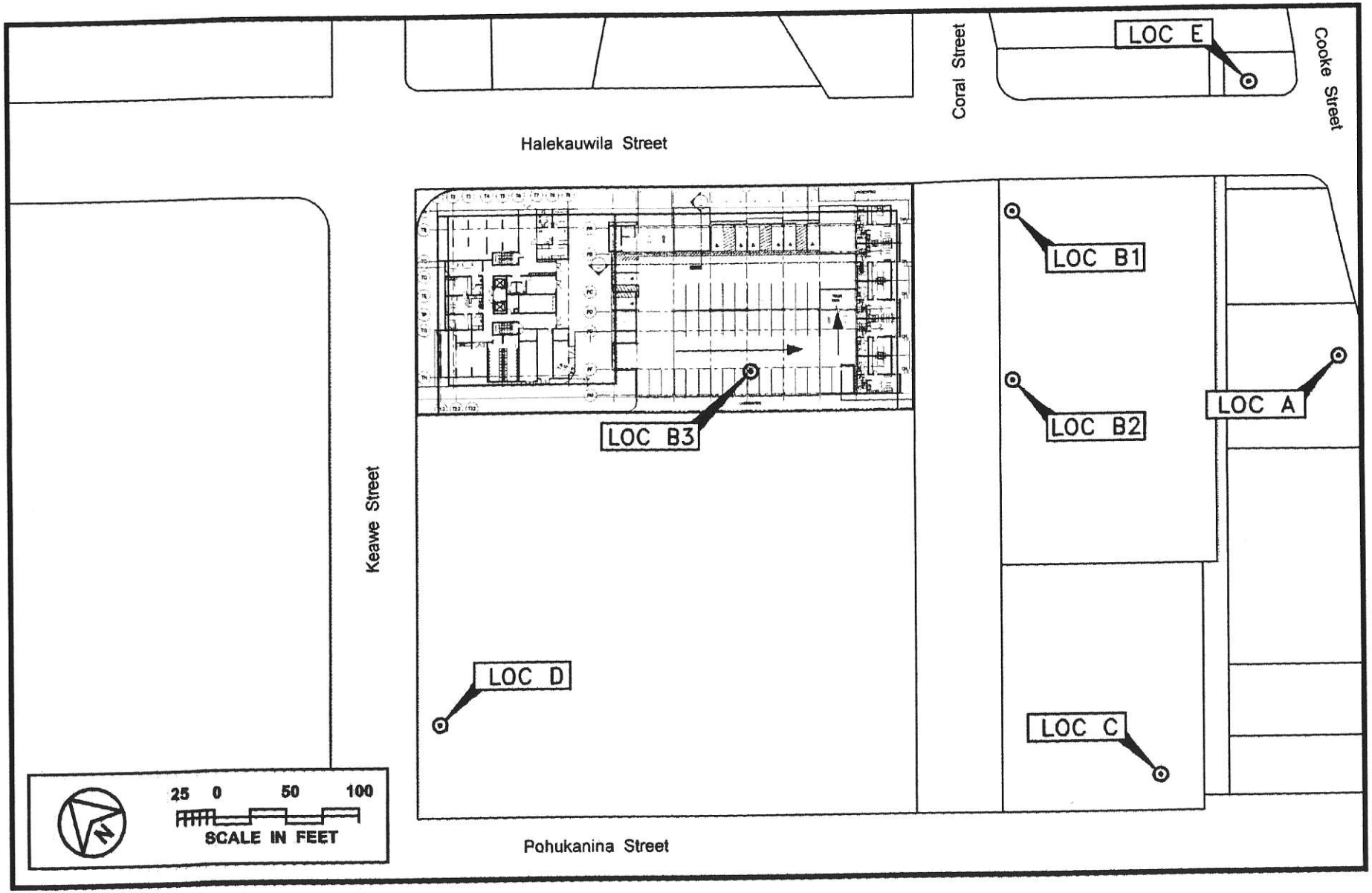
Along Halekauwila Street, traffic noise levels are expected to remain at 62 Ldn at 50 foot distance from the centerline in CY 2012. Along Keawe, Cooke, and Pohukaina Streets, traffic noise levels are expected to increase by less than 0.5 Ldn by CY 2012 as a result of project and non-project traffic. Project traffic will add less than 0.4 Ldn additional units of noise along Halekauwila, Keawe, Cooke, and Pohukaina Streets in the immediate vicinity of the project. These levels of traffic noise increases resulting from project generated traffic are not considered to be significant. The predicted increases in traffic noise levels are not expected to generate adverse noise impacts by CY 2012.

In spite of these increases, the faces of the garage and residential tower buildings will not be exposed to traffic and/or aircraft noise levels which exceed the 65 Ldn FHA/HUD noise standard. In addition, the aircraft noise component should not exceed the State Department of Transportation, Airports Division, recommended planning level of 60 Ldn for residences. Mitigation of traffic or aircraft noise levels is not required for the planned units in the residential tower.

The Honolulu Fixed Guideway System is planned for construction following completion of the Halekauwila Place project and beyond 2012. Future noise levels from the fixed guideway system are anticipated to be similar to those projected for the existing high rise condominium at 860 Halekauwila Street, and are predicted to exceed the FHA/HUD noise standard of 65 Ldn at the 7th through 14th floors of the future Halekauwila Place units which face Halekauwila Street. It is anticipated that noise mitigation measures will be applied by the Honolulu Fixed Guideway System project as required.

Unavoidable, but temporary, noise impacts may occur during construction of the proposed project, particularly during the excavation and potential pile driving activities on the project site. Because construction activities are predicted to be audible within the project site and at adjoining properties, the quality of the acoustic environment may be degraded to unacceptable levels during periods of construction. Mitigation measures to reduce construction noise to inaudible levels will not be practical in all cases, but the use of quiet equipment is recommended as a standard mitigation measure.

Because of the presence of low and mid-rise buildings near the project site and the potential for damage to these buildings from vibration during potential pile driving



PROJECT SITE AND LOCATIONS OF SURROUNDING STREETS AND NOISE MEASUREMENTS

FIGURE 1

operations, vibration monitoring is recommended during close-in pile driving operations where vibration levels are expected to exceed 0.2 inches/second. In addition, it is expected that the design and construction methods for the project building will be optimized to minimize risks of damage to adjacent structures from settling or heaving. A vibration limit of 2.0 inches/second should not be exceeded at any of the adjacent buildings, and modifications to the project's plans prior to design and construction are recommended if these limits are expected to be exceeded.

CHAPTER II. PURPOSE

The primary objective of this study was to describe the existing and future traffic noise environment in the environs of the proposed Halekauwila Place in Kakaako on the island of Oahu. Traffic forecasts for 2012 were used. Traffic noise level increases and impacts associated with the proposed development were to be determined within the project site as well as along the public roadways which are expected to service the project traffic. A specific objective was to determine future traffic noise level increases associated with both project and non-project traffic, and the potential noise impacts associated with these increases.

Impacts from short term construction noise and vibration at the project site were also included as noise study objectives. Specifically, the potential risks of structural damage to adjacent buildings from pile driving operations on the project site were included in the noise and vibration impact assessment. Recommendations for minimizing identified noise and vibration impacts were also to be provided as required.

CHAPTER III. NOISE DESCRIPTORS AND THEIR RELATIONSHIP TO LAND USE COMPATIBILITY

The noise descriptor currently used by federal agencies (such as FHA/HUD) to assess environmental noise is the Day-Night Average Sound Level (Ldn or DNL). This descriptor incorporates a 24-hour average of instantaneous A-Weighted Sound Levels as read on a standard Sound Level Meter. By definition, the minimum averaging period for the Ldn descriptor is 24 hours. Additionally, sound levels which occur during the nighttime hours of 10:00 PM to 7:00 AM are increased by 10 decibels (dB) prior to computing the 24-hour average by the Ldn descriptor. A more complete list of noise descriptors is provided in APPENDIX B to this report.

TABLE 1, derived from Reference 1, presents current federal noise standards and acceptability criteria for residential land uses. Land use compatibility guidelines for various levels of environmental noise as measured by the Ldn descriptor system are shown in FIGURE 2. As a general rule, noise levels of 55 Ldn or less occur in rural areas, or in areas which are removed from high volume roadways. In urbanized areas which are shielded from high volume streets, Ldn levels generally range from 55 to 65 Ldn, and are usually controlled by motor vehicle traffic noise. Residences which front major roadways are generally exposed to levels of 65 Ldn, and as high as 75 Ldn when the roadway is a high speed freeway. In the project area, traffic noise levels associated with Cooke Street are typically greater than 65 Ldn along the Right-of-Way due to the large volume of traffic on that major thoroughfare.

For purposes of determining noise acceptability for funding assistance from federal agencies (FHA/HUD and VA), an exterior noise level of 65 Ldn or less is considered acceptable for residences. This standard is applied nationally (Reference 2), including Hawaii. Because of our open-living conditions, the predominant use of naturally ventilated dwellings, and the relatively low exterior-to-interior sound attenuation afforded by these naturally ventilated structures, an exterior noise level of 65 Ldn does not eliminate all risks of noise impacts. Because of these factors, and as recommended in Reference 3, a lower level of 55 Ldn is considered as the "Unconditionally Acceptable" (or "Near-Zero Risk") level of exterior noise. However, after considering the cost and feasibility of applying the lower level of 55 Ldn, government agencies such as FHA/HUD and VA have selected 65 Ldn as a more appropriate regulatory standard.

For commercial, industrial, and other non-noise sensitive land uses, exterior noise levels as high as 75 Ldn are generally considered acceptable. Exceptions to this occur when naturally ventilated office and other commercial establishments are exposed to exterior levels which exceed 65 Ldn.

On the island of Oahu, the State Department of Health (DOH) regulates noise from construction activities, through the issuance of permits for allowing excessive

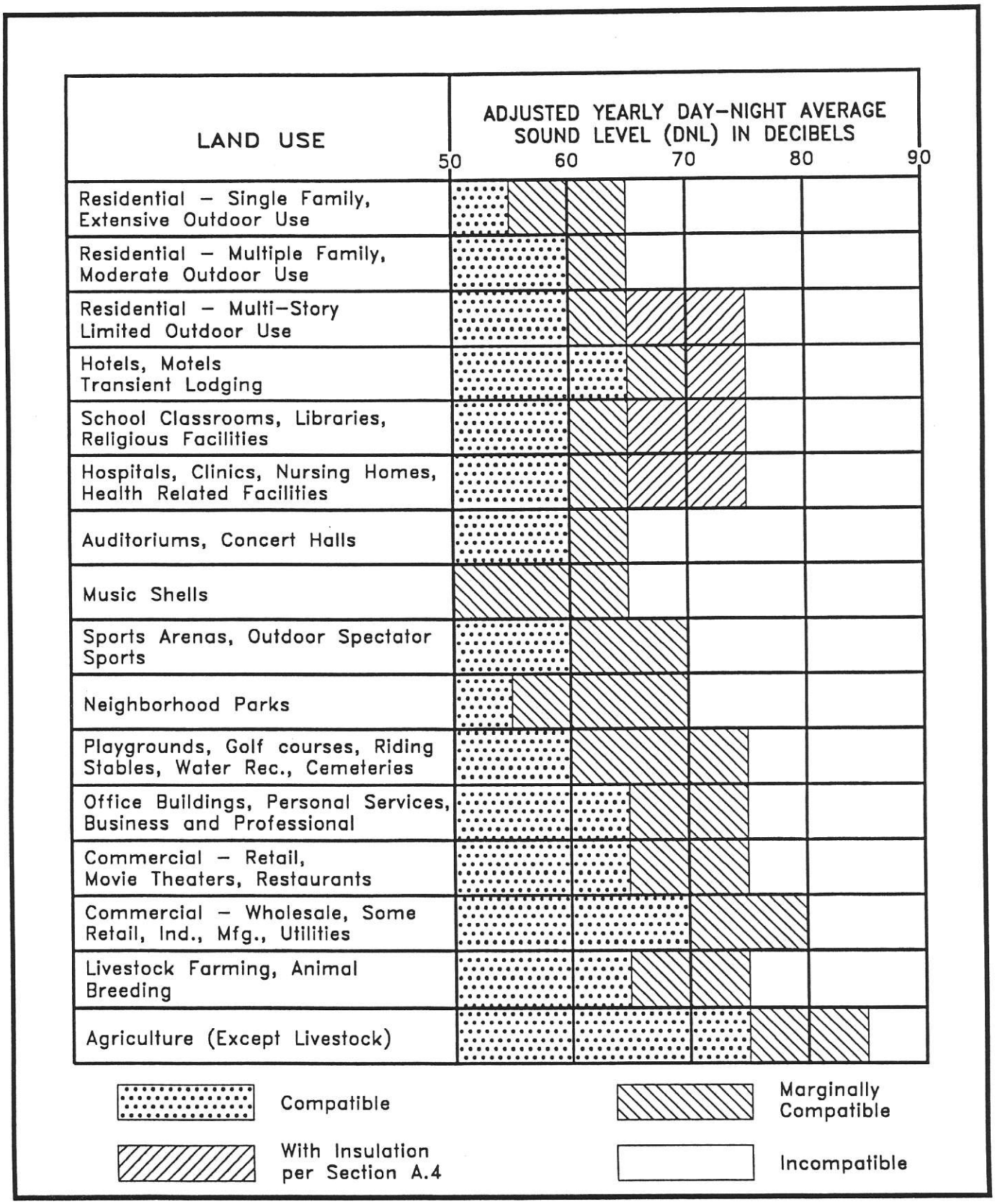
TABLE 1

EXTERIOR NOISE EXPOSURE CLASSIFICATION (RESIDENTIAL LAND USE)

NOISE EXPOSURE CLASS	DAY–NIGHT SOUND LEVEL	EQUIVALENT SOUND LEVEL	FEDERAL (1) STANDARD
Minimal Exposure	Not Exceeding 55 DNL	Not Exceeding 55 Leq	Unconditionally Acceptable
Moderate Exposure	Above 55 DNL But Not Above 65 DNL	Above 55 Leq But Not Above 65 Leq	Acceptable(2)
Significant Exposure	Above 65 DNL But Not Above 75 DNL	Above 65 Leq But Not Above 75 Leq	Normally Unacceptable
Severe Exposure	Above 75 DNL	Above 75 Leq	Unacceptable

Notes: (1) Federal Housing Administration, Veterans Administration, Department of Defense, and Department of Transportation.

(2) FHWA uses the Leq instead of the Ldn descriptor. For planning purposes, both are equivalent if: (a) heavy trucks do not exceed 10 percent of total traffic flow in vehicles per 24 hours, and (b) traffic between 10:00 PM and 7:00 AM does not exceed 15 percent of average daily traffic flow in vehicles per 24 hours. The noise mitigation threshold used by FHWA for residences is 67 Leq.



LAND USE COMPATIBILITY WITH YEARLY AVERAGE DAY-NIGHT AVERAGE SOUND LEVEL (DNL) AT A SITE FOR BUILDINGS AS COMMONLY CONSTRUCTED.
(Source: American National Standards Institute S12.9-1998/Part 5)

FIGURE 2

noise during limited time periods. State DOH noise regulations are expressed in maximum allowable property line noise limits rather than Ldn (see Reference 4). Although they are not directly comparable to noise criteria expressed in Ldn, State DOH noise limits for residential, commercial, and industrial lands equate to approximately 55, 60, and 76 Ldn, respectively.

It should be noted that the noise compatibility guidelines and relationships to the Ldn noise descriptor may not be applicable to impulsive noise sources such as pile drivers. The use of penalty factors (such as adding 10 dB to measured sound levels or the use of C-Weighting filters) have been proposed. However, the relationships between levels of impulsive noise sources and land use compatibility have not been as firmly established as have the relationships for non-impulsive sources. The State DOH limits for impulsive sounds which exceed 120 impulses in any 20 minute period are 10 dB above the limits for non-impulsive sounds. If impulsive sounds do not exceed 120 impulses in any 20 minute time period, there are no regulatory limits on their sound levels under the State DOH regulations.

CHAPTER IV. GENERAL STUDY METHODOLOGY

Existing traffic noise levels were measured at four locations (A, B1, C, and D) in the project environs to provide a basis for developing the project's traffic noise contributions along the roadways which will service the proposed development. The locations of the measurement sites are shown in FIGURE 1. Traffic noise measurements were performed during the months of April and May, 2000. The results of the traffic noise measurements were compared with calculations of existing traffic noise levels to validate the computer model used. The traffic noise measurement results, and their comparisons with computer model predictions of existing traffic noise levels are summarized in TABLE 2.

Traffic noise calculations for the existing conditions as well as noise predictions for 2012 were performed using the Federal Highway Administration (FHWA) Traffic Noise Model (Reference 5). Traffic data entered into the noise prediction model were: roadway and receiver locations; hourly traffic volumes, average vehicle speeds; estimates of traffic mix; and "Loose Soil" propagation loss factor. The traffic data and forecasts for the project (Reference 6), plus the spot traffic counts obtained during the noise measurement periods were the primary sources of data inputs to the model. APPENDIX C summarizes the AM and PM peak hour traffic volumes for CY 2009 and 2012, which were used to model existing and future traffic noise along the streets surrounding the project site. For existing and future traffic along the streets surrounding the project site, it was assumed that the average noise levels, or Leq(h), during the PM peak traffic hour were approximately equal to the 24-hour Ldn along those roadways.

Traffic noise calculations for both the existing and future conditions in the project environs were developed for ground level and elevated receptors with and without the benefit of shielding from the proposed residential tower building. Traffic noise levels were also calculated for future conditions with and without the proposed project. The forecasted changes in traffic noise levels over existing levels were calculated with and without the project, and noise impact risks evaluated. The relative contributions of non-project and project traffic to the total noise levels were also calculated, and an evaluation of possible traffic noise impacts was made.

In addition to the traffic noise measurements, aircraft noise measurements were obtained at Location B2, and nighttime background ambient noise measurements were obtained at Locations B3 and E. The results of these measurements are shown in TABLES 2 and 3. The results of these measurements plus the results of the traffic noise measurements and predictions were used to determine if the proposed housing units are in the acceptable noise zone of 65 Ldn or less.

Calculations of average exterior and interior noise levels from construction activities were performed for typical naturally ventilated and air conditioned dwellings. Predicted noise levels were compared with existing background ambient noise levels,

TABLE 2

TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	Hourly Traffic Volume AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
A. 50 FT from the center-line of Cooke Street. (5/22/00)	1600 TO 1700	35	880	8	1	65.1	65.4
B1. 50 FT from the center-line of Halekauwila St. (4/13/00)	1600 TO 1700	35	466	6	1	61.5	61.6
B1. 50 FT from the center-line of Halekauwila St. (4/14/00)	0700 TO 0800	35	318	12	1	61.1	61.2
B2. 168 FT from the center-line of Halekauwila St. (4/14/00)	0838 TO 1000	N/A	N/A	N/A	N/A	58.0	N/A
B3. 159 FT from the center-line of Halekauwila St. (5/24-25/00)	2100 TO 0112	N/A	N/A	N/A	N/A	52.2	N/A

TABLE 2 (CONTINUED)

TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	Hourly Traffic Volume AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
C. 50 FT from the center-line of Pohukaina St. (5/22/00)	1600 TO 1700	35	557	15	2	63.3	63.3
D. 50 FT from the center-line of Keawe St. (4/14/00)	1600 TO 1700	20	145	0	1	60.7	57.0
E. 3rd Floor Stairwell at DH makai corner of 610 Cooke St. (4/14-15/00)	2315 TO 0200	N/A	N/A	N/A	N/A	58.7	N/A

TABLE 3

SUMMARY OF AIRCRAFT NOISE MEASUREMENTS AT LOCATION "B2"

AIRCRAFT TYPE	MAXIMUM SOUND LEVELS Lmax (in dB)	SOUND EXPOSURE LEVELS Lse (in dB)
B-717(200)	67.5; 63.4; 59.2; 63.5; 61.3; 58.8; 63.8; 62.4; 67.1; 59.8; 61.7; (AVE. = 62.6)	67.7; 69.3; 64.9; 69.8; 65.6; 63.8; 68.6; 65.1; 67.8; 60.8; 66.9 (AVE. = 66.4)
B-767	64.8; 66.5; 64.0; 67.2; 61.5; 61.9; 62.2; 64.0 (AVE. = 64.0)	67.3; 68.5; 68.9; 72.8; 65.6; 65.4; 68.1; 65.7 (AVE.= 67.8)
B-747	72.0; 63.6; 70.0; 65.1; 60.9; 64.2; 67.9 (AVE. = 66.2)	77.3; 73.5; 75.2; 64.6; 65.4; 68.8; 69.0 (AVE. = 70.5)
2-Engine Pass. Jet	30.2; 64.2' 61.2; 60.8; 63.6; 65.5; 66.9; 59.5; 58.9; 61.4; 67.0; 56.4; 63.3; 60.7; 64.6; (AVE. = 62.3)	64.4; 66.3; 72.6; 65.2; 65.6; 69.2; 69.0; 61.9; 61.7; 63.1; 70.6; 62.0; 67.3; 65.0; 62.4 (AVE.= 65.8)
GA-2	63.7; 77.4; 67.3; 62.5; 60.9; 59.2; 59.4; 59.0 (AVE. = 63.7)	67.0; 85.2; 67.2; 66.1; 68.0; 65.0; 67.5; 64.2; (AVE. = 68.8)
GA-1	69.5	75.2
Helicopter	64.4; 60.3; 67.3; 68.3 (AVE = 65.1)	70.9; 66.1; 67.9; 74.3 (AVE. = 69.8)
F-15	81.9; 79.1; 75.0; 69.9; 70.2 (AVE. = 75.2)	84.3; 83.9; 80.8; 74.5; 77.9 (AVE. = 80.3)
4-Engine Mil. Jet	73.3; 58.8 (AVE. = 66.1)	80.1; 65.2 (AVE. = 72.7)

Total Measured Aircraft Noise Level: Leq(4 hours, 10 minutes) = 50.3 dBA
Total Measured Non-Aircraft Noise Level: Leq(4 hours, 10 minutes) = 56.7 dBA

and the potential for noise impacts was assessed. Potential noise and vibration impacts from pile driving operations were also discussed, and mitigation measures recommended.

The potential noise impacts associated with the planned Honolulu Fixed Guideway System were also evaluated in respect to the Halekauwila Place project using the information contained in Reference 7. Reference 7 did not evaluate the potential noise impacts on the Halekauwila Place project, but did evaluate the potential noise impacts on the nearby high rise condominium at 860 Halekauwila Street. Because the Halekauwila Place tower building will be affected in a manner similar to the high rise tower building at 860 Halekauwila Street, the conclusions regarding noise impacts from the Fixed Guideway System at the 860 Halekauwila Street building in Reference 7 were applied to the Halekauwila Place project.

V. EXISTING ACOUSTICAL ENVIRONMENT

The existing background ambient noise levels within the project area are controlled by traffic along Cooke, Pohukaina, Halekauwila, and Keawe Streets; by local traffic within the existing parking lot; and by interisland and military jet aircraft departures from Honolulu International Airport. Traffic, aircraft, and background ambient noise measurements were obtained at six locations (A, B1, B2, B3, C, D, and E) in the project environs. These locations are shown in FIGURE 1.

Aircraft noise level measurements were obtained in 2000 and 2009, with the 2009 results shown in TABLE 3. In 2000, the loudest aircraft noise events were typically associated with departures by interisland jet aircraft. Occasionally, departures by the louder military jet aircraft (such as the F-15) were also audible and measurable. Aircraft noise events were typically louder than motor vehicles, and were audible over longer periods than other noise events. Nevertheless, aircraft noise levels at the project site did not exceed 60 Ldn in 2000, which is the level above which the Hawaii State Department of Transportation, Airports Division, considers to be unacceptable for residences. By 2009, the B-737 and DC-9 jet aircraft formerly used for interisland passenger service had been replaced by quieter CRJ 200 and B-717(200) aircraft, so aircraft noise in the project area have been reduced by at least 3 Ldn units. Because of the modernization of the interisland passenger jet aircraft, aircraft noise is not a major contributor to the noise environment at the project site.

The existing traffic noise levels in the project environs along Cooke Street are in the "Moderate Exposure, Acceptable" category and less than 65 Ldn within 50 feet of the roadway's centerline. Along Halekauwila, Pohukaina, and Keawe Streets, existing traffic noise levels are also in the "Moderate Exposure, Acceptable" category at 50 feet or greater distance from the roadways' centerlines.

The results of the traffic and background ambient noise measurements are summarized in TABLE 2, with measurement locations identified in FIGURE 1. The measurement Sites A through D were located at street level, and Location E was at the third level of the makai/Diamond Head stairs of the 610 Cooke Street building. As shown in TABLE 2, correlation between measured and predicted traffic noise levels was good. The Traffic Noise Model's "Loose Soil" propagation loss factor was used to obtain the good correlation.

The traffic, aircraft, and background ambient noise level measurements at Locations B1, B2, and B3 indicated that total noise levels are between 60 to 62 Ldn on the project site in the vicinity of the proposed residential tower. Aircraft noise levels are approximately 55 to 58 Ldn, while traffic noise levels range from approximately 55 to 62 Ldn at ground level to 59 to 60 Ldn at receptor elevations of 43 feet or more above ground level. Traffic noise levels increase with receptor elevation due to the decrease in noise shielding effects and the reduction of excess ground attenuation effects.

Results of calculations of existing (CY 2009) traffic noise levels at the future residential tower building on the project site are shown in TABLE 4. The results of the calculations are shown for ground level receptors without noise shielding effects from the proposed tower building. As indicated in TABLE 4, the existing noise levels over the project site are higher near Halekauwila Street (along the north side of the project site), and are lower near the south side of the project site. Existing traffic and aircraft noise levels, singly and in combination, do not exceed 65 Ldn, and existing noise levels are considered to be "Acceptable" for residences by FHA/HUD and other federal agencies.

TABLE 4

EXISTING AND 2012 TRAFFIC NOISE LEVELS
(VARIOUS ELEVATIONS, PM PEAK HOUR)

RECEPTOR LOCATION	SETBACK DIST. FROM EXIST. C/L	RECEPTOR ELEVATION	EXISTING (CY 2009) Leq or Ldn	FUTURE (CY 2012) LEVELS NO BUILD Leq or Ldn	BUILD Leq or Ldn
Location A	50 FT from Cooke St.	5 FT Above Ground	64	64	64
Location B1	50 FT from Halekauwila	5 FT Above Ground	62	62	62
Location B2	168 FT from Halekauwila	5 FT Above Ground	56	56	55
Location B3	159 FT from Halekauwila	5 FT Above Ground	54	54	37
Location C	443 FT from Halekauwila	5 FT Above Ground	63	63	63
Location D	403 FT from Halekauwila	5 FT Above Ground	62	62	62
Location E	37 FT from Halekauwila	5 FT Above Ground	66	66	66
Tower North Wall	48 FT from Halekauwila	43 FT Above Ground	62	62	61
Tower North Wall	48 FT from Halekauwila	95 FT Above Ground	62	62	61
Tower East Wall	108 FT from Halekauwila	43 FT Above Ground	60	60	39
Tower East Wall	108 FT from Halekauwila	95 FT Above Ground	59	59	54
Tower South Wall	168 FT from Halekauwila	43 FT Above Ground	59	59	46
Tower South Wall	168 FT from Halekauwila	95 FT Above Ground	59	59	55
Tower West Wall	108 FT from Halekauwila	43 FT Above Ground	61	61	59
Tower West Wall	108 FT from Halekauwila	95 FT Above Ground	60	60	59
Garage North Wall	48 FT from Halekauwila	43 FT Above Ground	62	62	61
Garage East Wall	86 FT from Halekauwila	43 FT Above Ground	60	60	59

CHAPTER VI. FUTURE NOISE ENVIRONMENT

Predictions of future traffic noise levels were made using the traffic volume assignments of Reference 6 for CY 2012 with and without the proposed project. The future projections of project plus non-project traffic noise levels on the roadways which would service the project are shown in TABLE 4 for the PM peak hour of traffic, under the Build Alternative. The corresponding non-project traffic noise contributions for the No Build Alternative are also shown in the table. Essentially no significant changes in traffic noise levels are expected in the project environs between CY 2009 and 2012, with or without the project. With the construction of the proposed garage and residential tower buildings, traffic noise levels along the east and south faces of the tower building should decrease due to the shielding of the traffic noise contributions from Halekauwila and Keawe Streets. Except for noise shielding effects from the project's tower building, future traffic noise levels should be nearly identical with or without the proposed housing project.

The dominant traffic noise source in the project area will continue to be traffic noise from Halekauwila, Cooke, Keawe, and Pohukaina Streets, but the changes in traffic noise levels following project build-out are not expected to be significant. TABLE 4 shows the predicted future traffic noise levels at the four faces of the proposed tower building on the project site following project build-out in CY 2012 for elevated (above the 4th floor) receptors. The beneficial effects of shielding from the proposed high-rise structure, as well as the additive noise contributions from the adjoining streets, are included in the sound level predictions shown in TABLE 4. As indicated in the table, the elevated residential units in the tower building are expected to be exposed to traffic noise levels less than 65 Ldn, and are expected to be in the "Acceptable" noise exposure category in respect to the FHA/HUD noise standard for residences.

Aircraft noise levels over the project site are not expected to change significantly between CY 2009 and 2012, and should remain at or below the current levels of 55 to 58 Ldn. The future changes in aircraft noise levels over the project site will be more dependent upon the future changes in military jet aircraft operations rather than upon the future changes in civilian jet aircraft operations at Honolulu International Airport. This is because the composite civilian jet aircraft fleet has become quieter in recent times, while the composite military jet aircraft fleet has not.

Reference 7 indicates that noise levels from the Honolulu Fixed Guideway System could ranged between 56 to 61 Ldn from ground level to the 6th floor level at the 860 Halekauwila Street and, by analogy, also at the Halekauwila Place project. From the 7th to the 13th floors, rail system noise levels are predicted to range from 65 to 69 Ldn. Above the 13th floor, rail system noise levels decline from 64 to 61 Ldn or less. These noise level predictions assumed that wheel skirts and sound attenuation walls were incorporated into the Honolulu Fixed Guideway System as noise mitigation measures. However, because the sound attenuation walls are not effective at elevated receptor locations above the 6th floor level, both the FHA/HUD and Federal Transit

Administration noise impact criteria will probably be exceeded along portions of the north, west, and east tower faces of the Halekauwila Place project.

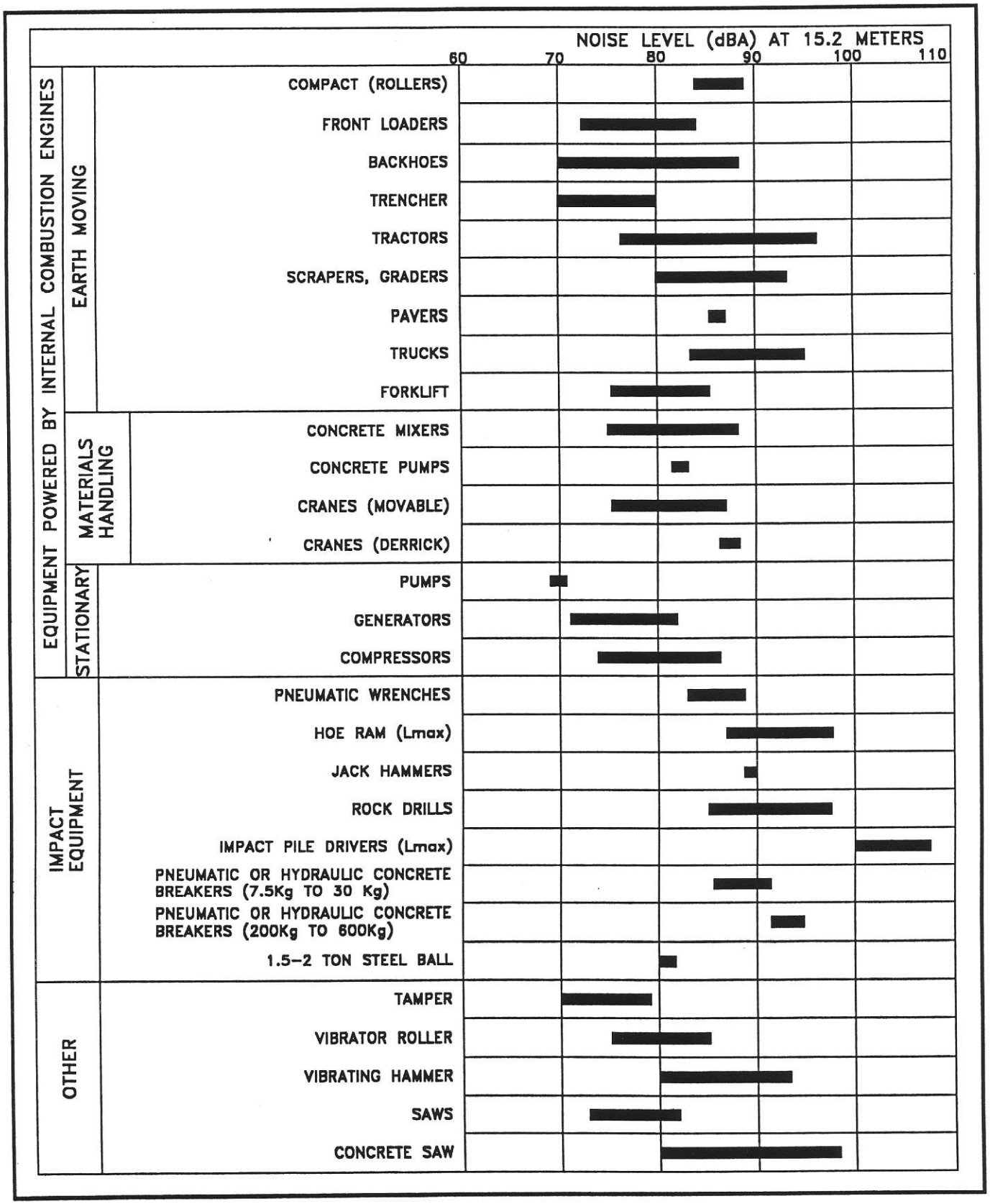
CHAPTER VII. DISCUSSION OF PROJECT-RELATED NOISE AND VIBRATION IMPACTS AND POSSIBLE MITIGATION MEASURES

Traffic Noise. For the residential units in the proposed residential tower building, traffic noise mitigation measures should not be required for traffic noise projected through CY 2012. Noise impacts from project related traffic along the surrounding roadways which are expected to service the project are not expected due to the very low levels of traffic noise associated with project traffic.

General Construction Noise. Audible construction noise will probably be unavoidable during the entire project construction period. The total time period for construction is unknown, but it is anticipated that the actual work will be moving from one location on the project site to another during that period. Actual length of exposure to construction noise at any receptor location will probably be less than the total construction period for the entire project. FIGURE 3 depicts the range of noise levels of various types of construction equipment when measured at 50 FT distance from the equipment. Typical levels of exterior noise from construction activity (excluding pile driving activity) at various distances from the job site are shown in FIGURE 4. The impulsive noise levels of impact pile drivers are approximately 15 dB higher than the levels shown in FIGURE 4, while the intermittent noise levels of vibratory pile drivers are at the upper end of the noise level ranges depicted in the figure.

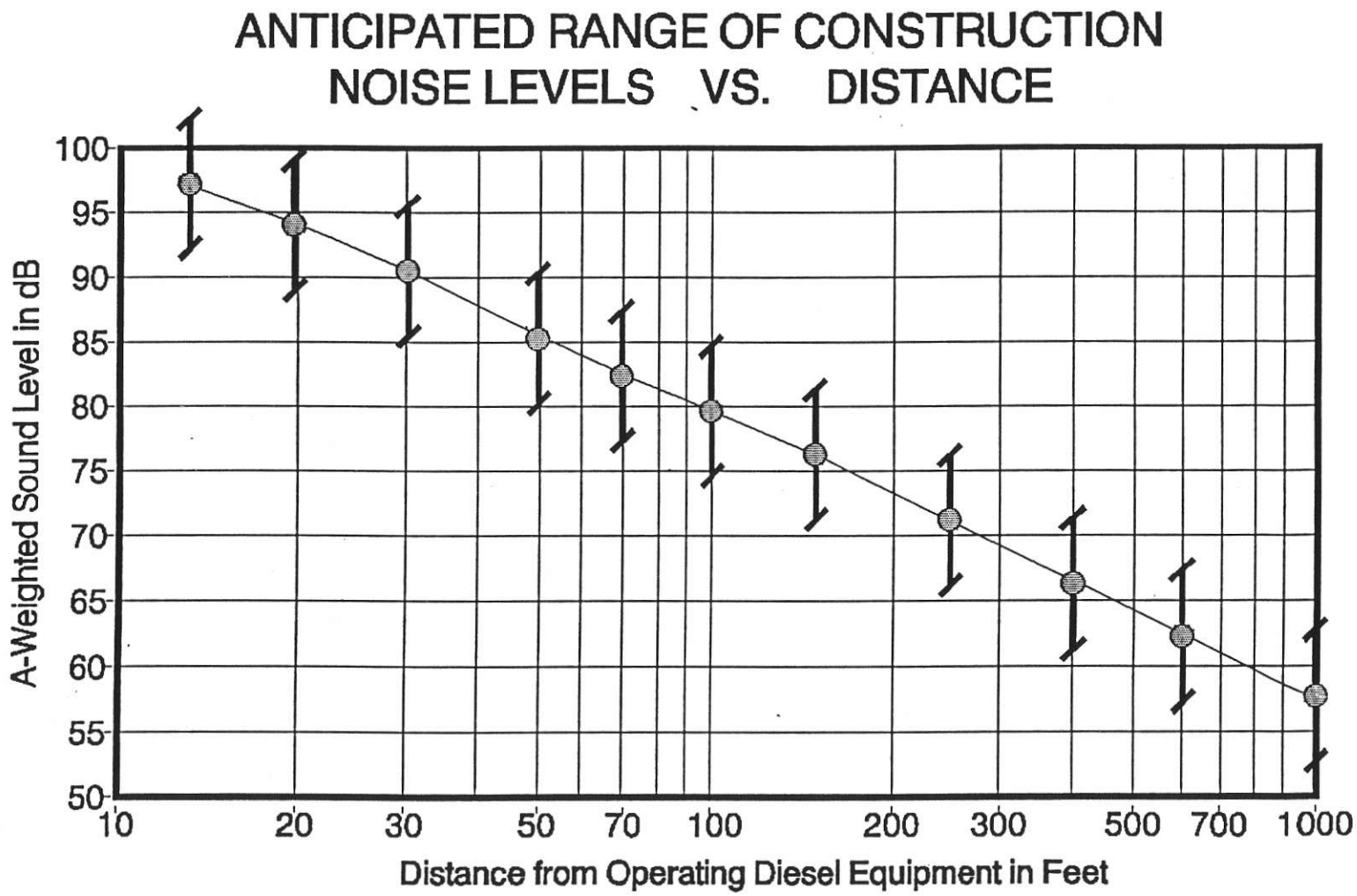
FIGURE 4 is useful for predicting exterior noise levels at short distances (within 100 FT) from the work when visual line of sight exists between the construction equipment and the receptor. Direct line-of-sight distances from the construction equipment to existing residential and commercial buildings will range from 70 FT to 450 FT, with corresponding average noise levels of 83 to 65 dBA (plus or minus 5 dBA). For receptors along a cross-street, the construction noise level vs. distance curve of FIGURE 4 should be reduced by approximately 8 dBA when the work is occurring at the intersection with the cross street, and should be reduced by 15 dBA when work is occurring at least 100 FT from the intersection (and the visual line-of-sight is blocked by intervening buildings). Typical levels of construction noise inside naturally ventilated and air conditioned structures are approximately 10 and 20 dB less, respectively, than the levels shown in FIGURE 4.

The business offices, produce business, and elderly housing facility across Halekauwila Street are predicted to experience the highest noise levels during construction activities due to their close proximity to the construction site. Adverse impacts from construction noise are not expected to be in the "public health and welfare" category due to the temporary nature of the work, the business/commercial character of the neighborhood, and due to the administrative controls available for regulation of construction noise. Instead, these impacts will probably be limited to the temporary degradation of the quality of the acoustic environment in the immediate vicinity of the project site.



RANGES OF CONSTRUCTION EQUIPMENT NOISE LEVELS

FIGURE 3



CONSTRUCTION NOISE LEVELS VS. DISTANCE

FIGURE 4

Mitigation of construction noise to inaudible levels will not be practical in all cases due to the intensity of construction noise sources (80 to 90+ dB at 50 FT distance), and due to the exterior nature of the work (pile driving, grading and earth moving, trenching, concrete pouring, hammering, etc.). The use of properly muffled construction equipment should be required on the job site.

Peak airborne noise levels from pile diving may be as much as 15 dBA greater than noise levels shown in FIGURE 4 for non-impulsive (steady) construction noise sources. Although the pile driving can produce more intense noise levels, each pulse is of short individual duration (less than one second). Therefore, its impact on speech communication is not as severe as that of steady source of the same noise level.

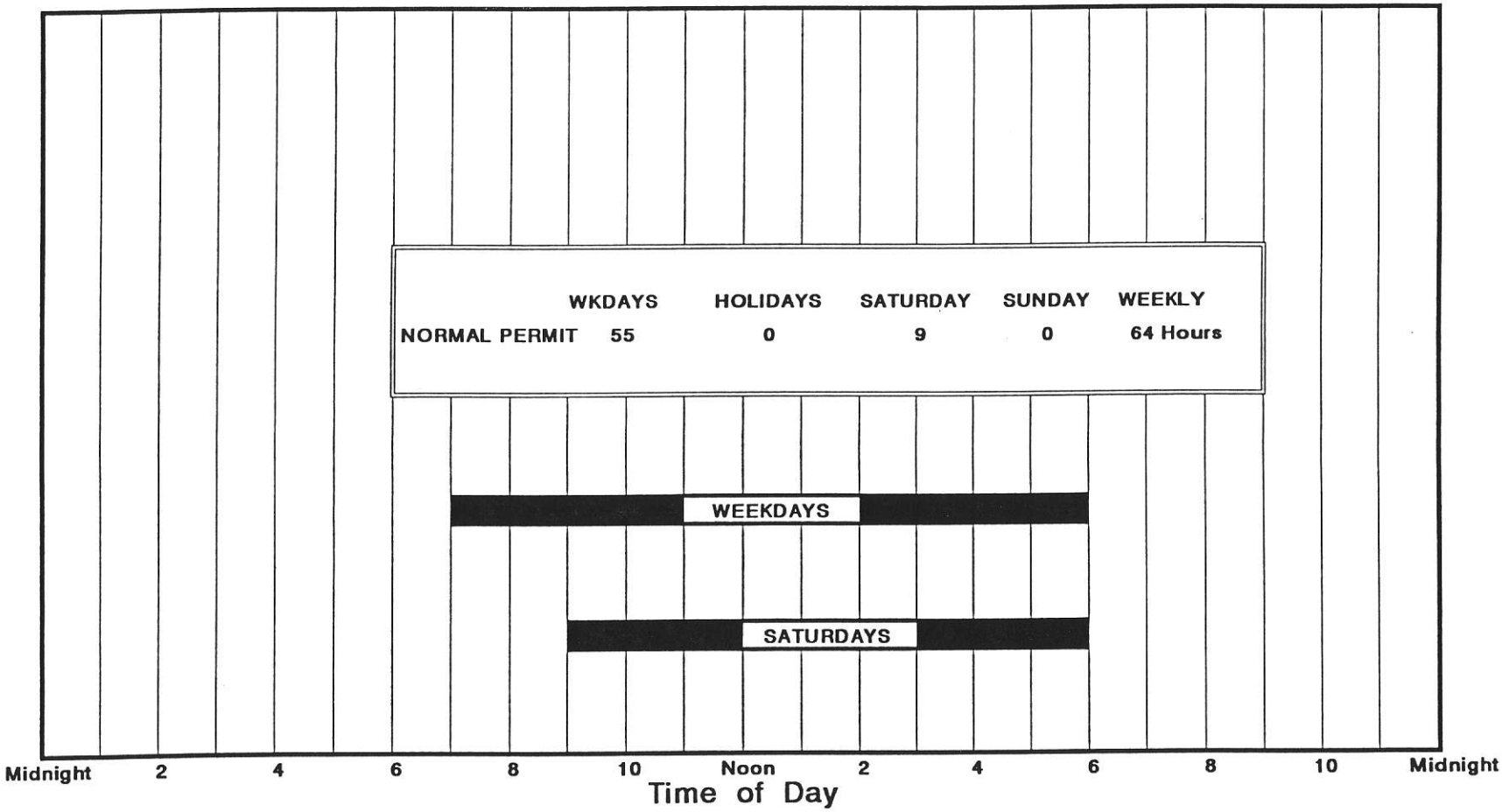
Severe noise impacts are not expected to occur inside air conditioned structures which are within 70 to 450 FT of the project construction site. Inside naturally ventilated structures, interior noise levels (with windows or doors opened) are estimated to range between 55 to 73 dBA at 70 FT to 450 FT distances from the construction site. Closure of all doors and windows facing the construction site would generally reduce interior noise levels by an additional 5 to 10 dBA.

The incorporation of State Department of Health construction noise limits and curfew times, which are applicable throughout the State of Hawaii (Reference 4), is another noise mitigation measure which is normally applied to construction activities. FIGURE 5 depicts the normally permitted hours of construction. Noisy construction activities are not allowed on Sundays and holidays, during the early morning, and during the late evening and nighttime periods under the DOH permit procedures.

Vibration from Pile Driving. Pile driving will probably be necessary to implant piles into the ground over the project site. Impact driven concrete and sheet piles may both be used on the project site. Induced ground vibrations from the pile driving operations have the potential to cause architectural and structural damage to structures.

Ground vibrations generated during pile driving operations are generally described in terms of peak particle (or ground) velocity in units of inches/second. The human being is very sensitive to ground vibrations, which are perceptible at relatively low particle velocities of 0.01 to 0.04 inches/second. Damage to structures, however, occur at much higher levels of vibration as indicated in TABLE 5. The most commonly used damage criteria for structures is the 2.0 inches/second limit derived from work by the U.S. Bureau of Mines. A more conservative limit of 0.2 inches/second is also used, and is suggested for planning purposes on this project because of the repetitive nature of pile driving operations which can increase risks of damage due to fatiguing.

Based on measured vibration levels during pile driving operations under various soil conditions and at various distances, estimates of ground vibration levels vs. distance from the pile driver have been made for various soil conditions and for various



AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

FIGURE 5

TABLE 5

SUMMARY OF BUILDING DAMAGE CRITERIA

PEAK GROUND VELOCITY (mm/sec)	PEAK GROUND VELOCITY (in/sec)	COMMENT
193.04	7.6	Major damage to buildings (mean of data).
137.72	5.4	Minor damage to buildings (mean of data).
101.16	4.0	'Engineer structures' safe from damage.
50.8	2.0	Safe from damage limit (probability of damage <5%).
		No structural damage.
33.02	1.3	Threshold of risk of 'architectural' damage for houses.
25.4	1.0	No data showing damage to structures for vibration <1 in./sec.
15.24	0.6	No risk of 'architectural' damage to normal buildings.
10.16	0.4	Threshold of damage in older homes.
5.08	0.2	Statistically significant percentage of structures may experience minor damage (including earthquake, nuclear event, and blast data for old and new structures).
		No 'architectural' damage.
3.81	0.5 to 0.15	Upper limits for ruins and ancient monuments.
1.0	0.04	Vertical vibration clearly perceptible to humans.
0.32	0.01	Vertical vibration just perceptible to humans.

Source: 'State-of-the-Art Review: Prediction and Control of Groundborne Noise and Vibration from Rail Transit Trains'; U.S. Department of Transportation; December 1983.

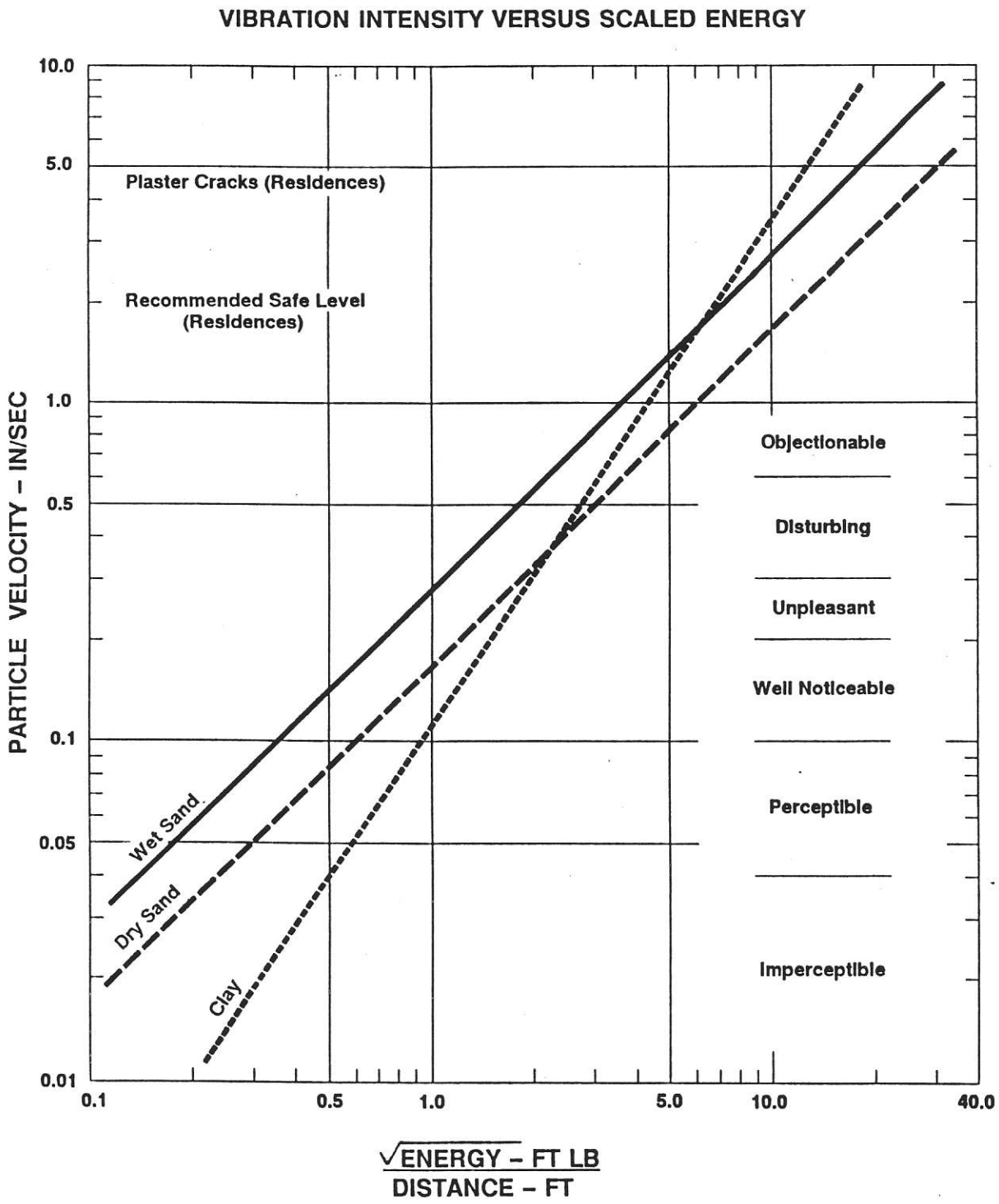
energy ratings of the pile drivers. FIGURE 6, which was extracted from Reference 8, may be used to predict vibration levels for the soil conditions indicated. When coral layers must be penetrated, vibration levels can be expected to be higher than those shown in FIGURE 6, particularly if the adjacent structures are supported by the common coral layer. From FIGURE 6, and for wet sand soil conditions, the 0.2 inches/second vibration damage criteria will be exceeded at a scaled energy distance factor of approximately 0.7. The scaled energy distance factor is equal to the square root of the energy (in foot-pounds) per blow of the hammer divided by the distance (in feet) between the pile tip and the monitoring location. For a 2,500 foot-pound small pile driver, a scaled energy distance of 0.7 equates to a required separation distance of 71 FT. Under clay soil conditions, and using the prediction procedures contained in FIGURE 6, a shorter separation distance of 47 FT is required to not exceed the 0.2 inches/second criteria when using a 2,500 foot-pound pile driver. It should be noted that 0.2 inches/second vibration levels were measured from a much larger 22,400 foot-pound pile driver at even shorter separation distances of approximately 30 FT in sandy, layered soil (Reference 9). The measurement data reported in Reference 9 are significantly lower than the vibration levels predicted by the methodology of Reference 8.

As indicated above, predictions of peak ground vibration levels vs. scaled energy distance factor from the driven pile are not precise, with initial uncertainty factor for a given location in the order of 10:1. For this reason, it is standard practice to employ seismograph monitoring of ground vibrations during pile driving operations with a 3-axis geophone or accelerometer. If sheet pile drivers of approximately 2,500 foot-pounds or smaller ratings are anticipated to be used on the job site, the initial vibration predictions indicate that there is some risk of exceeding the 0.2 inches/second vibration damage criteria at 47 to 71 FT separation distances, and monitoring during pile driving operations is warranted if pile driving are planned at those distances from any existing structures. For pile driver operations, risks of damage to the buildings across Halekauwila Street are considered to be very low.

The following preventative measures are recommended for implementation during the planning and design phases of the project:

- In addition to the normal planning and design concerns regarding potential damage due to settling and heaving during construction, consideration should also be given to risks of damage due to vibration from pile driving. A damage criteria of 0.2 inches/second should be used in conjunction with the vibration prediction method of Reference 8 to identify the potential damage risk distances to the driven piles.

- If predicted vibration levels from pile driving exceed 0.2 inches/second at a building, and predicted levels cannot be reduced by sizing of the pile driver, test piles should be driven and their vibrations monitored and recorded prior to completion of the foundation design. The monitoring of the test piles should be



MINIMUM VIBRATION INTENSITIES EXPECTED FROM PILE DRIVING

FIGURE 6

designed to measure the expected peak, 3-axis vibration levels at the building. The results of the monitoring should be used to define empirical distance from the driven pile to the 0.2 inches/second damage risk location, and to evaluate the risks of structural damage to the adjacent structure during actual construction.

- If predicted vibration levels from pile driving exceed 2.0 inches/second at a building, the use of alternate types of piles or shoring should be considered for implementation during the design phase.

Honolulu Fixed Guideway System Noise. The Halekauwila Place living units are not planned to be air conditioned, so noise mitigation measures will not be included in the project plans. However, wall openings in the living units will be provided for the addition of air conditioning units by the building's occupants. If the Halekauwila Place project is completed prior to the completion of the Honolulu Fixed Guideway System, it is possible that noise mitigation measures at Halekauwila Place may be incorporated into the Honolulu Fixed Guideway System project. So the mitigation of potential noise impacts from the Honolulu Fixed Guideway System will be deferred to the rail project.

APPENDIX A. REFERENCES

(1) "Guidelines for Considering Noise in Land Use Planning and Control;" Federal Interagency Committee on Urban Noise; June 1980.

(2) "Environmental Criteria and Standards, Noise Abatement and Control, 24 FR, Part 51, Subpart B;" U.S. Department of Housing and Urban Development; July 12, l979.

(3) "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety;" Environmental Protection Agency (EPA 550/9-74-004); March 1974.

(4) "Title 11, Administrative Rules, Chapter 46, Community Noise Control;" Hawaii State Department of Health; September 23, 1996.

(5) "FHWA Traffic Noise Model User's Guide;" FHWA-PD-96-009, Federal Highway Administration; Washington, D.C.; January 1998 and Version 2.5 Upgrade (April 14, 2004).

(6) Traffic Impact Report, Halekauwila Place; Wilson Okamoto Corporation; October 2009.

(7) Noise and Vibration Technical Report, Honolulu High-Capacity Transit Corridor Project; City and County of Honolulu; October 1, 2008.

(8) Wiss, John F., Janney, Elstner and Assoc.; "Damage of Pile Driving Vibration;" Highway Research Record, Number 155.

(9) Gutowski, T.G.; Wittig, L.E.; and Dym, C.L.; "Some Aspects of the Ground Vibration Problem;" Noise Control Engineering; May-June 1978.

APPENDIX B

EXCERPTS FROM EPA'S ACOUSTIC TERMINOLOGY GUIDE

Descriptor Symbol Usage

The recommended symbols for the commonly used acoustic descriptors based on A-weighting are contained in Table I. As most acoustic criteria and standards used by EPA are derived from the A-weighted sound level, almost all descriptor symbol usage guidance is contained in Table I.

Since acoustic nomenclature includes weighting networks other than "A" and measurements other than pressure, an expansion of Table I was developed (Table II). The group adopted the ANSI descriptor-symbol scheme which is structured into three stages. The first stage indicates that the descriptor is a level (i.e., based upon the logarithm of a ratio), the second stage indicates the type of quantity (power, pressure, or sound exposure), and the third stage indicates the weighting network (A, B, C, D, E.....). If no weighting network is specified, "A" weighting is understood. Exceptions are the A-weighted sound level and the A-weighted peak sound level which require that the "A" be specified. For convenience in those situations in which an A-weighted descriptor is being compared to that of another weighting, the alternative column in Table II permits the inclusion of the "A". For example, a report on blast noise might wish to contrast the LCdn with the LAdn.

Although not included in the tables, it is also recommended that "Lpn" and "LepN" be used as symbols for perceived noise levels and effective perceived noise levels, respectively.

It is recommended that in their initial use within a report, such terms be written in full, rather than abbreviated. An example of preferred usage is as follows:

The A-weighted sound level (LA) was measured before and after the installation of acoustical treatment. The measured LA values were 85 and 75 dB respectively.

Descriptor Nomenclature

With regard to energy averaging over time, the term "average" should be discouraged in favor of the term "equivalent". Hence, Leq, is designated the "equivalent sound level". For Ld, Ln, and Ldn, "equivalent" need not be stated since the concept of day, night, or day-night averaging is by definition understood. Therefore, the designations are "day sound level", "night sound level", and "day-night sound level", respectively.

The peak sound level is the logarithmic ratio of peak sound pressure to a reference pressure and not the maximum root mean square pressure. While the latter is the maximum sound pressure level, it is often incorrectly labelled peak. In that sound level meters have "peak" settings, this distinction is most important.

"Background ambient" should be used in lieu of "background", "ambient", "residual", or "indigenous" to describe the level characteristics of the general background noise due to the contribution of many unidentifiable noise sources near and far.

With regard to units, it is recommended that the unit decibel (abbreviated dB) be used without modification. Hence, DBA, PNdB, and EPNdB are not to be used. Examples of this preferred usage are: the Perceived Noise Level (Lpn was found to be 75 dB. Lpn = 75 dB). This decision was based upon the recommendation of the National Bureau of Standards, and the policies of ANSI and the Acoustical Society of America, all of which disallow any modification of bel except for prefixes indicating its multiples or submultiples (e.g., deci).

Noise Impact

In discussing noise impact, it is recommended that "Level Weighted Population" (LWP) replace "Equivalent Noise Impact" (ENI). The term "Relative Change of Impact" (RCI) shall be used for comparing the relative differences in LWP between two alternatives.

Further, when appropriate, "Noise Impact Index" (NII) and "Population Weighed Loss of Hearing" (PHL) shall be used consistent with CHABA Working Group 69 Report Guidelines for Preparing Environmental Impact Statements (1977).

TABLE I

A-WEIGHTED RECOMMENDED DESCRIPTOR LIST

TERM	SYMBOL
1. A-Weighted Sound Level	L_A
2. A-Weighted Sound Power Level	L_{WA}
3. Maximum A-Weighted Sound Level	L_{max}
4. Peak A-Weighted Sound Level	L_{Apk}
5. Level Exceeded x% of the Time	L_x
6. Equivalent Sound Level	L_{eq}
7. Equivalent Sound Level over Time (T) (1)	$L_{eq(T)}$
8. Day Sound Level	L_d
9. Night Sound Level	L_n
10. Day-Night Sound Level	L_{dn}
11. Yearly Day-Night Sound Level	$L_{dn(Y)}$
12. Sound Exposure Level	L_{SE}

(1) Unless otherwise specified, time is in hours (e.g. the hourly equivalent level is $L_{eq(1)}$). Time may be specified in non-quantitative terms (e.g., could be specified a $L_{eq(WASH)}$ to mean the washing cycle noise for a washing machine).

SOURCE: EPA ACOUSTIC TERMINOLOGY GUIDE, BNA 8-14-78,

APPENDIX B (CONTINUED)

TABLE II

RECOMMENDED DESCRIPTOR LIST

TERM	A-WEIGHTING	ALTERNATIVE[1] A-WEIGHTING	OTHER[2] WEIGHTING	UNWEIGHTED
1. Sound (Pressure)[3] Level	L_A	L_{pA}	L_B, L_{pB}	L_p
2. Sound Power Level	L_{WA}		L_{WB}	L_W
3. Max. Sound Level	L_{max}	L_{Amax}	L_{Bmax}	L_{pmax}
4. Peak Sound (Pressure) Level	L_{Apk}		L_{Bpk}	L_{pk}
5. Level Exceeded x% of the Time	L_x	L_{Ax}	L_{Bx}	L_{px}
6. Equivalent Sound Level	L_{eq}	L_{Aeq}	L_{Beq}	L_{peq}
7. Equivalent Sound Level[4] Over Time(T)	$L_{eq(T)}$	$L_{Aeq(T)}$	$L_{Beq(T)}$	$L_{peq(T)}$
8. Day Sound Level	L_d	L_{Ad}	L_{Bd}	L_{pd}
9. Night Sound Level	L_n	L_{An}	L_{Bn}	L_{pn}
10. Day-Night Sound Level	L_{dn}	L_{Adn}	L_{Bdn}	L_{pdn}
11. Yearly Day-Night Sound Level	$L_{dn(Y)}$	$L_{Adn(Y)}$	$L_{Bdn(Y)}$	$L_{pdn(Y)}$
12. Sound Exposure Level	L_S	L_{SA}	L_{SB}	L_{Sp}
13. Energy Average Value Over (Non-Time Domain) Set of Observations	$L_{eq(e)}$	$L_{Aeq(e)}$	$L_{Beq(e)}$	$L_{peq(e)}$
14. Level Exceeded x% of the Total Set of (Non-Time Domain) Observations	$L_{x(e)}$	$L_{Ax(e)}$	$L_{Bx(e)}$	$L_{px(e)}$
15. Average L_x Value	L_x	L_{Ax}	L_{Bx}	L_{px}

(1) "Alternative" symbols may be used to assure clarity or consistency.

(2) Only B-weighting shown. Applies also to C,D,E,.....weighting.

(3) The term "pressure" is used only for the unweighted level.

(4) Unless otherwise specified, time is in hours (e.g., the hourly equivalent level is Leq(1). Time may be specified in non-quantitative terms (e.g., could be specified as Leq(WASH) to mean the washing cycle noise for a washing machine.

APPENDIX C

SUMMARY OF BASE YEAR AND YEAR 2012 TRAFFIC VOLUMES

ROADWAY LANES	**** CY 2009 ***** AM VPH	PM VPH	CY 2012 (NO BUILD) AM VPH	PM VPH	CY 2012 (BUILD) AM VPH	PM VPH
Halekauwila - Ewa (EB)	177	290	180	295	185	306
Halekauwila - Ewa (WB)	142	121	144	122	154	128
Two-Way	319	411	324	417	339	434
Halekauwila - Middle (EB)	127	312	129	317	146	336
Halekauwila - Middle (WB)	202	133	204	135	218	154
Two-Way	329	445	333	452	364	490
Halekauwila - Diamond Head (EB)	99	256	100	260	114	273
Halekauwila - Diamond Head (WB)	169	154	172	156	177	174
Two-Way	268	410	272	416	291	447
Coral - Mauka (NB)	35	25	35	25	38	26
Coral - Mauka (SB)	47	57	47	57	48	64
Two-Way	82	82	82	82	86	90
Keawe - Mauka (NB)	59	61	59	62	60	63
Keawe - Mauka (SB)	98	113	99	114	99	115
Two-Way	157	174	158	176	159	178
Keawe - Middle (NB)	71	102	72	104	73	106
Keawe - Middle (SB)	204	176	207	179	214	180
Two-Way	275	278	279	283	287	286
Keawe - Makai (NB)	86	110	87	111	88	112
Keawe - Makai (SB)	100	181	101	183	103	185
Two-Way	186	291	188	294	191	297
Cooke - Mauka (NB)	217	442	220	449	228	457
Cooke - Mauka (SB)	345	407	350	414	354	423
Two-Way	562	849	570	863	582	880
Cooke - Middle (NB)	202	352	205	356	206	357
Cooke - Middle (SB)	294	399	299	405	305	407
Two-Way	495	750	503	761	510	764
Cooke - Makai (NB)	163	210	165	213	166	214
Cooke - Makai (SB)	187	366	189	371	193	373
Two-Way	350	576	354	584	359	587

APPENDIX C (CONTINUED)

SUMMARY OF BASE YEAR AND YEAR 2012 TRAFFIC VOLUMES

ROADWAY LANES	**** CY 2009 *****		CY 2012 (NO BUILD)		CY 2012 (BUILD)	
	AM VPH	PM VPH	AM VPH	PM VPH	AM VPH	PM VPH
Pohukaina - Ewa (EB)	109	211	110	213	109	213
Pohukaina - Ewa (WB)	250	250	253	253	257	252
Two-Way	359	461	363	466	366	465
Pohukaina - Middle (EB)	136	289	138	293	137	292
Pohukaina - Middle (WB)	207	208	210	212	209	211
Two-Way	343	497	348	505	346	502
Pohukaina - Diamond Head (EB)	107	236	109	240	110	239
Pohukaina - Diamond Head (WB)	174	173	177	175	176	175
Two-Way	281	409	286	415	286	414
Coral - Makai (NB)	86	178	88	181	88	181
Coral - Makai (SB)	66	52	66	52	66	52
Two-Way	152	230	154	233	154	233