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FILE COPY

SEP - 8 2020

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County of Hawai'i
PLANNING DEPARTMENT

August 25, 2020

Keith Kawaoka, Acting Director
Office of Environmental Quality Control
235 S. Beretania Street, Suite 702
Honolulu, HI 96813

Dear Mr. Kawaoka,

Subject: **Republish Draft Environmental Assessment (DEA)**
Applicant: **Kona Three, LLC**
Project: **Royal Vistas Housing Project**
TMKs: **(3) 7-6-021:016-019, North Kona District, Island of Hawai'i**

With this letter, the Planning Department requests your office to republish the Draft Environmental Assessment and Anticipated Finding of No Significant Impact (DEA-AFONSI) pursuant to HAR 11-200.1-6, for the proposed Royal Vistas Housing Project located on the subject parcels on the Island of Hawai'i. The DEA/AFONSI was transmitted to your office on July 30, 2020 and was published in the August 8, 2020 bulletin.

Please republish the unchanged DEA/AFONSI in the September 8, 2020 bulletin to provide a 30-day public comment period.

If you have any question regarding this letter, please contact Maija Jackson of our Planning Department staff at (808) 961-8159.

Sincerely,

For MICHAEL YEE
Planning Director

21-043

MJJ:kvs
P:\\coh33\planning\public\wpwin60\ch343\2020\royal vistas dea\royalvistasdea to oeqc republish.docx

cc by email: Michele Lefebvre, Stantec Consulting, Environmental Consultant, <michele.lefebvre@stantec.com>

Richard Wheelock, Kona Three LLC, Applicant, <richard@eastwestrealty.org>

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PLANNING DEPARTMENT

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July 30, 2020

Keith Kawaoka, Acting Director
Office of Environmental Quality Control
235 S. Beretania Street, Suite 702
Honolulu, HI 96813

Dear Mr. Kawaoka,

Subject: **Draft Environmental Assessment (DEA)**
Applicant: **Kona Three, LLC**
Project: **Royal Vistas Housing Project**
TMKs: **(3) 7-6-021:016-019, North Kona District, Island of Hawai'i**

With this letter, the Planning Department hereby transmits electronically via the OEQC website, the Draft Environmental Assessment and Anticipated Finding of No Significant Impact (DEA-AFONSI), online submittal form, and kmz file for the proposed Royal Vistas Housing Project located on the subject parcels on the Island of Hawai'i. Please publish the DEA-AFONSI in the next available edition of the Environmental Notice.

Simultaneously with this letter, the applicant will provide one paper copy of the DEA-AFONSI to the state library nearest the subject property, one paper copy to the Hawai'i Document Center, and electronic or paper copies to agencies, citizen groups, and individuals that may be affected by the proposed action in accordance with HAR Section 11-200.1-5(e)(1).

The Planning Department, as approving agency, anticipates that the proposed action is not likely to have a significant effect and therefore is issuing a notice of an Anticipated Finding of No Significant Impact for the Draft EA, subject to the public review provisions of HAR Section 11-200.1-20.

If you have any question regarding this letter, please contact Maija Jackson of our Planning Department staff at (808) 961-8159.

Sincerely,

MICHAEL YEE
Planning Director

MJJ: kvs
P:\ coh33 planning public wpwin60\ch343\2020\royal vistas dea\royalvistasdea to oeqc.docx

cc by email: Michele Lefebvre, Stantec Consulting, Environmental Consultant, <michele.lefebvre@stantec.com>

Richard Wheelock, Kona Three LLC, Applicant, <richard@eastwestrealty.org>

From: webmaster@hawaii.gov
To: HI Office of Environmental Quality Control
Subject: New online submission for The Environmental Notice
Date: Thursday, July 30, 2020 6:57:35 PM

Action Name

Royal Vistas Housing Project

Type of Document/Determination

Draft environmental assessment and anticipated finding of no significant impact (DEA-AFNSI)

HRS §343-5(a) Trigger(s)

- (1) Propose the use of state or county lands or the use of state or county funds

Judicial district

North Kona, Hawai‘i

Tax Map Key(s) (TMK(s))

(3) 7-6-021:016; (3) 7-6-021:017; (3) 7-6-021:018; (3) 7-6-021:019

Action type

Applicant

Other required permits and approvals

Grading, Drainage, Building Permits; Plan Approval; NPDES; Permit to Work in County Right-of-Way; Zoning Ordinance Amendment

Discretionary consent required

Amendment of Change of Zone Ordinance

Approving agency

County of Hawaii Planning Department

Agency contact name

Michael Yee

Agency contact email (for info about the action)

planning@hawaiicounty.gov

Email address or URL for receiving comments

planning@hawaiicounty.gov

Agency contact phone

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Hilo, Hawaii 96720
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Applicant

Kona Three LLC

Applicant contact name

Richard Wheelock

Applicant contact email

richard@eastwestrealty.org

Applicant contact phone

(808) 753-3167

Applicant address

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Hilo, Hawaii 96720
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Map It

Was this submittal prepared by a consultant?

Yes

Consultant

Stantec Consulting and Geometrician Associates LLC

Consultant contact name

Michele Lefebvre

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(808) 494-2039

Consultant address

P.O. Box 191
Hilo, Hawaii 96721
United States
Map It

Action summary

The proposed project is located approximately 2.7 miles south of downtown Kailua-Kona and would consist of necessary improvements to construct up to 450 multi-family residential units in clusters of two- and three-story buildings on approximately 70 acres. Units would target local renters and buyers in the “market” price points. The project is the final phase of the original zoning ordinance (No. 84-23) signed on May 15, 1984, and includes the multi-family zoned land which was planned for work-force housing. Electrical and sewer would be extended from nearby utility grid terminus and water commitments have already been purchased for the project. The proposed project has been designed to minimize impacts from surface water run-off. Traffic impacts would be minimized with a new un-signalized intersection off Queen Ka‘ahumanu Highway. No impacts to biological resources, historic or archaeological resources, or cultural sites or practices are expected from the project.

Reasons supporting determination

Refer to Part 5 of the Draft EA for reasons supporting the determination.

Attached documents (signed agency letter & EA/EIS)

- Royal-Vistas-Housing-Project-DEA-Volume-7-of-7.pdf
- Royal-Vistas-Housing-Project-DEA-Volume-6-of-7.pdf
- Royal-Vistas-Housing-Project-DEA-Volume-5-of-7.pdf
- Royal-Vistas-Housing-Project-DEA-Volume-4-of-7.pdf
- Royal-Vistas-Housing-Project-DEA-Volume-3-of-7.pdf
- Royal-Vistas-Housing-Project-DEA-Volume-2-of-7.pdf
- Royal-Vistas-Housing-Project-DEA-Volume-1-of-7.pdf
- DEA-to-OEQC.PDF

Action location map

- Royal-Vistas-KMZ.zip

Authorized individual

Maija Jackson

Authorization

- The above named authorized individual hereby certifies that he/she has the authority to make this submission.

DRAFT ENVIRONMENTAL ASSESSMENT

Royal Vistas Housing Project

TMKs (3) 7-6-021:016, 7-6-021:017, 7-6-021:018, and 7-6-021:019
North Kona District, Hawai‘i Island
State of Hawai‘i

July 2020

Applicant
Kona Three LLC
101 Hualalai Street
Hilo, HI 96720

Approving Agency
County of Hawai‘i Planning Department
101 Pauahi Street, Suite 3
Hilo, HI 96720

DRAFT ENVIRONMENTAL ASSESSMENT

Royal Vistas Housing Project

TMKs (3) 7-6-021:016, 7-6-021:017, 7-6-021:018, and 7-6-021:019
North Kona District, Hawai‘i Island, State of Hawai‘i

APPLICANT:

Kona Three LLC
101 Hualalai Street
Hilo, HI 96720

APPROVING AGENCY:

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101 Pauahi Street, Suite 3
Hilo, HI 96720

CONSULTANT:

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Hilo, HI 96721

Geometrician Associates
P.O. Box 396
Hilo, HI 96721

CLASS OF ACTION:

Use of County Lands

This document is prepared pursuant to:

The Hawai‘i Environmental Policy Act,
Chapter 343, Hawai‘i Revised Statutes, and
Title 11, Chapter 200.1, Hawai‘i Department of Health Administrative Rules

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SUMMARY OF THE PROPOSED ACTION, ENVIRONMENTAL IMPACTS, AND MITIGATION MEASURES

The proposed project is located approximately 2.7 miles south of downtown Kailua-Kona and would consist of necessary improvements to construct up to 450 multi-family residential units in clusters of two- and three-story buildings on approximately 70 acres. The following are estimates for the number of units, floor plans, bedroom/bathroom counts, and buildings heights. The numbers may be adjusted during final design and permitting. The development would conceptually include approximately 174 "For Rent" units consisting of 122 two-bedroom/two-bath units and 52 three-bedroom/two-bath units plus a resident manager's unit, all in two-story buildings on the *makai* portion of the project site. The development would also include approximately 274 "For Sale" units consisting of 147 two bedroom/two-bath units and 137 three-bedroom/two-bath units plus a resident manager's unit. The "For Sale" units would be located in approximately ten two-story buildings and approximately 39 three-story buildings, with the two-story buildings being four units each and the three-story buildings being six units each. Parking would consist of a mix of covered and open spaces for residents and guests. The project would be developed in two or more phases, with Phase I having a maximum of 258 units and Phase II having the balance of 192 units. Phase I would include all the Rental units and some Sale units. Both Rental and Sale units would target local renters and buyers in the "market" price points. There would be two Community Centers, one for the Rental units and one for the Sale units. Each center would have a pool and facilities for use by the residents. The project is the final phase of the original zoning ordinance (No. 84-23) signed on May 15, 1984, and includes the multi-family zoned land which was planned for work-force housing. Electrical and sewer would be extended from nearby utility grid terminus and water commitments have already been purchased for the project.

The proposed project has been designed to minimize impacts from surface water run-off. Traffic impacts would be minimized with a new un-signalized intersection serving the project off Queen Ka'ahumanu Highway. No impacts to biological resources, historic or archaeological resources, or cultural sites or practices, are expected from the project.

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PART 1: PROJECT DESCRIPTION, LOCATION, AND ENVIRONMENTAL ASSESSMENT PROCESS

1.1 Project Location and Property Ownership

Kona Three LLC (Kona Three) proposes to develop the Royal Vista Housing Project ("Proposed Project") which would occur within Tax Map Keys (TMKs) (3) 7-6-021:016, 7-6-021:017, 7-6-021:018, and 7-6-021:019 in North Kona ("Project Site") as shown on Figures 1 and 2. Kona Three owns TMKs 7-6-021:016 and 7-6-021:017 which together cover approximately 69 acres, while the County of Hawai'i Department of Public Works (DPW) manages TMKs 7-6-021:018 and 7-6-021:019 which together cover approximately 7.3 acres. The Project Site is located 2.7 miles south of downtown Kailua-Kona along Queen Ka'ahumanu Highway (Highway 19). Photos 1 and 2 were taken at the Project Site.

1.2 Project Description

Housing Project

Kona Three proposes to construct up to 450 multi-family residential units in clusters of two- and three-story buildings on approximately 70 acres. A conceptual drawing of the layout of the buildings is shown on Figure 3. The following are estimates for the number of "For Rent" and "For Sale" units, floor plans, bedroom/bathroom counts, and buildings heights. Although the numbers may be adjusted during final design and permitting, the EA analyzes the maximum building height of three stories and the maximum number of units (450 units). The medium density development would include approximately 174 "For Rent" units consisting of 122 two-bedroom/two-bath units and 52 three-bedroom/two-bath units plus a resident manager's unit, all in two-story buildings on the *makai* portion of the Project Site. A property management firm would manage the rental units. A schematic showing the site sections for two- and three-story buildings is shown on Figure 4, and the concepts for layout shown on Figure 5. The development would also include approximately 274 "For Sale" units consisting of 147 two bedroom/two-bath units and 137 three-bedroom/two-bath units plus a resident manager's unit. The "For Sale" units would be located in ten two-story buildings and 39 three-story buildings, with the two-story buildings being four units each and the three-story buildings being six units each. Parking would consist of a mix of covered and open spaces for residents and guests.

The Project would be developed in two or more phases, with Phase I having a maximum of 258 units and Phase II having the balance of 192 units. Phase I would include all the Rental units and some Sale units. Both Rental and Sale units would target local renters and buyers in the "market" price points. Phase I is expected to be completed by 2024, and Phase II is expected to be completed by 2029.

There would be two Community Centers, one for the Rental units and one for the Sale units. Each center would have a pool and facilities for use by the residents. Construction could start as early as third quarter of 2021, following Plan Approval and construction permits, and would be expected to last 12 to 18 months. Construction would be conducted in accordance with any applicable COVID-19 emergency proclamations in place at that time.

The Project is the final residential development identified in the zoning ordinance (No. 84-23) signed in 1984. The original zoning ordinance and subsequent amendments included the following:

- 103 acres for 215 single-family units;
- 71 acres for multi-family, mid-market[1] units (the Proposed Project); and
- An additional 12 acres acquired at the behest of the County of Hawai‘i, Office of Housing and Community Development (OHCD) at TMK (3): 7-6-24:025.

The development of the single-family units on 103 acres was mostly completed by the previous developer. The previous developers built and installed roadways, intersection, and drainage improvements, as well as driveways, light poles, utility infrastructure, landscaping, and other assets for the new community. The 12-acre area for the affordable housing project is located on what are now TMKs (3) 7-6-24:25, 111, and 112 and the area is slated for development in the near future. As a condition in the zoning ordinance, Kona Three had an agreement to convey the 12 acres of land for the affordable housing when construction of the Project's drainage system is completed.

Electrical and sewer service would be extended from nearby public grid terminus and water commitments have already been purchased for the Project. The Project is in an urban area located between Kona Vistas and Pualani Estates subdivisions and is in close proximity to major roadways, recreational opportunities, and essential services, including grocery and wholesale stores, employment, hospital/clinics, public transit, gas stations, schools, financial institutions, government agencies/ services, and the airport.

To address housing shortages in Kona, the Kona Community Development Plan (CDP) identifies Objective HSG-4: Build More Units and Policy HSG-4.2: Workforce Housing. The workforce gap group (up to 180% of median income) includes the part of the population that earns too much to qualify for affordable housing programs, yet too little to buy or rent decent housing close to their jobs. The Project would build units that offer a variety of housing types for both the rental

[1] Mid-market refers to the price point that the Project targets, which is in between the subsidized housing market and the wealthy or upper middle market groups.

and buyer segments of the mid-market which includes the workforce group. Although the Project is not specifically a workforce project, it would provide a housing option for the workforce gap group.

The Project is an infill project located within the Kona Urban Area as designated by the Official Kona Land Use Map (Figure 4-7 in the Kona CDP), although it is not in the Transit-Oriented Development (TOD) area nor within a CDP Concurrency Zone. As stated in the CDP, "Within this Kona Urban Growth Area, growth would be directed to compact villages located along proposed transit routes **or to infill areas within, or adjacent to, existing development**." The Proposed Project is consistent with this designation.

Roads

The existing Zoning Ordinance for the Project requires Kona Three to build three main road segments to County dedicable standards and to dedicate these segments to the County. Specifically, these segments are laid out in the "Official Transportation Network Map - Nani Kailua Area" as part of the County's plan to expand the road grid to help alleviate traffic and provide safer driving conditions. These segments that are designed include:

- to connect County-owned Leilani Street (in the Kona Vistas project) to County-owned Ho'omama Street (in the Pualani Estates project);
- to connect County-owned Kekuana'oa Place (in the Kona Vistas project) to County-owned Paulehia Street (in the Pualani Estates project); and
- to connect these new roads to each other within the Project area. Kona Three is required to build and dedicate these roads by Ordinance.

The Proposed Project would extend Kekuana'oa Place, it would construct Royal Vistas Roadway, and it would construct the Leilani Street extension in the Project Site as shown on Figure 2. The Proposed Project would stub-out the Leilani Street extension on the southern Project Site boundary and would not connect it across the private parcel (TMK (3) 7-6-021:014 owned by the Calvary Community Church of Kona) to the existing Leilani Street. None of the roads proposed for the Project would be connected to Ho'omama Street and Paulehia Street. Those connections occur across another privately-owned parcel TMK (3) 7-6-013:004 north of the Project Site not controlled by Kona Three.

Drainage Improvements

TMKs 7-6-021:018 and 7-6-021:019 are owned and managed by the County of Hawai'i Department of Public Works (DPW) as drainages located adjacent to the proposed housing development (Figure 1). TMK (3) 7-6-21:19 encompasses approximately 4.25 acres, includes part of the Holualoa Ditch, and runs along the southern boundary of the Project Site. Infrastructure during Phase II of the

Proposed Project includes installation of a culvert system across the ditch to extend Kekuana‘oa Street, which would then be dedicated to the County as required by Ordinance and called for in the KCDP “Official Transportation Map.” This improvement is the HEPA trigger for the EA since it crosses County-owned land.

TMK (3) 7-6-21:18 encompasses approximately 3.0 acres, includes the *mauka* portion of the Horseshoe Bend Ditch, and runs between the two subject parcels of the Proposed Project. The Proposed Project includes infrastructure for channelizing a small portion of this ditch (approximately 100 linear feet, or 15,000 square feet) and includes a road and utility system crossing this ditch to provide the connector road required by Ordinance and the KDCP’s “Official Transportation Map.” This is also a HEPA trigger for the EA.

The *makai* portion of the Horseshoe Bend Ditch is located within the Project Site (TMK (3) 7-6-21:016), and as part of the Project this portion would be channelized where it is primarily sheet flow and moved closer to the northern Project boundary to make room for the planned roadway intersection at Queen Ka‘ahumanu Highway at the location approved by the State Department of Transportation Highways Division.

1.3 Purpose and Need

The purpose of the Proposed Project is to complete the final phase of the project and provide multi-family mid-market housing in North Kona. According to the Kona Community Development Plan (CDP), although home construction has outpaced population growth, Kona continues to experience a housing crisis as the production of new homes has been skewed to upper income levels. The project would “provide housing choices” to residents of North Kona, consistent with several of the guiding principles in the CDP.

The Project is the final phase of the larger development project that includes Kona Vistas, which was approved as part of the same zoning ordinance passed in 1984 and is needed to provide mid-market housing (for rent and for sale) in North Kona in a centrally located area near existing infrastructure, including shopping, schools, and job centers, and easily accessible from existing main roads and utility grids.

Figure 1 Project Location Map

Figure 2 Proposed Roads

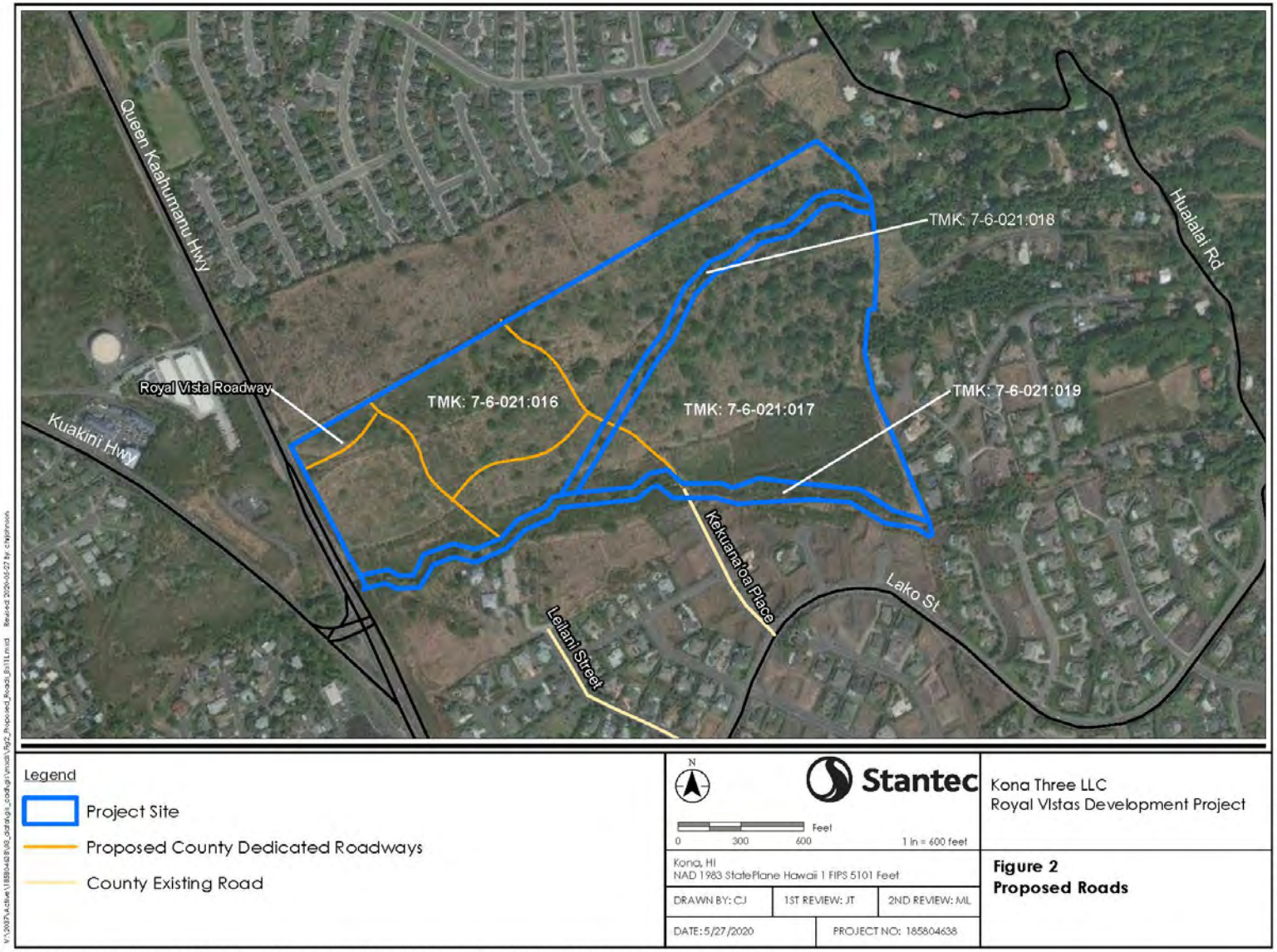


Photo 1 Project Site: Mid-*makai* section (looking west)

Photo 2 Project Site: *Mauka* section (looking northeast)

Figure 3 Conceptual Building Layout

Figure 4 Two-Story and Three-Story Building Schematic

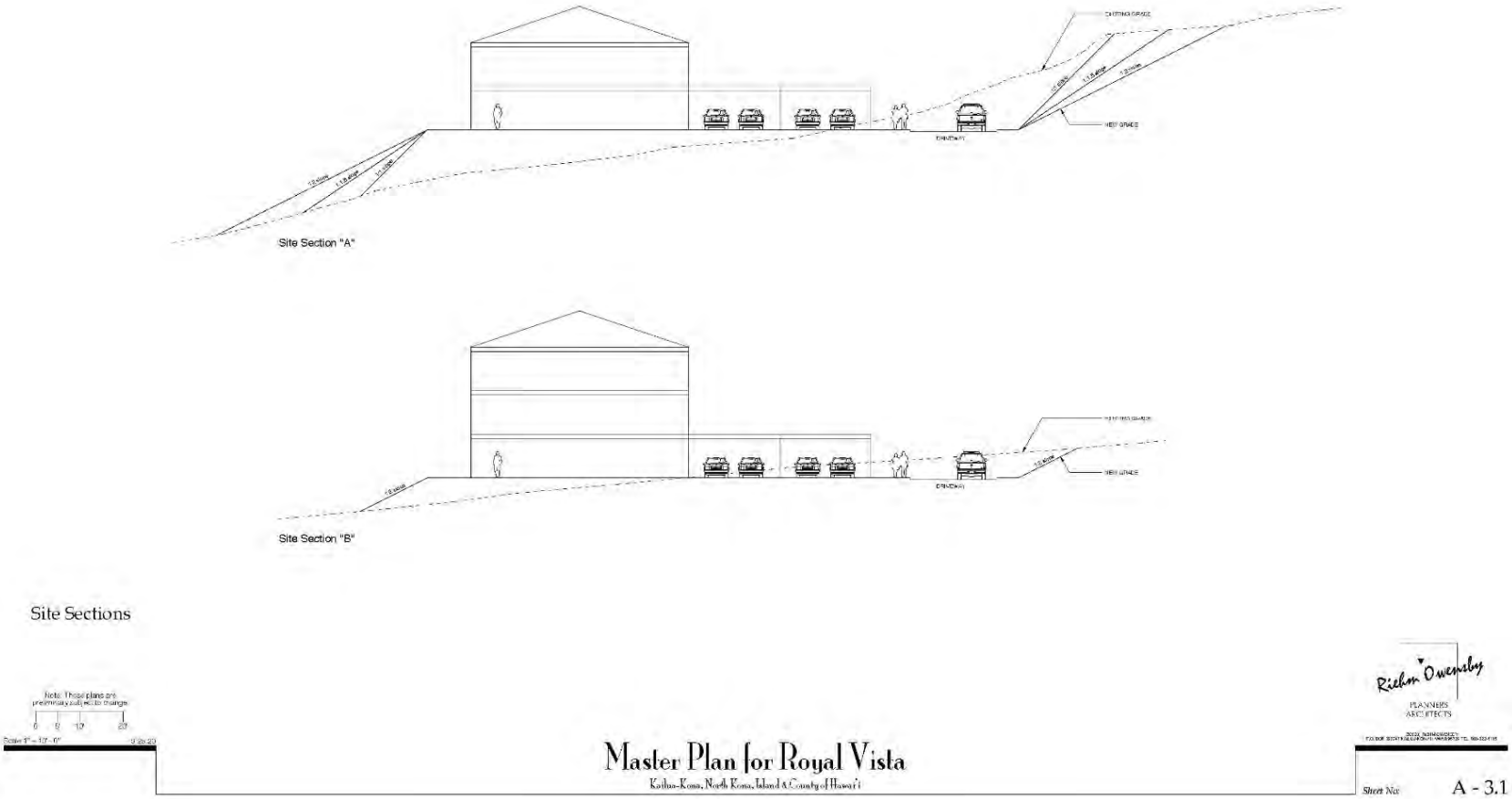
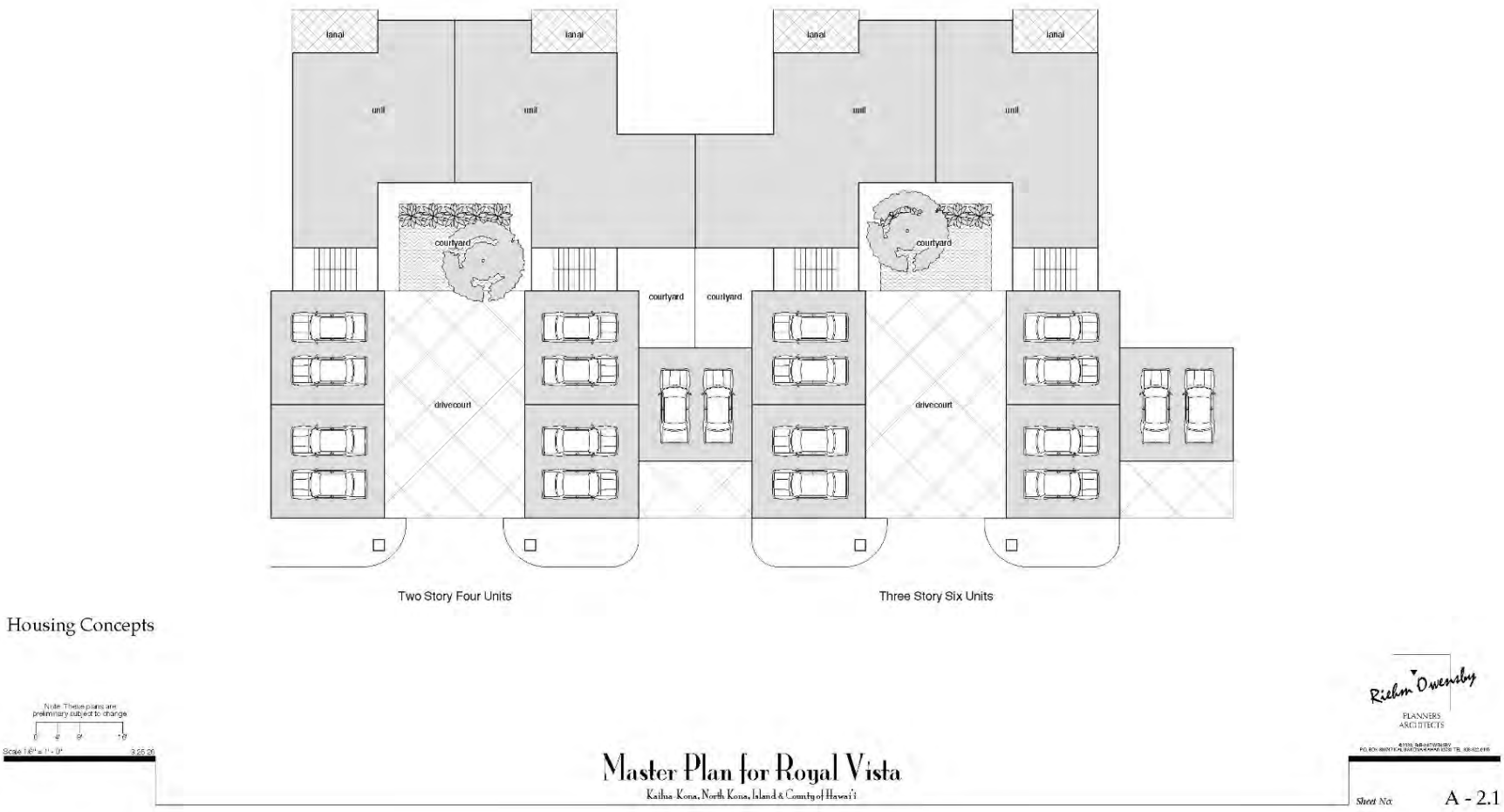


Figure 5 Concepts for Building Layout



1.4 Environmental Assessment Process

This Environmental Assessment (EA) process is being conducted in accordance with Chapter 343 of the Hawai‘i Revised Statutes (HRS). This law, along with its implementing regulations, Title 11, Chapter 200.1, of the Hawai‘i Administrative Rules (HAR), is the basis for the environmental impact process in the State of Hawai‘i. Section 343-5, HRS established nine types of actions that "trigger" compliance. The use of State or County lands is one of these "triggers." Since portions of the Proposed Project cross parcels (TMK (3) 7-6-21:18 and 19) that are controlled by the County of Hawai‘i DPW, compliance with HRS and HAR is required.

According to Chapter 343, an EA is prepared to determine impacts associated with an action, to develop mitigation measures for adverse impacts, and to determine whether any of the impacts are significant according to thirteen specific criteria.

Part 4 of this document states the anticipated Finding of No Significant Impact; Part 5 provides a review and analysis of the "Significance Criteria" defined in Section 12 of the Chapter 11-200.1, HAR. In the EA process, if the approving agency determines after considering comments to the Draft EA that no significant impacts would likely occur, then the agency issues a Finding of No Significant Impact (FONSI), and the action is permitted to proceed to obtaining any other discretionary permits and approvals. If the agency concludes that significant impacts are expected to occur as a result of the proposed action, then an Environmental Impact Statement is prepared to analyze the impacts and identify mitigation.

1.5 Public Involvement and Agency Coordination

The following agencies and organizations were consulted in development of the EA:

<u>Federal</u>:

National Park Service, Kaloko-Honokōhau National Historical Park
U.S. Fish and Wildlife Service

<u>State:</u>

Department of Education
Department of Land and Natural Resources
Department of Transportation
Governor's Office
State Historic Preservation Division
Office of Hawaiian Affairs

County:

Civil Defense Agency
County Council
Department of Environmental Management
Department of Parks and Recreation
Department of Public Works
Department of Water Supply
Fire Department
Mass Transit Agency
Planning Department
Police Department

Private:

Inter Pacific Motors Inc.
Sierra Club
Calvary Community Church of Kona
Kona Vistas Community Association

Copies of communications received during early consultation are contained in Appendix 1 and relevant aspects of reply letters are discussed in the text of the EA.

PART 2: ALTERNATIVES

2.1 Proposed Project

The action under consideration is described in Sections 1.1 to 1.3, above.

2.2 No Action

Under the No Action Alternative, the Proposed Project would not be developed on the site and no ground disturbance associated with the Proposed Project would occur. Under this alternative, there would not be 450 multi-family units available in North Kona at this site. The site is owned by Kona Three; however, under this alternative the parcel could either be held or sold. The parcel could be developed as some other type of project or not be developed for some time. These options would not help the existing and growing mid-market/workforce population in Kona and if it is developed, it is unknown whether it would be developed with both Rental and Sale units. Focusing development within the Kona Urban Area is a guiding principle of the Kona CDP. The no action alternative would fail to focus such uses and provide such improvements within the Kona Urban Area as prescribed by the Kona CDP. Also, under the no action alternative Policy TRAN 2.1: Connectivity Standards would not occur and there would be no roadway interconnectivity.

2.3 Alternatives Considered but Eliminated from Detailed Analysis

Kona Three considered alternative building configurations, alternative building locations and numbers, alternative access, and different numbers of Rental and Sale units.

Kona Three looked at building larger structures more like conventional high-density buildings with a heavier density (zoning of the land allows in excess of 600 units to be built). However, it was decided that the larger structures did not match nearby communities, were less aesthetically pleasing, and would have more environmental impacts than the 450 units of "flats" and "courtyard" styles that are the style for the Proposed Project. Kona Three considered that the larger structures did not offer a lifestyle to the target market (both Rental and Sale units) that is conducive to family living on Hawai'i Island as compared to the "flats" and "courtyard" style structures.

Alternative design features were considered including wider access roads and stand-alone rather than clustered structures, but these features limited the amount of green space available for the Project.

Kona Three's initial land plan (known then as "Kona Village") presented to the community and government officials in late 2018 included 260 of the 450 units contained in three-story buildings to help minimize ground disturbance. Access

for the first phase of that plan was designed to be from Lako Street via Kekuana'oa Place, in Kona Vistas Phase IV, which would have eventually connected to Paulehia Street in Pualani states.

Based on responses from members of the communities of Kona Vistas and Pualani Estates, Kona Three changed the name of the Project from Kona Village, reduced the estimated number of units in three-story buildings from 260 to 156 units (a 40 percent reduction), and moved the access for Phase I from Kekuana'oa Place to Queen Ka'ahumanu Highway via a new un-signalized intersection (proposed to be built).

These changes were made in response to community concerns about 1) confusing the Project with the similar named "Kona Village Resort," 2) eliminating all three-story buildings on the *makai* portion of the Project site to reduce visual impacts to existing Kona Vistas residents, and 3) providing separate access to the Project from Queen Ka'ahumanu Highway to reduce and delay traffic impacts on the Lako Street/Queen Ka'ahumanu Highway intersection as well as traffic on Kekuana'oa Place.

In response to community concerns, Kona Three also considered changing the zoning from Multiple-Family Residential, with a minimum building site of 5,000 square feet per dwelling unit (RM-5) to either Single-Family Residential District (minimum building site area of 10,000 square feet) (RS-10) or Single-Family Residential District (minimum building site area of 15,000 square feet) (RS-15) for the development. However, rezoning to RS-10 or RS-15 would result in a development with homes similar to those already present in the vicinity, which would not meet the purpose and need for the Project to provide housing choices for various community sub-markets compared to the RM-5 zoning.

Additionally, if there were a change of zoning that resulted in a reduction of density of less than 450 units, then any left over water credits (which have already been committed and paid for) would be effectively "lost" since they cannot be transferred except to "adjacent" properties. Currently, there is no known plan by the owner to develop the adjacent property. These credits are difficult to obtain and cannot be transferred by County policy, except to adjoining properties. Not building on this site at the proposed density would effectively eliminate a housing project that serves the mid-market/workforce community in the Kona area for the foreseeable future, since any other similar projects would depend on further water improvements in Kona which is a process that would take years. Similarly, the extension of the County sewer system to this Project would allow leveraging Kona's limited amount of sewer capacity required for multi-family housing, in addition to providing the future opportunity to have surrounding, existing properties hook up to the extended sewer system to eliminate environmental contamination.

In the end, none of the other alternatives were found to be optimal for the property or the perceived demand in the market, or resulted in more environmental impacts than the Proposed Project and were eliminated from detailed analysis.

PART 3: ENVIRONMENTAL SETTING, ENVIRONMENTAL CONSEQUENCES, CUMULATIVE IMPACTS, AND MITIGATION MEASURES

3.1 General Setting

The two parcels and location of the Project is referred to throughout this EA as the Project Site. The term Project Area is used to describe the general area of North Kona. The Project Site is located approximately 2.7 miles south of downtown Kailua-Kona on Queen Ka'ahumanu Highway adjacent to its intersection with Kuakini Highway.

Archaeological studies indicate that the Project Site was used prior to Western contact for a variety of activities, leaving features associated with agriculture, habitation, burial, and transportation (SCS 2016). More recently, the Project Site was farmed for coffee and ranched since the early 1900s. The lower portion of the Project Site was still used to pasture cattle until August 2019; evidence of ranching including fencing, cattle walls, several corrals and cattle chutes are present. The Project Site and surrounding lands were bulldozed sometime between the 1940s and 1970s in preparation for a commercial agricultural project, most likely coffee growing. The Project is bounded to the north by undeveloped cattle pasture, to the east and south by residential subdivisions and by Queen Ka'ahumanu Highway to the west.

3.2 Environmental Consequences

This section of the EA includes a description of the environmental setting of the Project Site as well as the potential impacts from the Proposed Project and alternatives to the resources. Environmental consequences, both primary and secondary, and the cumulative as well as the short-term and long-term impacts are considered. Cumulative impacts are impacts on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. Cumulative impacts include the direct and indirect impacts of a project together with the reasonably foreseeable future actions of others.

Past projects in the vicinity of the Project Site have included the following: flood control projects for the Horseshoe Bend and Holualoa Drainageways; urban residential development including Kona Vistas Phases 1 through 4; commercial development west of the Project Site (Scarlet Thread alteration shop, Power Self Storage-Kuakini) and south of the Project Site (Orchid Isle Auto Center); construction and use of the Calvary Community Church; as well as a number of infrastructure projects including construction of the Lako Street-Kuakini Highway

intersection, construction of the Leilani Street extension, Pualani Street extension, and Kilohana Street extension, and ongoing road maintenance and improvements.

The nearest reasonably foreseeable future project is dedication of the three remaining roadway lots (Kona Three is currently working with the County of Hawai‘i DPW to accept dedication of these). The development of the affordable housing project located approximately 0.1 mile from the Proposed Project to be built by others, *makai* of Kuakini Highway is also reasonably foreseeable. The affordable housing requirement was part of the original zoning ordinance (1984) and is located on approximately 12 acres. Subject to approval by the OHCD, Kona Three's affiliate which owns the 12 acres would deed the parcel to the County or their nominee to satisfy a portion of the affordable housing development requirement, and the homes would be built by qualified affordable housing developers.

In the TIAR prepared for the Project (Appendix 2), future road improvements include the widening of Kuakini Highway from Henry Street to Kamehameha III Road by two travel lanes as well as bicycle facilities and sidewalks. The Bike Plan Hawai‘i also identifies a signed shared road on Kuakini Highway from Lako Street to Hualalai Road, and a signed shared road on Queen Ka‘ahumanu Highway from Henry Street to Kuakini Highway.

3.3 Physical Environment

3.3.1 Climate, Geology, Soils, and Geologic Hazards

Environmental Setting

The Project Site has an elevation that varies from 330 feet above mean sea level (amsl) to 900 feet amsl and receives an average annual rainfall of between 35 and 38 inches, increasing in the *mauka* direction (Giambelluca et al. 2013).

The geologic substrate on most of the Project Site is soil-covered pahoehoe lava flows from Hualālai dated between 5,000 and 10,000 years in age (Wolfe and Morris 1996). Soil in the Project Site is classified as Waiaha medial silt loam (Map Unit Symbol 243), on 2 to 10 or 10 to 20 percent slopes, depending on location (NRCS 2019). This soil forms on ash-covered pahoehoe flows and has a 10- to 25-inch depth to bedrock. It is well drained but also has a high runoff potential (Sato et al. 1973).

Hawai‘i Island is subject to geologic hazards, such as lava flows and earthquakes. However, the Project Site appears to be stable with no evidence of subsidence or landslides. Volcanic hazard as assessed by the U.S. Geological Survey in this

area of North Kona is Zone 4, on a scale of ascending risk from 9 to 1 (Heliker 1990). The hazard risk is based on the fact that Hualālai has steep slopes and is the third most historically active volcano on the island.

Volcanic hazard Zone 4 areas have about 5 percent of their land area covered by lava or ash flows since the year 1800 and less than 15 percent of their land area covered by lava in the past 750 years. They are at lower risk than Zone 3 areas because the frequency of Hualālai eruptions is lower than those of Kilauea and Mauna Loa.

The Island of Hawai'i experiences high seismic activity caused by eruptive process within active volcanoes or by deep structural adjustments due to the weight of the islands on Earth's underlying crust (USGS 2019a). Although the earthquakes are seldom large enough to cause widespread damage, they can produce locally extensive ground fractures and subsidence (USGS 2019b). For example, the 6.6 magnitude earthquake that occurred in 2006 centered just off the northwest shore of Hawai'i Island resulted in widespread damage to buildings and roads in Kona.

Impacts and Mitigation Measures

Geologic Hazards

In general, geologic conditions do not impose undue constraints on the Project Site. Building design will meet all appropriate seismic standards ensuring safety for the future residents.

Climate Change

According to the EPA, global climate change could mean a rise in sea level that could worsen Hawai'i's existing coastal hazards, including waves, hurricanes, and tsunamis, and extreme tides (EPA 2016). Of the man-made greenhouse gases, the greatest contribution currently comes from CO_2 emissions. Through complex interactions on a regional and global scale, these greenhouse gas emissions and net losses of biological carbon sinks (i.e., vegetation) cause a net warming effect of the atmosphere, primarily by decreasing the amount of heat energy radiated by the earth back into space. Although greenhouse gas levels have varied for millennia, recent industrialization and burning of fossil carbon sources have caused greenhouse gas concentrations to increase dramatically and are a possible contributor to overall global climatic changes (IPCC 2007).

Potential changes to Hawai'i resulting from the effects of climate change include higher than normal temperatures, contraction or expansion of existing vegetation species distribution, the expansion of the range of existing invasive species populations, and the introduction of new pathogens and invasive species,

decrease in prevailing northeasterly trade winds, decline in rainfall and increased variability in rainfall patterns, increased ocean acidity, sea level rise, and threats to human health (University of Hawai'i at Mānoa Sea Grant College Program 2014).

The State of Hawai'i in Hawai'i Revised Statutes §226-109 identifies priorities to prepare the State to address the impacts of climate change. Also, Title 11-200.1-13 includes significance criteria to consider in environmental impact analysis that includes the hazardousness of sea level rise including: 1) the potential effects of a proposed action on climate change as indicated by assessing greenhouse gas emissions in a qualitative, or if reasonable, quantitative way; and 2) the effects of climate change on a proposed action and its environmental impacts. It recommends that agencies consider the short- and long-term effects and benefits in the alternatives and mitigation analysis in terms of climate change effects and resiliency to the effects of a changing climate.

Figure 6 illustrates that the Project's elevation of more than 300 feet above amsl and 0.85-mile distance from the coast protects the site from sea level rises of 3.2 feet, which could occur as early as the 2060s (PacIOOS 2017). The Project's design including surface runoff drainage plans address the potential impact from flooding that could occur if increased variability in rainfall patterns occur. A more detailed description of flood and drainage plans are described in Section 3.3.2.

Potential impacts to climate change from the Project include direct impacts from emissions of greenhouse gases during construction and occupation of the proposed development related to the consumption of fuels (combustion) and indirect impacts from greenhouse gas emissions associated with electrical power consumption. Since the Project addresses an existing demand for housing, it is expected that a portion of the residents that would occupy the development already live in Kona or on Hawai'i Island, and there would not be a substantial increase in emissions when residents occupy the Project. Therefore, Project impacts would be considered a negligible increase to the global annual greenhouse gas emissions.

Under the No Action Alternative, the Proposed Project would not be constructed, and the site would remain unchanged from current conditions. There would be no change in impacts to climate, or from geologic conditions or seismic activity, under this alternative.

Figure 6 Sea Level Rise Exposure Map

Cumulative Impacts

Since there are no impacts from the Proposed Project, there are no anticipated cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions to these resources.

3.3.2 Flood Zones and Drainage

Existing Environment

The Project Site is located approximately 0.85 miles from the ocean at elevations ranging from 330 to 900 feet amsl, outside the area affected by coastal flooding. The area of North Kona includes a series of narrow drainageways that flow to the ocean. Two intermittent drainageways are located adjacent to the proposed development on the parcels managed by the County of Hawai'i DPW, Horseshoe Bend and Holualoa Drainageways.

The Federal Emergency Management Agency's (FEMA's) Flood Insurance Rate Map (FIRM) 1551660952F (9/29/2017) shows the Project Site and proposed development is in Flood Zone X, and part of the Project Site is in the 0.2% annual chance floodplain (Figure 7). Horseshoe Bend and Holualoa Drainageways, cross and are adjacent to the Project Site, are located in Special Flood Hazard Areas (SFHAs) Zone AE. Zone AE is defined as areas inundated by flood having a 1% probability of being equaled or exceed in any given year (base flood) and the

floodways are in Zone AEF. These drainages merge *makai* of Queen Ka'ahumanu Highway.

Channelization of much of both Horseshoe Bend and Holualoa Drainages was planned starting in 1976 (Master Plan for Kona Flood Control Project for the County of Hawai'i DPW by Stanley S. Shimabakuro & Associates), but not completed. The County installed a lined drainageway just south of the Ali'i Kai subdivision and a basin to contain the flow from this channel, but the *mauka* end of the channel ended below Kupuna Street.

During the extension of Queen Ka'ahumanu Highway (downstream of the Project) in the early 1980s, the State of Hawaii constructed culverts for the Holualoa Drainageway and the Horseshoe Bend Drainageway under Queen Ka'ahumanu Highway to direct flow under this major arterial. Culverts were also constructed under Kuakini Highway by the State for the Holualoa Drainageway; however, the culverts that were proposed for under County-owned Kuakini Highway for the Horseshoe Bend Drainageway waters were never constructed. As a result, during heavy rain events flooding occurs across Kuakini Highway which flows down and impacts Kuakini Highway and the residents *makai* of Kuakini Highway.

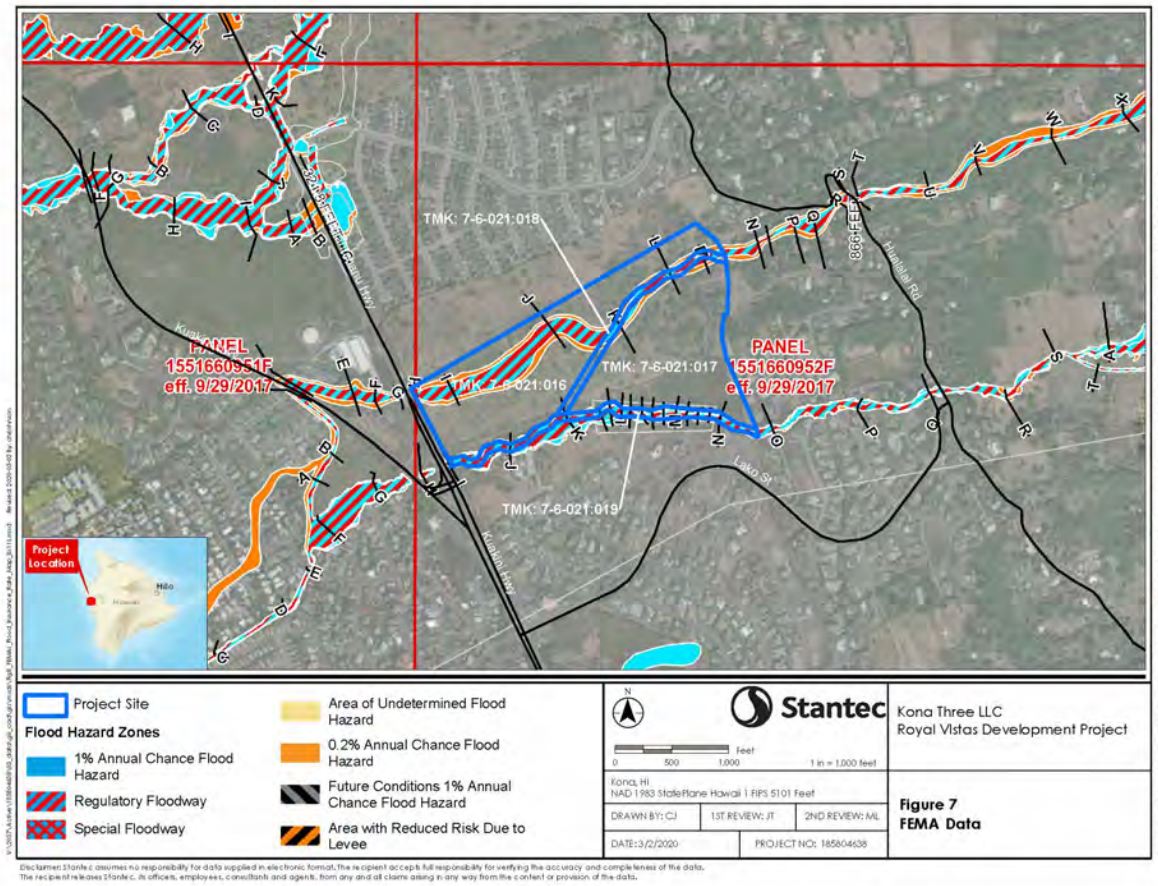
Holualoa Drainageway and Horseshoe Bend Drainageway waters have a confluence at the *makai* end of the 12 acres. Working with the County, the previous developer of the Project assisted in obtaining private property owners' co-operation to achieve land use rights that allow the confluence to feed into the County channel. The current developer is now processing a Conditional Letter of Map Revision (CLOMR) with the FEMA to further channelize the portion of Holualoa Drainageway that crosses the 12 acres to allow more safe and efficient transfer of these flood waters. This channelization protects the lands *makai* of this work from flood exposure as well as further implementing Phase II of the County of Hawai'i's Master Flood Control Plan. It also allows more efficient development of the 12 acres into residential use in a safe manner.

These drainageways continue to act as runoff distribution and flood control and most recently, the Effective FIRM (effective September 2017) increased the Q (estimated flow) within the Holualoa Drainageway, including the section within the County-owned ditch adjacent to the Project Site. To address the existing flooding concerns, several options for correction are being considered in the vicinity of the Project Site in conjunction with the County of Hawai'i DPW.

The State of Hawai'i, Department of Land and Natural Resources Flood Assessment Tool shows the Project Site outside the area that should be evacuated during a tsunami warning (http://gis.hawaiinfip.org/fhat/, accessed December

2019). No known areas of local (non-stream or ocean related) flooding are present at the Project Site.

Figure 7 National Flood Hazard Layer FIRM Map



Impacts and Mitigation Measures

The Project would be required to follow County regulations and policies related to flood control and drainage, among them Chapter 27 of the Hawai‘i County Code. Chapter 27 requires the difference between pre-development and post-development runoff to be contained onsite, limiting impacts. A drainage study will be prepared and reviewed and approved by the County of Hawai‘i DPW. Implementation of the approved Drainage Plan would ensure that runoff from the Project Site would not be directed toward adjacent properties. The Project does not propose to impact the existing flows within the Horseshoe or Holualoa Drainageways, other than to channelize portions of the Horseshoe Bend Drainageway where it sheet flows and as needed to address downstream flooding issues once the options are analyzed and a solution is approved. Kona Three would coordinate with County of Hawai‘i DPW and FEMA on the CLOMR discussed above, which proposes to re-locate the Flood Zone (Zone AEF) within

the new flood control channels; therefore, no Project-related surface disturbance associated with grading, parking, and landscaping would occur within the Flood Zone.

Kona Three will continue working with the County to alleviate the downstream flooding issue caused by the lack of culverts under Kuakini Highway; however, these issues would not be exacerbated by the Project. The final design of the improvement projects for the Horseshoe Bend and Holualoa Drainages would be developed by Kona Three in coordination with the County of Hawai‘i DPW. Completion of the drainage system improvements is required prior to the issuance of a certificate of occupancy for the Project.

Under the No Action Alternative, the Proposed Project would not be constructed and the site would remain unchanged from current conditions. There would be no impacts to flood zones under this alternative and improvements to the drainages to reduce flooding of downstream properties would not occur.

Cumulative Impacts

Since there are no impacts associated with flood zone exposure from the Proposed Project, there are no anticipated cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions to flood zones.

3.3.3 Water Quality and Water Quantity

Existing Environment

Groundwater

The State Commission on Water Resource Management (CWRM) classification of aquifers locates this part of Kona within the Keauhou Aquifer System of the Hualālai Aquifer Sector. The Project Site is not located above any of the nine Principal or Sole-Source aquifers identified in the U.S. EPA's Region 9 (https://archive.epa.gov/region9/water/archive/web/html/ssa.html, accessed on-line December 2019).

Water commitments for the Proposed Project have been secured from the DWS and fully paid for all the multi-family residential units through Keauhou Source Agreement commitments and Kealakekua Source Agreement commitments. According to a letter received during early consultation, the Project Site is served by an existing service that can accommodate a 4-inch meter on ‘Io Place, and is limited to 180,400 gallons per day, or 451 units of water. The demand for the Project is expected to be 180,400 gallons per day, which is included in the Department of Water Supply's calculation of Authorized Plan Use.

Landscaping is planned for the Project Site as well, and water use for landscaping is accounted for in the water credits.

Surface Waters

The Project Site is approximately 0.85 miles from the Pacific Ocean and has no nearby surface water bodies or waters of the U.S. According to maps from the U.S. Fish and Wildlife Service, confirmed by field inspection, no wetlands are present on the Project Site (http://www.fws.gov/wetlands/Data/Mapper.html). The Wai'aha Stream is the nearest riverine habitat and is located approximately one mile north of the Project.

Impacts and Mitigation Measures

Potential impacts from the Project could occur to water quality during land clearing and construction activities from erosion and sedimentation. These impacts would be minimized since grading of the Project Site during construction would be conducted in accordance with the grading permit which would be issued by Hawai'i County. Prior to the initiation of construction for the Proposed Project, Kona Three would ensure that a National Pollutant Discharge Elimination System (NPDES) general permit is in place. The permit would require best management practices (BMPs) to minimize erosion and for stormwater pollution prevention. Oversight of the BMPs would be conducted weekly for the duration of construction, with updates and corrective actions documented and transmitted to the State Department of Health, Clean Water Branch. Additionally, all earthwork and grading would conform with Chapter 10 – Erosion and Sedimentation Control – of the Hawai'i County Code.

The intent is for the Proposed Project to collect and convey stormwater runoff into multiple onsite seepage pits with sizing based on a 10-year, 1-hour rainfall event. Based on the initial concept plan shown on Figure 3, a portion of the Project Site would be landscaped, including two parks in Phase 1, and the rest of the site would consist of buildings, parking areas, and roads. Water runoff from parking lots, driveways, and other surfaces would be treated to minimize potential impacts to inland and coastal waters using standard stormwater pollution prevention technology. The specific technology, or combination of technologies, that would be implemented for the Project would be identified during the final design.

Where feasible, the Proposed Project would include water efficient fixtures and provide water-saving recommended measures for residents. To minimize water demand, the Project would minimize landscaping and use xeriscape landscaping where landscaping is installed. In addition, the Proposed Project aims to

implement and balance xeriscape with the provision of safe and adequate recreational space for residents. The Project would utilize reclaimed or reuse water for landscaping, if possible.

No impacts to groundwater are expected from generation of wastewater since the Project would tie in with the County's sewer system.

Under the No Action Alternative, the Proposed Project would not be constructed and the site would remain unchanged from current conditions. There would be no impacts to water quality under this alternative.

Cumulative Impacts

The relevant past, present, and reasonably foreseeable future projects for cumulative impacts are described in Section 3.2. Each project has or could result in depletion of water quantity and impacts to water quality, including depletion of available groundwater, sedimentation or nutrient loading to surface water and groundwater. The issue comes not from the impacts of an individual project, but cumulative impacts in the region. As described above, impacts to water quality and water quantity from the Proposed Project would be negligible. Therefore, the cumulative impacts of the Proposed Project in combination with past, present, and reasonably foreseeable future actions are expected to be minor.

3.3.4 Flora, Fauna, and Ecosystems

Existing Environment

Vegetation

A survey for biological resources was conducted by Geometrician Associates for the Project Site (Appendix 3). The pre-human vegetation in the Project Site was likely Lowland Dry/Mesic Forest, which likely consisted of an open canopy forest dominated by a wide variety of trees, shrubs, herbs, vines, and ferns. However, current vegetation at the Project Site includes introduced species that are common throughout Kona and include the non-native haole koa (*Leucaena leucocephala*), opiuma (*Pithecellobium dulce*), and guinea grass (*Megathyrsus maximus*).

The Project Site includes two vegetation types that are distinguished primarily by previous management activities. The higher elevation portion of the Project Site contains few cattle, is intensely overgrown with guinea grass, and could be described as a scattered forest or thick savanna dominated by koa haole, opiuma, and monkeypod (*Samanea saman*). The lower elevation portion of the Project Site is moderately grazed and has a very similar but slightly more diverse canopy, including kiawe (*Prosopis pallida*), klu (*Acacia farnesiana*), and several

other non-native trees. The understory in both vegetation types include a diversity of non-native grasses, herbs, shrubs and vines, with a very few natives, including ‘uhaloa (*Waltheria indica*) and ‘ilima (*Sida fallax*).

Although two drainageways traverse the property, no aquatic or true riparian vegetation is present in the Project Site.

All plant species found on the property during the survey are listed in Table 1. Of the 46 species detected, six were indigenous (native to the Hawaiian Islands and elsewhere) and only three were endemic (found only in the Hawaiian Islands). No rare, threatened, or endangered plant species were present in the Project Site.

Table 1 Plant Species Observed in the Project Site

Scientific Name	Family	Common Name	Life Form	Status*
Ferns				
Nephrolepis multiflora	Nephrolepidaceae	Sword fern	Herb	A
Phymatosorus grossus	Polypodiaceae	Maile scented fern	Fern	A
Flowering Plants				
Abutilon grandifolium	Malvaceae	Abutilon	Shrub	A
Acacia farnesiana	Fabaceae	Klu	Shrub	A
Aleurites moluccana	Euphorbiaceae	Kukui	Tree	PI
Amaranthus viridis	Amaranthaceae	Slender amaranth	Herb	A
Bidens alba	Asteraceae	Beggar’s tick	Herb	A
Bidens cynapiifolia	Asteraceae	Blue bidens	Herb	A
Bidens pilosa	Asteraceae	Beggar’s tick	Herb	A
Buddleia asiatica	Scrophulariaceae	Buddleia	Shrub	A
Caesalpinia decapetala	Fabaceae	Wait-a-bit	Vine	A
Chamaecrista nictitans	Fabaceae	Partridge pea	Herb	A
Chamaesyce hirta	Euphorbiaceae	Garden spurge	Herb	A
Chamaesyce hypericifolia	Euphorbiaceae	Graceful Spurge	Herb	A
Chloris barbata	Poaceae	Swollen fingergrass	Herb	A
Coccinia grandis	Cucurbitaceae	Ivy gourd	Vine	A
Crotalaria sp.	Fabaceae	Crotalaria	Herb	A
Cynodon dactylon	Poaceae	Bermuda grass	Herb	A
Desmanthus virgatus	Fabaceae	Slender mimosa	Shrub	A
Digitaria ciliaris	Poaceae	Crabgrass	Herb	A
Digitaria insularis	Poaceae	Sourgrass	Herb	A
Digitaria setigera	Poaceae	Crabgrass	Herb	A
Dysphania carinata	Chenopodiaceae	Dysphania	Herb	A
Eleusine indica	Poaceae	Goose grass	Herb	A
Eragrostis tenella	Poaceae	Lovegrass	Herb	A
Hyptis pectinate	Lamiaceae	Comb hyptis	Shrub	A
Indigofera suffruticosa	Fabaceae	Indigo	Shrub	A
Ipomoea obscura	Convolvulaceae	Obscure morning glory	Vine	A
Kalanchoe pinnata	Crassulaceae	Air plant	Herb	A
Lantana camara	Verbenaceae	Lantana	Shrub	A

Scientific Name	Family	Common Name	Life Form	Status*
Leonotis nepetifolia	Lamiaceae	Lion's ear	Herb	A
Leucaena leucocephala	Fabaceae	Haole koa	Shrub	A
Malvastrum coromandelianum	Malvaceae	False mallow	Herb	A
Megathyrsus maximus	Poaceae	Guinea grass	Herb	A
Melinis repens	Poaceae	Natal redtop	Herb	A
Merremia tuberosa	Convolvulaceae	Woodrose	Vine	A
Mimosa pudica	Fabaceae	Sleeping grass	Herb	A
Momordica charantia	Cucurbitaceae	Bitter gourd	Vine	A
Paederia foetida	Rubiaceae	Maile pilau	Vine	A
Parthenium hysterophorus	Asteraceae	Santa Maria	Herb	A
Passiflora edulis	Passifloraceae	Lilikoi	Vine	A
Phyllanthus debilis	Euphorbiaceae	Niruri	Herb	A
Pithecellobium dulce	Fabaceae	Dulce	Tree	A
Plumbago auriculata	Plumbaginaceae	Leadwort	Shrub	A
Plumbago zeylanica	Plumbaginaceae	'Ilie'e	Herb	I
Portulaca pilosa	Portulacaceae	Portulaca	Herb	A
Prosopis pallida	Fabaceae	Kiawe	Tree	A
Psidium guajava	Myrtaceae	Common guava	Tree	A
Ricinus communis	Euphorbiaceae	Castor bean	Shrub	A
Rivina humilis	Phytolaccaceae	Coral berry	Herb	A
Samanea saman	Fabaceae	Monkeypod	Tree	A
Schinus terebinthifolius	Anacardiaceae	Christmas berry	Tree	A
Senna occidentalis	Fabaceae	Coffee senna	Shrub	A
Sida fallax	Malvaceae	'Ilima	Shrub	I
Sida rhombifolia	Malvaceae	Sida	Herb	A
Sida spinosa	Malvaceae	Sida	Herb	A
Solanum americanum	Solanaceae	Popolo	Herb	I
Solanum seaforthianum	Solanaceae	Vining solanum	Herb	A
Sonchus oleraceus	Asteraceae	Sow thistle	Herb	A
Spathodea campanulata	Bignoniaceae	African tulip	Tree	A
Thevetia peruviana	Apocynaceae	Be-still tree	Tree	A
Thunbergia fragrans	Acanthaceae	White thunbergia	Vine	A
Triumfetta rhomboidea	Tiliaceae	Bur brush	Shrub	A
Waltheria indica	Sterculiaceae	'Uhaloa	Herb	I

*A = alien, E = endemic, I = indigenous, PI = Polynesian, END = Federal and State Listed Endangered (none)

An online mapping tool provided by the USFWS indicates that no designated or proposed critical habitat for endangered plant (or animal) species is located on or near the property (USFWS 2019). The nearest designated critical plant habitat is for endangered haha (*Cyanea hamatiflora* ssp. *carlsonii*) approximately seven miles northeast of the Project Site.

Blackburn's Sphinx Moth

The one endangered insect found in many parts of Kona is the Blackburn's sphinx moth (*Manduca blackburnii*). It is generally associated with drier environments and 'a'a substrates. The native host plant aiea (*Nothocestrum* spp.) is extremely rare, but a substitute host, the prolific weed tree tobacco (*Nicotiana glauca*), quickly colonizes dry, disturbed lava flows. Neither host was found within the survey area.

Birds

The 15 species of birds detected during the survey were all non-native and typical of those found in similar areas of lowland disturbed habitat in Kona (Table 2). The most common species encountered were spotted dove (Streptopelia chinensis), northern cardinal (*Cardinalis cardinalis*), cattle egret (*Bubulcus ibis*), parakeet (*Aratinga* sp.), Japanese white-eye (*Zosterops japonicus*), and house finch (*Carpodacus mexicanus*). No native birds were detected, and it is generally poor habitat for most native birds. The short-eared owl may utilize habitat at the Project Site and vicinity for foraging. The trees in the survey area are generally too short to serve as typical Hawaiian hawk (*Buteo solitarius*) nests, but individuals could forage at least occasionally in the area.

Table 2 Bird Species Observed in the Project Site

Scientific Name	Common Name	Status
Acridotheres tristis	Common myna	Alien resident
Aratinga sp.	Parakeet	Alien resident
Bubulcus ibis	Cattle egret	Alien resident
Cardinalis	Northern cardinal	Alien resident
Carpodacus mexicanus	House finch	Alien resident
Francolinus pondecerianus	Black francolin	Alien resident
Geopelia striata	Zebra dove	Alien resident
Leiothrix lutea	Red-billed leiothrix	Alien resident
Lonchura punctulata	Nutmeg mannikin	Alien resident
Padda oryzivora	Java sparrow	Alien resident
Passer domesticus	House sparrow	Alien resident
Serinus mozambicus	Yellow-fronted canary	Alien resident
Sicalis flaveola	Saffron finch	Alien resident
Streptopelia chinensis	Spotted dove	Alien resident
Zosterops japonicus	Japanese white-eye	Alien resident

A number of other rare, threatened, and endangered birds are fairly unlikely to be found at the Project Site and vicinity. The Hawaiian goose or nēnē (*Branta sandvicensis*) is an endemic, federally listed endangered species that is only occasionally observed in urban Kona, although it is more abundant at Big Island Country Club in the Kekaha region of Kona. Some endangered Hawaiian petrels

(*Pterodroma sandwichensis* or ‘ua‘u) and band-rumped storm-petrels (*Oceanodroma castro*), as well as threatened Newell’s shearwaters (*Puffinus auricularis newelli*), may overfly the area between the months of June and October. All three of these pelagic seabird species nest high in the mountains in burrows. Most recently (November 2019) a Hawaiian petrel burrow and chick were observed in a newly documented ‘ua‘u colony inside the Pu‘u O Umi Natural Reserve Area on Kohala Mountain.

There is no suitable nesting habitat for any of these seabird species within or near the Project Site. The primary cause of mortality in all these seabird species in Hawai‘i is thought to be predation by alien mammalian species at the nesting colonies. Collision with man-made structures is another significant cause. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. When disoriented, seabirds may collide with manmade structures. If they are not killed outright, the dazed or injured birds are easy targets of opportunity for feral mammals. Although not a listed species, the Hawaiian endemic sub-species of the short-eared owl or pueo (*Asio flammeus sandwichensis*), a protected migratory bird, nests and hunts in tall grasslands and shrublands and could conceivably be occasionally present at the Project Site.

Hawaiian Hoary Bat

The endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), the only native Hawaiian land mammal, may utilize the property, as it is found in most areas on the island of Hawai‘i and has been observed in surrounding areas with similar vegetation. It was not observed in our survey, which took place in daylight and did not use any detection equipment, but it should be presumed present. Bats may forage for flying insects over portions of the property on a seasonal basis, and they may find some of the larger shrubs and trees (both exotic and native) suitable roosting habitat. Hawaiian hoary bats are vulnerable to disturbance during the summer pupping season.

Introduced Mammals, Reptiles, and Amphibians

The only live mammals seen during the survey were cattle (*Bos taurus*), feral pigs (*Sus scrofa*) which were abundant in the survey area, and small Indian mongooses (*Herpestes a. auropunctatus*). Given the Project’s location in an urban area, It is likely that feral cats (*Felis catus*), mice (*Mus* spp.), rats (*Rattus* spp.), and domestic dogs, (*Canis f. familiaris*) are occasionally present. There are no native terrestrial reptiles or amphibians in Hawai‘i. The only reptile observed during the survey was the day gecko (*Phelsuma* sp.). It is likely that other species of gecko, anoles, and skinks are also present. No amphibians were seen or heard. None of these alien

mammals or reptiles have conservation value and all are deleterious to native flora and fauna.

Impacts and Mitigation Measures

Vegetation

As discussed above, no threatened or endangered plant species as listed by the USFWS appear to be present in the Project Site, nor are there uniquely valuable habitats. No existing or proposed federally designated critical plant (or animal) habitat is present in the Project Site. There appears to be no potential to adversely affect rare, threatened, or endangered plant species.

Although existing vegetation would be cleared during Project construction activities including grading, the plants that would be removed are all non-native. Landscaping is an important aspect for housing developments both for residents' experience and property value. The Proposed Project would plant new vegetation as part of landscaping following Project construction. As requested in an early consultation letter from DLNR, Kona Three would plant native or non-invasive trees as part of landscaping for the Proposed Project.

Blackburn's Sphinx Moth

In order to prevent potential impacts to the Blackburn's sphinx moth, the Proposed Project would include the following protection measures. A biologist familiar with the species would survey for Blackburn's sphinx moth and its larval host plants (tree tobacco and native 'aiea) between November and April or several weeks after a significant rain and within four to six weeks prior to construction. Surveys should include searches for eggs, larvae, and signs of larval feeding (chewed stems, frass, or leaf damage). If moths or native 'aiea or tree tobacco over three feet are found during the survey, Kona Three would coordinate with the USFWS for guidance to avoid impacts.

If no Blackburn's sphinx moth, 'aiea, or tree tobacco are found during pre-disturbance surveys, Kona Three would ensure that measures are taken to avoid attraction of Blackburn's sphinx moth and prohibit tree tobacco from entering the site. Tree tobacco can grow more than three feet in approximately six weeks, and above three feet in height the tree tobacco can become a host plant for Blackburn's sphinx moth. The Proposed Project would remove tree tobacco less than three feet tall and monitor the Project Site for new tree tobacco grown before, during, and after Project construction. Monitoring for tree tobacco after construction, can be completed by any staff, such as regular maintenance crew, provided with pictures of tree tobacco at different life stages.

Birds

If construction for the Project is scheduled to occur in the Hawaiian hawks breeding season (between March 1 and September 30), a qualified biologist would conduct a pre-disturbance survey for hawk nests within and immediately adjacent to the property. If a Hawaiian hawk nest is located during the pre-disturbance nest survey, no land clearing or construction should occur within 1,600 feet of any active Hawaiian hawk nest during the breeding season until the young have fledged (usually October). Regardless of time of year, Kona Three would coordinate with the USFWS prior to trimming or cutting trees with Hawaiian hawk nests, as nests may be re-used during consecutive breeding seasons.

The Proposed Project would not involve any unshielded lighting for either construction or operation, in conformance with Hawai'i County Code § 14 – 50 et seq, which would avoid impacts to nocturnally flying Hawaiian petrels and Newell's shearwaters. Additionally, during operation the site would use lighting only where and when it is needed for safety purposes. The use of outdoor lamps with warmer colors (less blue light) and energy efficient fixtures would be considered when the building is being constructed.

If the Proposed Project incorporates additional outdoor lighting, it may attract threatened and endangered Hawaiian seabirds, which may become disoriented by the lighting, resulting in birds being downed. To avoid the potential downing of these threatened and endangered seabirds due to interaction with outdoor lighting, no construction using unshielded equipment maintenance lighting should be permitted after dark between the months of April and October. All additional permanent lighting should conform to the Hawai'i County Outdoor Lighting Ordinance (Hawai'i County Code Chapter 9, Article 14), which requires shielding of exterior lights so as to lower the ambient glare caused by unshielded lighting. The Proposed Project would also avoid nighttime construction during the seabird fledging period, September 15 through December 15.

Hawaiian Hoary Bat

The endangered Hawaiian hoary bat is vulnerable to disturbance while roosting with its juveniles in the pupping season. To minimize impacts during construction, woody plants taller than 15 feet would not be removed or trimmed during the bat birthing and pup rearing season (June 1 through September 15). Additionally, Hawaiian hoary bats forage for insects from as low as 3 feet to higher than 500 feet above the ground and can become entangled in barbed wire, if used for fencing. The Proposed Project would not use barbed wire for fencing.

Marine Species

Factors that might impair urban Kona's coastal water quality and potentially affect threatened or endangered marine species are wastewater, chemical contaminants from industrial and commercial uses, and polluted runoff from streets and parking lots. Runoff from the drainageways in the Project Site could reach the ocean; however, the runoff from the Project would not be directed into the drainageways or increase flow during flood events. Potential impacts to water quality would be minimized through wastewater and stormwater treatments described in Section 3.3.2 and 3.3.3.

Additional Impacts

A mix of native species, Polynesian introduced species, and non-invasive introduced ornamentals would be used in landscaping for the Project Site and an invasive weed control plan for the Project Site would be developed to minimize impacts from fire-prone, non-native vegetation species. Additionally, where no grading or grubbing is required, existing vegetation would be left in place. Biosecurity protocols during construction would include cleaning and inspection of construction equipment for invasive species (including insects, frogs, rats, and mice), and would be applied as applicable.

Under the No Action Alternative, the Project would not be constructed and the site would remain unchanged from current conditions. There would be no vegetation removed, and, therefore, no impacts to the native plant species present in the Project Site or removal of potential habitat for protected wildlife species. However, there would be no invasive weed control plan in place under this alternative, and existing weeds at the Project Site would continue to spread at the Project Site.

Cumulative Impacts

Past, present, and reasonably foreseeable future projects in the vicinity have impacted biological resources through alteration of the landscape through introduction of weeds, removal of native vegetation, and loss of habitat for native wildlife species.

Impacts to biological resources from the Proposed Project would be minor, due to the limited number of native species present at the Project Site and the protection measures outlined to avoid impacts to Federally-listed species and prevent spread of non-native weeds.

Therefore, the cumulative impacts of the Proposed Project in combination with past, present, and reasonably foreseeable future actions are expected to be minor.

3.3.5 Noise

Environmental Setting

Noise on the Project Site is low to moderate; the main source of noise at the site is traffic traveling on Queen Ka'ahumanu Highway.

The noise descriptor used to assess environmental noise by the Department of Housing and Urban Development (HUD) is the day-night average A-weighted (dBA) sound level (DNL). DNL is a representation of the average noise during a typical day of the year. DNL levels of 55 or less are typical of quiet, rural or suburban areas. DNL exposure levels of 55 to 65 are typical of urbanized areas with medium to high levels of activity and street traffic. DNL exposure levels above 65 are representative of dense urban sites and areas near large highways or airports.

Administrative Rules for the Department of Health, Chapter 11-46, Community Noise Control set permissible noise levels to provide for the prevention, control, and abatement of noise pollution in the state. The Project Site is zoned Multiple-Family Residential 5,000 square feet (RM-5). Multi-family dwellings are in a Class B zoning district defined by HAR §11-46-3. The maximum permissible sound level in a Class B zoning district is 60 dBA from 7:00 a.m. until 10:00 p.m. and 50 dBA from 10:00 p.m. to 7:00 a.m. (HAR §11-46-4).

Various agencies have different standards of noise compatibility. Per 24 CFR 51.103, HUD exterior standards are as follows:

- Acceptable (DNL not exceeding 65 dBA): The noise exposure may be of some concern but common building constructions will make the indoor environment acceptable and the outdoor environment will be reasonably pleasant for recreation and play.
- Normally Unacceptable (DNL above 65 but not exceeding 75 dBA): The noise exposure is significantly more severe; barriers may be necessary between the Project Site and prominent noise sources to make the outdoor environment acceptable; special building constructions may be necessary to ensure that people indoors are sufficiently protected from outdoor noise.
- Unacceptable (DNL above 75 dBA): The noise exposure at the site is so severe that the construction cost to make the indoor noise environment acceptable may be prohibitive and the outdoor environment would still be unacceptable.

Impacts and Mitigation Measures

During construction of the Proposed Project, there would be moderate levels of noise from the operation of heavy equipment during grading and construction. In cases where construction noise is expected to exceed the State DOH "maximum permissible" property-line noise levels, builders must obtain a permit per Title 11, Chapter 46, HAR (Community Noise Control) prior to construction. The DOH reviews the proposed activity, location, equipment, project purpose, and timetable in order to decide upon conditions and mitigation measures, such as restriction of equipment type, maintenance requirements, restricted hours, and portable noise barriers. Kona Three and/or its construction contractor will consult with DOH to determine if a permit will be required and what, if any, noise reduction measures are necessary. During operation, moderate levels of noise which would be consistent with the level of noise from neighboring residential subdivisions is anticipated. Therefore, the Proposed Action is not expected to significantly impact any existing residential subdivisions within the vicinity of the Project Site.

Under the No Action Alternative, the Proposed Project would not be constructed and the site would remain unchanged from current conditions. There would be no additional impacts to noise from this alternative.

Cumulative Impacts

Since there are no impacts from the Proposed Project, there are no anticipated cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions from noise.

3.3.6 Air Quality and Scenic Resources

Environmental Setting

Air quality in Hawai'i is generally good, below criteria levels for most pollutants in most locations at almost all times. There are no State Department of Health (DOH) air monitoring stations in the immediate vicinity of the Project Site. The nearest site is the Kailua-Kona monitoring site which is located on Walua Road approximately one mile north of the Project Site. Air pollution in West Hawai'i, when present, is mainly derived from volcanic emissions of sulfur dioxide, which convert into particulate sulfate and produce a volcanic haze (vog) that can affect North and South Kona. Vog concentrations are dependent on the amount of sulfur dioxide emitted from Kīlauea Volcano, the distance downwind, and the wind direction and speed on a given day. Minor levels of air pollution also come from urban uses including traffic and other nearby industrial activities.

Neither the Project Site nor any surrounding areas are mentioned in the County of Hawai‘i General Plan as being notable for their natural beauty (County of Hawai‘i 2005). The nearest site is the White Sands Beach which is located on the coast approximately 2.6 miles northwest of the Project and is not visible from the Project Site.

Impacts and Mitigation Measures

Short term direct and indirect impacts on air quality could potentially occur due to Project construction, principally through fugitive dust from vehicle movement and soil excavation, and exhaust emissions from onsite construction equipment. Adequate fugitive dust control can typically be accomplished by the establishment of a frequent watering program to keep bare dirt surfaces in construction areas from becoming significant sources of dust. In dust prone or dust sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Onsite mobile and stationary construction equipment also would emit air pollutants from engine exhausts, but no sensitive receptors are present. The contractor will be required to prepare a dust control plan during construction compliant with provisions of HAR, Chapter 11-60.1, “Air Pollution Control,” and Section 11-60.1-33, “Fugitive Dust.”

Also, the Proposed Project includes proposed landscaping on the Proposed Project’s parcel; therefore, impacts to scenic resources are not expected to occur.

Under the No Action Alternative, the Proposed Project would not be constructed and the site would remain unchanged from current conditions. There would be no additional impacts to air quality or scenic resources from this alternative.

Cumulative Impacts

Since there are only minimal impacts from the Proposed Project, any potential cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions to air quality or scenic resources would be minor.

3.3.7 Hazardous Materials and Wastes

Existing Environment

Based on the known land uses of the Project Site for agricultural and livestock grazing and since the Project Site has not been previously developed or used for industrial purposes, no hazardous materials or waste are expected to be present.

Additionally, no hazardous or solid wastes were noted by the field inspections completed for the Project.

State databases did not indicate any Underground Storage Tanks (USTs), Leaking Underground Storage Tanks (LUSTs), or records of incidents or releases on the Project Site or in surrounding properties (https://eha-cloud.doh.hawaii.gov/iheer/#!/viewer, accessed December 2019).

Impacts and Mitigation Measures

Previous land use and informal review has shown that is unlikely that any potentially hazardous, toxic, or radioactive waste would be found on the Project Site. Reasonable precautions would be undertaken in the context of the Project construction Best Management Practices to include provisions for the appropriate reporting to the State and readiness for response and remediation should any such hazardous, toxic, or radioactive material be encountered during the construction phase of the Project.

Construction equipment would use fossil fuels, and hydraulic power would be used in grading and construction. There a possibility of leaks, spills, or accidents during construction and during occupation of the development by residents (from an accidental vehicle leak). The construction contractors will be required to develop and maintain an emergency action plan for management and recovery of any release of petroleum or hazardous materials to the environment. Onsite stormwater treatment would minimize impacts from spills during when the Project Site is occupied by residents.

No impacts to hazardous materials or waste are expected from the No Action Alternative.

Cumulative Impacts

Since there are minimal potential impacts from the Proposed Project, there are no anticipated cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions to hazardous materials or wastes.

3.4 Socioeconomics

Population as measured in the 2010 U.S. Census (the most recent U.S. census) for North Kona, a Census County Division (CCD), was 18,642 (U.S. Census Bureau 2010a). Table 3 provides information on the socioeconomic characteristics of the State of Hawai‘i, the County of Hawai‘i, and North Kona CCD, from the U.S. Census Bureau.

Table 3 Selected Socioeconomic Characteristics

Description	State of Hawai'i	County of Hawai'i	North Kona CCD
Total Population	1,360,301	185,079	37,875
Median age (years)	37.2	40.9	41.4
Total housing units	519,508	82,324	18,642
Median Household Income[2]	$71,977	$53,936	$65,682*
Individuals below poverty level[2]	10.8%	18.7%	13.7%*
Race and Hispanic Origin			
White alone	24.7%	33.7%	45.6%
Black or African American	1.6%	0.6%	0.5%
American Indian or Alaska Native	0.3%	0.5%	0.5%
Asian alone	38.6%	22.2%	15.3%
Native Hawaiian	5.9%	8.5%	11.2%
Two or More Races	23.6%	29.5%	23.8%
Hispanic or Latino (of any race)	8.9%	11.6%	11.3%

Source: U.S. Census Bureau 2010a, 2010b, and 2010c
[2]Source: U.S. Census Bureau 2016
*Estimates for CCDs have a high margin of error due to small population and sample size.

The County of Hawai'i's population in the 2010 census was 185,079, an increase of 24 percent from 2000. The population of the North Kona District increased from 28,543 in 2000 to 37,875 in 2010, representing a 33 percent increase. In South Kohala the population increased from 13,131 in 2000 to 17,627 in 2010 which is a 34 percent increase. This rate of population growth is significantly higher than the rate of growth for the state which was only 12 percent over the same period and the County of Hawai'i which was 25 percent. The combined population of the two districts was 55,502 in 2010 which amounted to 30 percent of the island-wide population (U.S. Census Bureau 2010a, 2010b, 2010c).

According to the latest Housing Planning Study, in recent years building has focused on units that are not available for Hawai'i families (SMS 2019). "In spite of continuing moderate growth of subdivision activity and housing construction in the North Kona district, housing problems for the low and moderate income groups have been particularly acute." Residents, including families, compete with the visitor market for the rental of apartment and condominium units. The General Plan anticipated in 2005 that the in-migration to the district would continue as would the need for housing for residents. The Draft General Plan 2040 predicts that over the next 25 years the population in Hawai'i County will grow roughly 50 percent, and identifies that housing is a burden for more than 50 percent of households (County of Hawai'i 2019).

Lastly, the high cost of housing is reflected in the number of households that are crowded (two or more persons/bedroom), doubled up, or both. In the North Hawai'i District, 17.3 percent of the 10,203 households are crowded, doubled up

or both while 14.6 percent of the 14,184 North Kona households were in the same category. As such, there are 3,836 households in North Hawai'i and North Kona living in crowded conditions or are doubled up (OHCD 2019). This is a trend that has been increasing since 2003 (SMS 2019).

As discussed in Section 3.10.2, the Proposed Project conforms with all land use designations.

Impacts and Mitigation Measures

The Proposed Project would provide 450 mid-market Rental units and For Sale units. These units are much needed in the area of North Kona as identified in the 2005 General Plan and Draft 2040 General Plan (County of Hawai'i 2005 2019). Occupants for the development would either come from on-island residents (i.e., existing overcrowded or doubled-up households) or new residents to the island.

The Proposed Project would address a portion of this demand.

The Proposed Project would generate work for the local construction industry, which would stimulate local economic spending. The Proposed Project would provide infill mid-market housing in the urban area and allow resident households better access and the ability to safely manage commutes between home, work, and recreation. Stable households lead to stable communities and associated [mid-market], and promotes a functional economy. The Project would also increase demand for services from residents both during construction (transportation and trade services) and during occupancy (infrastructure, school, utilities, government) (see Section 3.7). Revenues of local government can increase as a result of a housing development project, at first from building fees, taxes on construction workers' wages, and taxes on sale and transport of building materials and then in the long term from property taxes and mortgage and deed transfer taxes (Housing Assistance Council 2019).

Under the No Action Alternative, the site would remain unchanged from current conditions and the mid-market housing development Project would not be constructed.

Cumulative Impacts

Since there are no impacts from the Proposed Project, there are no anticipated cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions to socioeconomics. The Proposed Project does not require any changes to land use designations and would not cumulatively affect land use because it is consistent with community plans.

3.5 Cultural Practices and Sites

The following text are excerpts quoted from the Cultural Impact Assessment (CIA) prepared for the Project Site (Appendix 4).

The Project Site is in Hōlualoa 1st Ahupua'a within the area of *Kona kai'ōpua in Kona 'ākau*. Hōlualoa literally means "long sled course," and Hōlualoa 1st is a traditional *ahupua'a* stretching from the ocean to the foot of Hualālai in the uplands.

Very little is recorded of Hōlualoa Ahupua'a in traditional oral accounts. *The Heart Stirring Legend of Ka-Miki*, published in the Hawaiian language newspaper *Ka Hoku o Hawaii* contains the only description of Hōlualoa. The legend is set in the 13th century but also reflects more recent influences. According to the narrative,

> The lands of Hōlualoa were named for the chief of that name; both Hōlualoa and Puapua'a were high chiefs, who controlled the lands from mountain to sea, which bear their names... Kaluaokalani served as a priest of Hōlualoa at the temple of Pākiha. This heiau was near the contest field of Hōlualoa... The lands of this region are named for various ali'i, all of whom were related. When the chief Hōlualoa took up the challenge against Kepaka'ili'ula on behalf of the Kona chiefs, Hōlualoa called upon his god Kālaipāhoa to assist him in his battle... Hōlualoa was the first chief to call upon the god Kālaipāhoa, and this was the beginning of this god's use by the chiefs of Hawai'i.

Pre-Contact Era

Hōlualoa, Kona, and much of the leeward side of Hawai'i Island, while well populated at the time of European Contact, were settled later than the windward side. This in part may be due to the fertile land, numerous streams, and abundant rainfall on the windward side. Many archaeologists believe that Hawai'i Island was first settled around A.D. 1,000 by people sailing from the Marquesas.

During early settlement of the leeward side permanent habitations were established in Kona concentrated along the shoreline and lowland slopes. Informal fields were cleared at higher elevations where rainfall was higher. Between AD 1200 and 1400, habitation and agriculture expanded across the slopes and coastal area of Hualālai. The initial construction of the Kona Field System (KFS) began approximately between AD 1400 to 1600. The development of these extensive formal walled fields coincides with a dramatic population increase and with the development of the stratified chiefdom structure which is reflected through large residential complexes and heiau. Thus, there was a

need to expand the previously limited agricultural base. The royal centers and larger heiau were in place by AD 1600 to 1800 which reflect the growth in power of the rulers and chiefs in the region. Royal centers are located at Kailua, Hōlualoa, Kahalu'u, Kealakekua, and Hōnaunau.

The region of Hōlualoa developed into a royal center in the late 1600s to early 1700s under the reigns of Keakamahana (reigned 1680-1700) and Keakealaniwahine (reigned 1700-1720). Many 'ali'i and konohiki residences and numerous religious sites are known to have existed in this region. The majority of the heiau and royal residences were constructed along or near the coast, most notably at Kamoa Point south of the project area. The royal center at Hōlualoa was eclipsed in the second half of the 1700s by the royal center in the Kahalu'u and Keauhou region.

The Kona Field System

The Kona Field System extends north at least to Kau Ahupua'a and south to Hōnaunau, west from the coastline and east to the forested slopes of Hualālai. During his travels in 1823, William Ellis noted the extensive field system divided with "low stone walls, made of fragments of lava", producing "bananas, sweet potatoes, mountain taro, tapa trees, melons and sugar cane" and "flourishing luxuriantly in every direction." Many of the archaeological projects conducted within Kona deal with components of the Kona Field System. The kula zone of the Kona Field System is from sea level to 150 m amsl. This zone is associated with habitations along the shoreline and cultivation of sweet potatoes (uala), paper mulberry (wauke), and gourds (ipu). Clearing mounds, planting depressions, planting mounds, planting terraces, and modified outcrops are common agricultural features in the kula zone. Permanent habitation including royal and high chiefly centers as well as non-agricultural activities such as fishing, ceremonies and burial practices were usually concentrated along the shoreline zone portion of the kula zone. The higher elevation zones are the kalu'ulu zone, 'apa'a zone and the 'ama'u zone. The current project area is in the kalu'ulu zone. This wetter region is above 150 m amsl where bread fruit, sweet potatoes (*Ipomoea batatas*), ki (*Cordyline fruticosa*) wauke (*Broussonetia papyrifera*), karo (*Colocasia esculenta*), sugar cane (*Saccharum* sp.), and other arboreal crops were grown. The 'apa'a zone is above the kalu'ulu zone. Hawaiians cultivated melons, sweet potatoes, ti, bananas, taro, wauke and sugar cane in fields with low stone walls. The highest zone, the 'ama'u zone, was used to grow bananas and plantains in walled fields. The 'apa'a zone and the 'ama'u zone were also used to collect timber and catch birds therefore temporary habitations were constructed.

Post-Contact Era

During the post-contact era, the Kona Field System was exploited and the planting of coffee, sugar, sisal, citrus, and cotton took over original Hawaiian crops until eventually the land was used for cattle pasture. The first cattle and sheep were brought to the island by Vancouver in 1793 and 1794. Horses, mules, oxen, goats, and donkeys were brought shortly after. Feral cattle, sheep, and goats overran agricultural fields by 1813 to 1815. By 1848, in the Kona District, a Great Wall (the Kuakini Wall) was constructed from Lanihau to ʻŌnouli to keep them away from homes and agricultural areas. Formal cattle ranching began in the Kona region in the mid-1800s.

The Kona landscape evolved rapidly with the turn of the century. The rapid growth of the sugar industry produced the Kona Sugar Company in 1899. A railroad was built in 1901 to help sustain this influx in produce. It was later used to haul lumber and freight along with the sugarcane. The rail line was seven miles long and extended from Hōlualoa to Kaʻawaloa. Cotton, tobacco, and sisal were grown in the drier lands below the railroad.

The changing subsistence and trade regimes developed by incoming European and American settlers, as well as other historical factors, caused a depopulation of the coastal areas of Kona. Ranches were established at middle and upper elevations, and farms were established in the uplands where rainfall was higher and the temperatures were cooler. Cattle ranching and clearing for sugar cane and coffee removed many of the endemic species of plants. The suite of vegetation that existed prior to the pre-Contact era were replaced by koa haole (*Leucaena leucocephala*), kiawe (*Prosopis pallida*), and other newly introduced invasive plant species.

Schools, churches, stores, and other businesses were also established in the uplands. During the late 1800s and early 1900s, coastal Kona was no longer the densely populated sociopolitical center it once was. It became a small cluster of houses along the trail from Kailua Bay to Keauhou. Homesteads, ranches, and plantations developed in the uplands during this period as reflected in the pattern of Land Commission Awards (LCA) and Land Grants (LG) recorded during the Māhele.

The project area is just *makai* (west) of most of the land commission awards and is at the same elevation as portions of the land grants in the region. Based on historic documents, the project area and surrounding lands were likely being used for subsistence and commercial agriculture, as well as for cattle pasture from the mid to late 1800s. The project area might have been used later than surrounding lands because of its steep slopes and very rocky soil, but based on

aerial photographs, the project area was bulldozed sometime around the 1950s through the 1970s in preparation for commercial agriculture.

The Māhele

The Land Commission awarded the majority of Hōlualoa 1st and 2nd Ahupua'a to Victoria Kamāmalu Ka'ahumanu IV, Kuhina Nui of Hawai'i Island and Crown Princess of Hawai'i as Land Commission Award (LCA) Number 7713, 'Apana 43. Several smaller LCA and LG properties were also recorded in the upland region of Hōlualoa 1st and 2nd Ahupua'a. Twenty four Land Commission awards were recorded in Hōlualoa 1st Ahupua'a, the *ahupua'a* where the project area is located. A portion of LCA #3660 to John G. Munn makes up a thin strip of land located through the center of the current project area. With the notable exception of LCA #3660 and a few other large LCAs, the average award was 2.8 acres, most (n=16) were for less than 3.0 acres. Three Land Grants (LG #1592, 1602, and 3630) were also recorded in Hōlualoa 1st and 2nd Ahupua'a. LG #1592 was a 25.0-acre parcel sold to Kealalio and LG #3630 was a 38.2-acre parcel sold to W.H. Cromwell. Almost all of the awards and grants were used as subsistence and commercial farm land, and some were used to pasture cattle.

Cultural Resources and Practices Related to the Proposed Development

Consultation for the Proposed Project

Gathering input from community members with genealogical ties and longstanding residency relationships to the Project Area is vital to the process of assessing potential cultural impacts to resources, practices, and beliefs. These individuals ascribe meaning and value to traditional resources and practices.

The following text has been quoted from SCS's CIA for the Project (Appendix 4).

> In the case of the present parcel, consultation was sought from Jordan Kea Calpito, SHPD Burial Sites Specialist; Kamakana Ferreira, OHA Compliance Officer; Nicole Lui, cultural descendant, Sean Naleimaile, State Historic Preservation Division (SHPD) Hawai'i Island Archaeologist; Kekoa Nazara, Kona Hawaiian Civic Club President; Shane Nelson, OHA West Hawai'i Representative; and J. Curtis Tyler III, cultural descendant. Consultation was also conducted via telephone with Gregg Kashiwa who served as project property manager for parcels 016 and 017 in the early 1980s.
>
> Public notices were placed in the December 2019 issue of the Office of Hawaiian Affairs (OHA) Ka Wai Ola Newspaper. Public notices were also published in the Honolulu Star-Advertiser, and the West Hawai'i Today on November 17th, 20th and 21st.

> There were no responses to the public notices published in the OHA Ka Wai Ola, West Hawai'i Today or the Honolulu Star-Advertiser newspapers. J. Curtis Tyler III, Nicole Lui and Greg Kashiwa did provide information concerning lands of Hōlualoa 1st Ahupua'a. There were no past or ongoing cultural practices identified with lands of the current project area.

Impacts and Mitigation Measures

The following text has been quoted from SCS's CIA for the Project (Appendix 4).

> An analysis of the potential effect of the proposed construction of residences on cultural resources, practices or beliefs, its potential to isolate cultural resources, practices or beliefs from their setting, and the potential of the project to introduce elements which may alter the setting in which cultural practices take place is a requirement of the OEQC (No. 10, 1997). Based on historical research and responses from the above listed contacts, it is reasonable to conclude that, there would be no traditional cultural practices affected and there would be no direct adverse effect upon cultural practices or beliefs in the broader project area region.

Under the No Action Alternative, no impacts to cultural practices or sites would occur.

Cumulative Impacts

Through on-going consultation, no cultural practices have been identified in the Project Site. Any potential impacts to cultural sites from the Proposed Project would be mitigated; therefore, no cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions are anticipated to cultural practices or sites.

3.6 Historic and Archaeological Resources

An archaeological inventory survey (AIS) was conducted in 1984 for the entire project except for a 5-acre portion in TMK (3) 7-6-021:017 of the project site (CSH 1984). In a letter to the County of Hawai'i Planning Department dated July 30, 2018, (Log. No. 2018.00878 Doc. No. 1807SN01), the SHPD requested a new pedestrian survey to identify all archaeological historic properties present in the Project Site and an update of the previous archaeological documentation to include site plans for each site with site boundaries and areas impacted by bulldozing, photographs of all sites and features, an assessment of their integrity, and site significance.

Kona Three contracted with SCS to conduct an inventory on 76.1 acres to update the original 1984 area and a second archaeological inventory was conducted on the 5-acre portion that had been previously excluded. Based on an interview with a local resident, the five-acre section of the project area was excluded from the original AIS because the property owners were planning to give the five acres to a group to use as a school. The two most current AISs are included in Appendix 5, and the results are summarized below.

Existing Resources

In the AIS for the 76.121-acre portion of the project site, 18 archaeological sites were identified and recorded. Fifteen of the sites were previously documented in the 1984 AIS and three sites were previously unrecorded and included a small coffee shed enclosure (Site TS-1), several ranch walls (Site TS-2), and a possible petroglyph (Isolated Find-1). The Draft AIS was submitted in March 2020.

Six of the 18 sites recorded were determined to be pre-Contact era, three associated with habitation, one with agriculture, a single petroglyph site, and one single feature site (Site 10012) contained two burials. The remaining 12 sites were determined to be historic era, with many of the sites associated with coffee agriculture and cattle ranching, as well as two historic era habitation sites. The following text is from the AIS submitted in 2020 for the 76.121-acre portion of the Project Site (Appendix 5).

> All of the archaeological sites were assessed significant under criterion "d" as they are likely to yield information important to prehistory and/or history. The railroad berm Site 30592 is also significant under criteria "a" and "c" as it is associated with events that have made a significant contribution to the broad patterns of our history and it embodies distinctive characteristics of the type, period, and method of railroad bed construction. A petroglyph (Isolated Find-1) is also significant criterion "e" as it has important value to Hawaiian people and people of other ethnic backgrounds in the state.
>
> The railroad berm Site 30592 and the petroglyph were recommended for preservation with preservation measures to be outlined in an archaeological Preservation Plan. The petroglyph (Site TS-1) is recommended for preservation in a safe location on the project area. No further work was recommended at the remaining 16 sites.

Site 10012, a pre-Contact site described in the 1984 AIS, included two burials. The burials were removed and reinterred off-project prior to 1984. The site was further excavated to ensure that all *iwi* had been removed. The site was then back-filled and leveled by bulldozer.

In the AIS for the 5.0-acre portion of the project site, 22 newly identified archaeological sites were recorded. The AIS was accepted by SHPD (Log No. 2018.01123, Doc. No. 1805SN05). The following text is from the AIS prepared for the 5.0-acre portion (Appendix 5).

> The sites are primarily agricultural terraces associated with pre-Contact era to Historic era agriculture. Several rock walls and enclosures are associated with Historic era agriculture and ranching. A pre-Contact era to later post-Contact era lava tube burial and a portion of the old railroad berm were also recorded.
>
> All 22 sites identified during the current AIS study were assessed significant under criterion "d" as they are likely to yield information important to history. The railroad berm is also significant under criteria "a" and "c" as it is associated with events that have made a significant contribution to the broad patterns of our history and it embodies distinctive characteristics of the type, period, and method of railroad bed construction. The burial is also significant criterion "e" as it has important value to Hawaiian people and people of other ethnic backgrounds in the state. The burial is recommended for preservation in place with preservation treatments to be outlined in a Burial Site Component of a Preservation Plan (BSCPP), which has been completed and approved. The railroad berm is recommended for preservation with preservation measures to be outlined in an archaeological preservation plan now under review by SHPD.

Impacts and Mitigation

The preservation of the railroad berm (Site 30592) and petroglyph (IF-1) with a Preservation Plan would prevent impacts to archaeological resources from the Project (Appendix 6). The Preservation Plan was drafted in February 2019 for the railroad berm, and revised in March 2020 to include preservation of the petroglyph which was located in the subsequent AIS.

The Preservation Plan outlines short-term and long-term preservation measures for the railroad berm, as well as archaeological monitoring during construction. During construction, a 20-foot buffer from the western perimeter of the berm would be established with orange fencing. An archaeological monitor would be required for any construction work using earthmoving equipment in close proximity to the buffer. No construction activities would take place between the railroad berm and the eastern property boundary except for the breaches allowed for access as outlined in the Preservation Plan. Any construction within 30 feet of the railroad bed and berm would be monitored by an archaeological monitor. A permanent preservation buffer would be established twenty feet from

the western perimeter of Site 30592, excluding the approved breaches. Native ornamental plants may be used to mark the 20-foot preservation buffer, excluding the breaches. No use of heavy earthmoving equipment would be allowed within the twenty foot buffer. Hand-tools only would be permitted within the twenty-foot permanent preservation buffer, excluding the breaches.

Kona Three is responsible for keeping the easement clear and open, and ensuring pedestrian access to the site. Parking is available on ‘Io Place. Access would be permitted seven days a week, one-half hour before sunrise to one-half hour after sunset. Signage would also be placed at the railroad bed at the end of ‘Io Place.

Under the No Action Alternative, no impacts to historic or archaeological resources would occur.

Cumulative Impacts

Following implementation of an archaeological preservation plan, there are not expected to be any impacts to historic or archaeological resources from the Project; therefore, no cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions are anticipated to historic or archaeological resources.

3.7 Infrastructure

3.7.1 Utilities and Public Services including Wastewater Treatment and Solid Waste Management

Existing Facilities and Services

The Project would also increase demand for services from residents during construction and occupancy including utilities, services, infrastructure, school, and government. Electrical power to the Project Site would be supplied by Hawai‘i Electric Light Company. Telephone and data service are available from both Spectrum and Hawaiian Telephone. Wastewater would be disposed of through a tie-in with the County sewer system.

During Project operation, solid waste would be hauled off site by a private contractor on a regular basis to a solid waste management facility in compliance with the applicable provisions (HAR, Chapter 11-58.1, “Solid Waste Management Control”). No burning of wastes would occur on site during construction or during operation of the Proposed Project.

Fire, police, and emergency management services are available in this part of North Kona. A police station is located in Kona, about five miles north of the Project Site. The Kailua Fire Station is located approximately 3.5 miles northeast of

the Project Site. Emergency medical services are provided by the Hawai‘i County Fire Department. Emergency medical services are available at Kona Community Hospital, approximately 7.5 miles to the south.

Kahakai and Holualoa Elementary Schools are the nearest public elementary schools to the Proposed Project, approximately 1.2 miles west and 1 mile east, respectively, of the Project Site. In a Final EA prepared for a new classroom building for Kealakehe Elementary School in 2018, the Department of Education (DOE) projected the school could see a growth of approximately 33 students from 2015 to 2021 at the nearby Kealakehe Elementary School (DOE 2018). It is reasonable that the same level of growth could be assumed for Kahakai and Holualoa Elementary Schools. With a current student population of 749 students at Kahakai (DOE 2019a) and 519 students at Holualoa Elementary (DOE 2019b), this would be a three percent increase over a six-year period.

Kealakehe Intermediate School is the nearest intermediate school, located approximately 3.2 miles north of the Project Site. Konawaena High and Kealakehe High School are the nearest public high schools, located approximately 7.9 miles south and 2.8 miles north, respectively, of the Project Site. Current student populations at the Intermediate school is 689 (DOE 2019c). There are currently 1,374 students at Kealakehe High School and 831 students at Konawaena High School (DOE 2019d and 2019e). According to a letter received during early consultation, Konawaena Intermediate has capacity for additional students for the next five years, and the remaining schools are currently over capacity and expected to remain over capacity for the next five years (Appendix 1).

Additionally, Hawai‘i Community College – Pālamanui campus and the University of Hawai‘i Center, West Hawai‘i, are located approximately 10 miles north of the Project Site. The nearest private schools are Makua Lani Christian Academy approximately 9 miles north of the Project Site, and West Hawaii Explorations Academy Public Charter School is approximately 8 miles northwest of the Project Site.

The Proposed Project is designed to serve the demand of the existing mid-market population of North Kona, which as described in the socioeconomics section consists of households that are currently overcrowded or doubled-up in market rate rentals.

Impacts and Mitigation Measures

Electricity and telephone/data service would be extended from existing lines. There could be minimal impacts from solid waste generated from construction. However, these would be hauled off-site. Since the development is approximately

450 units, the Project would result in moderate impacts to the county solid waste disposal system if occupancy is at 100 percent. Trash from all parts of Hawaii Island are trucked north of Kona to the Pu'uanahulu landfill, which has anywhere from 20 to 100 years capacity (HPR 2020).

The Project is expected to serve the existing demand for mid-market housing for on-island residents.

According to a comment letter received on the Draft EA from the Department of Education, the Project is expected to house approximately 99 HIDOE students. Although the Proposed Project is located within the West Hawaii School Impact Fee District, the DOE has currently suspended fee collections. Kona Three would coordinate with DOE and comply with all applicable DOE requirements at the time of Project implementation.

Although this may result in a shift or addition of approximately 99 students potentially from other on-island or North Kona DOE schools, the Proposed Project would provide much-needed housing for residents including families. The net of impact of the Project to the mid-market community in general is expected to be positive compared to the impacts to facilities.

Under the No Action Alternative, the Proposed Project would not be constructed and the site would remain unchanged from current conditions and no utilities would be needed and no solid waste from the Proposed Project would be generated.

Cumulative Impacts

Existing utilities and public services have and plan for the capacity to accommodate developments such as the Proposed Project, therefore, cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions are expected to be minor.

3.7.2 Traffic

Existing and Proposed Facilities

The concept of level-of-service (LOS) is often used to describe the quality of traffic flow. There are six levels-of-service, A through F, which relate to the driving conditions from best to worst, respectively. In general, LOS A represents free-flow conditions with no congestion. LOS F, on the other hand, represents severe congestion with stop-and-go conditions. LOS D is typically considered acceptable for peak hour conditions in urban areas. LOS is usually applied to peak hour traffic, which is the "worst-case" scenario.

A traffic study for the Proposed Project conducted by SSFM International included analysis at eight existing intersections on Queen Ka'ahumanu Highway (Appendix 2). Five intersections were analyzed north of the Project Site: 1) Palani Road, 2) Henry Street, 3) Hualalai Road (North), 4) Hualalai Road (South), and 5) Puapuaanui Street. Three additional intersections south of the Project Site were also analyzed: 6) Kuakini Highway, 7) Lako Street, 8) Kamehameha III Road (Figure 8).

In the vicinity of the Project Site, Queen Ka'ahumanu Highway (Route 19) is undivided, two-lane, State-owned arterial, oriented in the north-south direction. Queen Ka'ahumanu Highway extends from Kawaihae Road (Route 19) in the north to the intersection with Palani Road (Route 130) where it turns into State Route 11. The posted speed limit varies from 45 to 55 miles per hour (mph). Approximately 2.4 miles north of the Project Site, Queen Ka'ahumanu Highway opens to four to five lanes with dedicated left turning and right turning lanes at major intersections.

Turning movement counts were recorded at each of the intersections at peak morning and afternoon traffic hours. The peak hours for the local roadway network were found to be between 7:00am to 8:00am and 3:45 to 4:45pm. Existing LOS were determined for the morning and evening (AM/PM) peak hours at each of the eight intersections. The results are included in the TIAR (Appendix 2).

Impacts and Mitigation

The TIAR calculated the projected increase in background traffic volumes within the local roadway network (without the Proposed Project) in 2024 and 2029 (Appendix 2: Tables 12, 13, 19, and 20). Background traffic volumes are volumes not directly associated with the development proposed. These volumes are comprised of regional volumes using Queen Ka'ahumanu Highway and the rest of the local roadway network to travel past the Proposed Project. A background growth rate of one percent per year was assumed, to account for additional traffic at the intersections.

The TIAR also assessed impacts from the Proposed Project following completion of 258 units in Phase I (2024) and then following completion of 192 units in Phase II (2029) (Appendix 2: Tables 14, 15, 21, and 22). Only one roadway is planned to provide access for Phase I of the Proposed Project. This roadway would intersect with Queen Ka'ahumanu Highway, approximately 600 feet north of the intersection with Kuakini Highway. In the TIAR this Proposed Project access road is referred to as "Royal Vistas Roadway."

The TIAR analyzed impacts of the Proposed Project under the presumption that the Royal Vistas Roadway approach would have a left turn and a right turn lane. Turn lanes for this road would be provided for the southbound left turn and northbound right turn into the Proposed Project. Right turns would be channelized and this intersection was analyzed as a two-way stop-controlled intersection. A crosswalk would be provided on the east side of the intersection for pedestrian connectivity to cross Royal Vistas Roadway. There would be a refuge lane for westbound left turns onto Queen Ka‘ahumanu Highway to make this turn easier for drivers. The expected future lane configuration is shown in Figure 9.

The traffic analysis for Phase I of the Proposed Project indicates the only detectable changes to LOS under the With Project condition would occur at one turn movement. The Hualalai Westbound Right turn at the Queen Ka‘ahumanu Highway and Hualalai Road (South) intersection is predicted to decrease from LOS E to F in morning traffic. Under the Without Project condition, the analysis for 2024 projects a decrease in LOS at both (1) Queen Ka‘ahumanu Highway and Puapuaanui Street intersection (from LOS A to B in the morning and evening) and (2) Queen Ka‘ahumanu Highway and Lako Street intersection (from LOS C to D in the morning). No other turning movement at any other intersection or turn movement within the roadway network is projected (in 2024) to demonstrate a detectable delay increase (Appendix 2).

The traffic analysis for Phase II of the Project indicates the detectable changes to LOS under the With Project condition include: (1) afternoon decrease from LOS C to D in the Hualalai westbound right turn movement at Queen Ka‘ahumanu Highway and Hualalai Road (South) intersection; (2) morning decrease from LOS C to D in the Queen Ka‘ahumanu northbound left turn movement at the Queen Ka‘ahumanu Highway and Kuakini Highway intersection; and morning decrease from LOS B to C at the Queen Ka‘ahumanu Highway/Kamehameha III Road intersection. Under the Without Project condition, the analysis for 2029 projects a decrease in LOS at the following: (1) afternoon decrease from LOS C to D at the Queen Ka‘ahumanu Highway and Henry Street intersection; (2) morning decrease from LOS E to F at Hualalai westbound right turn at the Queen Ka‘ahumanu Highway and Hualalai Road (South) intersection; and (3) morning decrease from LOS C to D at Queen Ka‘ahumanu Highway and Lako Street intersection (Appendix 2).

The traffic analysis indicates that only one intersection and two turn movements would experience decreased LOS under the With Project condition, and many vehicle trip delay issues are unrelated to the Proposed Project (i.e., they would occur even if the Project did not proceed) (Appendix 2).

Figure 8 Local Intersections Studied for the Project

Legend

Project Site

Stantec

0 1,500 3,000 Feet 1 in = 3,000 feet

Kona, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: CJ | 1ST REVIEW: JT | 2ND REVIEW: ML

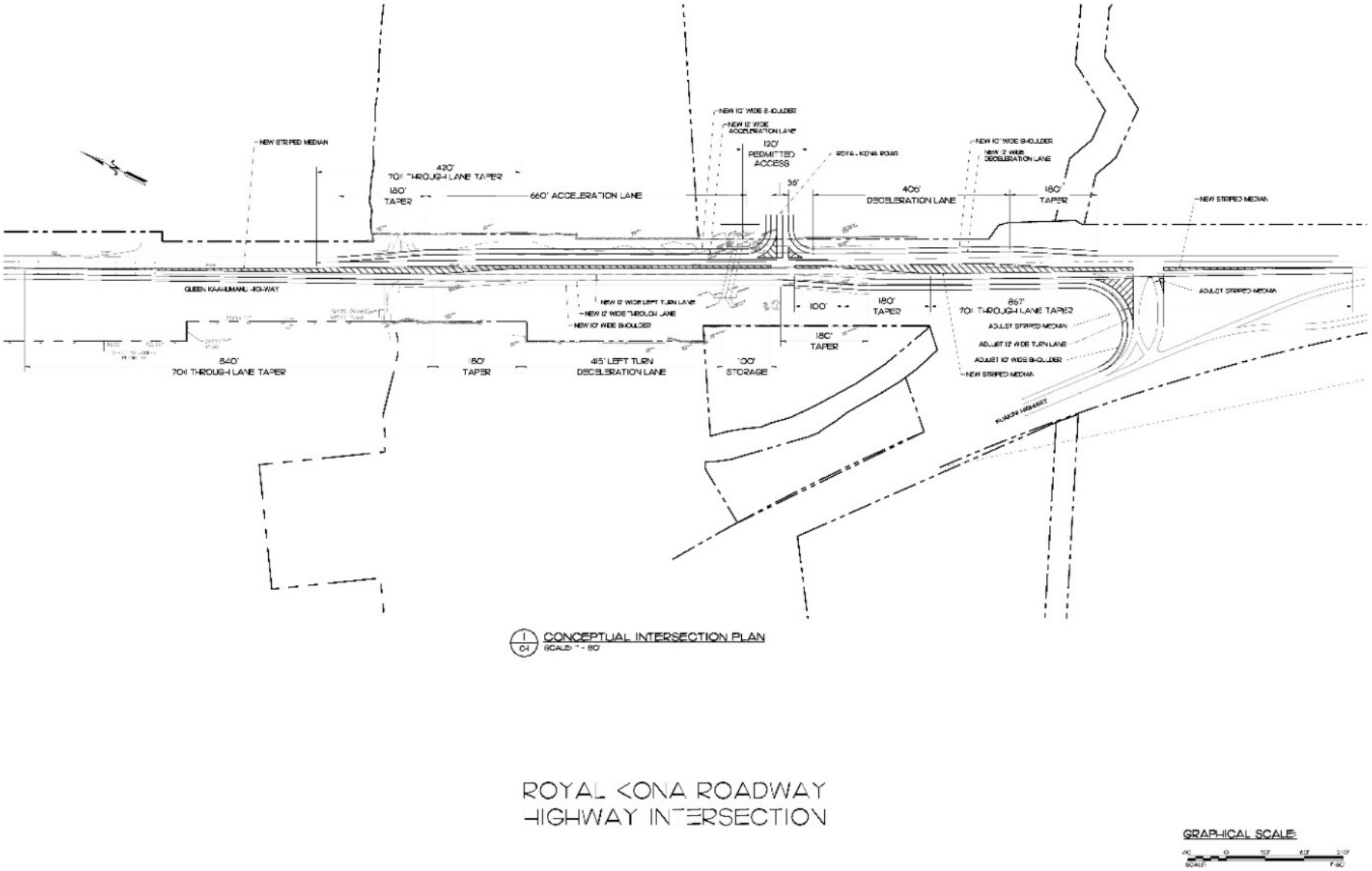
DATE: 5/19/2020 | PROJECT NO: 185804638

Kona Three LLC
Royal VIstas Development Project

Figure 8
Local Intersections Studied for the Project

Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data. The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.

Figure 9 Proposed Improvements to Project Intersection with Queen Ka‘ahumanu



The Kona CDP includes the official Transportation Network Map – Nani Kailua Area and shows future connections of 'minor collectors' running parallel to Queen Ka'ahumanu Highway in the location of the Proposed Project, extending Hoomama Street to Leilani Street and Paulehia Street to Kekuana'oa Place (Figure 10). While the exact timing of these improvements is unknown, it is not expected they would be completed prior to Phase I (i.e., in 2024). The most likely scenario is that the developers of Royal Vistas would construct a collector road to the south before the completion of Phase II.

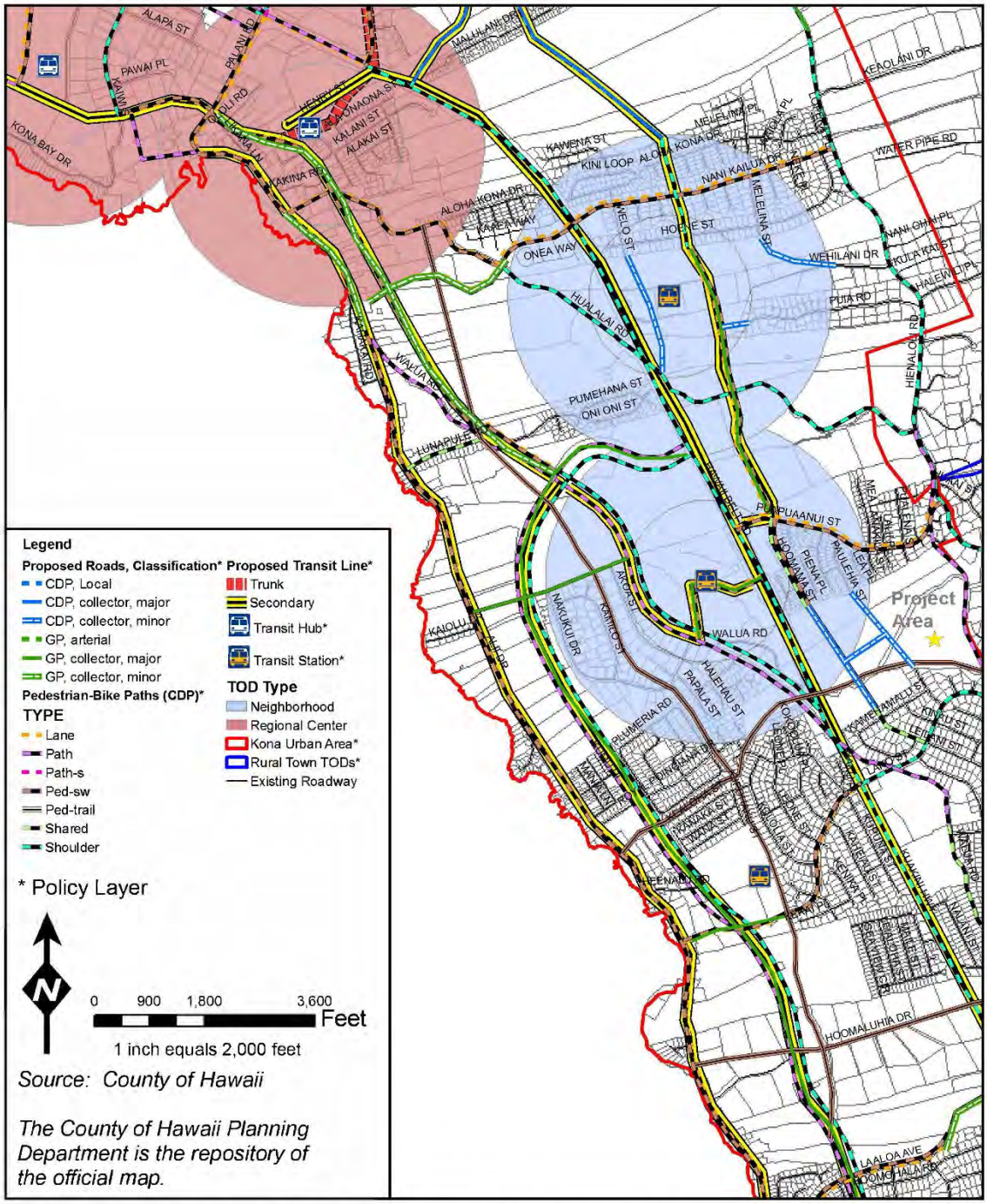
The connection of these roads north to the Pualani Estates subdivision is not proposed for this Project, since these roads cross TMK (3) 7-6-013:004 which is owned by the Frank and Betty Gomes Trust (Figure 1). In addition, the traffic impact analysis shows no impacts to LOS from the Project above the background rate at the intersection of Queen Ka'ahumanu Highway and Puapuaanui Street which is the main entrance to Pualani Estates subdivision.

Potential impacts to the Kona Vistas subdivision would be alleviated by constructing the Royal Vistas Roadway intersection with Queen Ka'ahumanu Highway. Also, the traffic impact analysis shows no impacts to LOS from the Project above the background rate to the intersection of Queen Ka'ahumanu Highway and Lako Street which is the main entrance to the neighboring Kona Vistas subdivision.

As shown on Figure 2 and explained under Roads in the Project description (Section 1.3), one existing County-owned road would be extended (Kekuana'oa Street), the Leilani Street extension would be constructed and stubbed-out on the south end of the Project Site at the Calvary Church property between the Project and Kona Vistas, and one new road would be constructed (Royal Vistas Roadway). All would be dedicated to the County as part of the Proposed Project. While Figure 10 from the Kona CDP shows connector roads connecting County-owned Leilani Street (in the Kona Vistas project) to County-owned Ho'omama Street (in the Pualani Estates project) and Kekuana'oa Street (in the Kona Vistas project) to County-owned Paulehia Street (in the Pualani Estates project), these connections would not be built as part of the Proposed Project. Additionally, no *mauka-makai* connector roads from Hualalai Road to Queen Ka'ahumanu Highway are proposed as part of the Proposed Project. Therefore, the Proposed Project would have no effect to neighbors in adjacent subdivisions from Phase I, and only minimal impacts after Phase II.

Additionally, any work that is conducted within the County Right-of-Way would conform to Chapter 22 – County Streets – of the Hawai'i County Code.

Figure 10 CDP Transportation Network Map in the Vicinity of the Project



Kona Community Development Plan, Figure 4-2d Official Transportation Network Map - Nani Kailua Area

Figure 10: CDP Transportation Network Map in the Vicinity of the Project Area

Under the No Action Alternative, the Proposed Project would not be constructed, and the site would remain unchanged from current conditions and LOS are predicted to decline in 2024 and 2029 as shown in the Without Project tables in Appendix 2.

Cumulative Impacts

The predicted impacts from past, present, and reasonably foreseeable future projects are estimated for 2024 and 2029 in Appendix 2. The predicted cumulative impacts of the Proposed Project in addition to past, present, and reasonably foreseeable future actions are estimated in the With Project projections in Appendix 2. As stated above, the traffic analysis indicates the only detectable changes to LOS in the With Project condition in 2024 and 2029 would occur at one intersection and two turn movements, and other predicted delays are not predicted as a result of the Project.

Based on existing traffic volumes and future projections of traffic from Royal Vistas on the surrounding roadways, the following system-wide intersection improvements are recommended in the TIAR (Appendix 2) for ongoing consideration by Hawaii County and the Hawaii Department of Transportation (HDOT):

1. Queen Ka'ahumanu Highway and Palani Road: monitor and update signal timing to ensure left turn queues clear every cycle.
2. Queen Ka'ahumanu Highway and Henry Street: monitor and update signal timing to ensure left turn queues clear every cycle, consider changing the split phasing at Henry Street to protected left turn phases to lower overall delay.
3. Queen Ka'ahumanu Highway and Hualalai Road (North): depending on monitoring, a traffic signal or roundabout may need to be installed but priority should be given to keep Queen K Highway traffic moving.
4. Queen Ka'ahumanu Highway and Hualalai Road (South): monitor future traffic.
5. Queen Ka'ahumanu Highway and Puapuaanui Street: monitor and update signal timing to increase traffic clearing the Queen Ka'ahumanu intersection in one cycle.
6. Queen Ka'ahumanu Highway and Kuakini Highway: depending on monitoring, a traffic signal or roundabout may need to be installed.
7. Queen Ka'ahumanu Highway and Lako Street: consider changing the phasing from split to protected left turns to help lower the predicted delay. This intersection would also improve significantly if Queen Ka'ahumanu Highway is widened to four lanes as in the 2035 Transportation Plan.

8. Queen Ka‘ahumanu Highway and Kamehameha III Road: monitor and update signal timing as needed.

3.8 Irreversible and Irretrievable Commitments of Resources

A commitment of resources is irreversible when primary or secondary impacts limit the future options for a resource; an irretrievable commitment refers to the use or consumption of resources that are neither renewable nor recoverable for future use.

All the land to be used by the Proposed Project is in a State Land Use Urban District and, therefore, has been characterized by “city-like” concentrations of people, structures and services. This District also includes vacant areas for future development. No new land would be irreversibly and irretrievably committed as a result of the Proposed Project.

The Proposed Project would require the commitment of natural, physical, and human resources to plan, design, construct, and operate. Diesel fuel to power equipment would be used during Proposed Project construction and building materials, such as concrete and asphalt, would be consumed. Some of those materials could ultimately be recycled for reuse, those that are not would be expended.

3.9 Unavoidable Adverse Impacts

No unavoidable adverse impacts from the Proposed Project are anticipated.

3.10 Unresolved Issues

As stated in Section 3.3.2, the Project does not propose to impact the existing flows within the Horseshoe or Holualoa Drainageways. Kona Three will continue working with the County to alleviate the flooding issues caused by the lack of culverts in the *makai* Kuakini Highway; however, these issues would not be exacerbated by the Project. The final design of the improvement projects for the Horseshoe Bend and Holualoa Drainages would be developed by Kona Three in coordination with the County of Hawai‘i DPW. Completion of the drainage system improvements is required prior to the issuance of a certificate of occupancy for the Project.

3.11 Required Permits and Approvals

The Proposed Project requires granting the following permits and approvals, which are listed by responsible agency:

- County of Hawai‘i, Department of Public Works, Building Division Approval and Building Permit
- County of Hawai‘i, Department of Public Works, Engineering Division, Grading Permit
- County of Hawai‘i, Department of Public Works, Engineering Division, Drainage Plan
- County of Hawai‘i, Planning Department Plan Approval
- State Department of Health, National Pollutant Discharge Elimination System Permit
- State Historic Preservation Division, Chapter 6e Historic Sites Clearance
- State Department of Transportation – Highways Division, Permit to Perform Work in State ROW
- County Council – Approval of Amendments to Zoning Ordinance

3.12 Consistency with Government Plans and Policies

3.12.1 Hawai‘i State Land Use Law, Hawai‘i State Plan, and State Housing Functional Plan

The subject parcels are designated as Urban by the State Land Use Commission, and State Land Use Commission Docket No. A83-549 determined the status of condition compliance for these land use entitlements.

The Hawaii State Plan (Hawaii Revised Statutes, Chapter 226, as amended) establishes a set of themes, goals, objectives and policies that are meant to guide the State's long-run growth and development activities. The three themes that express the basic purpose of the Hawai‘i State Plan are individual and family self-sufficiency, social and economic mobility, and community or social well-being. The Proposed Project would provide much needed mid-market housing to residents of North Kona.

The Proposed Project is consistent with the State Plan objectives and policies related to housing and facility systems as cited below:

Ch. 226-4 State goals. In order to ensure, for present and future generations, those elements of choice and mobility that ensure that individuals and groups may approach their desired levels of self-reliance and self-determination, it shall be the goal of the State to achieve:

(1) A strong, viable economy, characterized by stability, diversity, and growth, that enables the fulfillment of the needs and expectations of Hawaii's present and future generations.

(2) A desired physical environment, characterized by beauty, cleanliness, quiet, stable natural systems, and uniqueness, that enhances the mental and physical well-being of the people.

(3) Physical, social, and economic well-being, for individuals and families in Hawaii, that nourishes a sense of community responsibility, of caring, and of participation in community life.

The Proposed Project would meet this goal by providing choices for mid-market/workforce families in North Kona to rent or buy homes in communities near their work.

Ch. 226-5 Objective and policies for population.

(a) It shall be the objective in planning for the State's population to guide population growth to be consistent with the achievement of physical, economic, and social objectives contained in this chapter.

(b) To achieve the population objective, it shall be the policy of this State to:

(1) Manage population growth statewide in a manner that provides increased opportunities for Hawaii's people to pursue their physical, social, and economic aspirations while recognizing the unique needs of each county.

(2) Encourage an increase in economic activities and employment opportunities on the neighbor islands consistent with community needs and desires.

(3) Promote increased opportunities for Hawaii's people to pursue their socio-economic aspirations throughout the islands.

(4) Encourage research activities and public awareness programs to foster an understanding of Hawaii's limited capacity to accommodate population needs and to address concerns resulting from an increase in Hawaii's population.

(5) Encourage federal actions and coordination among major governmental agencies to promote a more balanced distribution of immigrants among the states, provided that such actions do not prevent the reunion of immediate family members.

(6) Pursue an increase in federal assistance for states with a greater proportion of foreign immigrants relative to their state's population.

(7) Plan the development and availability of land and water resources in a coordinated manner so as to provide for the desired levels of growth in each geographic area.

By providing mid-market housing to those that need it, the Proposed Project would promote increased opportunities for local residents to pursue their socio-economic aspirations.

Ch. 226-13 Objectives and policies for the physical environment--land, air, and water quality.

(a) Planning for the State's physical environment with regard to land, air, and water quality shall be directed towards achievement of the following objectives:

(1) Maintenance and pursuit of improved quality in Hawaii's land, air, and water resources.

(2) Greater public awareness and appreciation of Hawaii's environmental resources.

(b) To achieve the land, air, and water quality objectives, it shall be the policy of this State to:

(1) Foster educational activities that promote a better understanding of Hawaii's limited environmental resources.

(2) Promote the proper management of Hawaii's land and water resources.

(3) Promote effective measures to achieve desired quality in Hawaii's surface, ground, and coastal waters.

(4) Encourage actions to maintain or improve aural and air quality levels to enhance the health and well-being of Hawaii's people.

(5) Reduce the threat to life and property from erosion, flooding, tsunamis, hurricanes, earthquakes, volcanic eruptions, and other natural or man-induced hazards and disasters.

(6) Encourage design and construction practices that enhance the physical qualities of Hawaii's communities.

(7) Encourage urban developments in close proximity to existing services and facilities.

(8) Foster recognition of the importance and value of the land, air, and water resources to Hawaii's people, their cultures and visitors.

The Proposed Project has been designed to minimize impacts to natural and cultural resources during construction and operation as described in the resource sections above.

Ch. 226-15 Objectives and policies for facility systems--solid and liquid wastes.

(a) Planning for the State's facility systems with regard to solid and liquid wastes shall be directed towards the achievement of the following objectives:

(1) Maintenance of basic public health and sanitation standards relating to treatment and disposal of solid and liquid wastes.

(2) Provision of adequate sewerage facilities for physical and economic activities that alleviate problems in housing, employment, mobility, and other areas.

(b) To achieve solid and liquid waste objectives, it shall be the policy of this State to:

(1) Encourage the adequate development of sewerage facilities that complement planned growth.

(2) Promote reuse and recycling to reduce solid and liquid wastes and employ a conservation ethic.

(3) Promote research to develop more efficient and economical treatment and disposal of solid and liquid wastes.

As described in the water quality and water quantity section above, the Proposed Project has been designed to maintain basic public health and sanitation standards by tying with the County sewer service. As the final phase of the larger development, the Proposed Project complements planned growth as part of the authorized 1984 zoning ordinance.

Ch. 226-16 Objective and policies for facility systems – water.

(a) Planning for the State's facility systems with regard to water shall be directed towards achievement of the objective of the provision of water to adequately accommodate domestic, agricultural, commercial, industrial, recreational, and other needs within resource capacities.

(b) To achieve the facility systems water objective, it shall be the policy of this State to:

(1) Coordinate development of land use activities with existing and potential water supply.

(2) Support research and development of alternative methods to meet future water requirements well in advance of anticipated needs.

(3) Reclaim and encourage the productive use of runoff water and wastewater discharges.

(4) Assist in improving the quality, efficiency, service, and storage capabilities of water systems for domestic and agricultural use.

(5) Support water supply services to areas experiencing critical water problems.

(6) Promote water conservation programs and practices in government, private industry, and the general public to help ensure adequate water to meet long-term needs.

As described in the water quality and quantity section above, the Proposed Project would utilize the existing water supply through coordination with DWS and meet that objective. Through water efficient fixtures and xeriscape landscaping, it would meet the water conservation objective.

Ch. 226-19 Objectives and policies for socio-cultural advancement – housing.

(a) Planning for the State's socio-cultural advancement with regard to housing shall be directed toward the achievement of the following objectives:

(1) Greater opportunities for Hawaii's people to secure reasonably priced, safe, sanitary, and livable homes, located in suitable environments that satisfactorily accommodate the needs and desires of families and individual, through collaboration and cooperation between government and nonprofit and for-profit developers to ensure that more affordable housing is made available to extremely low-, very low-, lower-, moderate-, and above moderate-income segments of Hawaii's population.

(2) The orderly development of residential areas sensitive to community needs and other land uses

(3) The development and provision of affordable rental housing by the State to meet the housing needs of Hawaii's people.

(b) To achieve the housing objectives, it shall be the policy of this State to:

(1) Effectively accommodate the housing needs of Hawaii's people.

(2) Stimulate and promote feasible approaches that increase housing choices for low income, moderate-income, and gap-group households.

(3) Increase homeownership and rental opportunities and choices in terms of quality, location, cost, densities, style, and size of housing.

(4) Promote appropriate improvement, rehabilitation, and maintenance of existing housing units and residential areas.

(5) Promote design and location of housing developments taking into account the physical setting, accessibility to public facilities and services, and other concerns of existing communities and surrounding areas.

(6) Facilitate the use of available vacant, developable, and underutilized urban lands for housing.

(7) Foster a variety of lifestyles traditional to Hawaii through the design and maintenance of neighborhoods that reflect the culture and values of the community.

(8) Promote research and development of methods to reduce the cost of housing construction in Hawaii.

The Proposed Project would meet this objective by providing the mid-market/workforce population (a gap-group) housing options to buy or rent in North Kona. The Project Site is zoned for multi-family residential and is an in-fill project on vacant land that is surrounded by residential development and has utilities available.

Ch. 226-104 Population growth and land resources priority guidelines.

(a) Priority guidelines to effect desired statewide growth and distribution:

(1) Encourage planning and resource management to insure that population growth rates throughout the State are consistent with available and planned resource capacities and reflect the needs and desires of Hawaii's people.

(2) Manage a growth rate for Hawaii's economy that will parallel future employment needs for Hawaii's people.

(3) Ensure that adequate support services and facilities are provided to accommodate the desired distribution of future growth throughout the State.

(4) Encourage major state and federal investments and services to promote economic development and private investment to the neighbor islands, as appropriate.

(5) Explore the possibility of making available urban land, low-interest loans, and housing subsidies to encourage the provision of housing to support selective economic and population growth on the neighbor islands.

(6) Seek federal funds and other funding sources outside the State for research, program development, and training to provide future employment opportunities on the neighbor islands.

(7) Support the development of high technology parks on the neighbor islands.

(b) Priority guidelines for regional growth distribution and land resource utilization:

(1) Encourage urban growth primarily to existing urban areas where adequate public facilities are already available or can be provided with reasonable public expenditures, and away from areas where other important benefits are

present, such as protection of important agricultural land or preservation of lifestyles.

(2) Make available marginal or nonessential agricultural lands for appropriate urban uses while maintaining agricultural lands of importance in the agricultural district.

(3) Restrict development when drafting of water would result in exceeding the sustainable yield or in significantly diminishing the recharge capacity of any groundwater area.

(4) Encourage restriction of new urban development in areas where water is insufficient from any source for both agricultural and domestic use.

(5) In order to preserve green belts, give priority to state capital-improvement funds which encourage location of urban development within existing urban areas except where compelling public interest dictates development of a noncontiguous new urban core.

(6) Seek participation from the private sector for the cost of building infrastructure and utilities, and maintaining open spaces.

(7) Pursue rehabilitation of appropriate urban areas.

(8) Support the redevelopment of Kakaako into a viable residential, industrial, and commercial community.

(9) Direct future urban development away from critical environmental areas or impose mitigating measures so that negative impacts on the environment would be minimized.

(10) Identify critical environmental areas in Hawaii to include but not be limited to the following: watershed and recharge areas; wildlife habitats (on land and in the ocean); areas with endangered species of plants and wildlife; natural streams and water bodies; scenic and recreational shoreline resources; open space and natural areas; historic and cultural sites; areas particularly sensitive to reduction in water and air quality; and scenic resources.

(11) Identify all areas where priority should be given to preserving rural character and lifestyle.

(12) Utilize Hawaii's limited land resources wisely, providing adequate land to accommodate projected population and economic growth needs while ensuring the protection of the environment and the availability of the shoreline, conservation lands, and other limited resources for future generations.

(13) Protect and enhance Hawaii's shoreline, open spaces, and scenic resources.

The Proposed Project helps meet the demand for mid-market housing in North Kona, which is needed to support existing needs as well as predicted population growth in the area. It is located on vacant land in an urban area surrounded by residential development with utilities available.

Ch. 226-108 (2) – Sustainability.

(1) Encouraging balanced economic, social, community, and environmental priorities;

(2) Encouraging planning that respects and promotes living within the natural resources and limits of the State;

(3) Promoting a diversified and dynamic economy;

(4) Encouraging respect for the host culture;

(5) Promoting decisions based on meeting the needs of the present without compromising the needs of future generations;

(6) Considering the principles of the ahupuaa system; and

(7) Emphasizing that everyone, including individuals, families, communities, businesses, and government, has the responsibility for achieving a sustainable Hawaii.

The Project Site is within the Urban Expansion and Low Density Urban zoning district in the LUPAG, and is consistent with this designation. The Proposed Project would provide much needed housing options for the mid-market/workforce population in North Kona, and meets the sustainability objective by meeting the needs of the present without compromising the needs of future generations and promotes living within the natural resources and limits of the State.

Chapter 205 Hawai‘i Revised Statutes classifies all land in the State of Hawai‘i into one of four land use categories – Urban, Rural, Agricultural, or Conservation – and determines permissible uses in each district. The Project Site is in the State Land Use Urban District. The proposed use is consistent with intended uses for this land use district.

3.12.2 Coastal Zone Management Program (Chapter 205A, Hawaii Revised Statutes)

HRS 205A defines the coastal zone as “all the lands of the State and the area extending seaward from the shoreline to the limit of the State’s police power and management authority, including the United States territorial sea”, the Project Site is located in the coastal zone management area.

The Project Site is located approximately 0.85 miles *mauka* of the shoreline at an elevations from 330 to 900 feet amsl and would not influence coastal process or conditions. The Proposed Project would also have no impact to coastal recreation opportunities, historic resources, scenic and open space resources, coastal ecosystems, economic uses, coastal hazards, managing development, public participation, beach protection, and marine resources (HAR § 205A-2). Detailed explanations of potential impacts are described above in the environmental consequences sections. As the site and actions on it are not likely to influence coastal processes or conditions within coastal areas, no potential impacts are anticipated.

3.12.3 Hawai'i County Zoning, Special Management Area, and General Plan

The subject parcels are zoned Multiple-Family Residential, with a minimum building site of 5,000 square feet per dwelling unit (RM-5), by the County of Hawaii. County of Hawaii Ordinance No. 02-131, which amended previous ordinances to establish zoning on the parcels. As described in Section 1.2, the Project is the final residential development identified in the zoning ordinance (No. 84-23) signed in 1984, and subject to subsequent amendments. An amendment is required in order to provide additional time to commence construction of the Project. This amendment request would be reviewed by the Planning Commission, with a decision by the County Council. Aside from the need for more time, this Project and the zoning that supports it continues to conform with the original findings and reasons for its approval by the County Council in 1984, and as amended as recently as in 2002.

County of Hawai'i Ordinance 02-131 amended previous ordinances to establish the zoning on the properties and required the applicant comply with conditions A through S, and the State Land Use Commission Docket No. A83-549, to determine the status of condition compliance for these land use entitlements.

The General Plan for the County of Hawai'i is a policy document expressing the broad goals and policies for the long-range development of the Island of Hawai'i (County of Hawai'i 2005). The plan was adopted by ordinance in 1989 and revised in 2005 (Hawai'i County Planning Department). The General Plan itself is organized into thirteen functional elements. In general, the Proposed Project would be consistent with the goals, policies and objectives, standards, and principles for several functional areas. This section addresses the consistency of the proposed action with relevant policies of the County.

Housing Goals:

- Attain safe, sanitary, and livable housing for the residents of the County of
- Hawaii.

- Attain a diversity of socio-economic housing mix throughout the different parts of the County.
- Maintain a housing supply that allows a variety of choices.
- Improve and maintain the quality and affordability of the existing housing inventory
- Seek sufficient production of new affordable rental and fee-simple housing in the County in a variety of sizes to satisfactorily accommodate the needs and desires of families and individuals.
- Encourage and expand home ownership opportunities for residents.

Housing Policies:

- Encourage a volume of construction and rehabilitation of housing sufficient to meet growth needs and correct existing deficiencies.
- Increase rental opportunities and choices in terms of quality, cost, amenity, style and size of housing, especially for low and moderate income households.
- Aid and encourage the development of a wide variety of housing to achieve a diversity of socio-economic housing mix.

Discussion: The Proposed Project would incorporate measures to provide additional mid-market housing in a quickly growing part of the County. The location of the Proposed Project is adjacent to other housing developments and services for future residents, and would provide choices for the mid-market population in North Kona.

Historic Sites Goals:

- Protect and enhance the sites, buildings and objects of significant historical and cultural importance to Hawai‘i.
- Appropriate access to significant historic sites, buildings and objects of public interest should be made available.

Discussion: No impacts to archaeological sites would occur from the Proposed Project.

Natural Beauty Goals:

- Protect scenic vistas and view planes from becoming obstructed. Maximize opportunities for present and future generations to appreciate and enjoy natural and scenic beauty.

Discussion: The Proposed Project would not degrade the scenic environment of the area.

Transportation Goals:

- Provide a transportation system whereby people and goods can move efficiently, safely, comfortably and economically.

Discussion: The Proposed Project would include constructing an intersection from Queen Ka'ahumanu Highway that would allow for safe ingress and egress during Project construction and occupancy. In addition, the Proposed Project would build and dedicate a substantial portion of the expanding County planned roadway grid system.

Land Use Goals:

- Designate and allocate land uses in appropriate proportions and mix and in keeping with the social, cultural, and physical environments of the County.
- Protect and preserve forest, water, natural and scientific reserves and open areas.

Land Use Standards

- The designated land uses will be delineated on the General Plan Land Use Pattern Allocation Guide Map. The broad-brush boundaries indicated are graphic expressions of the General Plan policies, particularly those relating to land uses. They are long-range guides to general location and will be subject to: a) existing zoning; and b) State Land Use District. Similarly, the acreages allocated represent alternatives for the various levels of economic activity and supporting functions, such as resort, residential, commercial and industrial activities. Land required for community and governmental services and programs as well as new towns and resort centers may be accommodated within the allocated acreages.

Discussion: The *Hawai'i County General Plan Land Use Pattern Allocation Guide (LUPAG) and Facilities Map* components of the *General Plan* are graphic representations of the Plan's goals, policies, and standards as well as of the physical relationship between land uses. They also establish the basic urban and non-urban form for areas and the planned public and cultural facilities, public utilities and safety features, and transportation corridors. The Project Site is within the Urban Expansion and Low Density Urban zoning district in the LUPAG. As discussed above in this section, the Project Site has been found to be consistent with this designation. The Proposed Project would provide much needed mid-market housing for residents in North Kona.

3.12.4 Kona Community Development Plan

The Kona CDP encompasses the judicial districts of North and South Kona was developed under the framework of the February 2005 County of Hawai'i General Plan. The CDP is intended to translate broad General Plan Goals, Policies, and Standards into implementation actions as they apply to specific geographical regions around the County.

The General Plan now requires that a CDP shall be adopted by the County Council as an "ordinance," giving the CDP the force of law. This is in contrast to plans created over past years, adopted by "resolution" that served only as guidelines or reference documents to decision-makers. The Kona CDP was adopted in September 2008 and amended by Ordinance 19-91 in 2019 by the County Council. The version referenced in this Environmental Assessment is at: http://www.hawaiicountycdp.info/north-and-south-kona-cdp/cdp-final-drafts.

The Plan has many elements and wide-ranging implications, but there are several major strategies that embody the guiding principles related to the economy, energy, environmental quality, flooding and other natural hazards, historic sites, natural beauty, natural resources and shoreline, housing, public facilities, public utilities, recreation, transportation, and land use. The Proposed Project's proposed development is consistent with all aspects of the Kona CDP, including three of the eight guiding principles: (1) provide connectivity and transportation choices; (2) provide housing choices; and (3) Provide infrastructure and essential facilities concurrent with growth.

It is in keeping with the Plan's the Goals, Objectives, Policies, and Actions to develop a system of interconnected roads in Kona (Section 4.1). In particular, Section 4.1.3:

> **Objective TRAN-2 Street Network Connectivity. To develop a system of interconnected roads in Kona that will provide alternative transportation routes that will disperse automobile trips and reduce their length, while not compromising the through functions of arterials and major collectors with excessive intersections.**

Under this Objective, the Project complies with guiding principles established by the Kona Urban Area by promoting Policy TRAN-2.1: Connectivity Standards (5) Future Extensions and (6) Connectivity.

It is in keeping with the Plan's the Goal, Objectives, Policies, and Actions to guide the development of housing in Kona (Section 4.5). In particular, Section 4.5.3:

Housing Goal: Diversity of housing choices for all segments of the population close to places of employment and/or daily needs.

The Proposed Project specifically aligns with Objective HSG-4: Build More Units, Policy HSG-4.2: Workforce Housing and HSG-4.4: Housing Variety.

The final guiding principle emphasizes that future growth should occur where infrastructure (roads and utilities) and essential facilities (i.e. police, fire, and schools) are already in place. These facilities should be maintained at a level that will enhance the quality of life for Kona residents. This project is the final phase of a larger residential development that saw the completion of Kona Vistas, a 215-unit, single-family residential project on approximately 103 acres. The zoning that supports both the existing Kona Vistas and proposed Royal Vistas projects spans over 35 years. As last amended in 2002 to provide for additional time by which to complete both projects, the completion of Royal Vistas is encouraged by the Kona CDP as an infill rezoning.

PART 4: DETERMINATION

Based on the findings below, the Proposed Project will not significantly alter the environment, as impacts will be minimal, and therefore a FONSI is anticipated. A final determination will be made upon consideration of comments to the Draft EA.

PART 5: FINDINGS AND REASONS

Chapter 11-200.1-13, HAR, outlines those factors agencies must consider when determining whether an Action has significant effects:

1. *Irrevocably commit a natural, cultural, or historic resource.* No valuable natural or cultural resources would be committed or lost as a result of the Proposed Project. No impacts to archaeological resources would occur with the planned preservation of the railroad berm and petroglyph.
2. *Curtail the range of beneficial uses of the environment.* The proposed mid-market housing development does not curtail beneficial uses of the environment and is consistent with the medium density zoning in the LUPAG and conforms to the guiding principles regarding urban growth patterns as defined by the Kona CDP.
3. *Conflict with the State's environmental policies or long-term environmental goals established by law*. The State's long-term environmental policies are set forth in Chapter 344, HRS. The broad goals of this policy are to conserve natural resources and enhance the quality of life. The impact from the Proposed Project is minor and, therefore, is consistent with all elements of the State's long-term environmental policies and environmental goals.
4. *Have a substantial adverse effect on the economic, social welfare, or cultural practices of the community or State.* The Proposed Project would not adversely affect the social welfare of the community and would contribute to services. The Proposed Project would generate work for the local construction industry, which would stimulate local economic spending. The Proposed Project would balance the social welfare of the community by providing infill mid-market housing and allow resident households better access and the ability to safely manage commutes between home, work, and recreation. Stable households lead to stable communities and associated workforce, and promotes a functional economy.
5. *Have a substantial adverse effect on public health.* The Proposed Project would not affect public health in any way; stormwater would be appropriately disposed of in drainage structures. Traffic impacts have been taken into careful consideration in project design.
6. *Involve adverse secondary impacts, such as population changes or effects on public facilities*. No adverse secondary effects are expected since the development would utilize existing infrastructure, provide infill housing, and is not expected to result in substantial demands to County services.
7. *Involve a substantial degradation of environmental quality*. The impact from the Proposed Project is minor, and would thus not contribute to environmental degradation. BMPs and appropriate erosion control measures would be utilized during construction. Short-term impacts on air

and noise quality will be mitigated by employing BMPs. No long-term adverse impacts are expected from the Proposed Project.

8. *Is individually limited but cumulatively has substantial adverse effect upon the environment or involves a commitment for larger actions.* The Proposed Project is not related to other activities in the region in such a way as to produce adverse cumulative effects or involve a commitment for larger actions.
9. *Have a substantial adverse effect on a rare, threatened, or endangered species, or its habitat.* There are no rare, threatened, or endangered species or suitable habitat for these species present at the Project Site, and no effects to these species are anticipated. Endangered Hawaiian hoary bats and formerly listed Hawaiian hawks, which are island wide-ranging species, would experience no adverse impacts due to mitigation in the form of timing of vegetation removal and/or hawk nest survey. Additionally, no rare, threatened, or endangered species of fauna are known to exist on or near the Project Site, and none would be directly affected by any project activities.
10. *Have a substantial adverse effect on air or water quality or ambient noise levels.* No adverse effects on air quality or noise would occur. The increase in noise levels on the site are acceptable and would be only a moderate increase in the existing levels. To minimize impacts to air quality during construction, the Proposed Project would implement a watering program for dust abatement. Other control measures during construction such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens would also be utilized as necessary to minimize impacts to air quality.
11. *Have a substantial adverse effect on or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, sea level rise exposure area, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters.* Although the property is located in an area with volcanic and seismic risk, the entire Island of Hawai‘i shares this risk, and the Proposed Project is not imprudent to construct. The property is approximately 0.85 miles from the shoreline and the development is outside any flood plain. Based on potential impacts from climate change, the Proposed Project has been designed to accommodate increased stormwater run-off from larger storms in the adjacent drainages and on site.
12. *Have substantial adverse effect on scenic vistas and viewplanes, during day or night, identified in county or state plans or studies.* No scenic vistas and viewplanes identified in the Hawai‘i County General Plan will be adversely affected by the Proposed Project.
13. *Require substantial energy consumption or emit substantial greenhouse gases*. The development would have solar water heating and incorporate

efficient appliances, as practical and possible. Negligible emissions of greenhouse gases would occur during construction and occupation of the proposed development. Since the Project addresses an existing demand for housing, it is expected that a portion of the residents that would occupy the development already live in Kona or on Hawai'i Island, and there would not be a substantial increase in emissions when residents occupy the Project. Therefore, Project impacts would be considered a negligible increase to the global annual greenhouse gas emissions.

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APPENDIX 1: Early Consultation Letters

Harry Kim
Mayor

Wil Okabe
Managing Director

David Yamamoto, P.E.
Director

Allan G. Simeon, P.E.
Deputy Director

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November 27, 2019

Michele Lefebvre, PhD
PO Box 191
Hilo, HI 96721
(via email to: michele.lefebvre@stantec.com)

Subject: Environmental Assessment Early Consultation for Proposed Royal Vistas Housing Project, Island of Hawai'i, North Kona District
Tax Map Key: (3) 7-6-021:016 and 7-6-021:017

We have reviewed the request for early consultation for an Environmental Assessment and our comments are as follows:

1. Flood zones AE and AEF affect the subject parcels as designated by the Flood Insurance Rate Map (FIRM). New construction and substantial improvements shall comply with Chapter 27 – Floodplain Management – of the Hawaii County Code.
2. Drainage improvements, including the combination of the Holualoa Drainageway and the Horseshoe Bend Drainageway, shall be submitted to the Department of Public Works for review and approval.
3. All development generated runoff shall be disposed of on-site and shall not be directed toward adjacent properties.
4. All earthwork and grading shall conform to Chapter 10 – Erosion and Sedimentation Control – of the Hawaii County Code.
5. All work within the County Right-of-Way shall conform to Chapter 22 – County Streets – of the Hawaii County Code.

Please provide us with a copy of the EA when it is completed for our review.

Should there be any questions concerning this matter, please feel free to contact Natalie Whitworth of our Kona Engineering Division office at 323-4853.

Natalie Whitworth

for Ben Ishii, Division Chief
Engineering Division

NW

Copy: Engineering Division - HILO/KONA, Planning Department - Hilo

County of Hawai'i is an Equal Opportunity Provider and Employer.

Harry Kim
Mayor

Paul K. Ferreira
Police Chief

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Deputy Police Chief

County of Hawai'i

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December 6, 2019

Ms. Michele Lefebvre, PhD
Environmental Scientist
Stantec Consulting Services Inc.
P.O. Box 191
Hilo, Hawaii 96721

Dear Ms. Lefebrvre:

SUBJECT: ENVIRONMENTAL ASSESSMENT EARLY CONSULTATION FOR PROPOSED ROYAL VISTAS HOUSING PROJECT, ISLAND OF HAWAI'I, NORTH KONA DISTRICT, TMKS: 7-6-021:016 AND 7-6-021:017

This is in response to your letter dated November 18, 2019, requesting comments related to your project.

Thank you for allowing the Hawaii Police Department the opportunity to participate. At this time, the Hawaii Police Department has no comments.

Should you have any questions, please contact Captain Gilbert Gaspar Jr., Commander of the Kona District, at 326-4646, extension 299.

Sincerely,

PAUL K. FERREIRA
POLICE CHIEF

ROBERT WAGNER
ASSISTANT POLICE CHIEF
AREA II OPERATIONS

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SUPERINTENDENT

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OFFICE OF FACILITIES AND OPERATIONS

December 10, 2019

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P.O. Box 191
Hilo, Hawaii 96721

Re: Environmental Assessment Early Consultation Request for Proposed Royal Vistas Housing Project; Hawaii TMK: 7-6-021:016 & 017, North Kona, Hawaii

Dear Ms. Lefebvre:

The Hawaii State Department of Education (HIDOE) has the following comments for the proposed Royal Vistas Housing Project (Project). According to the information provided Kona Three LLC proposes to develop 450 multi-family units, a combination of rental and for sale units, located in North Kona, Island of Hawaii, Hawaii, TMK: 7-6-021:016 & 017.

When the Project is mature and unit turnover stabilized, we would expect roughly 99 HIDOE students to reside there.

The HIDOE schools currently servicing the proposed Project area are Holuoloa Elementary, Kahakai Elementary, Kealakehe Middle, Konawaena Middle, Kealakehe High and Konawanena High. Konawaena Middle has capacity and is expected to have capacity over the next five years. The remaining schools are currently over capacity and are expected to remain over capacity over the next five years.

The proposed Project is located within the West Hawaii School Impact Fee District, however we are currently not collecting impact fees.

The HIDOE would like to receive a copy of the Draft Environmental Assessment for review.

Thank you for the opportunity to comment. Should you have questions, please contact Robyn Loudermilk, School Lands and Facilities Specialist, Facilities Development Branch, Planning Section at (808) 784-5093 or via email at robyn.loudermilk@k12.hi.us.

Respectfully,

Kenneth G. Masden II
Public Works Manager
Planning Section

KGM:rll

c: Art Souza Complex Area Superintendent, Honokaa/Kealakehe/Kohala/Konawaena Complex Area

DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAI'I
345 KEKŪANAŌ'A STREET, SUITE 20 • HILO, HAWAI'I 96720
TELEPHONE (808) 961-8050 • FAX (808) 961-8657

December 16, 2019

Ms. Michele Lefebvre
Stantec Consulting Services Inc.
1239 Moku Place
Hilo, HI 96720

Dear Ms. Lefebvre:

Subject: Pre-Environmental Assessment Consultation for Proposed Royal Vistas Housing Project Island of Hawai'i, North Kona District Tax Map Key 7-6-021:016 and 017

We have reviewed your Pre-Environmental Assessment Consultation letter, dated November 18, 2019.

Please be informed that the subject parcels are served by an existing service that can accommodate a 4-inch meter on Io Place, which is limited to 180,400 gallons per day, or 451 units of water.

Please note that the Department of Water Supply acknowledges that potable water is Hawai'i Island's most precious resource and encourages our communities to promote water conservation and reserve the highest quality of water for the most valuable end-use, which is the sustenance of life.

We request that the developer address the non-potable demand of water by minimizing the demand or propose to supply the demand by alternate methods (i.e. reclaimed or reuse water). The overall water demand should be reviewed as the water use, other than the residential dwelling units, will need to be included which would reduce the number of dwelling units that can be developed. Additional water beyond the total number of water units allocated to the subject parcels is not available.

Should there be any questions, please contact Mr. Ryan Quitoriano of our Water Resources and Planning Branch at 961-8070, extension 256.

Sincerely yours,

Keith K. Okamoto, P.E.
Manager-Chief Engineer

RQ:dmj

National Park Service
U.S. Department of the Interior

Kaloko-Honokōhau
National Historical Park

73-4786 Kanalani Street # 14
Kailua-Kona, Hawai'i 96740

808 329-6881 Phone
808 329-2597 Fax

Kaloko-Honokōhau

IN REPLY REFER TO:
L7621 (2019-10)

December 18, 2019

Dr. Michele Lefebvre
Stantec Consulting Services Inc.
P.O. Box 191
Hilo, Hawai'i 96721

Subject: National Park Service Comments for an early Consultation for an Environmental Assessment for the Proposed Royal Vistas Housing Project, Island of Hawai'i, North Kona District, TMKs: 7-6-021:016 and 7-6-021:017

Dear Dr. Lefebvre:

Thank you for providing the National Park Service (NPS) with the opportunity to comment for an early Consultation for an Environmental Assessment for the Proposed Royal Vistas Housing Project. The proposed project is located approximately 5 miles south of Kaloko-Honokōhau National Historical Park (Park) and 2.7 miles south of downtown Kailua-Kona along Queen Ka'ahumanu Highway and would consist of necessary improvements to construct up to 450 residential units in multi-family configurations with clusters of two- and three-story buildings.

Congress established Kaloko-Honokōhau National Historical Park in 1978 to preserve, interpret, and perpetuate traditional native Hawaiian activities and culture by protecting the cultural and natural resources within the Park (16 U.S.C. § 396d(a)). The Park contains more than 450 known archeological and cultural sites, among which are several heiau, networks of ancient and historic trails, traditional dry-laid masonry features, more than 180 known anchialine pools, two ancient Hawaiian fishponds with associated wetlands, and a fishtrap. The park lands and waters provide habitat for 17 federally listed species, and candidate species for listing, under the Endangered Species Act. 'Aimakapā Fishpond and wetland is "core habitat" for the recovery of two endangered waterbird species, the Hawaiian stilt (*Himantopus mexicanus knudseni*) and the Hawaiian coot (*Fulica americana alai*), and is an important habitat for migratory waterfowl.[1] In addition to the fishponds and pools, the Park boundary encompasses 596 acres of marine waters and coral reef habitat. As we stated above, there are many groundwater dependent ecosystems (GDEs) in the Park. All of the Park's GDEs are dependent upon groundwater inputs to maintain these ecosystems, especially as habitat for culturally important and rare native aquatic species.

[1] US Fish and Wildlife Service. 2011. Recovery Plan for Hawaiian Waterbirds, Second Revision.

Approximately 220,000 visitors per year visit the Park.[2] Local residents, cultural practitioners, and visitors from around the world come to experience Kaloko-Honokōhau's unique sense of place, bio-cultural and natural history, and to understand and perpetuate Hawaiian traditions.

According to the Water Resource Protection Plan 2019 Update, the current methodology used by the State of Hawai'i Commission on Water Resource Management (CWRM) for determining sustainable yields does not explicitly account for freshwater flows needed to preserve GDEs such as anchialine pools, fishponds, and wetlands.[3] CWRM has recognized the need to refine its management approach to groundwater and requested that its staff study ways to refine the estimation of sustainable yields to account for the needs of GDEs.[4] Therefore, CWRM is developing a "pilot adaptive management plan" for protecting GDEs in partnership with the NPS and cultural practitioners.[5] The pilot adaptive management plan will focus on GDEs within Kaloko-Honokōhau National Historical Park.

The Hawai'i County Department of Water Supply has also proposed measures to minimize the effects of new groundwater withdrawals on groundwater dependent ecosystems and the Native Hawaiian traditional and customary practices that rely upon them. The 2017 Water Use and Development Plan Update for the Keauhou Aquifer System Area describes these efforts and includes refined demand projections and a calculation of Authorized Plan Use (or Anticipated Water Demand) for the aquifer system (28.07 million gallons per day). Therefore, the NPS requests that the Environmental Assessment include the water demand for the proposed project and address whether this demand was included in the Department of Water Supply's calculation of Authorized Planned Use.

Thank you for allowing us to comment on the early Consultation for an Environmental Assessment for the Proposed Royal Vistas Housing Project. If you have any questions regarding this letter, please do not hesitate to contact Dr. Jeff Zimpfer of my staff (808-329-6881 x 1500 or jeff_zimpfer@nps.gov).

Sincerely,

Leonel Arguello
Acting Superintendent
Kaloko-Honokōhau National Historical Park
Pu'uhonua o HōnaunauNational Historical Park

[2] https://irma.nps.gov/Stats/
[3] Commission on Water Resource Management, 2018. Water Resource Protection Plan 2019 Update, Appendix F, Page 9, Public Review Draft, October 2018. Available at: http://dlnr.hawaii.gov/cwrm/planning/hiwaterplan/wrpp/
[4] Ibid., 11.
[5] Ibid., 65.

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE
MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

December 19, 2019

Stantec Consulting Services Inc.
Attention: Ms. Michele Lefebvre
Environmental Scientist
P.O. Box 191
Hilo, Hawaii 96721

via email: michele.lefebvre@stantec.com

Dear Ms. Lefebvre:

SUBJECT: Environmental Assessment Early Consultation for Proposed **Royal Vistas Housing Project** located at North Kona District, Island of Hawaii; TMKs: (3) 7-6-021:016 & 7-6-021:017 on behalf of Kona Three LLC

Thank you for the opportunity to review and comment on the subject matter. The Land Division of the Department of Land and Natural Resources (DLNR) distributed or made available a copy of your request pertaining to the subject matter to DLNR's Divisions for their review and comments.

At this time, enclosed are comments from the (a) Engineering Division, (b) Division of Forestry & Wildlife, and (c) Land Division – Hawaii District on the subject matter. Should you have any questions, please feel free to contact Darlene Nakamura at (808) 587-0417 or email: darlene.k.nakamura@hawaii.gov. Thank you.

Sincerely,

Russell Y. Tsuji
Land Administrator

Enclosures
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

November 26, 2019

MEMORANDUM

TO:

DLNR Agencies:
__Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
X Engineering Division
X Div. of Forestry & Wildlife
__Div. of State Parks
X Commission on Water Resource Management
__Office of Conservation & Coastal Lands
X Land Division – Hawaii District
X Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Environmental Assessment Early Consultation for Proposed **Royal Vistas Housing Project**
LOCATION: North Kona District, Island of Hawaii; TMKs: (3) 7-6-021:016 & 7-6-021:017
APPLICANT: Stantec Consulting Services, Inc. on behalf of Kona Three LLC

Transmitted for your review and comment is information on the above-referenced subject matter. Please submit comments by **December 18, 2019.**

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Darlene Nakamura at 587-0417 or by email at darlene.k.nakamura@hawaii.gov. Thank you.

( ) We have no objections.
( ) We have no comments.
(✓) Comments are attached.

Signed: _____

Print Name: Carty S. Chang, Chief Engineer

Date: 11/29/19

Attachments
cc: Central Files

DEPARTMENT OF LAND AND NATURAL RESOURCES
ENGINEERING DIVISION

LD/Russell Y. Tsuji

Ref: Environmental Assessment Early Consultation for Proposed Royal Vistas Housing Project
Location: North Kona District, Island of Hawaii
TMK(s): (3) 7-6-021:016 & 7-6-021:017
Applicant: Stantec Consulting Services, Inc. on behalf of Kona Three LLC

COMMENTS

The rules and regulations of the National Flood Insurance Program (NFIP), Title 44 of the Code of Federal Regulations (44CFR), are in effect when development falls within a Special Flood Hazard Area (high risk areas). State projects are required to comply with 44CFR regulations as stipulated in Section 60.12. Be advised that 44CFR reflects the minimum standards as set forth by the NFIP. Local community flood ordinances may stipulate higher standards that can be more restrictive and would take precedence over the minimum NFIP standards.

The owner of the project property and/or their representative is responsible to research the Flood Hazard Zone designation for the project. Flood Hazard Zones are designated on FEMA's Flood Insurance Rate Maps (FIRM), which can be viewed on our Flood Hazard Assessment Tool (FHAT) (http://gis.hawaiinfip.org/FHAT).

If there are questions regarding the local flood ordinances, please contact the applicable County NFIP coordinating agency below:

- Oahu: City and County of Honolulu, Department of Planning and Permitting (808) 768-8098.
- Hawaii Island: County of Hawaii, Department of Public Works (808) 961-8327.
- Maui/Molokai/Lanai County of Maui, Department of Planning (808) 270-7253.
- Kauai: County of Kauai, Department of Public Works (808) 241-4896.

Signed: _____
CARTY S. CHANG, CHIEF ENGINEER

Date: 11/29/19

2373

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RECEIVED AND FILED
DEC 12 AM 11:00

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

November 26, 2019

MEMORANDUM

~~TO:~~ From

DLNR Agencies:
__Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
X Engineering Division
X Div. of Forestry & Wildlife
__Div. of State Parks
X Commission on Water Resource Management
__Office of Conservation & Coastal Lands
X Land Division – Hawaii District
X Historic Preservation

~~FROM:~~ To: Russell Y. Tsuji, Land Administrator
SUBJECT: Environmental Assessment Early Consultation for Proposed **Royal Vistas Housing Project**
LOCATION: North Kona District, Island of Hawaii; TMKs: (3) 7-6-021:016 & 7-6-021:017
APPLICANT: Stantec Consulting Services, Inc. on behalf of Kona Three LLC

Transmitted for your review and comment is information on the above-referenced subject matter. Please submit comments by **December 18, 2019.**

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Darlene Nakamura at 587-0417 or by email at darlene.k.nakamura@hawaii.gov. Thank you.

( ) We have no objections.
(✓) We have no comments.
(✓) Comments are attached.

Signed: _____

Print Name: **DAVID G. SMITH, Administrator**

Date: 12/11/19

Attachments
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

DEC 12 AM 11:00

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
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

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

DEC 1 1 2019

Log no. 2373

MEMORANDUM:

TO: Russell Tsuji, Administrator
Land Division

FROM: David G. Smith, Administrator

SUBJECT: Division of Forestry and Wildlife Comments on Royal Vistas Housing Project

TMK No.: **(3) 7-6-02:016 & 7-6-021:017**

The Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife (DOFAW) has received your inquiry regarding Royal Vistas Housing Project. We appreciate the opportunity to provide consultation and first, because it appears trees will be removed for this proposed project, underscore but a few of the multiple benefits of trees and green infrastructure:

Clean Air: In addition to creating oxygen, essential for all life on Earth, trees clean the air by removing carbon dioxide and other air pollutants. One hundred large trees can remove 19 tons of carbon dioxide and 372 pounds of other air pollutants annually.

Health & Well-being: Tree-filled neighborhoods are safer, reduce mental and physical stress, and encourage people to spend more time outdoors, including transportation (i.e., walking and biking vs. driving). Tree-lined streets encourage slower driving and promote pedestrian safety.

Energy Cost Savings: Trees provide shade and cooling, greatly reducing energy costs. Trees save more than $622,000 per year (based on 2013 rates of $.32/kwh for 43,000 inventoried street trees in Honolulu.)

Watershed Protection: Trees cost-effectively filter and improve water quality by reducing stormwater runoff and flooding. Trees in Honolulu intercept more than 35 million gallons of stormwater per year. This contribution is valued at more than $350,000 annually.

Reef Protection: A healthy urban forest reduces erosion and filters pollutants significantly reducing runoff and the destruction of our valuable reefs.

Our comments as they pertain to trees, forests, and green infrastructuare are below:

☐ **Proposed tree removal:**

- Scope of work should include a tree protection plan and be supervised by a

certified arborist
- Consider pruning as an alternative to removal
- Replace removed trees with native or non-invasive canopy trees
- Designate which species of trees are proposed for removal

☐ **Proposed disturbance of area:**
- Scope of work should include a tree protection plan and be supervised by a certified arborist
- Install green infrastructure for rehabilitated areas post-disturbance

☐ **Proposed tree root & crown pruning:**
- Scope of work should include a tree protection plan and be supervised by a certified arborist

☐ **Proposed paving:**
- Consider permeable pavement or other permeable surface to allow for absorption of groundwater

Should you have any questions, please contact Heather McMillen @ heather.l.mcmillen@hawaii.gov

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

2019 DEC 12 AM 8:51
RECEIVED LAND DIVISION
2019 NOV 29 A 10:12
RECEIVED LAND DIVISION HILO, HAWAII

November 26, 2019

MEMORANDUM

TO: **DLNR Agencies:**
__Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
X Engineering Division
X Div. of Forestry & Wildlife
__Div. of State Parks
X Commission on Water Resource Management
__Office of Conservation & Coastal Lands
X Land Division – Hawaii District
X Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Environmental Assessment Early Consultation for Proposed **Royal Vistas Housing Project**
LOCATION: North Kona District, Island of Hawaii; TMKs: (3) 7-6-021:016 & 7-6-021:017
APPLICANT: Stantec Consulting Services, Inc. on behalf of Kona Three LLC

Transmitted for your review and comment is information on the above-referenced subject matter. Please submit comments by **December 18, 2019.**

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Darlene Nakamura at 587-0417 or by email at darlene.k.nakamura@hawaii.gov. Thank you.

( ) We have no objections.
(✓) We have no comments.
( ) Comments are attached.

Signed: _____

Print Name: GORDON C. HEIT

Date: 12/12/19

Attachments
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE
MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

December 23, 2019

Stantec Consulting Services Inc.
Attention: Ms. Michele Lefebvre
Environmental Scientist
P.O. Box 191
Hilo, Hawaii 96721

via email: michele.lefebvre@stantec.com

Dear Ms. Lefebvre:

SUBJECT: Environmental Assessment Early Consultation for Proposed **Royal Vistas Housing Project** located at North Kona District, Island of Hawaii; TMKs: (3) 7-6-021:016 & 7-6-021:017 on behalf of Kona Three LLC

Thank you for the opportunity to review and comment on the subject matter. In addition to our previous comments dated December 19, 2019, enclosed are comments from the Commission on Water Resource Management on the subject matter. Should you have any questions, please feel free to contact Darlene Nakamura at (808) 587-0417 or email: darlene.k.nakamura@hawaii.gov. Thank you.

Sincerely,

Russell Y. Tsuji
Land Administrator

Enclosures
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE
MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

November 26, 2019

MEMORANDUM

RECEIVED
COMMISSION ON WATER
RESOURCE MANAGEMENT
2019 NOV 27 PM 12: 21

TO: **DLNR Agencies:**
__Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
X Engineering Division
X Div. of Forestry & Wildlife
__Div. of State Parks
X Commission on Water Resource Management
__Office of Conservation & Coastal Lands
X Land Division – Hawaii District
X Historic Preservation

FR

TD:

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Environmental Assessment Early Consultation for Proposed **Royal Vistas Housing Project**
LOCATION: North Kona District, Island of Hawaii; TMKs: (3) 7-6-021:016 & 7-6-021:017
APPLICANT: Stantec Consulting Services, Inc. on behalf of Kona Three LLC

Transmitted for your review and comment is information on the above-referenced subject matter. Please submit comments by **December 18, 2019.**

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Darlene Nakamura at 587-0417 or by email at darlene.k.nakamura@hawaii.gov. Thank you.

( ) We have no objections.
( ) We have no comments.
(x) Comments are attached.

Signed: /s/ M. Kaleo Manuel

Print Name: Deputy Director

Date: December 16, 2019

Attachments
cc: Central Files

FILE ID: RFD. 5288.8
DOC ID: 22029

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON

BRUCE S. ANDERSON, PH.D.
KAMANA BEAMER, PH.D.
MICHAEL G. BUCK
NEIL J. HANNAHS
WAYNE K. KATAYAMA
PAUL J. MEYER

M. KALEO MANUEL
DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P.O. BOX 621
HONOLULU, HAWAII 96809

December 16, 2019

REF: RFD.5288.8

TO: Mr. Russell Tsuji, Administrator
Land Division

FROM: M. Kaleo Manuel, Deputy Director
Commission on Water Resource Management

SUBJECT: Environmental Assessment Early Consultation for Proposed Royal Vistas Housing Project

FILE NO.: RFD.5288.8
TMK NO.: (3) 7-6-021:016 & 7-6-021:017

Thank you for the opportunity to review the subject document. The Commission on Water Resource Management (CWRM) is the agency responsible for administering the State Water Code (Code). Under the Code, all waters of the State are held in trust for the benefit of the citizens of the State, therefore all water use is subject to legally protected water rights. CWRM strongly promotes the efficient use of Hawaii's water resources through conservation measures and appropriate resource management. For more information, please refer to the State Water Code, Chapter 174C, Hawaii Revised Statutes, and Hawaii Administrative Rules, Chapters 13-167 to 13-171. These documents are available via the Internet at http://dlnr.hawaii.gov/cwrm.

Our comments related to water resources are checked off below.

[X] 1. We recommend coordination with the county to incorporate this project into the county's Water Use and Development Plan. Please contact the respective Planning Department and/or Department of Water Supply for further information.

[ ] 2. We recommend coordination with the Engineering Division of the State Department of Land and Natural Resources to incorporate this project into the State Water Projects Plan.

[ ] 3. We recommend coordination with the Hawaii Department of Agriculture (HDOA) to incorporate the reclassification of agricultural zoned land and the redistribution of agricultural resources into the State's Agricultural Water Use and Development Plan (AWUDP). Please contact the HDOA for more information.

[X] 4. We recommend that water efficient fixtures be installed and water efficient practices implemented throughout the development to reduce the increased demand on the area's freshwater resources. Reducing the water usage of a home or building may earn credit towards Leadership in Energy and Environmental Design (LEED) certification. More information on LEED certification is available at http://www.usgbc.org/leed. A listing of fixtures certified by the EAP as having high water efficiency can be found at http://www.epa.gov/watersense.

[X] 5. We recommend the use of best management practices (BMP) for stormwater management to minimize the impact of the project to the existing area's hydrology while maintaining on-site infiltration and preventing polluted runoff from storm events. Stormwater management BMPs may earn credit toward LEED certification. More information on stormwater BMPs can be found at http://planning.hawaii.gov/czm/initiatives/low-impact-development/

[X] 6. We recommend the use of alternative water sources, wherever practicable.

[ ] 7. We recommend participating in the Hawaii Green Business Program, that assists and recognizes businesses that strive to operate in an environmentally and socially responsible manner. The program description can be found online at http://energy.hawaii.gov/green-business-program.

[X] 8. We recommend adopting landscape irrigation conservation best management practices endorsed by the Landscape Industry Council of Hawaii. These practices can be found online at http://www.hawaiiscape.com/wp-content/uploads/2013/04/LICH_Irrigation_Conservation_BMPs.pdf.

- [ ] 9. There may be the potential for ground or surface water degradation/contamination and recommend that approvals for this project be conditioned upon a review by the State Department of Health and the developer's acceptance of any resulting requirements related to water quality.
- [ ] 10. The proposed water supply source for the project is located in a designated water management area, and a Water Use Permit is required prior to use of water. The Water Use Permit may be conditioned on the requirement to use dual line water supply systems for new industrial and commercial developments.
- [ ] 11. A Well Construction Permit(s) is (are) are required before the commencement of any well construction work.
- [ ] 12. A Pump Installation Permit(s) is (are) required before ground water is developed as a source of supply for the project.
- [ ] 13. There is (are) well(s) located on or adjacent to this project. If wells are not planned to be used and will be affected by any new construction, they must be properly abandoned and sealed. A permit for well abandonment must be obtained.
- [ ] 14. Ground-water withdrawals from this project may affect streamflows, which may require an instream flow standard amendment.
- [ ] 15. A Stream Channel Alteration Permit(s) is (are) required before any alteration can be made to the bed and/or banks of a steam channel.
- [ ] 16. A Stream Diversion Works Permit(s) is (are) required before any stream diversion works is constructed or altered.
- [ ] 17. A Petition to Amend the Interim Instream Flow Standard is required for any new or expanded diversion(s) of surface water.
- [ ] 18. The planned source of water for this project has not been identified in this report. Therefore, we cannot determine what permits or petitions are required from our office, or whether there are potential impacts to water resources.

- [x] OTHER: Planning - The proposed water sources and projected water demands for the project, both potable and non-potable, should be identified and the calculations used to estimate demands should be provided. A discussion of the potential impacts on water resources and other public trust uses of water should be included, and any proposed mitigation measures described. Water conservation and efficiency measures to be implemented should also be discussed.

If you have any questions, please contact Lenore Ohye of the Commission staff at 587-0216.

Harry Kim
Mayor

Wil Okabe
Managing Director

West Hawai'i Office
74-5044 Ane Keohokalole Hwy
Kailua-Kona, Hawai'i 96740
Phone (808) 323-4770
Fax (808) 327-3563

County of Hawai'i
PLANNING DEPARTMENT

Michael Yee
Director

Duane Kanuha
Deputy Director

East Hawai'i Office
101 Pauahi Street, Suite 3
Hilo, Hawai'i 96720
Phone (808) 961-8288
Fax (808) 961-8742

December 23, 2019

Michele Lefebvre, PhD
Stantec Consulting Services Inc.
P.O. Box 191
Hilo, HI 96721

Dear Ms. Lefebvre:

SUBJECT: Comments for Early Consultation for Environmental Assessment for Proposed Royal Vistas Housing Project
Tax Map Keys: (3) 7-6-021:016 & 017, Hōlualoa 1st & 2nd, N. Kona, Hawai'i

This is in response to your letter dated November 18, 2019 requesting early consultation comments for an environmental assessment being prepared for a 450 multi-family residential unit development and related improvements on the above referenced property, including drainage and roadway improvements within County-owned parcels 18 and 19.

1. The subject properties are zoned Multiple-Family Residential, with a minimum building site of 5,000 square feet per dwelling unit (RM-5), by the County of Hawai'i and designated as Urban by the State Land Use Commission. Refer to County of Hawai'i Ordinance No. 02-131, which amended previous ordinances to establish the zoning on the properties, and State Land Use Commission Docket No. A83-549, to determine the status of condition compliance for these land use entitlements.

2. The General Plan Land Use Pattern Allocation Guide (LUPAG) map designation for the properties are Urban Expansion and Low Density Urban. Be aware that the County General Plan is undergoing a comprehensive review and these lands use designations may change soon upon adoption of an amended General Plan.

3. The property is not located within the Special Management Area (SMA) and is situated about 4,500 feet mauka of the shoreline.

4. The property is in an area affected by the Kona Community Development Plan, which was adopted by the Hawai'i County Council by Ordinance No. 08-131 and amended in 2019 by ordinance No. 19-91. Please indicate how the proposed project meets the goals, objectives, policies, and actions of the CDP.

5. The EA should describe the specific drainage and roadway improvements proposed within the County property and analysis of impacts and alternatives considered.

6. We strongly recommend you review the Planning Department files related to these properties because they contain information related to land use permitting history, cultural and historic resources, flooding, traffic, and public sentiment regarding the proposed project. The files can be viewed in the Hilo or Kona office. Please schedule an appointment so that we can ensure all the files are available for viewing.

7. Please include in the EA consultation process, surrounding property owners and community associations, including but not limited to, Kona Vistas Subdivision, Pualani Estates Subdivision, Kuakini Makai Subdivision, and property owners directly east of the subject properties.

We look forward to reviewing the draft EA when it is available. If you have any questions, please feel free to contact Maija Jackson at 961-8159.

Sincerely,

MICHAEL YEE
Planning Director

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cc w/copy of letter: Ronald Kim, Deputy Corporation Counsel

APPENDIX 2: Traffic Impact Assessment Report

FINAL

Royal Vistas

Tax Map Key (3) 7-6-021: 016, 17

Traffic Impact Analysis Report

Kona, Island of Hawaii

May 2020

Prepared for
Kona Three LLC.

Prepared by
SSFM International

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I. PROJECT DESCRIPTION

Kona Three LLC is planning to develop a Multi-family residential subdivision named Royal Vistas in Kona, on the Island of Hawaii. The property is located on the mauka side of the Queen Kaahumanu Highway at TMK (3) 7-6-021:016, 17 between Kona Vista Subdivision and Pualani Estates Subdivision. Only one roadway is planned to provide access for Phase I of the property. This roadway intersects with Queen Kaahumanu Highway, approximately 600 feet north of the intersection with Kuakini Highway. For this traffic impact analysis report (TIAR), this access is referred to as "Royal Vistas Roadway". The project location, along with the study intersections associated with this TIAR, are shown in Figure 1.

The proposed site is 70-acres and zoned "RM-5". Even though the new development's total buildout is estimated as 450 units, only 258 units are planned as Phase 1. Phase 1 is expected to be completed by 2024. Phase 2 will include the full buildout of the remaining 192 units. Phase 2 is expected to be completed by 2029. The Royal Vistas proposed conceptual site plan is shown in Figure 2. The intent of this TIAR is to evaluate existing conditions and assess impacts in the surrounding areas as a result of the proposed development. 5-year (Phase 1 completion) in 2024, 10-year (Phase 2 completion) in 2029, and 20-year future scenarios in 2039 will be analyzed. Future years will be evaluated with and without the Royal Vistas project.

Figure 1: Project Location Map

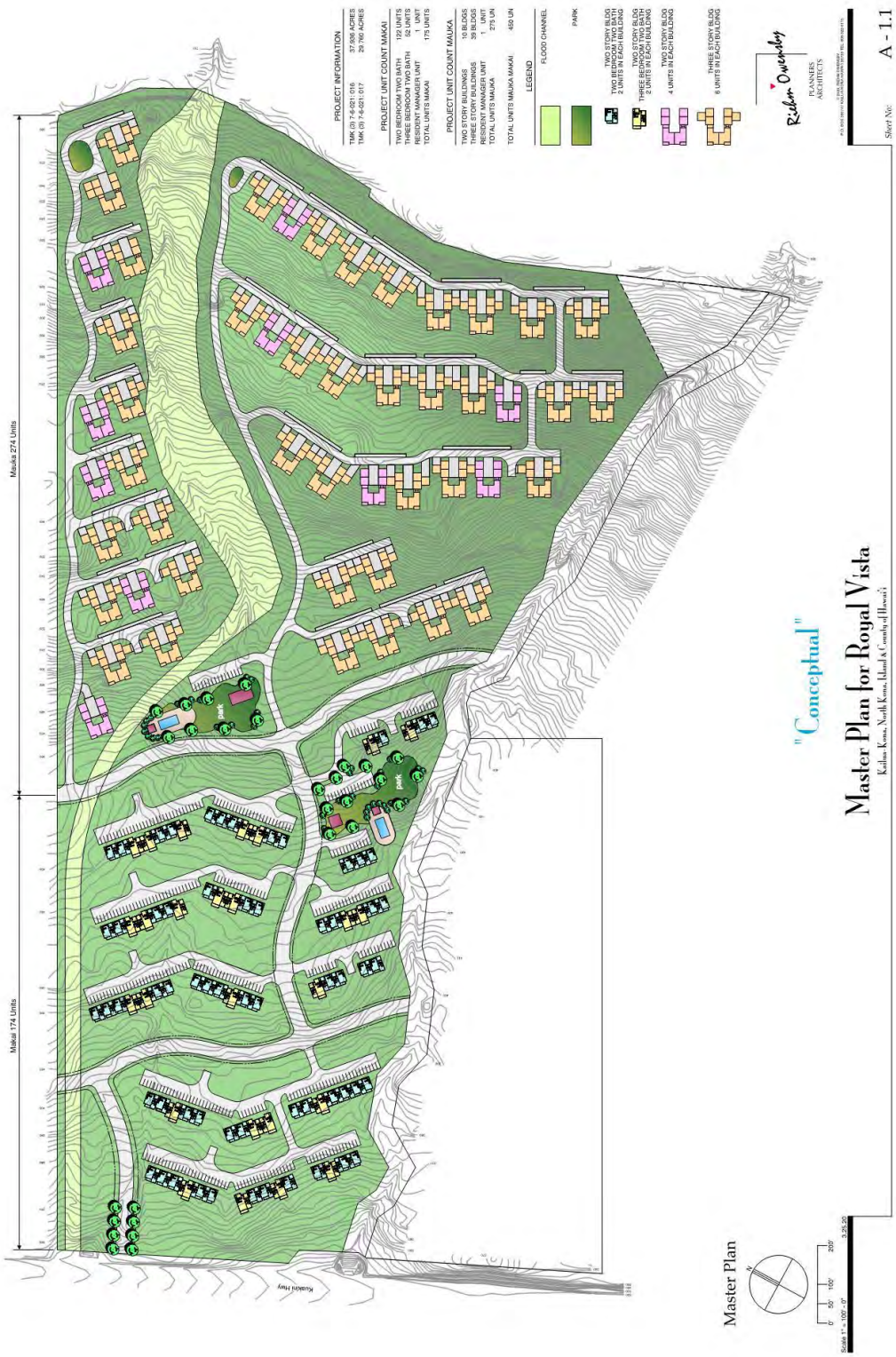


Figure 2: Conceptual Site Plan

II. EXISTING CONDITIONS

A. Geometric Configuration

1. Roadway Configuration

a) Queen Kaahumanu Highway

Where it intersects with Royal Vistas Roadway, Queen Kaahumanu Highway (Route 19) is undivided, two-lane, State-owned arterial, oriented in the north-south direction. Queen Kaahumanu Highway extends from Kawaihae Road (Route 19) in the north to the intersection with Palani Road (Route 130) where it turns into State Route 11. The posted speed limit varies from 45-55 mph. At the future Royal Vistas Roadway, the posted speed limit is 45 MPH. Queen Kaahumanu Highway opens to 4-5 lanes with dedicated left turning and right turning lanes at major intersections northwest of Henry Street.

2. Study Intersections

The study intersections include the following:

1. Queen Kaahumanu Highway and Palani Road
    a. Queen Kaahumanu Highway is predominantly oriented in an east-west direction and Palani Road is predominantly oriented in a north-south direction.
    b. Four-leg signalized intersection with dedicated left turning lanes and channelized right turn lanes for all approaches. The Queen Kaahumanu Highway approaches and the northbound Palani Road approach have double left turn lanes.
    c. All left turns are protected (have green arrow phases).
    d. The north leg of the intersection extends and connects with Mamalahoa Highway, another state-owned facility.
2. Queen Kaahumanu Highway and Henry Street
    a. Queen Kaahumanu Highway is oriented in an east-west direction and Henry Street is oriented in a north-south direction.
    b. Four-leg signalized intersection with dedicated left turning lanes and channelized right turn lanes for all approaches. The Queen Kaahumanu Highway approaches have double left turn lanes.
    c. Left tuns from Queen Kaahumanu Highway onto Henry Street are protected. The Henry Street phases are split (sequential rather than concurrent).
    d. The north leg of the intersection extends and connects with Ane Keohokalole Highway, another state-owned facility.
3. Queen Kaahumanu Highway and Hualalai Road (North)
    a. Queen Kaahumanu Highway is oriented in a north-south direction and Hualalai Road is oriented in an east-west direction.
    b. Three-leg, STOP sign controlled intersection with dedicated left turning lanes for the northbound and eastbound approaches.
    c. Channelized right turn lanes exist for the eastbound and southbound approaches.
    d. A refuge lane is provided for the eastbound left turns onto Queen Kaahumanu Highway.

4. Queen Kaahumanu Highway and Hualalai Road (South)
    a. Queen Kaahumanu Highway is oriented in a north-south direction and Hualalai Road is oriented in an east-west direction.
    b. Three-leg, STOP sign controlled intersection with dedicated left turning lanes for the southbound and westbound approaches.
    c. Channelized right turn lanes exist for the northbound and westbound approaches.
    d. A refuge lane is provided for the westbound left turns onto Queen Kaahumanu Highway.
5. Queen Kaahumanu Highway and Puapuaanui Street
    a. Queen Kaahumanu Highway is oriented in a north-south direction and Puapuaanui Street is oriented in an east-west direction.
    b. Three-leg, signalized intersection with dedicated left turning lanes for the southbound and westbound approaches.
    c. The southbound left turn is protected.
    d. Channelized right turn lanes provided for the northbound and westbound approaches.
6. Queen Kaahumanu Highway and Kuakini Highway
    a. Queen Kaahumanu Highway is oriented in a north-south direction and Kuakini Highway is oriented in an east-west direction.
    b. Three-leg, STOP sign controlled intersection with dedicated left turning lanes for northbound and eastbound.
    c. Channelized right turn lanes exist for the eastbound and southbound approaches.
    d. A refuge lane is provided for the eastbound left turns onto Queen Kaahumanu Highway.
    e. Kuakini Highway is a state-owned facility.
7. Queen Kaahumanu Highway and Lako Street
    a. Queen Kaahumanu Highway is oriented in a north-south direction and Lako Street is oriented in an east-west direction.
    b. Four-leg, signalized intersection with dedicated left turning lanes for each approach.
    c. Left turns from Queen Kaahumanu Highway onto Lako Street are protected-permitted. This is the only intersection in the project area on Queen Kaahumanu Highway that uses protected-permitted phasing. The Lako Street phases are split.
    d. Channelized right turn lanes exist for each approach.
8. Queen Kaahumanu Highway and Kamehameha III Road
    a. Queen Kaahumanu Highway is oriented in a north-south direction and Kamehameha III Road is oriented in an east-west direction.
    b. Four-leg, signalized intersection with dedicated left turn lanes exist on northbound, and southbound approaches.
    c. Left turns from Queen Kaahumanu Highway are protected. The Kamehameha III Road phases are split.
    d. Channelized right turn lane exists for southbound and eastbound approach.

Existing (2019) lane configurations and traffic controls at the study intersections are shown in Figure 3.

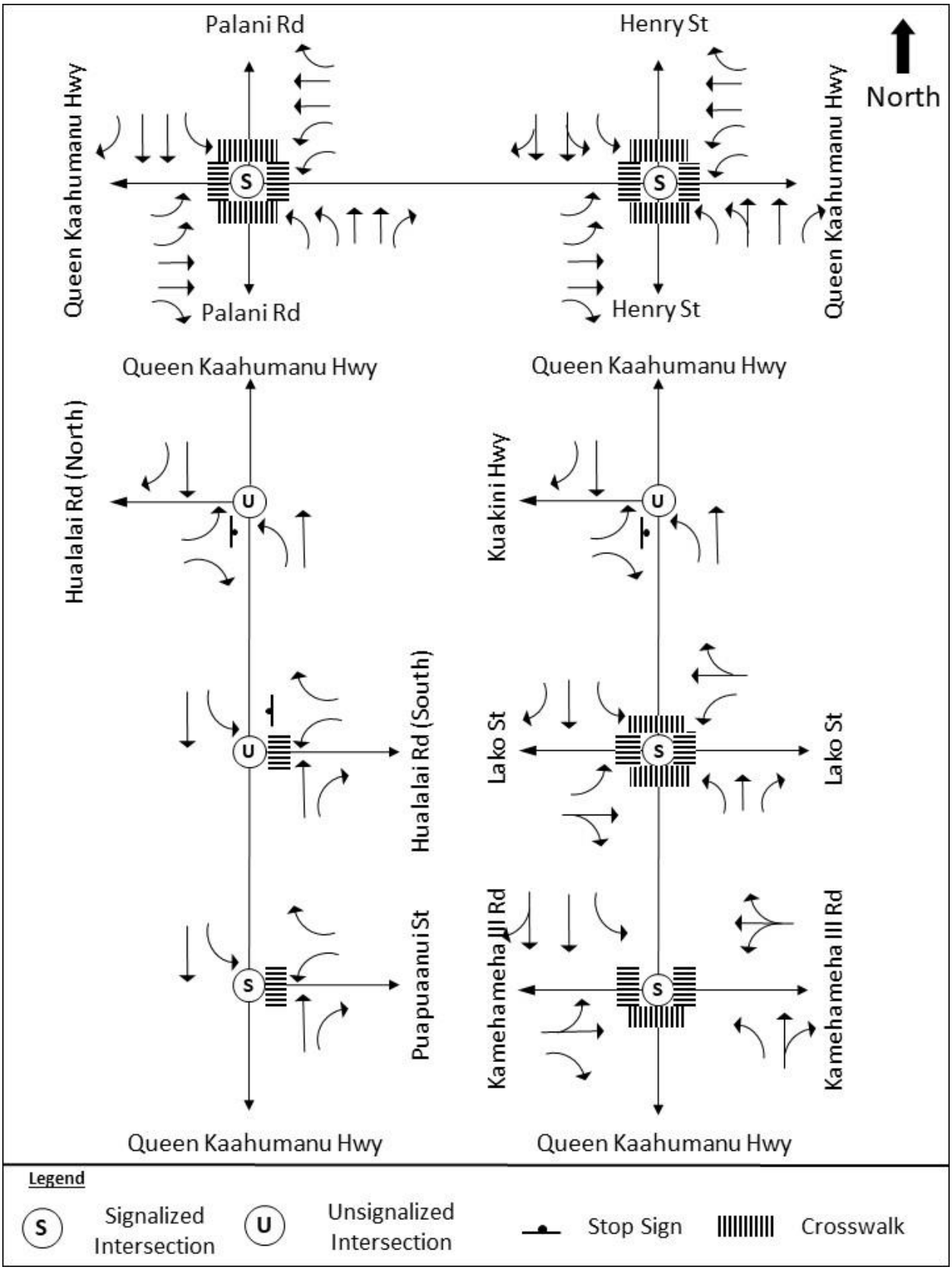


Figure 3: Existing 2019 Lane Configuration

3. Pedestrian Facilities

Sidewalks are provided on each corner of Palani Road and Henry Street. A sidewalk is provided on the south side of Queen Kaahumanu Highway between Palani Road and Henry Street. Sidewalks are provided on both sides of Puapuaanui Street and stop just before the intersection with Queen Kaahumanu Highway. The crosswalks provided at each intersection are shown in Figure 3.

4. Bike Facilities

Marked bike lanes are provided on Queen Kaahumanu Highway at Henry Street and extend north. There are no marked bike lanes south of this intersection. There are bike lanes on Lako Street east of Queen Kaahumanu Highway to Hualalai Road. Based on the State Route System, marked shoulders along Queen Kaahumanu Highway in the study area range from 6 feet to 10 feet.

5. Bus Stops and Bus Routes

The County of Hawaii's transit system (Hele-on Bus) doesn't have bus routes that travel along Queen Kaahumanu Highway near the study area. The closest bus stops to the proposed facility are located at Kona Commons Shopping Center, more than 3 miles away. The Intra Kona bus route serves this stop and operates between 6:55 AM to 8:30 PM, Monday to Saturday. Appendix B includes the detailed bus route schedule and map for this route.

B. Volumes

1. Vehicular Volume

a) Roadway Traffic Volumes

Historical average daily traffic (ADT) and peak hour volumes along Queen Kaahumanu Highway in the study area are shown in Table 1. The ADT is based on Hawaii DOT traffic counts included in *Historical Traffic Station Maps*.

Table 1: Roadway Traffic Volumes

Roadway	Location	ADT	Year
Queen Kaahumanu Highway	Between Nani Kailua Drive and Hualalai Road.	25,800	2016
		25,900	2015

Source: *Historical Traffic Station Maps* (HDOT)

The 24-hour traffic volume distribution along Queen Kaahumanu Highway (see Figure 4) at the traffic count station shows a variation in travel patterns throughout the day with prominent morning and afternoon commuter peak periods. Detailed 24-hour counts are included in Appendix A.

Along Queen Kaahumanu Highway, during the morning peak hour of 7:00 - 8:00 AM, there were approximately 1,083 vehicles per hour (vph) travelling northbound and 765 vph travelling southbound for a total of 1,848 vph. During the afternoon peak hour of 3:45 – 4:45 PM, there were approximately 914 vph travelling northbound and 1,017 travelling southbound for a total of 1,931 vph.

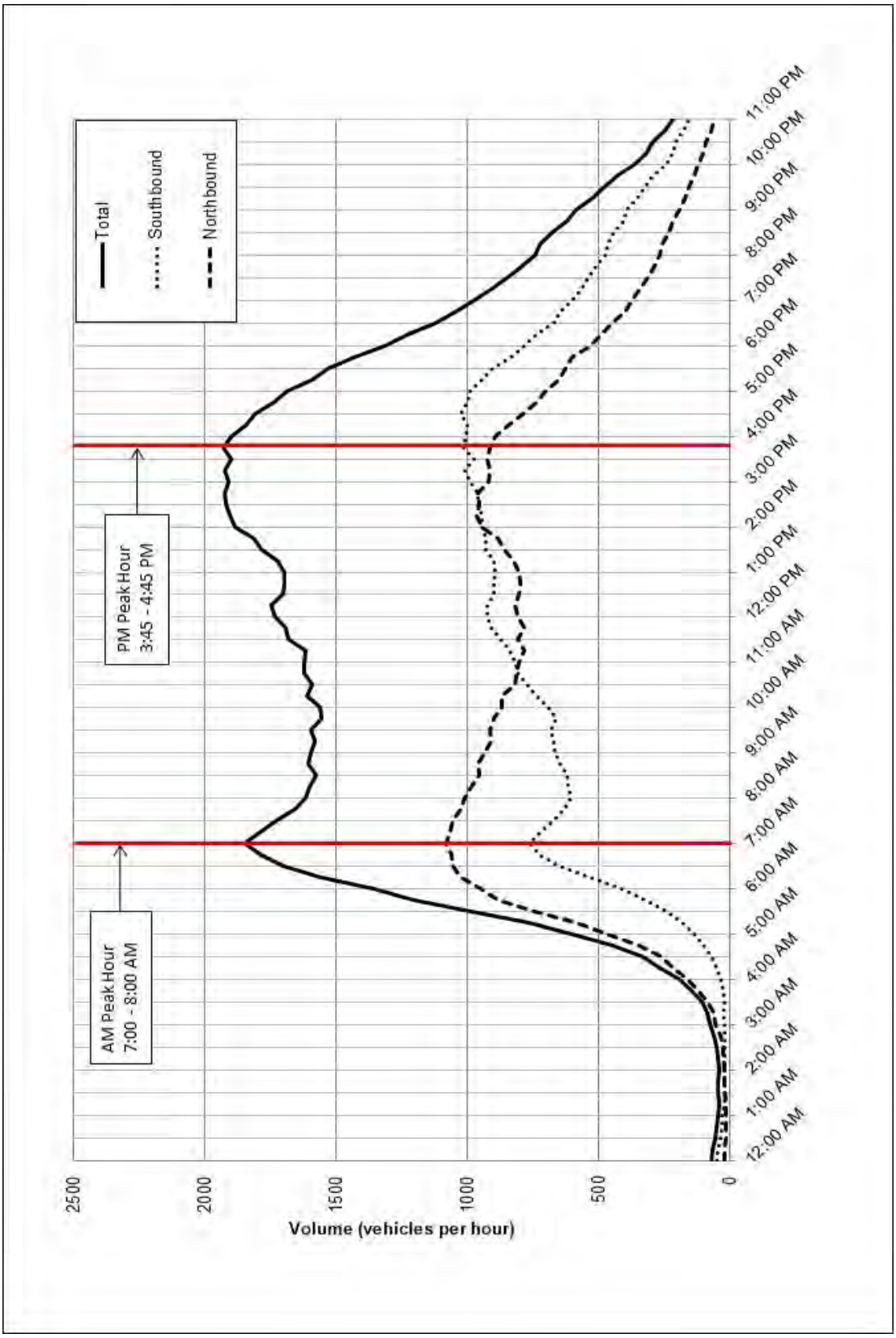


Figure 4: Queen Kaahumanu Hwy (Nani Kailua Dr to Hualalai Rd), 24-Hour Volume Distribution (2016)

b) Existing 2019 Intersection Peak Hour Volumes

Manual intersection turning movement traffic counts were taken at the eight study intersections: 1) Queen Kaahumanu Highway and Palani Road, 2) Queen Kaahumanu Highway and Henry Street, 3) Queen Kaahumanu Highway and Hualalai Road (north), 4) Queen Kaahumanu Highway and Hualalai Road (south), 5) Queen Kaahumanu Highway and Puapuaanui Street, 6) Queen Kaahumanu Highway and Kuakini Highway, 7) Queen Kaahumanu Highway and Lako Street, and 8) Queen Kaahumanu Highway and Kamehameha III Road. Counts were collected during the peak periods on Tuesday, April 30, 2019 and Thursday, August 24, 2019. Counts included tabulation of passenger vehicles, heavy trucks, pedestrians, and bicycles. The Existing (2019) peak hour volumes are shown in Figure 5. Detailed peak period counts are included in Appendix A. Pedestrian and Bicycle Volumes

2. Pedestrian and Bicycle Volumes

Queen Kaahumanu Highway is a frequently used training route for Ironman and therefore has regular bicycle activity. Table 2 shows the 2019 pedestrian and bicycle volumes. Most of the observed pedestrian activity occurred at Henry Street. Bicycle counts were higher in the AM peak hour than the PM peak hour.

Table 2: 2019 Pedestrian and Bicycle Volumes

Study Intersection	AM		PM	
	Ped	Bike	Ped	Bike
Queen Kaahumanu Hwy & Palani Rd	1	3	4	3
Queen Kaahumanu Hwy & Henry St	9	4	12	4
Queen Kaahumanu Hwy & Hualalai Rd (N)	0	3	0	1
Queen Kaahumanu Hwy & Hualalai Rd (S)	0	4	0	0
Queen Kaahumanu Hwy & Puapuaanui St	0	2	1	0
Queen Kaahumanu Hwy & Kuakini Hwy	0	2	0	0
Queen Kaahumanu Hwy & Lako St	1	2	1	0
Queen Kaahumanu Hwy & Kamehameha III Rd	1	10	0	2

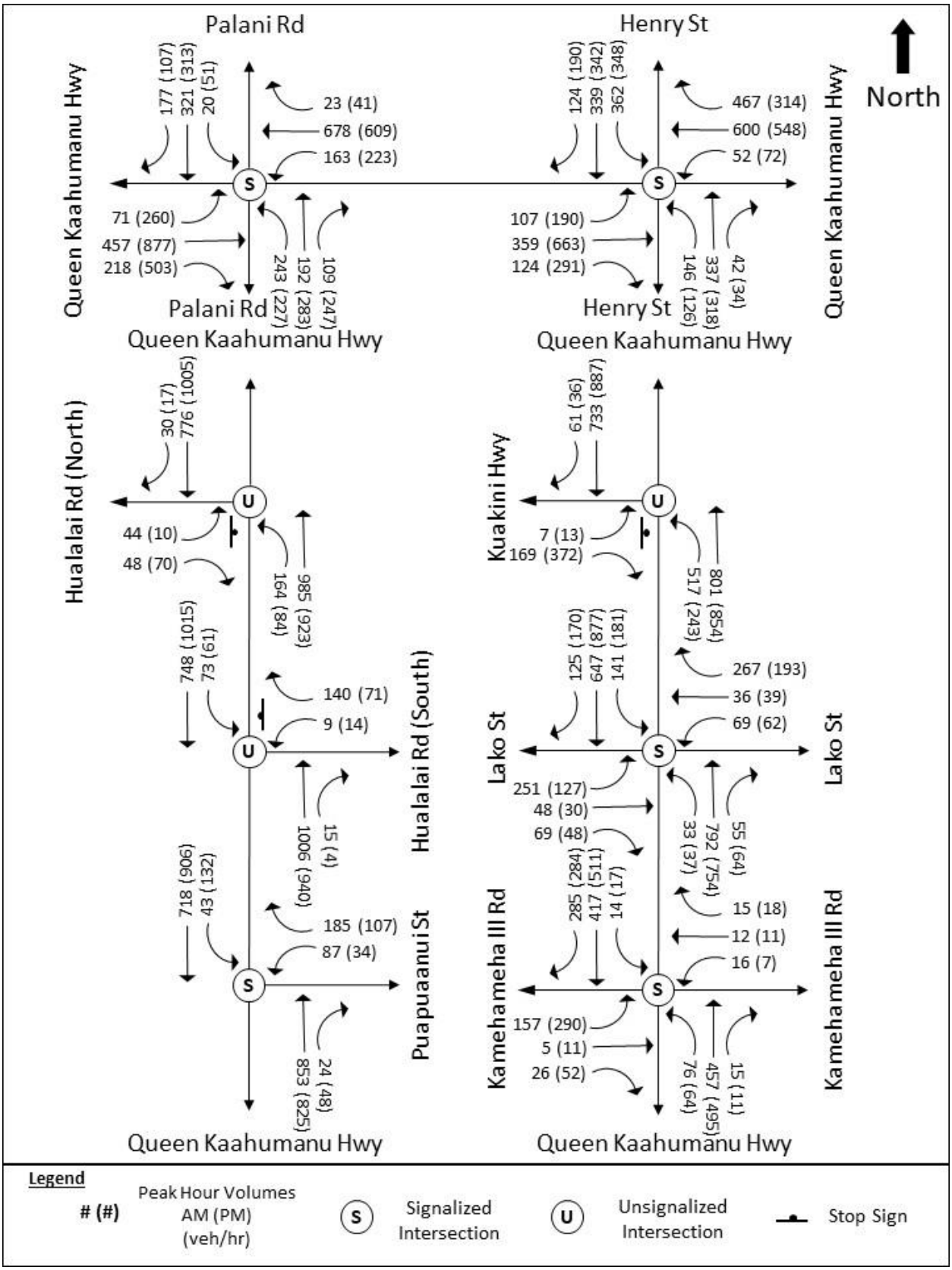


Figure 5: Existing 2019 Peak Hour Volumes

C. Traffic Operation Analysis

1. Level of Service Methodology

Level of service (LOS) is an operational analysis rating system used in traffic engineering to measure the effectiveness of roadway operating conditions. There are six LOS ranging from A to F. LOS A is defined as being the least interrupted flow conditions with little or no delays, whereas LOS F is defined as conditions where extreme delays exist. Guidelines from the *County of Hawaii* Chapter 25 (Zoning), Article 2 (Administration and Enforcement), Division 4 (Amendments), Section 46 (Concurrency Requirements) state that an"Acceptable level of service" means that the level of service of a transportation facility at the a.m. and p.m. peak hour is "D" or better. Level of service, or LOS, means a qualitative measure describing operational conditions within a traffic stream and shall be determined using the procedures in the latest edition of the Highway Capacity Manual, Transportation Research Board. Intersection LOS and delay were determined for the AM and PM peak hours using *Synchro 10* traffic analysis software and analyzed using *HCM* 6th Edition (TRB, 2016) methodologies.

As stated in the *Highway Capacity Manual* (*HCM*) 6th Edition (TRB, 2016), LOS for a two-way stop controlled (TWSC) intersection is determined by the measured control delay (see Table 3) and is defined for each movement. Vehicles traveling along the major, free-flow road, of a TWSC intersection, proceed through with minimal delay or no delay at all. Those vehicles approaching the intersection along the minor movement are controlled by a stop sign and thus experience delay attributable to the volume of vehicles passing along the free-flow road and the gaps available.

Table 3: LOS Criteria for Unsignalized Intersections

Average Control Delay (s/veh)	LOS by v/c Ratio	
	<=1.0	>1.0
≤ 10.0	A	F
>10 and ≤15	B	F
>15 and ≤25	C	F
>25 and ≤35	D	F
>35 and ≤50	E	F
>50	F	F

Source: *HCM* (TRB, 2016)

The LOS analysis for signalized intersections is based on average total vehicle delay based on the methodologies of the *HCM* (TRB, 2016), as shown in Table 4. The HCM 6th Edition doesn't support the analysis with both exclusive and shared lanes. In those cases, methodologies from HCM (TRB, 2000) are used.

Another measure of intersection delay is the volume to capacity (v/c) ratio. This is the ratio of the volume of traffic utilizing the intersection compared to the maximum volume of vehicles that can be accommodated by the intersection during a specific period. A v/c ratio under 0.85 means the intersection

is operating under capacity and excessive delays are not experienced. An intersection is operating near its capacity when v/c ratios range from 0.85 to 0.95. Unstable flows are expected when the v/c ratio is between 0.95 and 1.0. A traffic movement can have a poor LOS but low v/c, which suggests that the traffic volumes along that movement are low but must wait a long time to make the movement. This is common for low volume protected turn movements or side streets that must wait through a long cycle length for their split to come up.

Table 4: LOS Criteria for Signalized Intersections

Average Control Delay (s/veh)	LOS by v/c Ratio	LOS by v/c Ratio
	<=1.0	>=1.0
≤ 10.0	A	F
>10 and ≤20	B	F
>20 and ≤35	C	F
>35 and ≤55	D	F
>55 and ≤80	E	F
>80	F	F

Source: *HCM* (TRB, 2016)

Where signalized intersections are less than 2.0 miles apart, the facility should be classified as an urban street and analyzed with the methodologies of Urban Street Facilities (HCM, Chapter 16). For Urban Street Facilities, through vehicle travel speed is used to analyze vehicular LOS. This speed reflects the factors that influence running time along each link, and the delay incurred by through vehicles at each boundary intersection. This performance measure indicates the degree of mobility provided by the facility.

2. Existing 2019 Intersection LOS

Existing intersection and movement LOS and average delay (in seconds per vehicle) were determined for the AM and PM peak hours.

1. Queen Kaahumanu Highway and Palani Road. Overall Intersection LOS = C/C (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Palani Road resulted in appropriate LOS D or better during AM and PM peak hours.
2. Queen Kaahumanu Highway and Henry Street Overall Intersection LOS = C/C (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Henry Street resulted in appropriate LOS D or better during AM and PM peak hours.
3. Queen Kaahumanu Highway and Hualalai Road (North)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Street (north), eastbound left turning movement has LOS F (v/c of 1.31 and 0.23 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.

4. Queen Kaahumanu Highway and Hualalai Road (South)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Road (south), westbound left turning movement has LOS F (v/c of 0.18 and 0.31 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
5. Queen Kaahumanu Highway and Puapuaanui Street Overall Intersection LOS = A/A (AM/PM)
   The AM left turns operate at LOS E. The westbound left turn operates at LOS E during the PM peak hour. The left turn volumes are low and should clear every cycle. These delays are due to the cycle length.
6. Queen Kaahumanu Highway and Kuakini Highway
   At the unsignalized intersection of Queen Kaahumanu Highway with Kuakini Highway, eastbound left turning movement has LOS F (v/c of 1.08 and 0.46 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
7. Queen Kaahumanu Highway and Lako Street. Overall Intersection LOS = C/C (AM/PM)
   At the signalized intersection of Queen Kaahumanu Highway with Lako Street, the eastbound left turn operates at LOS E during the AM peak hour. This delay is attributed to the high eastbound left turn volume, and the split phasing for the Lako Street approaches. All other movements at Lako Street operates at LOS D or better during both peak hours.
8. Queen Kaahumanu Highway and Kamehameha III Road. Overall Intersection LOS = B/C (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Kamehameha III Road resulted in appropriate LOS D or better during AM and PM peak hours.

Tables 5 and 6 show the existing vehicular delay and level of service at each intersection. The shaded row indicates the overall intersection delay. Synchro output is in Appendix C.

3. Existing 2019 Traffic Signal Warrant

Four-Hour and Peak-Hour traffic signal warrants were evaluated at the unsignalized intersections. The 2009 MUTCD states: “At an intersection with high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the ‘minor-street’ volume and the corresponding single direction of opposing traffic on the major street as the ‘major-street” volume’ For analysis purposes, the Queen Kaahumanu Highway left turn was considered the minor street approach, and the opposing through volume was considered the major street approach. The satisfaction of a warrant does not necessarily require installing a traffic signal. The single Peak Hour warrant especially is not a good measure of whether or not a traffic signal should be installed in this setting. It is being evaluated and provided only as an indicator of when an intersection should be monitored. Traffic Signal Warrant analysis can be found in Appendix J.

For the Four-Hour warrant, Figure 4C-2 (MUTCD) was used since the posted speed limit on Queen Kaahumanu Highway is over 40 MPH. The “1 Lane & 1 Lane” curve was used for analysis. Table 7 shows the Four-Hour warrant analysis.

For the Peak-Hour warrant, Figure 4C-4 (MUTCD) was used since the posted speed limit on Queen Kaahumanu Highway is over 40 MPH. The "1 Lane & 1 Lane" curve was used for analysis. Table 8 shows the Peak-Hour warrant analysis.

1. Queen Kaahumanu Highway and Hualalai Road (North)
   This intersection passes the Four-Hour warrant and the Peak-Hour warrant in the AM peak hour.
2. Queen Kaahumanu Highway and Hualalai Road (South)
   This intersection does not pass either warrant.
3. Queen Kaahumanu Highway and Kuakini Highway
   This intersection passes the Four-Hour warrant and the Peak-Hour warrant in both the AM and PM peak hours.

Table 5: Existing 2019 Intersection Level of Service

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Palani Rd (overall)	**23.7**	**-**	**C**	**26.1**	**-**	**C**
Queen Kaahumanu EB Left	38.6	0.45	D	38.0	0.74	D
Queen Kaahumanu EB Through	14.1	0.30	B	17.9	0.57	B
Queen Kaahumanu WB Left	38.9	0.67	D	38.8	0.72	D
Queen Kaahumanu WB Through	14.2	0.42	B	16.4	0.41	B
Palani NB Left	37.4	0.72	D	39.1	0.73	D
Palani NB Through	25.8	0.25	C	28.8	0.42	C
Palani SB Left	47.7	0.50	D	48.3	0.68	D
Palani SB Through	33.7	0.66	C	33.6	0.62	C
Queen Kaahumanu Hwy & Henry St (overall)	**31.8**	**0.62**	**C**	**32.6**	**0.65**	**C**
Queen Kaahumanu EB Left	43.6	0.50	D	46.7	0.65	D
Queen Kaahumanu EB Through	24.6	0.34	C	27.8	0.57	C
Queen Kaahumanu EB Right	22.0	0.08	C	23.1	0.19	C
Queen Kaahumanu WB Left	45.0	0.37	D	48.4	0.52	D
Queen Kaahumanu WB Through	30.5	0.60	C	31.0	0.56	C
Queen Kaahumanu WB Right	26.9	0.31	C	26.7	0.21	C
Henry NB Left	34.9	0.46	C	35.9	0.41	D
Henry NB Left-Through	35.8	0.58	D	37.1	0.56	D
Henry NB Right	31.0	0.03	C	32.5	0.02	C
Henry SB Left	38.3	0.72	D	39.3	0.73	D
Henry SB Left-Through-Right	34.6	0.69	C	34.2	0.67	C
Queen Kaahumanu Hwy & Hualalai (N) (overall)	**10.3**	**-**	**-**	**1.0**	**-**	**-**
Queen Kaahumanu NB Left	10.8	0.22	B	11.2	0.13	B
Hualalai EB Left	429.0	1.31	F	107.3	0.23	F

Table 6: Existing 2019 Intersection Level of Service (continued)

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Hualalai (S) (overall)	**3.3**	**-**	**-**	**1.7**	**-**	**-**
Queen Kaahumanu SB Left	11.5	0.13	B	10.8	0.09	B
Hualalai WB Left	87.5	0.18	F	112.5	0.31	F
Hualalai WB Right	35.8	0.58	E	20.4	0.24	C
Queen Kaahumanu Hwy & Puapuaanui St (overall)	**9.7**	**-**	**A**	**9.8**	**-**	**A**
Queen Kaahumanu SB Left	60.4	0.71	E	53.1	0.81	D
Queen Kaahumanu WB Through	3.3	0.50	A	3.0	0.57	A
Puapuaanui WB Left	55.4	0.78	E	56.0	0.62	E
Puapuaanui WB Right	7.9	0.64	A	8.5	0.63	A
Queen Kaahumanu Hwy & Kuakini Hwy (overall)	**7.7**	**-**	**-**	**2.8**	**-**	**-**
Queen Kaahumanu NB Left	17.6	0.67	C	12.1	0.33	B
Kuakini EB Left	1035.4	1.08	F	208.2	0.46	F
Queen Kaahumanu Hwy & Lako St (overall)	**30.6**	**-**	**C**	**21.8**	**-**	**C**
Queen Kaahumanu NB Left	12.8	0.10	B	12.8	0.14	B
Queen Kaahumanu NB Through	30.4	0.87	C	18.8	0.75	B
Queen Kaahumanu SB Left	21.9	0.58	C	13.5	0.51	B
Queen Kaahumanu SB Through	19.2	0.68	B	20.1	0.82	C
Lako EB Left	60.2	0.88	E	44.3	0.76	D
Lako EB Through-Right	34.1	0.16	C	35.7	0.17	D
Lako WB Left	50.5	0.66	D	45.9	0.64	D
Lako WB Through-Right	44.5	0.33	D	41.2	0.39	D
Queen Kaahumanu Hwy & Kam III Rd (overall)	**17.7**	**-**	**B**	**22.0**	**-**	**C**
Queen Kaahumanu NB Left	43.5	0.79	D	47.2	0.75	D
Queen Kaahumanu NB Through	12.4	0.55	B	17.4	0.60	B
Queen Kaahumanu SB Left	42.2	0.46	D	45.7	0.48	D
Queen Kaahumanu SB Through	10.3	0.27	B	14.0	0.34	B
Kamehameha EB Left-Through	32.0	0.73	C	34.1	0.84	C
Kamehameha WB Left-Through-Right	41.4	0.66	D	44.9	0.61	D

Table 7: Four-Hour Warrant based on 2019 traffic volumes

Existing - Hualalai (N)	4-Hour Warrant		
	Major	Minor	Warrant?
6:45-7:45 AM	776	164	YES
7:45-8:45 AM	692	145	YES
3:00-4:00 PM	1005	84	YES
4:00-5:00 PM	926	74	YES
5:00-6:00 PM	986	58	NO
Existing - Hualalai (S)	4-Hour Warrant		
	Major	Minor	Warrant?
6:45-7:45 AM	1006	70	YES
7:45-8:45 AM	1030	26	NO
3:00-4:00 PM	940	59	NO
4:00-5:00 PM	864	64	NO
5:00-6:00 PM	765	56	NO
Existing - Kuakini	4-Hour Warrant		
	Major	Minor	Warrant?
6:45-7:45 AM	776	335	YES
7:45-8:45 AM	683	467	YES
3:00-4:00 PM	881	224	YES
4:00-5:00 PM	872	264	YES
5:00-6:00 PM	870	217	YES

Table 8: Peak-Hour Warrant based on 2019 traffic volumes[1]

Existing	Peak Hour Warrant					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	776	164	YES	1005	84	NO
Hualalai (S)	1006	73	NO	940	61	NO
Kuakini	733	517	YES	887	243	YES

[1] Single Peak Hour warrant was evaluated because sufficient data was available and to give an indication of whether or not an intersection should be considered and monitored for a traffic signal.

III. Near-Term (2024) – Completion of Phase 1

A. Surrounding Areas

Phase 1 is expected to be completed by 2024, representing the 5-year future forecast. Phase 1 will contain 258 dwelling units, and the only point of access will be the Royal Vistas Roadway intersecting with Queen Kaahumanu Highway, about 600 feet north of the Kuakini Highway intersection.

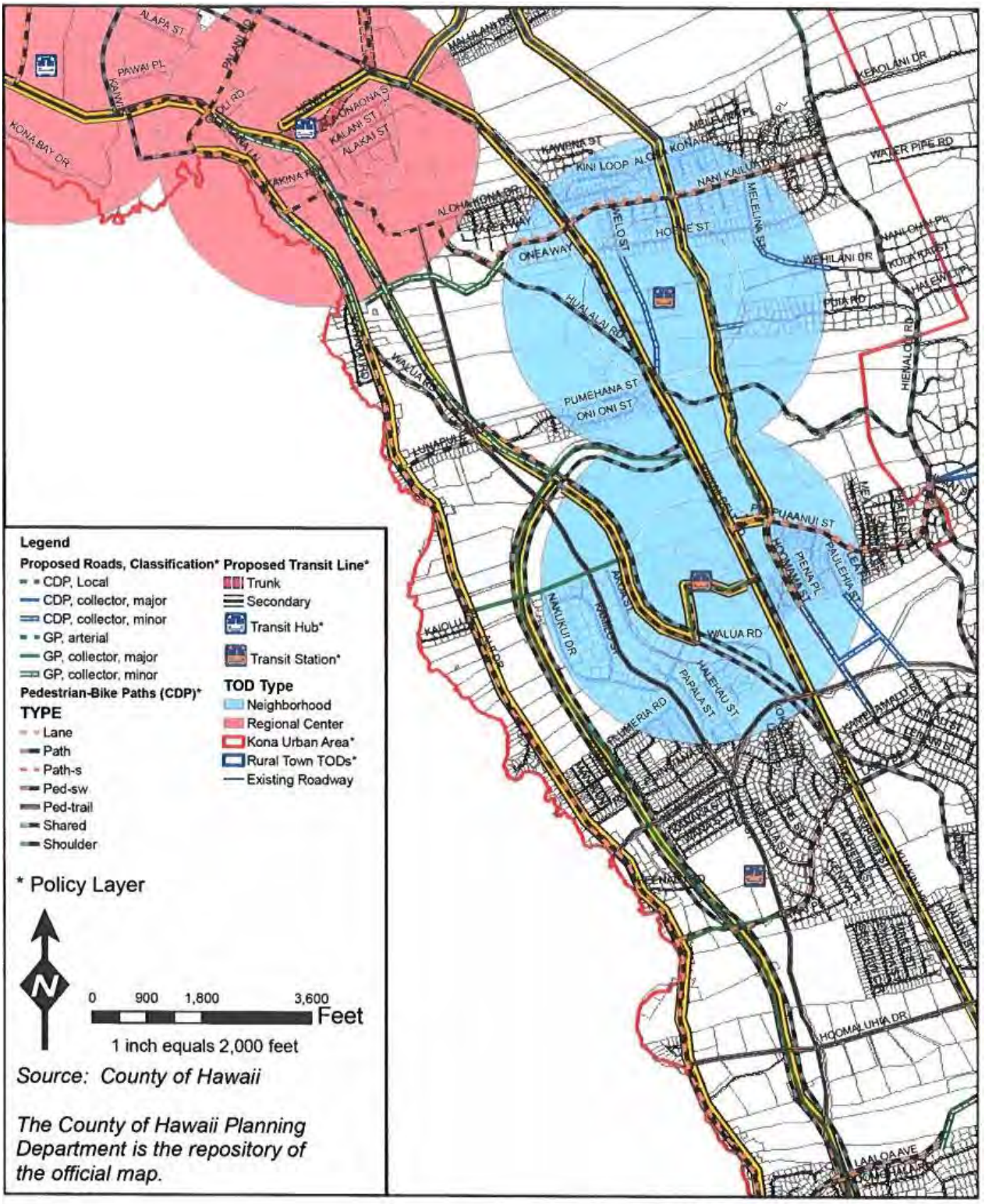
The official Transportation Network Map – Nani Kailua Area from the Kona Community Development Plan shows future connections of 'minor collectors' running parallel to Queen Kaahumanu Highway in the location of Royal Vistas, extending Hoomama Street to Leilani Street and Paulehia Street to Kekuanaoa Place, as shown in Figure 6. The timing of these improvements is undetermined, but it is not expected they will be completed prior to 2024. The most likely scenario is that the developers of Royal Vistas will complete a collector to the south before Phase 2 is occupied.

Based on the HDOT *Federal-Aid Highways 2035 Transportation Plan for the District of Hawaii* (July 2014), Kuakini Highway from Henry Street to Kamehameha III Road will be widened by 2 travel lanes and include bicycle facilities and sidewalks.

Bike Plan Hawaii (2003) references several near-term projects. Two of the projects nearby are: a signed shared road on Kuakini Highway from Lako Street to Hualalai Road, and a signed shared road on Queen Kaahumanu Highway from Henry Street to Kuakini Highway.

The 2011 Statewide Pedestrian Master Plan does not include any pedestrian facility upgrades or construction in the project area.

No other significant developments or future construction projects are expected in the surrounding area that would significantly affect the roadway geometrics or traffic volumes at the study intersections. This is based on research completed on October 10, 2019 at the State of Hawaii Office of Environmental Quality Control (OEQC) website and the Statewide Transportation Improvements Program (STIP). The projects referenced in the long-range transportation plan and Bike Plan Hawaii are not found in the STIP. The impacts of these projects were not considered in this TIAR.



Kona Community Development Plan

Figure 6: Kona Community Development Plan

B. Volumes

1. Future 2024 Without Project Volumes

The project study area within Kona has been experiencing modest growth. HDOT ADT counts on Queen Kaahumanu Highway between Nani Kailua Drive and Hualalai Road didn't show any increase in vehicular volumes from 2015 to 2016. The 2035 Federal Aid Highways Long Range Transportation Plan forecasts average daily traffic in Kona on Hawaii Belt Road to be 41,900 vehicles in 2020 and 48,000 vehicles in 2035. This equates to a 1% annual growth rate over 15 years in the Kona area. A background growth rate of 1% per year was assumed, to account for additional traffic at the study intersections. The estimated future volumes without the project for the future year 2024 are shown in Figure 7.

2. Project Related Volumes

The proposed Royal Vistas include 258 multi-family residential dwelling units for Phase 1. All of these are expected to be low rise units with two or three stories. Trips generated from the proposed facility were estimated using nationally accepted land use rates from the *Trip Generation*, 10th Edition (ITE, 2016). ITE defines the Multi-family Housing (Low Rise) Land Use [220] as follows: "includes apartments, townhouses and condominiums located within the same building with at least three other dwelling units" The analysis used 258 dwelling units as the independent variable to estimate new trips expected from the proposed project. The estimates for new trips generated by the project are shown in Table 9.

Table 9: Estimated Trips Generated - Phase 1

	AM		PM	
Land Use [ITE Code]	**Equation**		**Equation**	
Multi-family Housing (Low Rise) [220]	Ln (T) = 0.95 Ln (X) – 0.51		Ln (T) = 0.89*Ln (X) - 0.02	
Dwelling Units	258		258	
New Trips	117		137	
	In[2]	**Out**	**In**	**Out**
	23%	77%	63%	37%
	27	90	86	51

T = Total number of trips generated, X = Dwelling Units

3. Trip Distribution

Trips generated by the Royal Vistas Phase 1 will enter and exit at the Royal Vistas Roadway and be distributed onto Queen Kaahumanu Highway. The trips were distributed according to existing travel patterns.

The segment volumes between Puapuaanui Street and Kuakini Street were used to determine the inbound percent distribution.

[2] In and Out split provided by *Trip Generation*, 10th Edition (ITE 2016) for Land Use 220

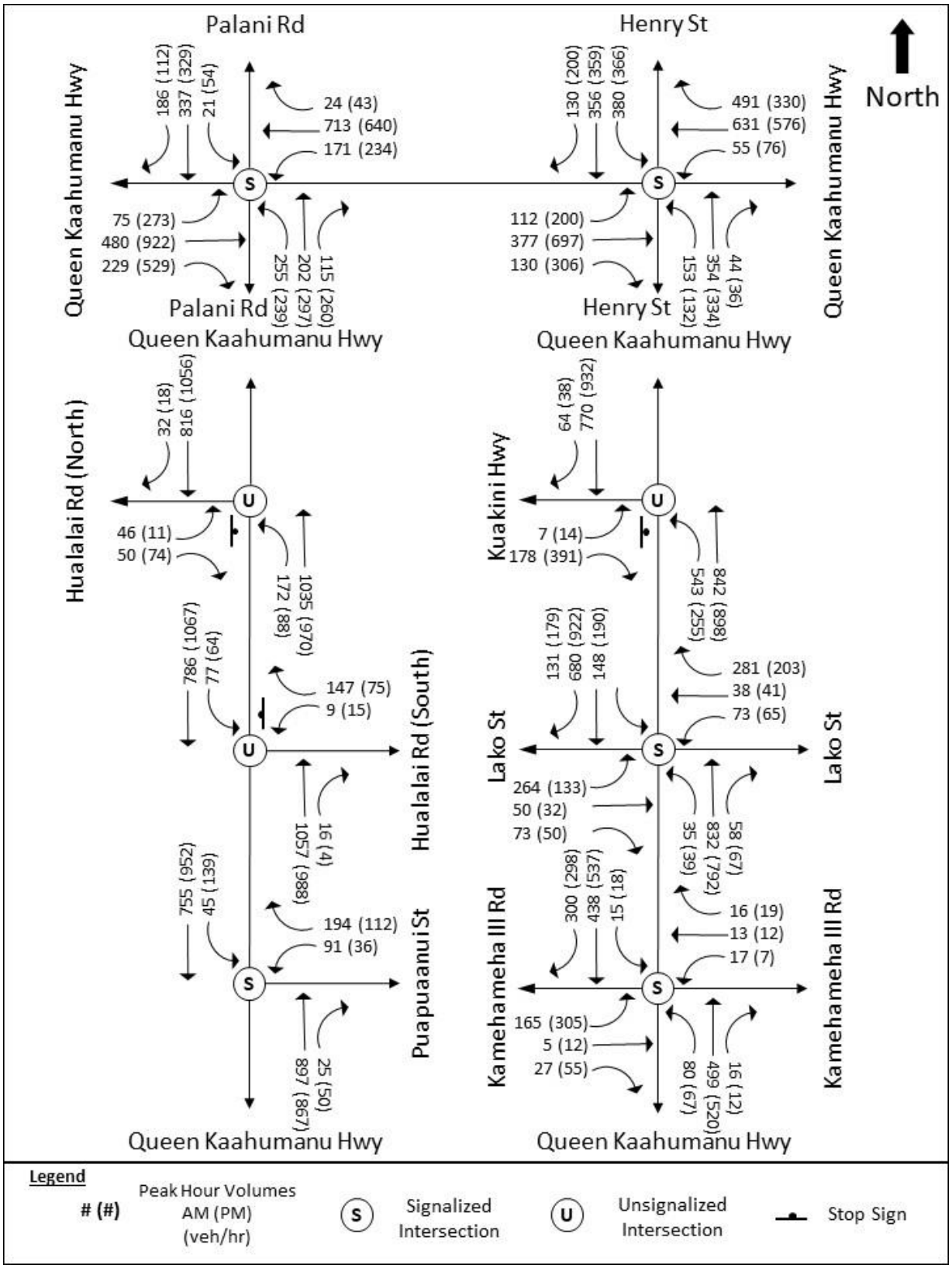


Figure 7: Future 2024 Without Project Peak Hour Volumes

Based on the existing traffic volumes on Queen Kaahumanu Highway between Puapuaanui Street and Lako Street, the AM peak hour direction is northbound, and the PM peak hour direction is southbound. Table 10 shows the directional percentages at Queen Kaahumanu Highway and Puapuaanui Street that were used to determine the inbound trip distribution.

Table 10: 2019 Volumes on Queen Kaahumanu Highway between Puapuaanui St and Kuakini Highway

	AM		PM	
	NB	SB	NB	SB
Volume	877[3]	805	873	940
Percent	52%	48%	48%	52%

The outbound volumes at Puapuaanui Street were used to determine the outbound percent distribution. Royal Vistas will have the same land use as Pualani Estates, which is just north of Royal Vistas and currently uses Puapuaanui Street as the main access to Queen Kaahumanu Highway. Outbound traffic distribution for Pualani Estates at Puapuaanui Street is anticipated to have a similar outbound distribution at Royal Vistas Roadway. Table 11 shows the existing outbound volumes for Pualani Estates at Puapuaanui Street during the AM and PM peak hours. The percentages shown in Table 11 were used for the outbound trip distribution at the Royal Vistas Roadway intersecting Queen Kaahumanu Highway.

Table 11: 2019 Outbound volumes at Puapuaanui Street

	AM		PM	
	WBR	WBL	WBR	WBL
Volume	185	87	107	34
Percent	68%	32%	76%	24%

The future 'with project' scenario analyzed the Royal Vistas Roadway approach to have a left turn and a right turn lane. Turn lanes are provided for the southbound left turn and northbound right turn into Royal Vistas. Right turns are channelized. A peak hour traffic signal warrant and a 4-hour traffic signal warrant were conducted for the new Royal Vistas Roadway. The new roadway intersection did not warrant a signal during the AM or PM peak hour. This intersection was analyzed as a two-way stop-controlled intersection. A crosswalk would be provided on the east side of the intersection for pedestrian connectivity. A refuge lane for westbound left turns onto Queen Kaahumanu Highway is recommended as this is an unsignalized intersection and will make this turn easier for the driver. The expected future lane configuration is shown in Figure 8. Project related trips for 2024 (Phase 1) are shown in Figure 9.

4. Future 2024 With Project Volumes

Phase 1 project related trips were added to the Future 2024 Without Project volumes to estimate Future 2024 With Project peak hour volumes (see Figure 10).

[3] Hourly Volumes taken from 2019 intersection counts at Puapuaanui Street.

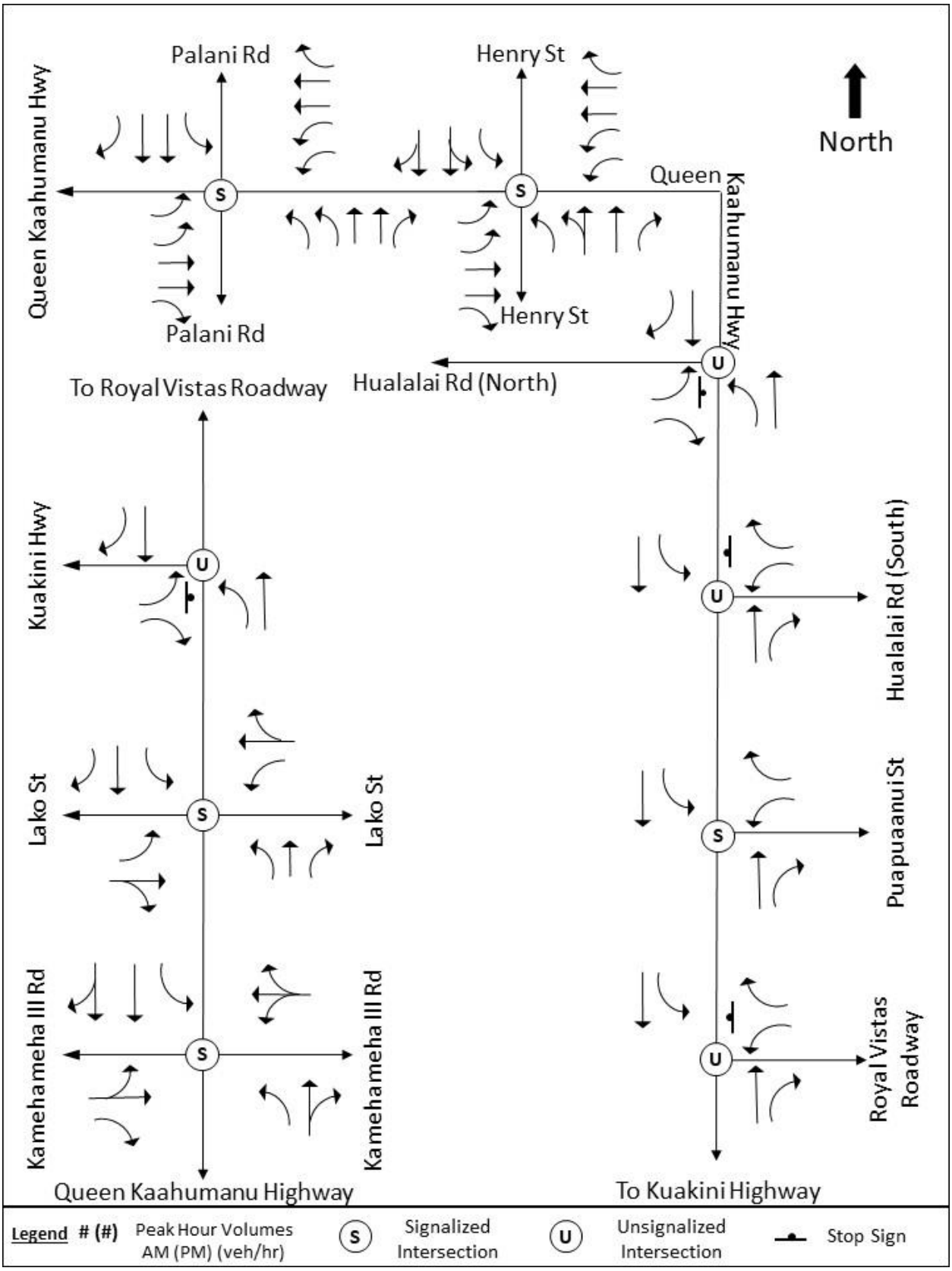


Figure 8: Expected Future Lane Configuration

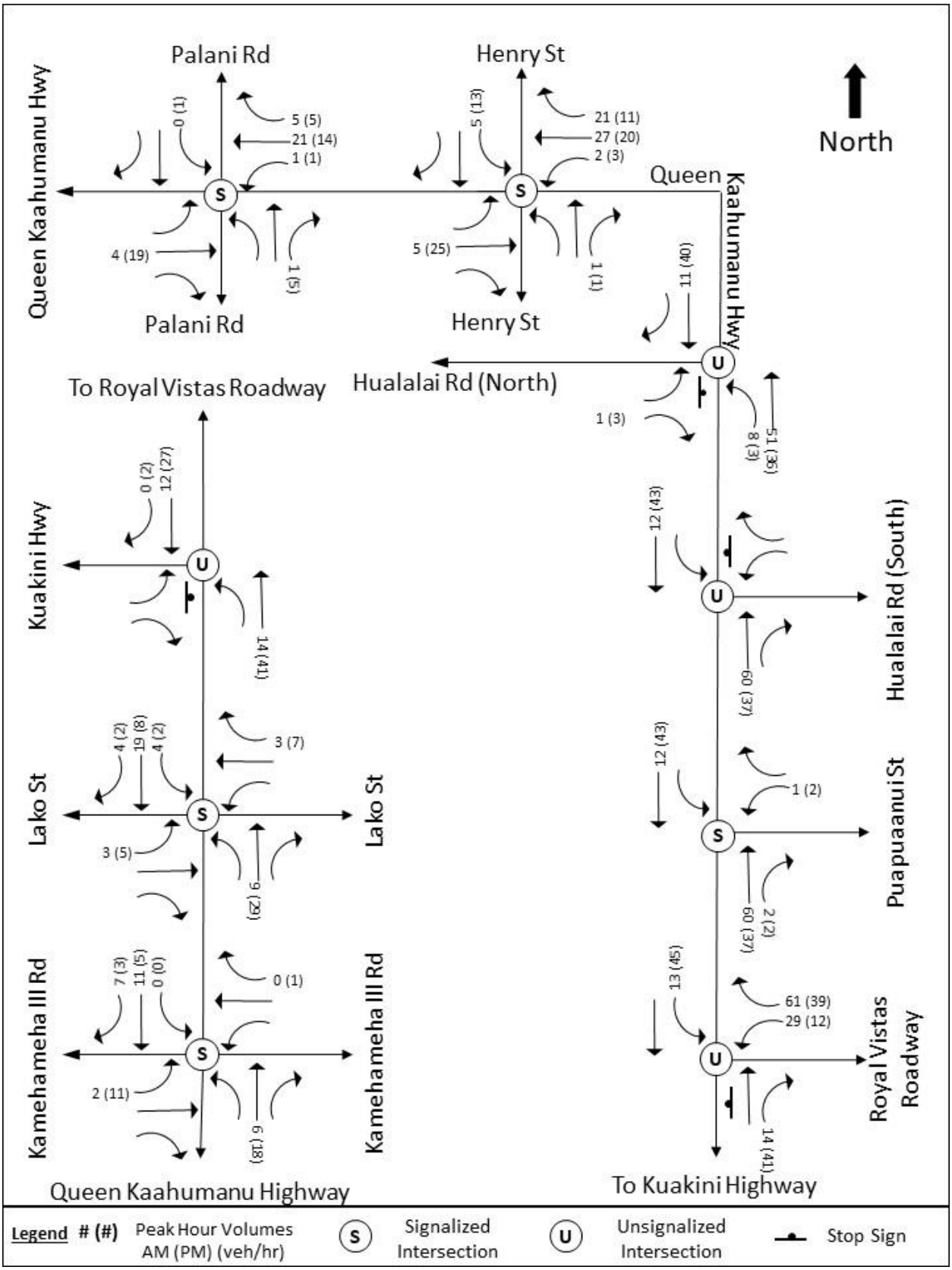


Figure 9: Phase 1 Project Related Trips

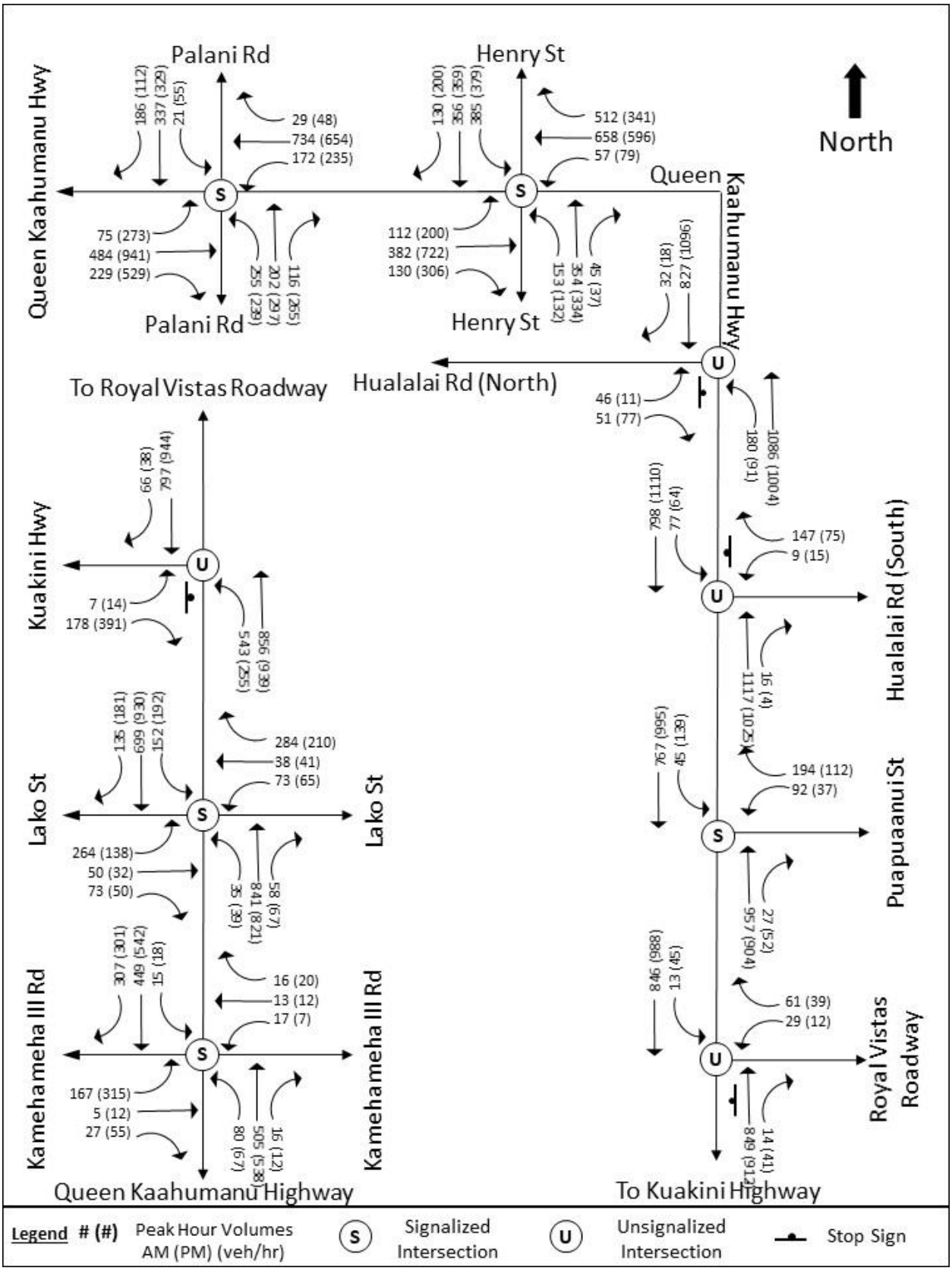


Figure 10: Future 2024 With Project Peak Hour Volumes

C. Future 2024 Intersection Traffic Operation Analysis

1. Future 2024 Without Project Intersection LOS

The 2024 Without Project intersection and movement LOS and average delay (in seconds per vehicle) were determined for the AM and PM peak hours.

1. Queen Kaahumanu Highway and Palani Road. Overall Intersection LOS = C/C (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Palani Road resulted in appropriate LOS D or better during AM and PM peak hours.
2. Queen Kaahumanu Highway and Henry Street. Overall Intersection LOS = C/C (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Henry Street resulted in appropriate LOS D or better during AM and PM peak hours.
3. Queen Kaahumanu Highway and Hualalai Road (North)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Street (north), eastbound left turning movement has LOS F (v/c of 1.65 and 0.30 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
4. Queen Kaahumanu Highway and Hualalai Road (South)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Road (south), westbound left turning movement has LOS F (v/c of 0.22 and 0.39 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
5. Queen Kaahumanu Highway and Puapuaanui Street. Overall Intersection LOS = B/B (AM/PM)
   The AM westbound left turn movement from Hualalai Road and southbound left turn movements from Queen K Highway operate at LOS E. The westbound left turn operates at LOS E during the PM peak hour. The left turn volumes are low and should clear every cycle. These delays are due to the cycle length.
6. Queen Kaahumanu Highway and Kuakini Highway
   At the unsignalized intersection of Queen Kaahumanu Highway with Kuakini Highway, eastbound left turning movement has LOS F (v/c of 1.51 and 0.62 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
7. Queen Kaahumanu Highway and Lako Street. Overall Intersection LOS = D/C (AM/PM)
   At the signalized intersection of Queen Kaahumanu Highway with Lako Street, the eastbound left turn operates at LOS E during the AM peak hour. This delay is attributed to the high eastbound left turn volume, and the split phasing for the Lako Street approaches. All other movements at Lako Street operates at LOS D or better during both peak hours.
8. Queen Kaahumanu Highway and Kamehameha III Road. Overall Intersection LOS = B/C (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Kamehameha III Road resulted in appropriate LOS D or better during AM and PM peak hours.

Tables 12 and 13 show the expected 2024 vehicular delay and level of service at each intersection. The shaded row indicates the overall intersection delay. Synchro output is in Appendix D.

Table 12: Future 2024 Without Project Intersection Level of Service

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Palani Rd (overall)	**24.3**	**-**	**C**	**27.1**	**-**	**C**
Queen Kaahumanu EB Left	39.2	0.47	D	39.3	0.76	D
Queen Kaahumanu EB Through	14.8	0.32	B	19.2	0.61	B
Queen Kaahumanu WB Left	39.3	0.68	D	40.1	0.73	D
Queen Kaahumanu WB Through	14.9	0.45	B	17.4	0.44	B
Palani NB Left	37.8	0.73	D	40.5	0.74	D
Palani NB Through	25.7	0.26	C	28.9	0.42	C
Palani SB Left	48.1	0.51	D	49.8	0.71	D
Palani SB Through	34.0	0.66	C	33.9	0.63	C
Queen Kaahumanu Hwy & Henry St (overall)	**32.9**	**0.65**	**C**	**33.8**	**0.68**	**C**
Queen Kaahumanu EB Left	45.2	0.53	D	49.7	0.69	D
Queen Kaahumanu EB Through	25.7	0.37	C	29.3	0.60	C
Queen Kaahumanu EB Right	22.8	0.09	C	24.0	0.20	C
Queen Kaahumanu WB Left	46.1	0.40	D	50.9	0.57	D
Queen Kaahumanu WB Through	32.3	0.65	C	32.6	0.60	C
Queen Kaahumanu WB Right	27.9	0.33	C	27.6	0.22	C
Henry NB Left	35.4	0.48	D	36.3	0.42	D
Henry NB Left-Through	36.6	0.60	D	37.9	0.58	D
Henry NB Right	31.3	0.03	C	32.8	0.02	C
Henry SB Left	39.3	0.74	D	40.2	0.75	D
Henry SB Left-Through-Right	35.2	0.71	D	34.8	0.69	C
Queen Kaahumanu Hwy & Hualalai (N) (overall)	**14.1**	**-**	**-**	**1.2**	**-**	**-**
Queen Kaahumanu NB Left	11.2	0.24	B	11.5	0.14	B
Hualalai EB Left	603.1	1.65	F	135.9	0.30	F
Queen Kaahumanu Hwy & Hualalai (S) (overall)	**4.0**	**-**	**-**	**2.0**	**-**	**-**
Queen Kaahumanu SB Left	12.0	0.14	B	11.1	0.10	B
Hualalai WB Left	105.7	0.22	F	143.3	0.39	F
Hualalai WB Right	43.7	0.65	E	22.1	0.27	C

Table 13: Future 2024 Without Project Intersection Level of Service (continued)

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Puapuaanui St (overall)	**10.2**	**-**	**B**	**10.5**	**-**	**B**
Queen Kaahumanu SB Left	61.3	0.73	E	54.4	0.81	D
Queen Kaahumanu WB Through	3.6	0.52	A	3.3	0.60	A
Puapuaanui WB Left	55.2	0.78	E	56.2	0.63	E
Puapuaanui WB Right	8.1	0.68	A	9.4	0.66	A
Queen Kaahumanu Hwy & Kuakini Hwy (overall)	**9.8**	**-**	**-**	**3.5**	**-**	**-**
Queen Kaahumanu NB Left	20.4	0.73	C	12.8	0.36	B
Kuakini EB Left	1546.3	1.51	F	302.1	0.62	F
Queen Kaahumanu Hwy & Lako St (overall)	**35.4**	**-**	**D**	**24.5**	**-**	**C**
Queen Kaahumanu NB Left	14.1	0.12	B	14.8	0.17	B
Queen Kaahumanu NB Through	38.0	0.93	D	21.4	0.80	C
Queen Kaahumanu SB Left	30.1	0.70	C	16.0	0.58	B
Queen Kaahumanu SB Through	21.3	0.72	C	23.8	0.87	C
Lako EB Left	63.7	0.89	E	44.5	0.77	D
Lako EB Through-Right	34.1	0.16	C	35.7	0.17	D
Lako WB Left	51.1	0.68	D	46.1	0.65	D
Lako WB Through-Right	44.9	0.33	D	41.4	0.40	D
Queen Kaahumanu Hwy & Kam III Rd (overall)	**18.2**	**-**	**B**	**23.3**	**-**	**C**
Queen Kaahumanu NB Left	43.1	0.79	D	49.0	0.78	D
Queen Kaahumanu NB Through	13.3	0.58	B	19.0	0.64	B
Queen Kaahumanu SB Left	42.1	0.47	D	46.1	0.49	D
Queen Kaahumanu SB Through	10.8	0.28	B	14.8	0.36	B
Kamehameha EB Left-Through	32.0	0.74	C	35.7	0.85	D
Kamehameha WB Left-Through-Right	42.1	0.68	D	45.7	0.63	D

2. Future 2024 With Project Intersection LOS

The 2024 With Project intersection and movement LOS and average delay (in seconds per vehicle) were determined for the AM and PM peak hours. NOTE: All Royal Vistas vehicles are routed through the one Royal Vistas Access Roadway to Queen Kaahumanu Highway for purposes of the Phase 1 analysis.

1. Queen Kaahumanu Highway and Palani Road. Overall Intersection LOS = C/C (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Palani Road resulted in appropriate LOS D or better during AM and PM peak hours.
2. Queen Kaahumanu Highway and Henry Street. Overall Intersection LOS = C/C (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Henry Street resulted in appropriate LOS D or better during AM and PM peak hours.
3. Queen Kaahumanu Highway and Hualalai Road (North)

At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Street (north), eastbound left turning movement has LOS F (v/c of 1.98 and 0.34 respectively) during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.

4. Queen Kaahumanu Highway and Hualalai Road (South)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Road (south), westbound left turning movement has LOS F (v/c of 0.24 and 0.34 respectively) during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The westbound right turn also operates at LOS F (v/c of 0.71) during the AM peak hour. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
5. Queen Kaahumanu Highway and Puapuaanui Street. Overall Intersection LOS = B/B (AM/PM)
   The AM left turns operate at LOS E. The westbound left turn operates at LOS E during the PM peak hour. The left turn volumes are low and should clear every cycle. These delays are due to the cycle length.
6. Queen Kaahumanu Highway and Royal Vistas Roadway
   At the proposed unsignalized intersection of Queen Kaahumanu Highway and the Royal Vistas Roadway, the southbound left turn movement from Queen Kaahumanu Highway into Royal Vistas Roadway functions well, with minimal delay, an average of 10 to 11 seconds during both peak hours. The westbound left turning movement has LOS F (v/c of 0.41 and 0.27 respectively) during both AM (29 vehicles) and PM (12 vehicles) peak hours are due to high through volumes on Queen Kaahumanu Highway. The intersection functions acceptably, with an average of 2.0 seconds of delay per vehicle in the AM peak hour and 1.2 seconds of delay per vehicle in the PM peak hour. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
7. Queen Kaahumanu Highway and Kuakini Highway
   At the unsignalized intersection of Queen Kaahumanu Highway with Kuakini Highway, eastbound left turning movement has LOS F (v/c of 1.88 and .68 respectively) during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
8. Queen Kaahumanu Highway and Lako Street. Overall Intersection LOS = D/C (AM/PM)
   At the signalized intersection of Queen Kaahumanu Highway with Lako Street, the eastbound left turn operates at LOS E during the AM peak hour. This delay is attributed to the high eastbound left turn volume, and the split phasing for the Lako Street approaches. All other movements at Lako Street operates at LOS D or better during both peak hours.
9. Queen Kaahumanu Highway and Kamehameha III Road. Overall Intersection LOS = B/C (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Kamehameha III Road resulted in appropriate LOS D or better during AM and PM peak hours.

Tables 14 and 15 show the expected vehicular delay and level of service at each intersection. The shaded row indicates the overall intersection delay. Synchro output is in Appendix E.

Table 14: Future 2024 With Project Intersection Level of Service

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Palani Rd (overall)	**24.2**	**-**	**C**	**27.2**	**-**	**C**
Queen Kaahumanu EB Left	39.2	0.47	D	39.3	0.76	D
Queen Kaahumanu EB Through	14.9	0.33	B	19.5	0.62	B
Queen Kaahumanu WB Left	39.3	0.68	D	40.2	0.74	D
Queen Kaahumanu WB Through	15.1	0.46	B	17.6	0.45	B
Palani NB Left	37.8	0.73	D	40.5	0.74	D
Palani NB Through	25.7	0.26	C	28.9	0.42	C
Palani SB Left	48.1	0.51	D	50.0	0.71	D
Palani SB Through	34.0	0.66	C	34.0	0.63	C
Queen Kaahumanu Hwy & Henry St (overall)	**33.2**	**0.66**	**C**	**34.1**	**0.69**	**C**
Queen Kaahumanu EB Left	45.5	0.54	D	49.8	0.69	D
Queen Kaahumanu EB Through	26.1	0.38	C	30.0	0.63	C
Queen Kaahumanu EB Right	23.1	0.09	C	24.1	0.20	C
Queen Kaahumanu WB Left	46.5	0.42	D	52.5	0.59	D
Queen Kaahumanu WB Through	33.4	0.68	C	33.2	0.62	C
Queen Kaahumanu WB Right	28.5	0.34	C	27.8	0.22	C
Henry NB Left	35.7	0.48	D	36.4	0.42	D
Henry NB Left-Through	36.9	0.60	D	38.0	0.59	D
Henry NB Right	31.5	0.03	C	32.9	0.02	C
Henry SB Left	38.4	0.72	D	40.4	0.76	D
Henry SB Left-Through-Right	34.8	0.70	C	35.0	0.70	D
Queen Kaahumanu Hwy & Hualalai (N) (overall)	**17.7**	**-**	**-**	**1.3**	**-**	**-**
Queen Kaahumanu NB Left	11.3	0.26	B	11.9	0.15	B
Hualalai EB Left	789.5	1.98	F	163.1	0.34	F
Queen Kaahumanu Hwy & Hualalai (S) (overall)	**4.5**	**-**	**-**	**2.2**	**-**	**-**
Queen Kaahumanu SB Left	12.4	0.15	B	11.3	0.10	B
Hualalai WB Left	121.6	0.24	F	172.6	0.44	F
Hualalai WB Right	52.8	0.71	F	23.3	0.28	C
Queen Kaahumanu Hwy & Puapuaanui St (overall)	**10.8**	**-**	**B**	**10.8**	**-**	**B**
Queen Kaahumanu SB Left	61.3	0.73	E	54.5	0.81	D
Queen Kaahumanu WB Through	3.7	0.53	A	3.6	0.63	A
Puapuaanui WB Left	55.1	0.78	E	56.4	0.64	E
Puapuaanui WB Right	9.8	0.73	A	10.1	0.69	B

Table 15: Future 2024 With Project Intersection Level of Service (continued)

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Kona Vista Rdwy (overall)	**2.0**	**-**	**-**	**1.2**	**-**	**-**
Queen Kaahumanu SB Left	10.0	0.02	A	10.5	0.07	B
Kona Vista WB Left	81.0	0.41	F	105.9	0.27	F
Kona Vista WB Right	18.8	0.20	C	19.0	0.14	C
Queen Kaahumanu Hwy & Kuakini Hwy (overall)	**11.4**	**-**	**-**	**3.7**	**-**	**-**
Queen Kaahumanu NB Left	21.8	0.75	C	12.9	0.36	B
Kuakini EB Left	1998.6	1.88	F	344.6	0.68	F
Queen Kaahumanu Hwy & Lako St (overall)	**36.9**	**-**	**D**	**25.9**	**-**	**C**
Queen Kaahumanu NB Left	14.6	0.12	B	15.3	0.18	B
Queen Kaahumanu NB Through	40.4	0.94	D	23.5	0.83	C
Queen Kaahumanu SB Left	34.2	0.74	C	18.5	0.62	B
Queen Kaahumanu SB Through	22.2	0.74	C	24.9	0.88	C
Lako EB Left	65.4	0.90	E	44.5	0.78	D
Lako EB Through-Right	34.1	0.16	C	35.5	0.17	D
Lako WB Left	51.3	0.68	D	46.2	0.65	D
Lako WB Through-Right	45.1	0.33	D	41.5	0.40	D
Queen Kaahumanu Hwy & Kam III Rd (overall)	**18.3**	**-**	**B**	**24.1**	**-**	**C**
Queen Kaahumanu NB Left	43.1	0.79	D	49.3	0.78	D
Queen Kaahumanu NB Through	13.5	0.59	B	20.1	0.67	C
Queen Kaahumanu SB Left	42.2	0.47	D	46.5	0.49	D
Queen Kaahumanu SB Through	10.9	0.29	B	15.2	0.37	B
Kamehameha EB Left-Through	32.0	0.74	C	36.7	0.85	D
Kamehameha WB Left-Through-Right	42.2	0.68	D	46.3	0.64	D

3. 2024 Traffic Signal Warrant

Peak-Hour volume traffic signal warrants were evaluated for the 2024 with and without project scenarios. Table 16 shows the Peak-Hour warrant analysis in 2024 with and without the project. Traffic Signal Warrant analysis can be found in Appendix J.

1. Queen Kaahumanu Highway and Hualalai Road (North)
   This intersection passes the Peak-Hour warrant in the AM and PM peak hour with and without the project.
2. Queen Kaahumanu Highway and Hualalai Road (South)
   This intersection passes the Peak-Hour warrant in the AM peak hour with and without the project.
3. Queen Kaahumanu Highway and Royal Vistas Roadway
   This intersection does not pass the peak hour warrant in either peak hour.

4. Queen Kaahumanu Highway and Kuakini Highway
   This intersection passes the Peak-Hour warrant in the AM and PM peak hour with and without the project.

Table 16: 2024 Peak-Hour Warrant

2024 Without Project	Peak Hour Warrant					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	816	172	YES	1056	88	YES
Hualalai (S)	1057	77	YES	988	64	NO
Kuakini	842	543	YES	932	255	YES
2024 With Project	**Peak Hour Warrant**					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	827	180	YES	1096	91	YES
Hualalai (S)	1117	77	YES	1025	64	NO
RKV Roadway	819	13	NO	912	45	NO
Kuakini	856	543	YES	944	255	YES

4. 2024 With Project Segment LOS

Arterial LOS was analyzed in Synchro on Queen Kaahumanu Highway from Hualalai (north) to Lako Street. Where signalized intersections are less than 2.0 mi apart, the facility should be classified as an urban street and analyzed with the methodologies of Urban Street Facilities. For Urban Street Facilities, through-vehicle travel speed is used to analyze vehicular LOS. Analysis worksheets can be found in Appendix E. The arterial LOS can be found in Table 17.

This segment of Queen Kaahumanu Highway operates at LOS C in the northbound direction and LOS B in the southbound direction during the AM and PM peak hours, respectively, satisfying the County of Hawaii Chapter 25 (Zoning), Article 2 (Administration and Enforcement), Division 4 (Amendments), Section 46 (Concurrency Requirements) regarding “acceptable level of service” for transportation facilities.

Table 17: 2024 with Project Segment LOS

	Northbound		Southbound	
	Speed (mph)	LOS	Speed (mph)	LOS
AM Peak Hour	18.3	C	25.3	B
PM Peak Hour	20.7	C	24.6	B

IV. Mid-Term (2029) – Completion of Phase 2

A. Surrounding Area Conditions

Phase 2 is expected to be completed by 2029, representing the full buildout 10-year future forecast. Phase 2 will contain 192 dwelling units. Inbound trips and Phase 1 outbound trips continue to use the Royal Vistas Roadway and Queen Kaahumanu Highway intersection.

Based on the HDOT *Federal-Aid Highways 2035 Transportation Plan for the District of Hawaii* (July 2014), Kuakini Highway from Henry Street to Kamehameha III Road will be widened by 2 travel lanes and include bicycle facilities and sidewalks.

No other significant developments or future construction projects are expected in the immediately surrounding area that would significantly affect the roadway geometrics or traffic volumes at the study intersections. This is based on research completed on October 10, 2019 at the State of Hawaii Office of Environmental Quality Control (OEQC) website and the Statewide Transportation Improvements Program (STIP). The current STIP has a 4-year outlook, from Fiscal Year 2019-2022. Future projects may impact roadway geometrics or traffic volumes. The Mid-Term future analysis may need to be reanalyzed and updated if the Kuakini Highway widening project is scheduled. This project was not included in the analysis.

B. Volumes

1. Future 2029 Without Project Volumes

The project study area within Kona has been experiencing modest growth. HDOT ADT counts on Queen Kaahumanu Highway between Nani Kailua Drive and Hualalai Road didn't show any increase in vehicular volumes from 2015 to 2016. Similarly, the 2035 Federal Aid Highways Long Range Transportation Plan forecasts average daily traffic in Kona to be 41,900 vehicles in 2020 and 48,000 vehicles in 2035. This is approximately equal to a 1% annual growth rate. The estimated future volumes without the project for the future year 2029 are shown in Figure 11.

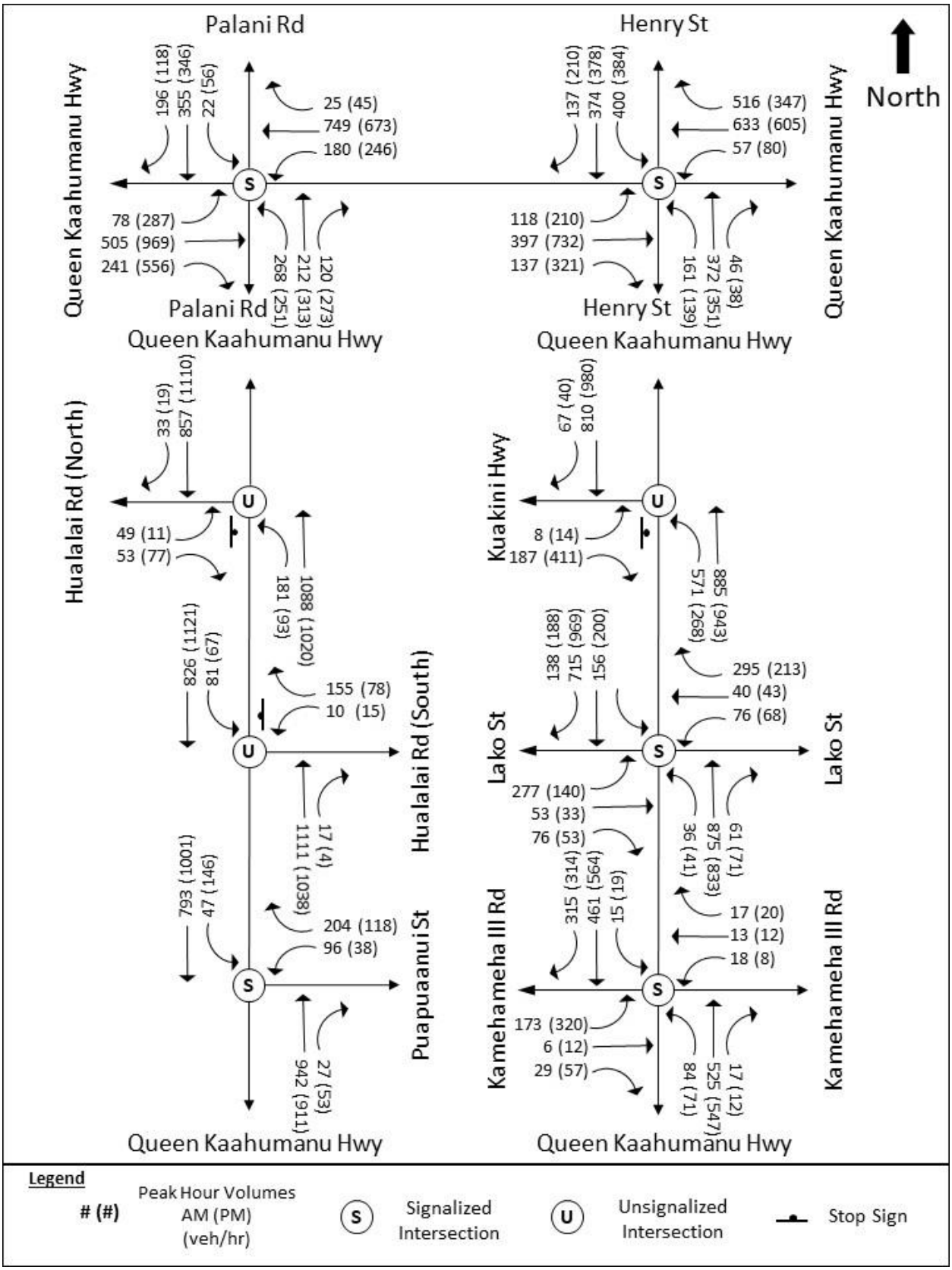


Figure 11: Future 2029 Without Project Peak Hour Volumes

2. Project Related Volumes

The proposed Royal Vistas include 192 multi-family residential dwelling units for Phase 2. All of these are expected to be low rise units with two or three stories. Trips generated from the proposed facility were estimated using nationally accepted land use rates from the *Trip Generation*, 10th Edition (ITE, 2016). ITE defines the Multi-family Housing (Low Rise) Land Use [220] as follows: "includes apartments, townhouses and condominiums located within the same building with at least three other dwelling units" The analysis used 192 dwelling units as the independent variable to estimate new trips expected from Phase 2 of the proposed project. The estimates for new trips generated by Phase 2 are shown in Table 18.

Table 18: Estimated Trips Generated by Project – Phase 2

	AM		PM	
Land Use [ITE Code]	**Equation**		**Equation**	
Multi-family Housing (Low Rise) [220]	Ln (T) = 0.95 Ln (X) – 0.51		Ln (T) = 0.89*Ln (X) - 0.02	
Dwelling Units	192		192	
New Trips	89		106	
	In[4]	**Out**	**In**	**Out**
	23%	77%	63%	37%
	20	69	67	39

T = Total number of trips generated, X = Dwelling Units

3. Trip Distribution

The trips were distributed according to existing travel volumes. The segment volumes between Puapuaanui Street and Kuakini Street were used to determine the inbound percent distribution. Future inbound trips will continue entering at the Royal Vistas Roadway at Queen Kaahumanu Highway. It is expected that once a connection to Lako Street is provided, Phase 2 left out (southbound traffic) will utilize the Lako Street intersection during the peak hours, since the traffic signal will provide guaranteed exit opportunities and drivers will not have to wait for a gap at the stop-controlled Royal Vistas driveway.

Figure 12 shows the Future lane configuration. It is the same as Phase 1 lane configuration.

Figure 13 shows the Phase 2 inbound project generated and distributed trips.

Figure 14 shows the Phase 2 outbound project generated and distributed trips.

4. Future 2029 With Project Volumes

Phase 1 (Figure 9) and Phase 2 project related trips (Figure 13 and Figure 14) were added to the Future 2029 Without Project volumes (Figure 11) to estimate Future 2029 With Project peak hour volumes (see Figure 15).

[4] In and Out split provided by *Trip Generation*, 10th Edition (ITE 2016) for Land Use 220

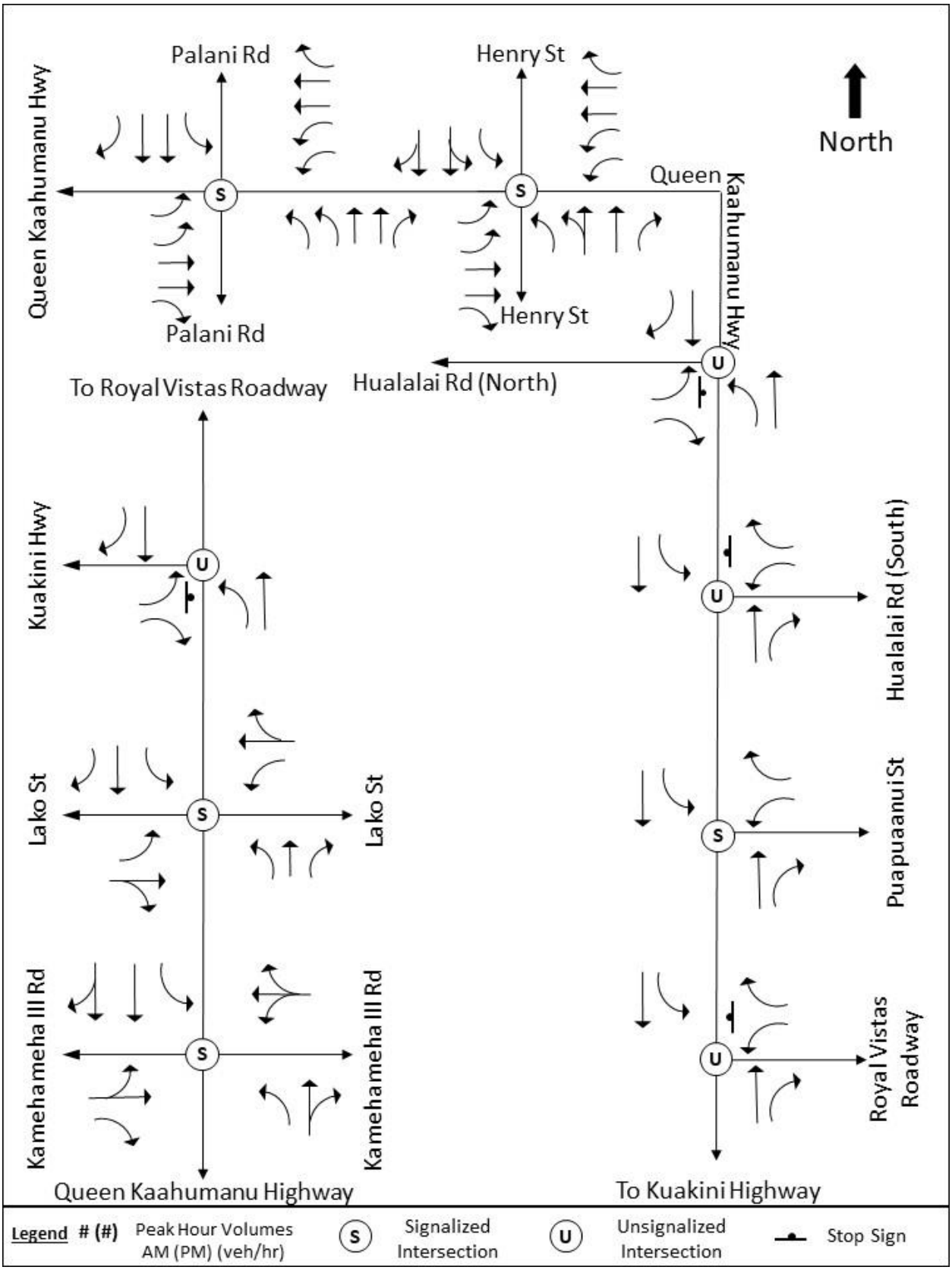


Figure 12: Future Lane Configuration for Phase 2

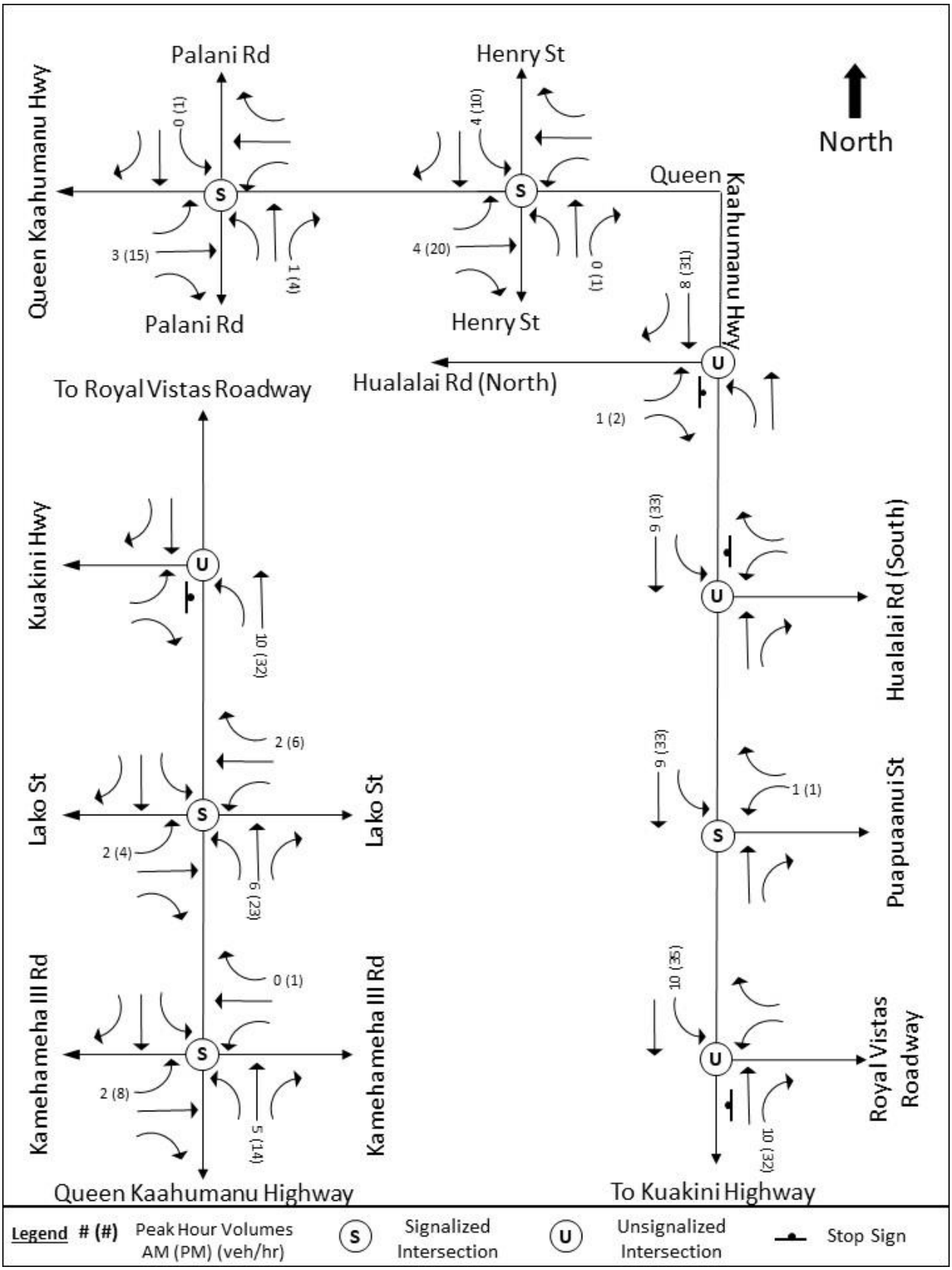


Figure 13: Phase 2 Inbound Project Related Trips

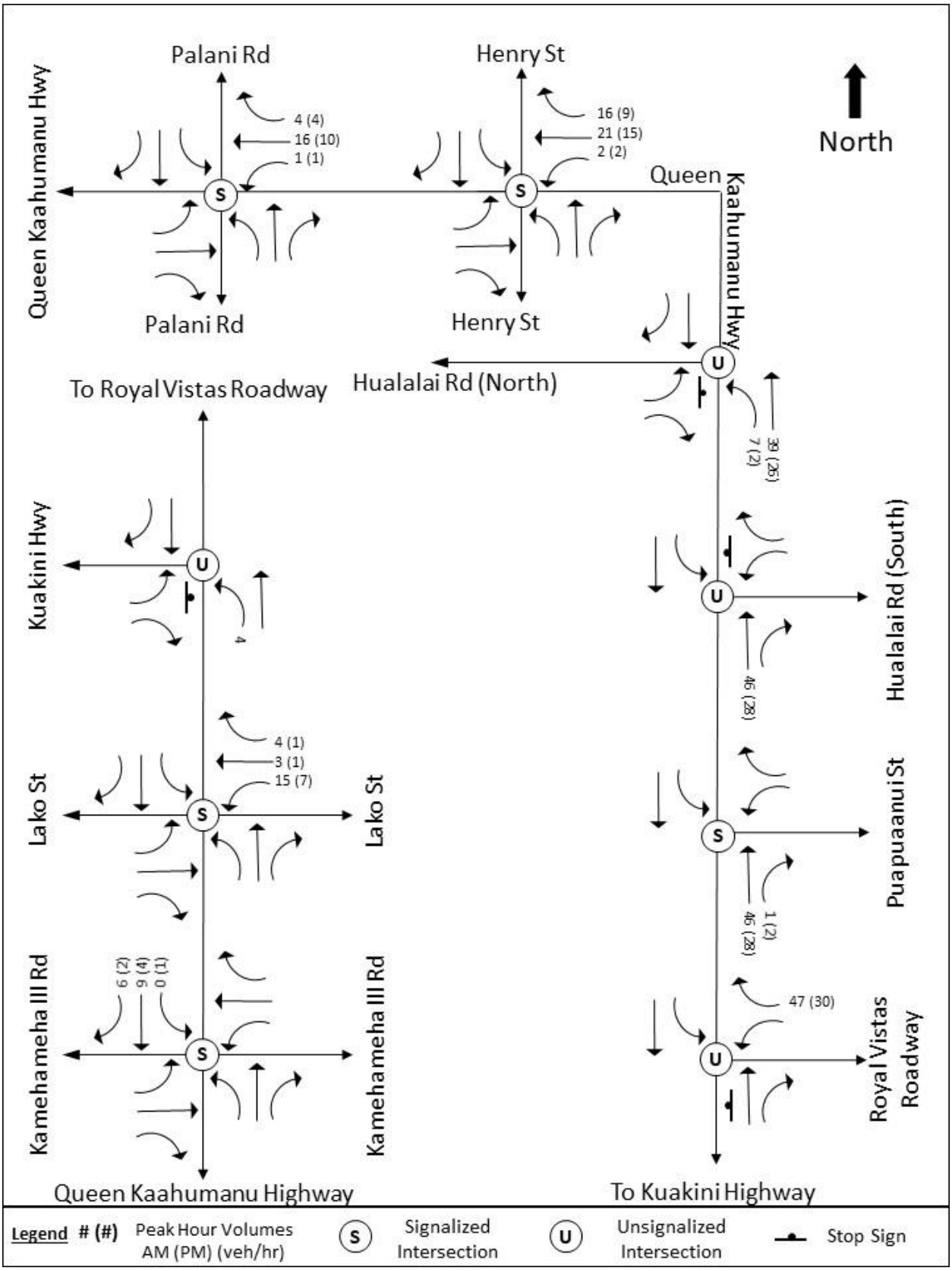


Figure 14: Phase 2 Outbound Project Related Trips

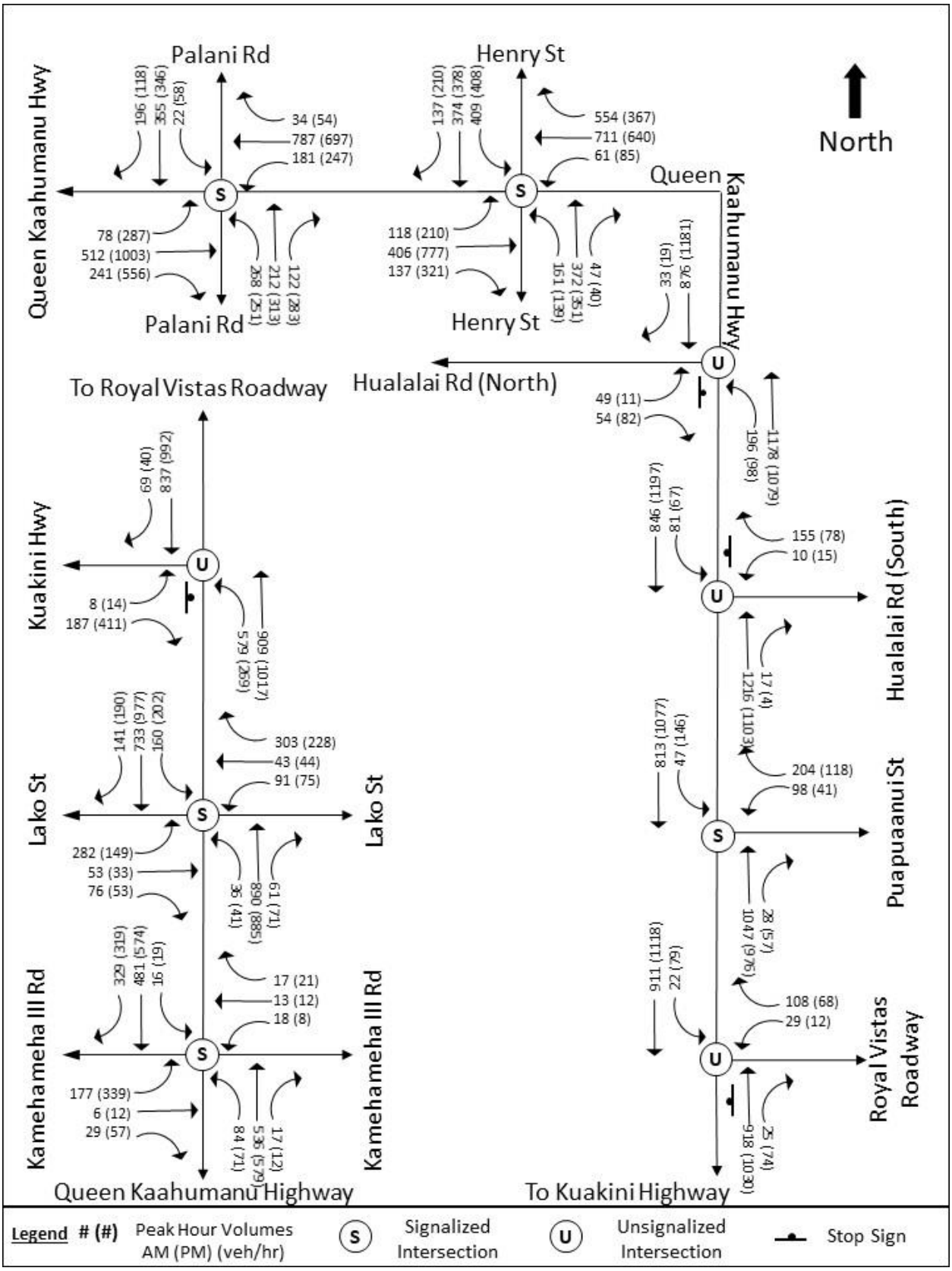


Figure 15: Future 2029 Without Project Peak Hour Volumes

C. Future 2029 Intersection Traffic Operation Analysis

1. Future 2029 Without Project Intersection LOS

The 2029 Without Project intersection and movement LOS and average delay (in seconds per vehicle) were determined for the AM and PM peak hours.

1. Queen Kaahumanu Highway and Palani Road. Overall Intersection LOS = C/C (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Palani Road resulted in appropriate LOS D or better during AM and PM peak hours.
2. Queen Kaahumanu Highway and Henry Street. Overall Intersection LOS = C/D (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Henry Street resulted in appropriate LOS D or better during AM and PM peak hours.
3. Queen Kaahumanu Highway and Hualalai Road (North)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Street (north), eastbound left turning movement has LOS F (v/c of 2.20 and 0.37 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
4. Queen Kaahumanu Highway and Hualalai Road (South)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Road (south), westbound left turning movement has LOS F (v/c of 0.28 and 0.47 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The westbound right turn also operates at LOS F (v/c of .74) during the AM peak hour. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
5. Queen Kaahumanu Highway and Puapuaanui Street. Overall Intersection LOS = B/B (AM/PM)
   The southbound left turn operates at LOS E during the AM and PM peak hour. The westbound left turn operates at LOS E during the PM peak hour. These delays are due to the cycle length. The left turn volumes are low and should clear every cycle.
6. Queen Kaahumanu Highway and Kuakini Highway
   At the unsignalized intersection of Queen Kaahumanu Highway with Kuakini Highway, eastbound left turning movement has LOS F (v/c of 2.87 and 0.79 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
7. Queen Kaahumanu Highway and Lako Street. Overall Intersection LOS = D/C (AM/PM)
   At the signalized intersection of Queen Kaahumanu Highway with Lako Street, the eastbound left turn operates at LOS E during the AM peak hour. This delay is attributed to the high eastbound left turn volume, and the split phasing for the Lako Street approaches. The southbound left also operates at LOS E during the AM peak hour. All other movements at Lako Street operates at LOS D or better during both peak hours.
8. Queen Kaahumanu Highway and Kamehameha III Road. Overall Intersection LOS = B/C (AM/PM)

All movements at the signalized intersections of Queen Kaahumanu Highway with Kamehameha III Road resulted in appropriate LOS D or better during AM and PM peak hours.

Tables 19 and 20 show the expected vehicular delay and level of service at each intersection. The shaded row indicates the overall intersection delay. Synchro output is in Appendix F.

Table 19: Future 2029 Without Project Intersection Level of Service

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Palani Rd (overall)	**24.9**	**-**	**C**	**28.3**	**-**	**C**
Queen Kaahumanu EB Left	39.8	0.49	D	40.7	0.77	D
Queen Kaahumanu EB Through	15.7	0.35	B	20.7	0.65	C
Queen Kaahumanu WB Left	39.8	0.69	D	41.6	0.75	D
Queen Kaahumanu WB Through	15.7	0.47	B	18.5	0.47	B
Palani NB Left	38.3	0.74	D	42.0	0.75	D
Palani NB Through	25.5	0.26	C	28.9	0.43	C
Palani SB Left	48.5	0.51	D	51.3	0.73	D
Palani SB Through	34.2	0.67	C	34.3	0.64	C
Queen Kaahumanu Hwy & Henry St (overall)	**34.0**	**0.67**	**C**	**35.2**	**0.71**	**D**
Queen Kaahumanu EB Left	47.6	0.58	D	53.1	0.74	D
Queen Kaahumanu EB Through	27.2	0.40	C	31.0	0.65	C
Queen Kaahumanu EB Right	23.9	0.09	C	24.8	0.21	C
Queen Kaahumanu WB Left	47.3	0.42	D	53.8	0.60	D
Queen Kaahumanu WB Through	34.0	0.67	C	34.2	0.64	C
Queen Kaahumanu WB Right	29.4	0.34	C	28.5	0.23	C
Henry NB Left	35.9	0.49	D	36.7	0.44	D
Henry NB Left-Through	37.4	0.62	D	38.4	0.60	D
Henry NB Right	31.6	0.03	C	33.0	0.03	C
Henry SB Left	39.9	0.75	D	42.1	0.78	D
Henry SB Left-Through-Right	35.6	0.72	D	35.8	0.72	D
Queen Kaahumanu Hwy & Hualalai (N) (overall)	**20.8**	**-**	**-**	**1.4**	**-**	**-**
Queen Kaahumanu NB Left	11.6	0.26	B	12.0	0.16	B
Hualalai EB Left	893.5	2.20	F	177.1	0.37	F
Queen Kaahumanu Hwy & Hualalai (S) (overall)	**5.1**	**-**	**-**	**2.3**	**-**	**-**
Queen Kaahumanu SB Left	12.5	0.15	B	11.4	0.11	B
Hualalai WB Left	133.6	0.28	F	187.7	0.47	F
Hualalai WB Right	56.7	0.74	F	24.1	0.30	C

Table 20: Future 2029 Without Project Intersection Level of Service (continued)

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Puapuaanui St (overall)	**10.9**	**-**	**B**	**11.3**	**-**	**B**
Queen Kaahumanu SB Left	62.3	0.74	E	55.9	0.82	E
Queen Kaahumanu WB Through	3.9	0.55	A	3.6	0.63	A
Puapuaanui WB Left	54.9	0.78	D	56.5	0.65	E
Puapuaanui WB Right	9.8	0.72	A	10.6	0.70	B
Queen Kaahumanu Hwy & Kuakini Hwy (overall)	**16.1**	**-**	**-**	**4.3**	**-**	**-**
Queen Kaahumanu NB Left	25.0	0.79	C	13.6	0.40	B
Kuakini EB Left	2938.5	2.87	F	429.8	0.79	F
Queen Kaahumanu Hwy & Lako St (overall)	**43.7**	**-**	**D**	**28.7**	**-**	**C**
Queen Kaahumanu NB Left	15.5	0.14	B	17.4	0.21	B
Queen Kaahumanu NB Through	51.3	0.99	D	25.1	0.85	C
Queen Kaahumanu SB Left	56.6	0.87	E	21.0	0.67	C
Queen Kaahumanu SB Through	23.7	0.77	C	29.5	0.92	C
Lako EB Left	67.3	0.91	E	44.7	0.78	D
Lako EB Through-Right	34.2	0.16	C	35.7	0.17	D
Lako WB Left	51.7	0.68	D	46.3	0.65	D
Lako WB Through-Right	45.5	0.34	D	41.6	0.40	D
Queen Kaahumanu Hwy & Kam III Rd (overall)	**18.8**	**-**	**B**	**24.7**	**-**	**C**
Queen Kaahumanu NB Left	42.7	0.79	D	48.8	0.78	D
Queen Kaahumanu NB Through	14.3	0.62	B	20.0	0.69	C
Queen Kaahumanu SB Left	42.5	0.47	D	46.6	0.50	D
Queen Kaahumanu SB Through	11.3	0.30	B	15.7	0.39	B
Kamehameha EB Left-Through	32.0	0.75	C	37.5	0.86	D
Kamehameha WB Left-Through-Right	42.8	0.69	D	46.8	0.64	D

2. Future 2029 With Project Intersection LOS

The 2029 With Project intersection and movement LOS and average delay (in seconds per vehicle) were determined for the AM and PM peak hours.

1. Queen Kaahumanu Highway and Palani Road. Overall Intersection LOS = C/C (AM/PM)
   All movements at the signalized intersections of Queen Kaahumanu Highway with Palani Road resulted in appropriate LOS D or better during AM and PM peak hours.
2. Queen Kaahumanu Highway and Henry Street. Overall Intersection LOS = C/D (AM/PM)
   The westbound left turn operates at LOS E during the PM peak hour. The overall delay and LOS have gradually gotten worse due to the increase in background volume and the trip generated by Royal Vistas. The westbound left during the PM peak hour has a volume of 85 vehicles. This volume will clear the intersection in 1 cycle. The delay increases from 53.8 seconds without the project, to 57 seconds with the project. The Royal Vistas traffic volume causes a slight increase in

the overall delay. Other factors that increase the delay are the increase in background volume and the split phase. All other movements at the signalized intersections of Queen Kaahumanu Highway with Henry Street resulted in appropriate LOS D or better during AM and PM peak hours.

3. Queen Kaahumanu Highway and Hualalai Road (North)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Street (north), eastbound left turning movement has LOS F (v/c of 2.93 and 0.45 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
4. Queen Kaahumanu Highway and Hualalai Road (South)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Road (south), westbound left turning movement has LOS F (v/c of 0.35 and 0.57 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The westbound right turn also operates at LOS F (v/c of 0.86) during the AM peak hour. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
5. Queen Kaahumanu Highway and Puapuaanui Street. Overall Intersection LOS = B/B (AM/PM)
   The southbound left turn operates at LOS E during the AM and PM peak hour. The westbound left turn operates at LOS E during the PM peak hour. These delays are due to the cycle length. The left turn volumes are low and should clear every cycle.
6. Queen Kaahumanu Highway and Royal Vistas Roadway
   At the proposed unsignalized intersection of Queen Kaahumanu Highway and the Royal Vistas Roadway, the southbound left turn movement from Queen Kaahumanu Highway into Royal Vistas Roadway functions well, with minimal delay, an average of 12 to 13 seconds during both peak hours. The westbound left turning movement has LOS F (v/c of 0.53 and 0.48 respectively) during both AM (29 vehicles) and PM (12 vehicles) peak hours due to high through volumes on Queen Kaahumanu Highway. Phase 2 left turns exiting Royal Vistas are expected to use Lako Street to access Queen Kaahumanu Highway. The intersection functions acceptably, with an average of 3.1 seconds of delay per vehicle in the AM peak hour and 2.3 seconds of delay per vehicle in the PM peak hour. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
7. Queen Kaahumanu Highway and Kuakini Highway
   At the unsignalized intersection of Queen Kaahumanu Highway with Kuakini Highway, eastbound left turning movement has LOS F (v/c of 0.89 during the PM peak hour) and long delays during both AM and PM peak hour are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
8. Queen Kaahumanu Highway and Lako Street. Overall Intersection LOS = D/C (AM/PM)
   At the signalized intersection of Queen Kaahumanu Highway with Lako Street, eastbound left operates at LOS F (v/c of 0.96) during the AM peak hour. The westbound left operates at LOS E during the AM peak hour. The eastbound left and westbound left operate at LOS E during the PM peak hour. This delay is attributed to the high volume and the split phasing for the Lako Street

approaches. All other movements at Lako Street operate at LOS D or better during both peak hours.

9. Queen Kaahumanu Highway and Kamehameha III Road. Overall Intersection LOS = C
   The westbound approach operates at LOS E during the AM peak hour. During the PM peak hour, the westbound approach, the northbound left, and the southbound left operate at LOS E. All other movements during both peak hours operate at LOS D or better.

Tables 21 and 22 show the expected vehicular delay and level of service at each intersection. The shaded row indicates the overall intersection delay. Synchro output is in Appendix G.

Table 21: Future 2029 With Project Intersection Level of Service

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Palani Rd (overall)	**24.8**	**-**	**C**	**28.4**	**-**	**C**
Queen Kaahumanu EB Left	39.8	0.49	D	40.8	0.77	D
Queen Kaahumanu EB Through	15.7	0.35	B	21.2	0.67	C
Queen Kaahumanu WB Left	39.7	0.69	D	41.8	0.75	D
Queen Kaahumanu WB Through	16.1	0.50	B	18.8	0.48	B
Palani NB Left	38.3	0.74	D	42.0	0.75	D
Palani NB Through	25.5	0.26	C	29.0	0.43	C
Palani SB Left	48.5	0.51	D	51.8	0.74	D
Palani SB Through	34.2	0.67	C	343.0	0.64	C
Queen Kaahumanu Hwy & Henry St (overall)	**34.7**	**0.70**	**C**	**35.9**	**0.73**	**D**
Queen Kaahumanu EB Left	48.0	0.58	D	53.9	0.74	D
Queen Kaahumanu EB Through	27.5	0.41	C	32.4	0.69	C
Queen Kaahumanu EB Right	24.0	0.09	C	25.1	0.21	C
Queen Kaahumanu WB Left	47.7	0.45	D	57.0	0.64	E
Queen Kaahumanu WB Through	36.7	0.75	D	35.6	0.68	D
Queen Kaahumanu WB Right	29.9	0.37	C	29.0	0.24	C
Henry NB Left	36.1	0.49	D	37.0	0.40	D
Henry NB Left-Through	37.5	0.62	D	38.8	0.60	D
Henry NB Right	31.7	0.03	C	33.3	0.03	C
Henry SB Left	39.9	0.75	D	42.4	0.78	D
Henry SB Left-Through-Right	35.7	0.73	D	32.0	0.73	D
Queen Kaahumanu Hwy & Hualalai (N) (overall)	**28.5**	**-**	**-**	**1.6**	**-**	**-**
Queen Kaahumanu NB Left	12.0	0.29	B	12.7	0.18	B
Hualalai EB Left	1310.5	2.93	F	237.0	0.45	F

Table 22: Future 2029 With Project Intersection Level of Service (continued)

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Hualalai (S) (overall)	**6.8**	**-**	**-**	**2.7**	**-**	**-**
Queen Kaahumanu SB Left	13.4	0.17	B	11.9	0.12	B
Hualalai WB Left	173.5	0.35	F	251.0	0.57	F
Hualalai WB Right	83.5	0.86	F	26.7	0.33	D
Queen Kaahumanu Hwy & Puapuaanui St (overall)	**12.6**	**-**	**B**	**12.5**	**-**	**B**
Queen Kaahumanu SB Left	78.0	0.78	E	69.0	0.84	E
Queen Kaahumanu WB Through	3.9	0.56	A	3.8	0.67	A
Puapuaanui WB Left	65.9	0.80	D	72.2	0.74	E
Puapuaanui WB Right	11.4	0.77	B	11.1	0.72	B
Queen Kaahumanu Hwy & Kona Vista Rdwy (overall)	**3.1**	**-**	**-**	**2.3**	**-**	**-**
Queen Kaahumanu SB Left	10.4	0.04	B	11.7	0.14	B
Kona Vista WB Left	118.2	0.53	F	228.2	0.48	F
Kona Vista WB Right	24.9	0.40	C	25.2	0.29	D
Queen Kaahumanu Hwy & Kuakini Hwy (overall)	**21.8**	**-**	**-**	**4.6**	**-**	**-**
Queen Kaahumanu NB Left	27.4	0.82	D	13.7	0.40	B
Kuakini EB Left	*	-	F	507.5	0.89	F
Queen Kaahumanu Hwy & Lako St (overall)	**43.4**	**-**	**D**	**28.0**	**-**	**C**
Queen Kaahumanu NB Left	16.6	0.13	B	17.7	0.18	B
Queen Kaahumanu NB Through	42.8	0.94	D	23.9	0.82	C
Queen Kaahumanu SB Left	50.2	0.84	D	23.9	0.68	C
Queen Kaahumanu SB Through	23.8	0.74	C	24.1	0.85	C
Lako EB Left	88.4	0.96	F	60.4	0.83	E
Lako EB Through-Right	41.9	0.17	D	45.7	0.17	D
Lako WB Left	62.1	0.75	E	59.3	0.71	E
Lako WB Through-Right	53.6	0.33	D	52.7	0.41	D
Queen Kaahumanu Hwy & Kam III Rd (overall)	**20.8**	**-**	**C**	**27.9**	**-**	**C**
Queen Kaahumanu NB Left	52.9	0.79	D	57.3	0.78	E
Queen Kaahumanu NB Through	12.6	0.55	B	21.4	0.67	C
Queen Kaahumanu SB Left	54.6	0.50	D	57.0	0.52	E
Queen Kaahumanu SB Through	11.0	0.27	B	16.7	0.36	B
Kamehameha EB Left-Through	43.3	0.79	D	45.9	0.88	D
Kamehameha WB Left-Through-Right	61.8	0.79	E	60.1	0.71	E

*delay exceeds 1,000 seconds per vehicle

3. 2029 Traffic Signal Warrant

Peak-Hour volume traffic signal warrants were evaluated for the 2029 with and without project scenarios. Table 23 shows the Peak-Hour warrant analysis in 2029 with and without the project. Traffic Signal Warrant analysis can be found in Appendix J.

1. Queen Kaahumanu Highway and Hualalai Road (North)
   This intersection passes the Peak-Hour warrant in the AM and PM peak hour with and without the project.
2. Queen Kaahumanu Highway and Hualalai Road (South)
   This intersection passes the Peak-Hour warrant in the AM peak hour with and without the project.
3. Queen Kaahumanu Highway and Kuakini Highway
   This intersection passes the Peak-Hour warrant in the AM and PM peak hour with and without the project.

Table 23: 2029 Peak-Hour Warrant

2029 Without Project	Peak Hour Warrant					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	857	181	YES	1110	93	YES
Hualalai (S)	1111	81	YES	1038	67	NO
Kuakini	885	571	YES	980	268	YES
2029 With Project	**Peak Hour Warrant**					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	876	196	YES	1181	98	YES
Hualalai (S)	1216	81	YES	1103	67	NO
Kuakini	810	579	YES	980	271	YES

4. 2029 With Project Segment LOS

Arterial LOS was analyzed in Synchro on Queen Kaahumanu Highway from Hualalai (north) to Lako Street. Where signalized intersections are less than 2.0 mi apart, the facility should be classified as an urban street and analyzed with the methodologies of Urban Street Facilities. For Urban Street Facilities, through-vehicle travel speed is used to analyze vehicular LOS. Analysis worksheets can be found in Appendix G. The arterial LOS can be found in Table 24.

This segment of Queen Kaahumanu Highway operates at LOS C in northbound direction and LOS B in the southbound direction during the AM and PM peak hours, respectively, satisfying the County of Hawaii Chapter 25 (Zoning), Article 2 (Administration and Enforcement), Division 4 (Amendments), Section 46 (Concurrency Requirements) regarding “acceptable level of service” for transportation facilities.

Table 24: 2029 with Project Segment LOS

	Northbound		Southbound	
	Speed (mph)	LOS	Speed (mph)	LOS
AM Peak Hour	18.6	C	25.2	B
PM Peak Hour	20.4	C	24.5	B

V. Long-Term (2039)

A. Surrounding Area Conditions

No other significant developments or future construction projects are expected in the surrounding area that would significantly affect the roadway geometrics or traffic volumes at the study intersections. This is based on research completed on October 10, 2019 at the State of Hawaii Office of Environmental Quality Control (OEQC) website and the Statewide Transportation Improvements Program (STIP).

B. Volumes

1. Future 2039 Without Project Volumes

The project study area within Kona has been experiencing modest growth. HDOT ADT counts on Queen Kaahumanu Highway between Nani Kailua Drive and Hualalai Road didn't show any increase in vehicular volumes from 2015 to 2016. However, the 2035 Federal Aid Highways Long Range Transportation Plan forecasts average daily traffic in Kona on Hawaii Belt Road to be 41,900 vehicles in 2020 and 48,000 vehicles in 2035. This is approximately equal to a 1% annual growth rate over 15 years in the Kona area.

Since there is a scope for development and to acknowledge all other projects which are in planning stage, a background growth rate of 1% per year was assumed, to account for additional traffic at the study intersections. The estimated future volumes without the project for the future year 2039 are shown in Figure 16.

2. Project Related Volumes

Phase 1 and Phase 2 will be completed by 2024 and 2029, respectively. The trips generated and distributed by Phase 1 and Phase 2 will not change.

3. Future 2039 With Project Volumes

Project related trips from Phase 1 (Figure 9) and Phase 2 (Figure 13 and Figure 14) were added to the Future 2039 Without Project volumes (Figure 16) to estimate Future 2039 With Project peak hour volumes (see Figure 17).

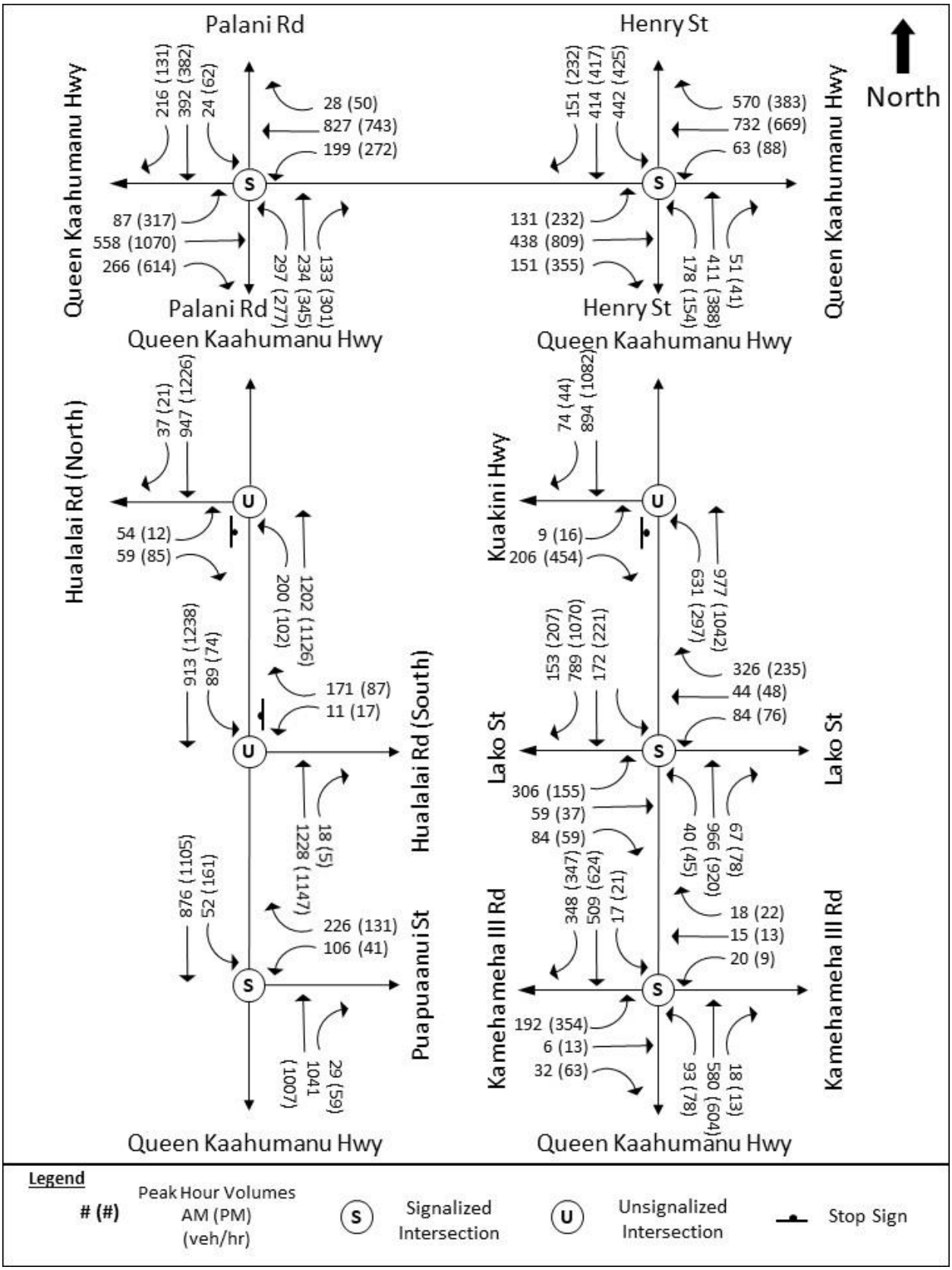


Figure 16: Future 2039 Without Project Peak Hour Volumes

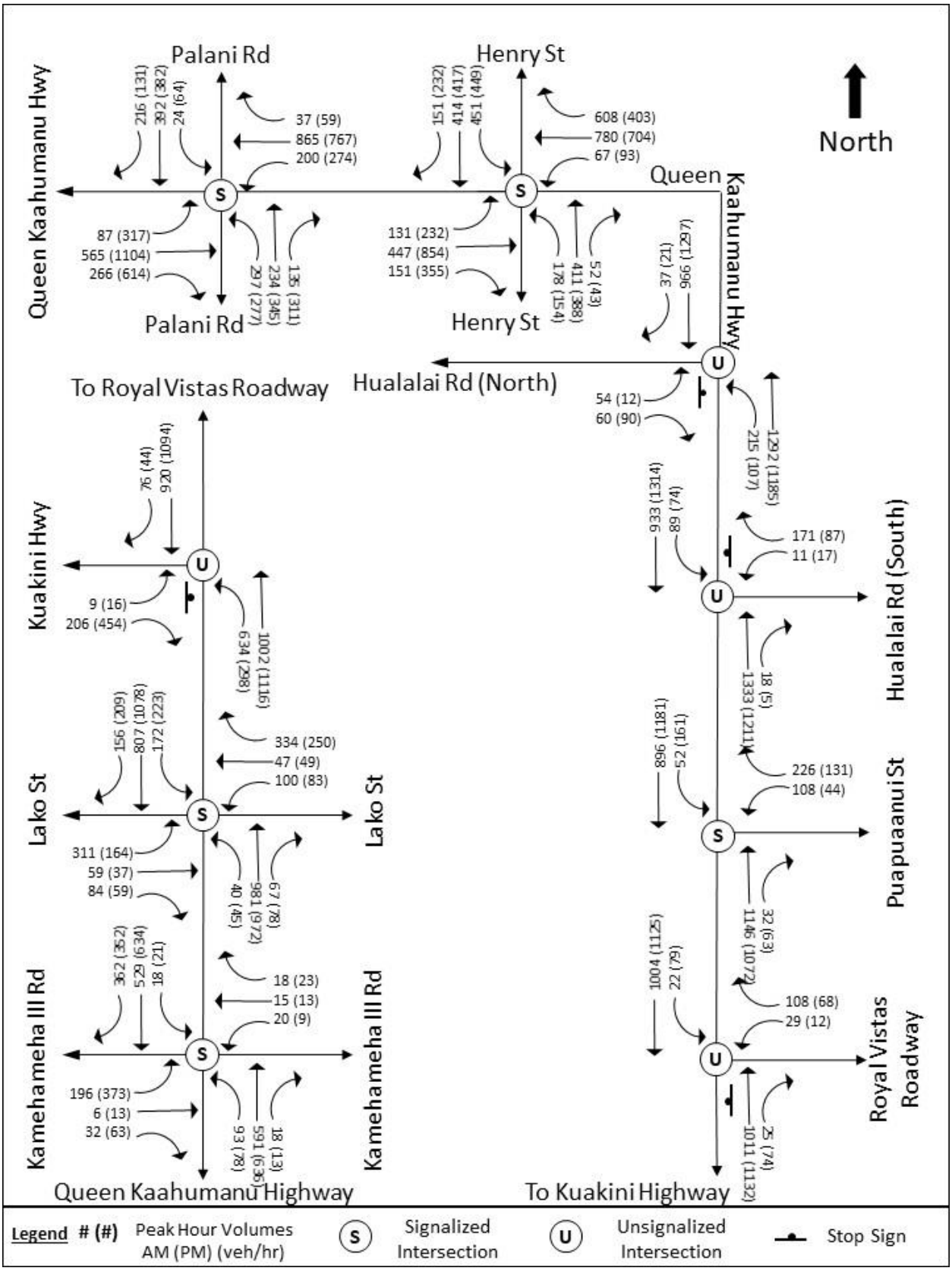


Figure 17: Future 2039 With Project Peak Hour Volumes

C. Future 2039 Intersection Traffic Operation Analysis

1. Future 2039 Without Project Intersection LOS

1. The 2039 Without Project intersection and movement LOS and average delay (in seconds per vehicle) were determined for the AM and PM peak hours. NOTE: 2039 Future projections assume 1% annual growth rate for 20 years, which is a conservative assumption. Tables 25 and 26 show the existing vehicular delay and level of service at each intersection. Queen Kaahumanu Highway and Palani Road. Overall Intersection LOS = C/C.
   The PM southbound left turn operates at LOS E. At 62 vehicles in the PM peak hour, this results in about 1 vehicle per minute. This movement should clear every cycle. The increase in delay is based on the increase of the background traffic volume.
2. Queen Kaahumanu Highway and Henry Street. Overall Intersection LOS = D/D.
   The PM eastbound and westbound left turns operate at LOS E. The overall delay and LOS have gradually gotten worse due to the increase in background growth rate. The increase in delay is based on the increase in background volumes.
3. Queen Kaahumanu Highway and Hualalai Road (North)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Street (north), the delay at this intersection is 41 seconds per vehicle. This is due to the high delay in the eastbound left turn volume. The eastbound left turning movement has LOS F (v/c of 0.59 during the PM peak hour) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
4. Queen Kaahumanu Highway and Hualalai Road (South)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Road (south), westbound left turning movement has LOS F (v/c of 0.46 and 0.76 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The westbound right turn also operates at LOS F (v/c of 0.97) during the AM peak hour. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
5. Queen Kaahumanu Highway and Puapuaanui Street. Overall Intersection LOS = B/B.
   The southbound left turns operate at LOS E during both peak hours. The westbound left turn operates at LOS E during the PM peak hour. These delays are due to the cycle length. The left turn volumes are low and should clear every cycle.
6. Queen Kaahumanu Highway and Kuakini Highway
   At the unsignalized intersection of Queen Kaahumanu Highway with Kuakini Highway, eastbound left turning movement has LOS F and long delays during the AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
7. Queen Kaahumanu Highway and Lako Street. Overall Intersection LOS = E/D.
   At the signalized intersection of Queen Kaahumanu Highway with Lako Street, the eastbound left turn, northbound through, and southbound left turn operate at LOS F (v/c of 1.01, 1.1, and 0.99

respectively). The PM southbound through operates at LOS F (v/c of 1.03). The delay increase is caused by the volumes generated by the background volume and the split phasing.

8. Queen Kaahumanu Highway and Kamehameha III Road. Overall Intersection LOS = C/B.
   All movements at the signalized intersections of Queen Kaahumanu Highway with Kamehameha III Road resulted in appropriate LOS D or better during AM and PM peak hours.

Tables 25 and 26 show the expected vehicular delay and level of service at each intersection. The shaded row indicates the overall intersection delay. Synchro output is in Appendix G.

Table 25: Future 2039 Without Project Intersection Level of Service

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Palani Rd (overall)	**26.3**	**-**	**C**	**31.1**	**-**	**C**
Queen Kaahumanu EB Left	41.4	0.53	D	44.2	0.80	D
Queen Kaahumanu EB Through	17.7	0.40	B	24.6	0.74	C
Queen Kaahumanu WB Left	40.8	0.71	D	45.3	0.78	D
Queen Kaahumanu WB Through	17.9	0.54	B	21.1	0.54	C
Palani NB Left	39.7	0.77	D	45.8	0.78	D
Palani NB Through	25.3	0.27	C	29.2	0.44	C
Palani SB Left	49.6	0.53	D	55.2	0.78	E
Palani SB Through	34.6	0.69	C	35.1	0.67	D
Queen Kaahumanu Hwy & Henry St (overall)	**37.5**	**0.74**	**D**	**38.9**	**0.78**	**D**
Queen Kaahumanu EB Left	53.9	0.67	D	65.5	0.84	E
Queen Kaahumanu EB Through	29.9	0.46	C	35.6	0.74	D
Queen Kaahumanu EB Right	25.7	0.10	C	26.8	0.23	C
Queen Kaahumanu WB Left	50.0	0.49	D	62.2	0.69	E
Queen Kaahumanu WB Through	40.8	0.80	D	39.0	0.73	D
Queen Kaahumanu WB Right	32.7	0.42	C	30.6	0.25	C
Henry NB Left	37.2	0.52	D	37.6	0.46	D
Henry NB Left-Through	38.9	0.65	D	39.9	0.64	D
Henry NB Right	32.2	0.04	C	33.4	0.03	C
Henry SB Left	43.4	0.79	D	46.0	0.82	D
Henry SB Left-Through-Right	37.8	0.77	D	37.8	0.77	D
Queen Kaahumanu Hwy & Hualalai (N) (overall)	**41.0**	**-**	**-**	**2.1**	**-**	**-**
Queen Kaahumanu NB Left	12.7	0.32	B	13.1	0.19	B
Hualalai EB Left	*	-	F	316.3	0.59	F
Queen Kaahumanu Hwy & Hualalai (S) (overall)	**9.2**	**-**	**-**	**3.7**	**-**	**-**
Queen Kaahumanu SB Left	13.7	0.19	B	12.3	0.13	B
Hualalai WB Left	229.1	0.46	F	345.7	0.76	F
Hualalai WB Right	109.5	0.97	F	30.3	0.39	D

*delay exceeds 1,000 seconds per vehicle

Table 26: Future 2039 Without Project Intersection Level of Service (continued)

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Puapuaanui St (overall)	**13.0**	**-**	**B**	**13.3**	**-**	**B**
Queen Kaahumanu SB Left	64.1	0.78	E	58.4	0.83	E
Queen Kaahumanu WB Through	4.8	0.62	A	4.6	0.70	A
Puapuaanui WB Left	54.5	0.79	D	57.1	0.67	E
Puapuaanui WB Right	13.0	0.80	B	13.8	0.79	B
Queen Kaahumanu Hwy & Kuakini Hwy (overall)	**11.3**	**-**	**-**	**8.6**	**-**	**-**
Queen Kaahumanu NB Left	46.0	0.95	E	15.8	0.48	C
Kuakini EB Left	*	-	-	*	-	F
Queen Kaahumanu Hwy & Lako St (overall)	**64.6**	**-**	**E**	**48.8**	**-**	**D**
Queen Kaahumanu NB Left	18.2	0.19	B	22.6	0.32	C
Queen Kaahumanu NB Through	85.1	1.10	F	44.8	0.98	D
Queen Kaahumanu SB Left	93.0	0.99	F	57.0	0.90	E
Queen Kaahumanu SB Through	29.4	0.85	C	52.9	1.03	F
Lako EB Left	92.7	1.01	F	46.1	0.80	D
Lako EB Through-Right	34.6	0.19	C	36.5	0.18	D
Lako WB Left	51.6	0.70	D	47.7	0.67	D
Lako WB Through-Right	45.3	0.35	D	42.8	0.41	D
Queen Kaahumanu Hwy & Kam III Rd (overall)	**20.4**	**-**	**C**	**28.3**	**-**	**B**
Queen Kaahumanu NB Left	42.0	0.79	D	51.0	0.78	D
Queen Kaahumanu NB Through	17.0	0.70	B	25.7	0.78	C
Queen Kaahumanu SB Left	42.6	0.48	D	47.9	0.51	D
Queen Kaahumanu SB Through	12.6	0.35	B	17.8	0.44	B
Kamehameha EB Left-Through	32.1	0.76	C	41.9	0.88	D
Kamehameha WB Left-Through-Right	44.7	0.73	D	49.3	0.68	D

*delay exceeds 1,000 seconds per vehicle

2. Future 2039 With Project Intersection LOS

Existing intersection and movement LOS and average delay (in seconds per vehicle) were determined for the AM and PM peak hours.

1. Queen Kaahumanu Highway and Palani Road. Overall Intersection LOS = C/C.
   All movements at the signalized intersections of Queen Kaahumanu Highway with Kamehameha III Road resulted in appropriate LOS D or better during AM and PM peak hours.
2. Queen Kaahumanu Highway and Henry Street. Overall Intersection LOS = D/D.
   All movements at the signalized intersections of Queen Kaahumanu Highway with Kamehameha III Road resulted in appropriate LOS D or better during AM and PM peak hours.

3. Queen Kaahumanu Highway and Hualalai Road (North)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Street (north), the delay at this intersection is 50.6 seconds per vehicle, a slight increase from the 2039 Without Project scenario. The eastbound left turning movement has LOS F (v/c of 0.73 in the PM peak hour) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
4. Queen Kaahumanu Highway and Hualalai Road (South)
   At the unsignalized intersection of Queen Kaahumanu Highway with Hualalai Road (south), westbound left turning movement has LOS F (v/c of 0.56 and 0.97 respectively) and long delays during both AM and PM peak hours are due to high through volumes on Queen Kaahumanu Highway. The westbound right turn also operates at LOS F (v/c of 1.14) during the AM peak hour. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
5. Queen Kaahumanu Highway and Puapuaanui Street. Overall Intersection LOS = B/B.
   The southbound left turns operate at LOS F (v/c of 0.78 and 0.87, respectively) during the AM and PM peak hours. The westbound left turn operates at LOS F (v/c of 0.77) during the PM peak hour. These delays are due to the cycle length. The left turn volumes are low and should clear every cycle.
6. Queen Kaahumanu Highway and Royal Vistas Roadway
   At the proposed unsignalized intersection of Queen Kaahumanu Highway and the Royal Vistas Roadway, the southbound left turn movement from Queen Kaahumanu Highway into Royal Vistas Roadway functions well, with minimal delay, an average of 11 to 13 seconds during both peak hours. The westbound left turning movement has LOS F (v/c of 0.70 and 0.69 respectively) during both AM (29 vehicles) and PM (12 vehicles) peak hours are due to high through volumes on Queen Kaahumanu Highway. Phase 2 left turns exiting Royal Vistas are expected to use Lako Street to access Queen Kaahumanu Highway. The intersection functions acceptably, with an average of 4.1 seconds of delay per vehicle in the AM peak hour and 2.9 seconds of delay per vehicle in the PM peak hour. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
7. Queen Kaahumanu Highway and Kuakini Highway
   At the unsignalized intersection of Queen Kaahumanu Highway with Kuakini Highway, the eastbound left turning movement has LOS F during the AM and PM peak hours. The northbound left turn operates at LOS F (v/c 0.98) during the AM peak hour. The major and other minor movements operated at acceptable levels of service during the AM and PM peak hours.
8. Queen Kaahumanu Highway and Lako Street. Overall Intersection LOS = E/D.
   The overall intersection operates at LOS E during the AM peak hour and LOS D during the PM peak hour. The delay is due to the increase in background volume, the traffic generated by Royal Vistas, and the split phasing. During the AM peak hour, the eastbound left turn, northbound through, and southbound left turn operate at LOS F (v/c of 1.04, 1.05, and 1.11 respectively). The PM eastbound left turn operates at LOS F (v/c of 0.87).
9. Queen Kaahumanu Highway and Kamehameha III Road. Overall Intersection LOS = C/C.

All movements at the signalized intersections of Queen Kaahumanu Highway with Kamehameha III Road resulted in appropriate LOS D or better during AM and PM peak hours.

Tables 27 and 28 show the expected vehicular delay and level of service at each intersection. The shaded row indicates the overall intersection delay. Synchro output is in Appendix I.

Table 27: Future 2039 With Project Intersection Level of Service

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Palani Rd (overall)	**26.3**	**-**	**C**	**31.3**	**-**	**C**
Queen Kaahumanu EB Left	41.4	0.53	D	44.3	0.80	D
Queen Kaahumanu EB Through	17.8	0.41	B	25.4	0.77	C
Queen Kaahumanu WB Left	40.8	0.71	D	45.5	0.78	D
Queen Kaahumanu WB Through	18.3	0.56	B	21.4	0.56	C
Palani NB Left	39.7	0.77	D	45.8	0.78	D
Palani NB Through	25.3	0.27	C	29.3	0.44	C
Palani SB Left	49.6	0.53	D	54.7	0.77	D
Palani SB Through	34.6	0.69	C	35.1	0.67	D
Queen Kaahumanu Hwy & Henry St (overall)	**38.6**	**0.76**	**D**	**40.2**	**0.80**	**D**
Queen Kaahumanu EB Left	53.9	0.67	D	64.6	0.84	E
Queen Kaahumanu EB Through	30.2	0.47	C	41.4	0.84	D
Queen Kaahumanu EB Right	25.8	0.10	C	28.1	0.23	C
Queen Kaahumanu WB Left	50.6	0.51	D	51.3	0.56	D
Queen Kaahumanu WB Through	44.3	0.85	D	42.4	0.80	D
Queen Kaahumanu WB Right	35.0	0.51	D	31.4	0.26	C
Henry NB Left	37.2	0.52	D	37.3	0.46	D
Henry NB Left-Through	38.9	0.65	D	39.6	0.63	D
Henry NB Right	32.2	0.04	C	33.2	0.03	C
Henry SB Left	43.4	0.79	D	44.6	0.82	D
Henry SB Left-Through-Right	38.0	0.78	D	37.2	0.77	D
Queen Kaahumanu Hwy & Hualalai (N) (overall)	**50.6**	**-**	**-**	**2.5**	**-**	**-**
Queen Kaahumanu NB Left	13.2	0.35	B	13.9	0.21	B
Hualalai EB Left	*	-	F	425.9	0.73	F
Queen Kaahumanu Hwy & Hualalai (S) (overall)	**13.1**	**-**	**-**	**4.6**	**-**	**-**
Queen Kaahumanu SB Left	14.8	0.21	B	12.8	0.14	B
Hualalai WB Left	308.6	0.56	F	495.2	0.97	F
Hualalai WB Right	168.4	1.14	F	34.3	0.43	D

*delay exceeds 1,000 seconds per vehicle

Table 28: Future 2039 With Project Intersection Level of Service (continued)

Intersection	AM			PM		
	Delay (s)	v/c	LOS	Delay (s)	v/c	LOS
Queen Kaahumanu Hwy & Puapuaanui St (overall)	**15.7**	**-**	**B**	**15.3**	**-**	**B**
Queen Kaahumanu SB Left	91.4	0.78	F	82.9	0.87	F
Queen Kaahumanu WB Through	4.9	0.62	A	4.6	0.72	A
Puapuaanui WB Left	65.6	0.81	E	84.3	0.77	F
Puapuaanui WB Right	16.1	0.85	B	14.0	0.78	B
Queen Kaahumanu Hwy & Kona Vista Rdwy (overall)	**4.1**	**-**	**-**	**2.9**	**-**	**-**
Queen Kaahumanu SB Left	10.9	0.04	B	12.5	0.15	B
Kona Vista WB Left	190.1	0.70	F	375.9	0.69	F
Kona Vista WB Right	30.1	0.46	D	29.9	0.34	D
Queen Kaahumanu Hwy & Kuakini Hwy (overall)	**12.7**	**-**	**-**	**9.3**	**-**	**-**
Queen Kaahumanu NB Left	52.8	0.98	F	16.1	0.49	C
Kuakini EB Left	*	-	-	*	-	F
Queen Kaahumanu Hwy & Lako St (overall)	**65.7**	**-**	**E**	**37.0**	**-**	**D**
Queen Kaahumanu NB Left	20.1	0.19	C	25.9	0.26	C
Queen Kaahumanu NB Through	72.4	1.05	F	29.0	0.86	C
Queen Kaahumanu SB Left	141.3	1.11	F	46.1	0.87	D
Queen Kaahumanu SB Through	29.2	0.83	C	30.6	0.91	C
Lako EB Left	109.6	1.04	F	85.9	0.87	F
Lako EB Through-Right	42.1	0.19	D	55.7	0.19	E
Lako WB Left	62.3	0.76	E	73.0	0.76	E
Lako WB Through-Right	53.6	0.34	D	64.5	0.44	E
Queen Kaahumanu Hwy & Kam III Rd (overall)	**22.5**	**-**	**C**	**33.1**	**-**	**C**
Queen Kaahumanu NB Left	53.6	0.80	D	66.8	0.79	E
Queen Kaahumanu NB Through	14.9	0.61	B	25.8	0.71	C
Queen Kaahumanu SB Left	55.9	0.51	E	67.8	0.56	E
Queen Kaahumanu SB Through	12.4	0.31	B	19.8	0.39	B
Kamehameha EB Left-Through	44.4	0.81	D	53.5	0.90	D
Kamehameha WB Left-Through-Right	60.4	0.78	E	73.2	0.77	E

*delay exceeds 1,000 seconds per vehicle

3. 2039 Traffic Signal Warrant

Table 29 shows the Peak-Hour warrant analysis in 2039 with and without the project. The Traffic Signal Warrant analysis can be found in Appendix J.

1. Queen Kaahumanu Highway and Hualalai Road (North)
   This intersection passes the Peak-Hour warrant in the AM and PM peak hour with and without the project.

2. Queen Kaahumanu Highway and Hualalai Road (South)
   This intersection passes the Peak-Hour warrant in the AM peak hour with and without the project.
3. Queen Kaahumanu Highway and Kuakini Highway
   This intersection passes the Peak-Hour warrant in the AM and PM peak hour with and without the project.

Table 29: 2039 Peak-Hour Warrant

2039 Without Project	Peak Hour Warrant					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	947	200	YES	1226	102	YES
Hualalai (S)	1228	89	YES	1147	74	NO
Kuakini	894	631	YES	1082	297	YES
2039 With Project	**Peak Hour Warrant**					
	AM			**PM**		
	Major	**Minor**	**Warrant?**	**Major**	**Minor**	**Warrant?**
Hualalai (N)	966	215	YES	1297	107	YES
Hualalai (S)	1333	89	YES	1212	74	NO
Kuakini	894	639	YES	1082	300	YES

4. 2039 With Project Segment LOS

Arterial LOS was analyzed in Synchro on Queen Kaahumanu Highway from Hualalai (north) to Lako Street. Where signalized intersections are less than 2.0 mi apart, the facility should be classified as an urban street and analyzed with the methodologies of Urban Street Facilities. For Urban Street Facilities, through-vehicle travel speed is used to analyze vehicular LOS. Analysis worksheets can be found in Appendix I. The arterial LOS can be found in Table 30.

This segment of Queen Kaahumanu Highway operates at LOS D in the northbound direction and LOS B in the southbound direction in the AM peak hour. During the PM peak hour, both directions operate at LOS C. The arterial LOS for the AM and PM peak hours satisfies the County of Hawaii Chapter 25 (Zoning), Article 2 (Administration and Enforcement), Division 4 (Amendments), Section 46 (Concurrency Requirements) regarding “acceptable level of service” for transportation facilities.

Table 30: 2039 with Project Segment LOS

	Northbound		Southbound	
	Speed (mph)	LOS	Speed (mph)	LOS
AM Peak Hour	15.6	D	24.2	B
PM Peak Hour	18.6	C	23.6	C

VI. SUMMARY AND RECOMMENDATIONS

The *Federal-Aid Highways 2035 Transportation Plan for the District of Hawaii* (July 2014) includes improvements to Kuakini Highway from Henry Street to Kamehameha III Road. Kuakini Highway will be widened by 2 travel lanes and include bicycle facilities and sidewalks. This project would have a significant impact on traffic operations. The installation of bike facilities and pedestrian facilities may lead to an increase in bicycle and pedestrian traffic, in which case bicycle and pedestrian safety will need to be further analyzed. Due to the difficulty of crossing a 4-lane roadway with a posted speed limit of 45 MPH, stop-controlled intersections may need to be signalized or converted to roundabouts.

Based on the existing traffic volumes and future projections of Royal Vistas on the surrounding roadways, the following system-wide intersection improvements are recommended for consideration by Hawaii County and HDOT:

1. Queen Kaahumanu Highway and Palani Road
   Signal timing should be monitored and updated to ensure that left turn queues clear every cycle.
2. Queen Kaahumanu Highway and Henry Street
   Signal timing should be monitored and updated to ensure that left turn queues clear every cycle. Henry Street approaches currently operate in split phases. Changing the split phasing to protected left turn phases on Henry Street will allow more green time on the major through movements, lowering the overall delay of the intersection.
3. Queen Kaahumanu Highway and Hualalai Road (North)
   Based on the 2019 traffic volumes, this intersection passes the Four-Hour warrant. This intersection passed the Peak-Hour warrant in the 2019 AM peak hour and for all peak hours in all future scenarios. Future traffic should be monitored, and a traffic signal or roundabout should be installed if needed, but priority should be given to keeping Queen Kaahumanu Highway traffic moving and not installing a traffic signal if not warranted by 4- or 8-hour warrants. The overall delay at this intersection is 41.0 and 50.6 seconds per vehicle in the 2039 AM peak hour, without and with the project, respectively. When the delay experienced by drivers reaches this level, the eastbound drivers are likely to find alternative routes.
4. Queen Kaahumanu Highway and Hualalai Road (South)
   As the westbound left turn delay gets worse, drivers may decide to use Puapuaanui Street to access Queen Kaahumanu Highway in the southbound direction. Based on the existing volumes, this intersection did not pass the Four-Hour warrant or the Peak-Hour warrant. This intersection did pass the Peak-Hour warrant for all future AM peak hour scenarios. Future traffic should be monitored.
5. Queen Kaahumanu Highway and Puapuaanui Street
   Signal timing should be monitored and adjusted as needed to increase the probability that queues on Queen Kaahumanu Highway can clear the intersection in 1 cycle.
6. Queen Kaahumanu Highway and Royal Vistas Roadway
   This intersection will function acceptably through the full Phase 1 buildout. Before any Phase 2 residences are occupied, it is recommended that the connection to Kekuanao'a Place is completed so that Royal Vistas Phase 2 'left out' traffic can access the Lako Street traffic signal.
7. Queen Kaahumanu Highway and Kuakini Highway

This intersection passes the Four-Hour warrant and Peak-Hour warrants during all peak hours for all scenarios. Future traffic should be monitored, and a traffic signal or roundabout should be installed if needed. The northbound left turn movement is very heavy (300-600 veh/hour by 2039 with project), which will be nearly at capacity. The westbound left turn, while small, is already over capacity in 2019 and will be far over capacity by 2039. Royal Vistas traffic has very little effect on this intersection.

8. Queen Kaahumanu Highway and Lako Street
   The Lako Street intersection operates at LOS E/D (AM/PM) with or without the Royal Vistas project in the 2039 scenario. Lako Street currently has split phasing (sequential rather than concurrent) on the Lako Street approaches. Changing the phasing from split to protected left turns would help lower the delay. This intersection would also improve significantly if Queen Kaahumanu Highway is widened to 4 lanes as in the 2035 Transportation Plan.
9. Queen Kaahumanu Highway and Kamehameha III Road
   Signal timing should be monitored and updated as needed.

Arterial LOS was analyzed in Synchro on Queen Kaahumanu Highway from Hualalai (north) to Lako Street. Where signalized intersections are less than 2.0 mi apart, the facility should be classified as an urban street and analyzed with the methodologies of Urban Street Facilities. For Urban Street Facilities, through-vehicle travel speed is used to analyze vehicular LOS. This segment of Queen Kaahumanu Highway operates at LOS D or better for each scenario in the AM and PM peak hours. The arterial LOS satisfies the County of Hawaii Chapter 25 (Zoning), Article 2 (Administration and Enforcement), Division 4 (Amendments), Section 46 (Concurrency Requirements) regarding “acceptable level of service” for transportation facilities.

VII. REFERENCES

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Appendix A

24-Hour and Peak Period Turn Movement Traffic Counts

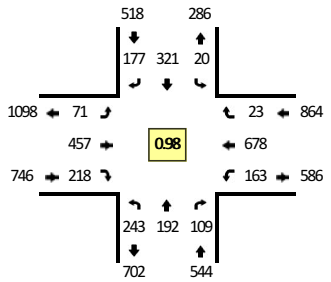
Type of peak hour being reported: User-Defined

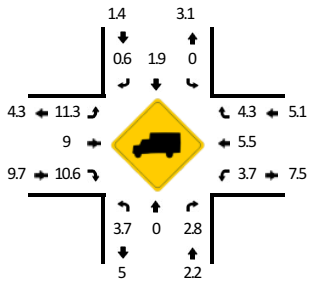
Method for determining peak hour: Total Entering Volume

LOCATION: Palani Rd -- Hawaii Belt Rd
CITY/STATE: Hawaii, HI

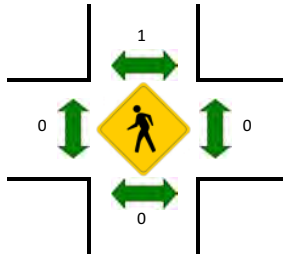
QC JOB #: 14972601
DATE: Tue, Apr 30 2019

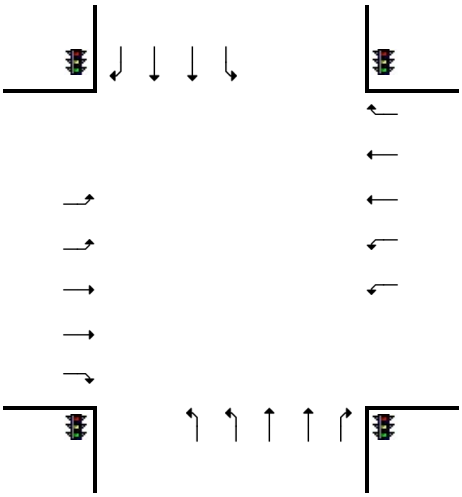
Peak-Hour: 7:20 AM -- 8:20 AM
Peak 15-Min: 7:30 AM -- 7:45 AM

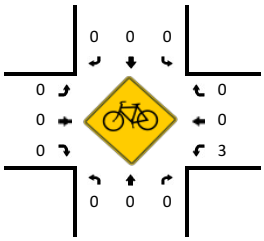


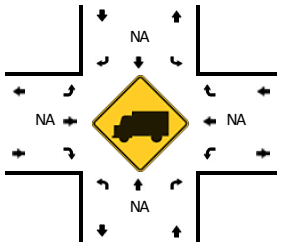


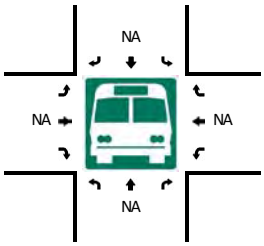
Quality Counts
DATA THAT DRIVES COMMUNITIES











15-Min Count Period Beginning At	Palani Rd (Northbound)				Palani Rd (Southbound)				Hawaii Belt Rd (Eastbound)				Hawaii Belt Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:45 AM	48	18	28	0	7	57	28	0	17	76	31	0	48	175	2	0	535	
7:00 AM	51	35	26	1	5	55	17	0	11	91	38	0	36	179	3	0	548	
7:15 AM	51	39	27	0	4	78	33	1	20	122	38	0	41	157	1	0	612	
7:30 AM	54	51	26	0	8	91	38	0	13	131	58	0	40	163	11	0	684	2379
7:45 AM	63	55	28	0	1	80	49	0	23	102	59	0	45	144	7	0	656	2500
8:00 AM	68	39	29	0	7	70	51	0	12	111	53	0	44	184	3	0	671	2623
8:15 AM	58	34	27	0	5	61	29	0	22	129	51	0	38	223	5	0	682	2693
8:30 AM	55	48	35	0	8	69	28	0	25	136	75	0	61	187	4	0	731	2740

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	216	204	104	0	32	364	152	0	52	524	232	0	160	652	44	0	2736
Heavy Trucks	8	0	0		0	8	0		4	52	28		0	28	0		128
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 5/13/2019 3:10 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

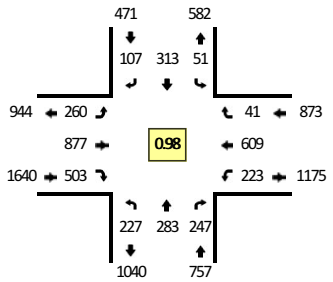
Type of peak hour being reported: User-Defined

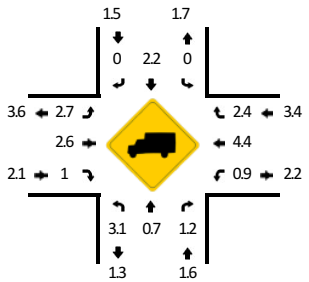
Method for determining peak hour: Total Entering Volume

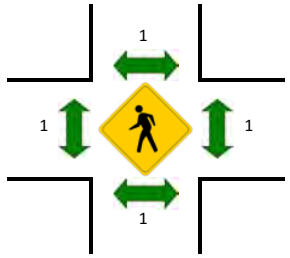
LOCATION: Palani Rd -- Hawaii Belt Rd
CITY/STATE: Hawaii, HI

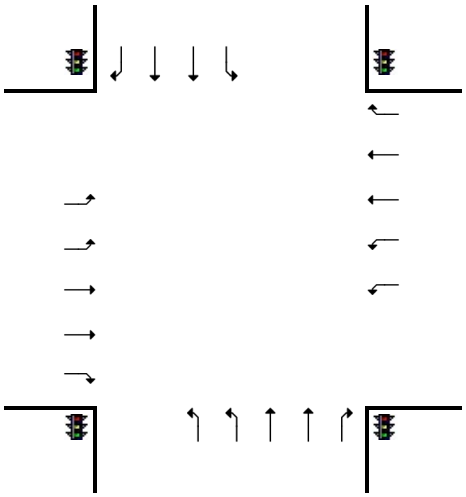
QC JOB #: 14972602
DATE: Tue, Apr 30 2019

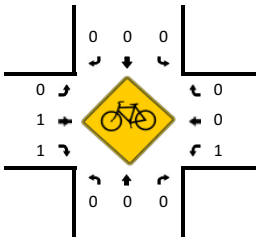
Peak-Hour: 3:45 PM -- 4:45 PM
Peak 15-Min: 3:45 PM -- 4:00 PM

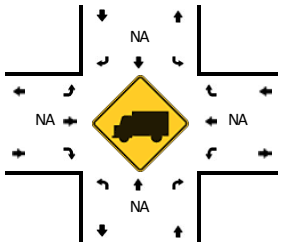


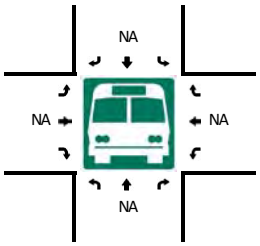












15-Min Count Period Beginning At	Palani Rd (Northbound)				Palani Rd (Southbound)				Hawaii Belt Rd (Eastbound)				Hawaii Belt Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:00 PM	66	67	66	0	10	102	35	1	52	189	93	0	54	184	18	0	937	
3:15 PM	56	76	61	0	13	84	29	0	46	175	115	1	55	156	8	0	875	
3:30 PM	77	61	59	0	15	94	27	0	53	193	114	0	52	158	4	0	907	
3:45 PM	55	82	65	0	21	93	29	0	55	198	131	1	56	154	11	0	951	3670
4:00 PM	52	57	48	1	9	74	27	0	80	227	129	0	56	172	9	0	941	3674
4:15 PM	73	69	61	0	12	79	32	0	60	213	134	0	56	138	6	0	933	3732
4:30 PM	46	75	73	0	9	67	19	0	63	239	109	1	55	145	15	0	916	3741
4:45 PM	59	71	63	0	16	94	37	0	65	176	123	0	52	114	17	0	887	3677
5:00 PM	67	79	57	1	11	69	36	0	63	225	111	2	47	155	8	1	932	3668
5:15 PM	64	68	66	0	4	91	34	0	66	176	101	0	63	142	8	0	883	3618
5:30 PM	47	75	55	0	3	66	19	0	46	166	94	0	57	120	8	0	756	3458
5:45 PM	51	88	50	0	7	59	13	0	38	164	69	1	41	101	9	0	691	3262

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	220	328	260	0	84	372	116	0	220	792	524	4	224	616	44	0	3804
Heavy Trucks	16	0	4		0	8	0		12	20	8		0	44	0		112
Pedestrians		0				4				4				4			12
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 5/13/2019 3:06 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

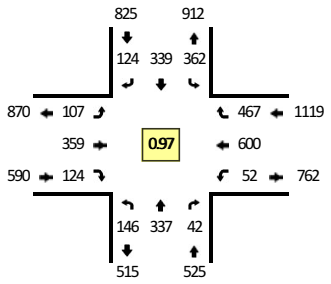
Type of peak hour being reported: User-Defined

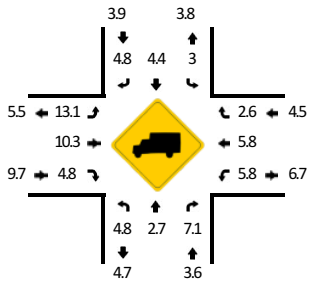
Method for determining peak hour: Total Entering Volume

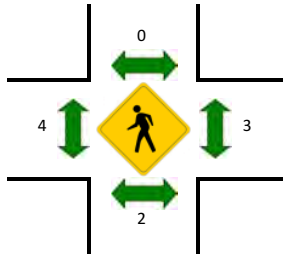
LOCATION: Henry St -- Hawaii Belt Rd
CITY/STATE: Hawaii, HI

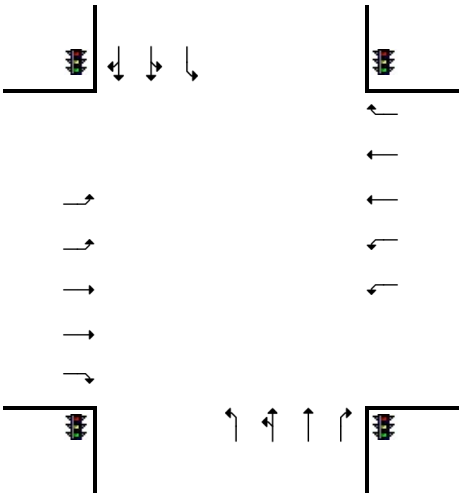
QC JOB #: 14972603
DATE: Tue, Apr 30 2019

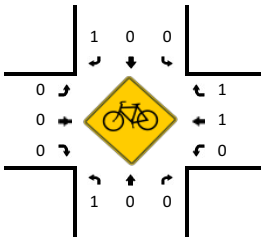
Peak-Hour: 7:20 AM -- 8:20 AM
Peak 15-Min: 8:15 AM -- 8:30 AM

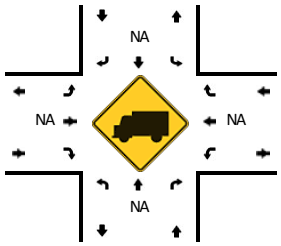


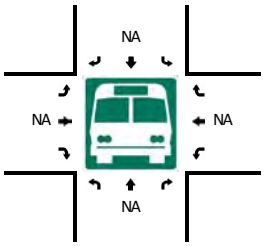












15-Min Count Period Beginning At	Henry St (Northbound)				Henry St (Southbound)				Hawaii Belt Rd (Eastbound)				Hawaii Belt Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:45 AM	31	57	5	0	77	48	26	0	16	77	23	0	13	162	103	0	638	
7:00 AM	32	40	13	0	109	69	20	0	19	86	16	0	7	170	89	0	670	
7:15 AM	44	81	8	0	112	78	25	0	27	107	18	0	8	138	132	0	778	
7:30 AM	24	81	7	0	78	68	35	0	32	105	40	0	14	160	124	0	768	2854
7:45 AM	34	82	7	0	82	93	31	1	23	79	27	0	14	142	110	0	725	2941
8:00 AM	40	83	15	0	86	85	26	0	27	93	30	0	15	165	117	0	782	3053
8:15 AM	50	81	12	0	89	77	37	0	25	97	37	0	19	184	86	0	794	3069
8:30 AM	46	68	14	0	84	63	40	0	45	90	35	0	16	163	91	0	755	3056

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	200	324	48	0	356	308	148	0	100	388	148	0	76	736	344	0	3176
Heavy Trucks	4	16	4		12	8	0		0	36	16		4	44	20		164
Pedestrians		0				0				12				4			16
Bicycles	0	0	0		0	0	0		0	0	0		0	0	2		2
Railroad																	
Stopped Buses																	

Comments:

Report generated on 5/13/2019 3:10 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

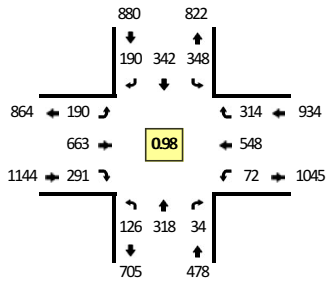
Type of peak hour being reported: User-Defined

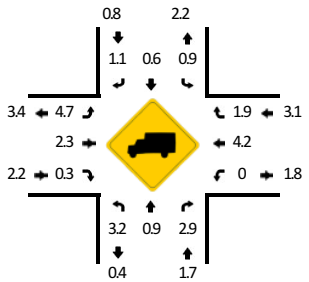
Method for determining peak hour: Total Entering Volume

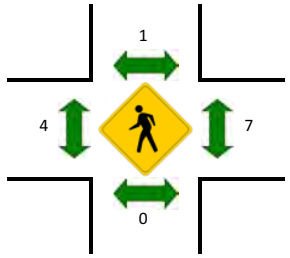
LOCATION: Henry St -- Hawaii Belt Rd
CITY/STATE: Hawaii, HI

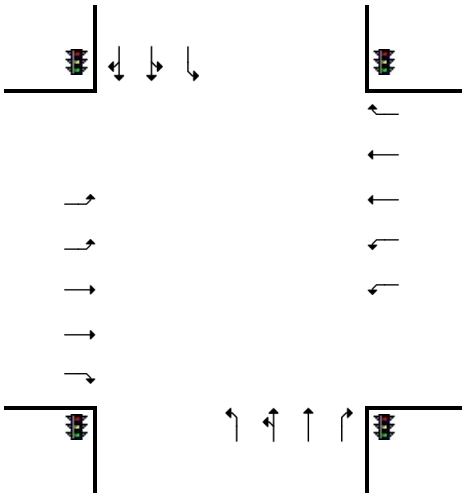
QC JOB #: 14972604
DATE: Tue, Apr 30 2019

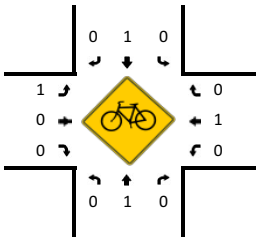
Peak-Hour: 3:45 PM -- 4:45 PM
Peak 15-Min: 3:45 PM -- 4:00 PM

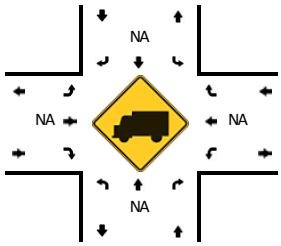


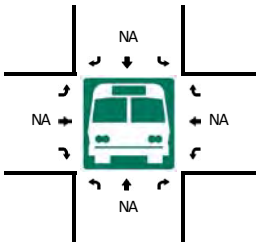












15-Min Count Period Beginning At	Henry St (Northbound)				Henry St (Southbound)				Hawaii Belt Rd (Eastbound)				Hawaii Belt Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:00 PM	43	74	9	0	91	93	61	0	48	148	51	0	8	152	85	0	863	
3:15 PM	29	95	9	0	110	83	52	0	46	156	54	0	18	143	76	0	871	
3:30 PM	42	85	20	0	84	73	41	0	56	156	58	0	29	145	82	0	871	
3:45 PM	31	72	12	0	99	80	51	0	45	182	67	0	17	147	74	0	877	3482
4:00 PM	36	71	7	0	80	94	54	0	40	161	69	0	14	127	73	0	826	3445
4:15 PM	29	88	6	0	88	70	34	0	51	164	73	0	25	148	84	0	860	3434
4:30 PM	30	87	9	0	81	98	51	0	54	156	82	0	16	126	83	0	873	3436
4:45 PM	28	80	6	0	87	80	47	0	55	168	64	0	10	119	85	0	829	3388
5:00 PM	30	85	7	0	87	82	54	0	40	154	72	0	8	123	80	0	822	3384
5:15 PM	23	88	13	0	78	78	55	0	49	162	51	0	12	127	80	0	816	3340
5:30 PM	27	63	8	0	82	61	45	0	41	150	36	0	12	118	53	0	696	3163
5:45 PM	18	76	4	0	78	68	27	0	48	143	40	0	5	101	77	0	685	3019

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	124	288	48	0	396	320	204	0	180	728	268	0	68	588	296	0	3508
Heavy Trucks	8	0	0		4	4	0		4	12	0		0	36	0		68
Pedestrians		0				0				8				12			20
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 5/13/2019 3:06 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

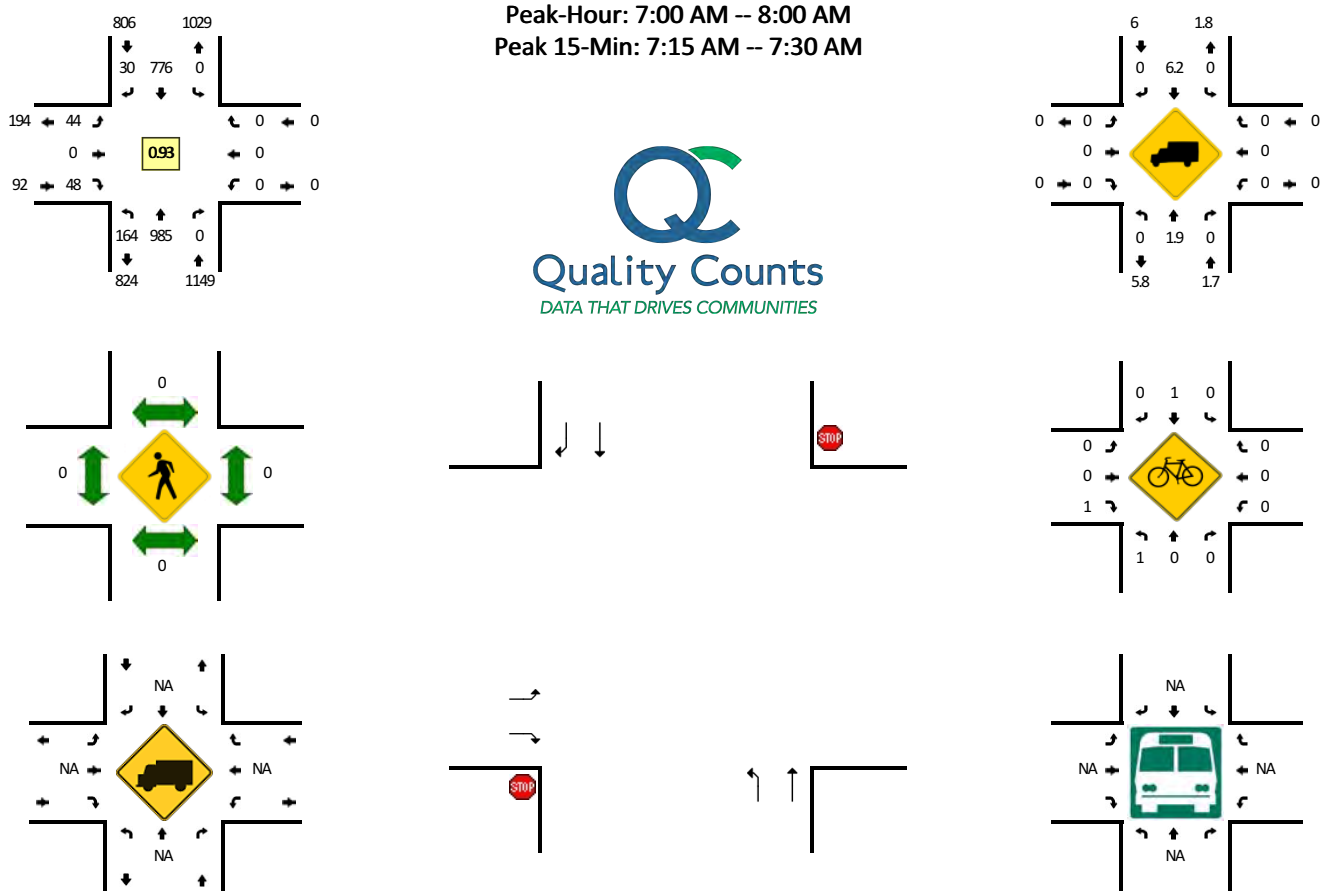
Type of peak hour being reported: System Peak

Method for determining peak hour: Total Entering Volume

LOCATION: Queen Kaahumanu Hwy -- Hualalai Rd (Northern Most)
CITY/STATE: Kailua, HI

QC JOB #: 15039901
DATE: Thu, Aug 29 2019

Peak-Hour: 7:00 AM -- 8:00 AM
Peak 15-Min: 7:15 AM -- 7:30 AM



15-Min Count Period Beginning At	Queen Kaahumanu Hwy (Northbound)				Queen Kaahumanu Hwy (Southbound)				Hualalai Rd (Northern Most) (Eastbound)				Hualalai Rd (Northern Most) (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	28	239	0	0	0	190	4	0	5	0	6	0	0	0	0	0	472	
7:15 AM	36	263	0	0	0	212	11	0	9	0	18	0	0	0	0	0	549	
7:30 AM	32	260	0	0	0	198	8	0	24	0	14	0	0	0	0	0	536	
7:45 AM	68	223	0	0	0	176	7	0	6	0	10	0	0	0	0	0	490	2047
8:00 AM	38	229	0	0	0	164	4	0	0	0	7	0	0	0	0	0	442	2017
8:15 AM	36	232	0	0	0	168	3	0	2	0	13	0	0	0	0	0	454	1922
8:30 AM	34	231	0	1	0	178	1	0	0	0	16	1	0	0	0	0	462	1848
8:45 AM	37	254	0	0	0	182	2	0	0	0	12	0	0	0	0	0	487	1845

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	144	1052	0	0	0	848	44	0	36	0	72	0	0	0	0	0	2196
Heavy Trucks	0	24	0		0	40	0		0	0	0		0	0	0		64
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 9/12/2019 10:40 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

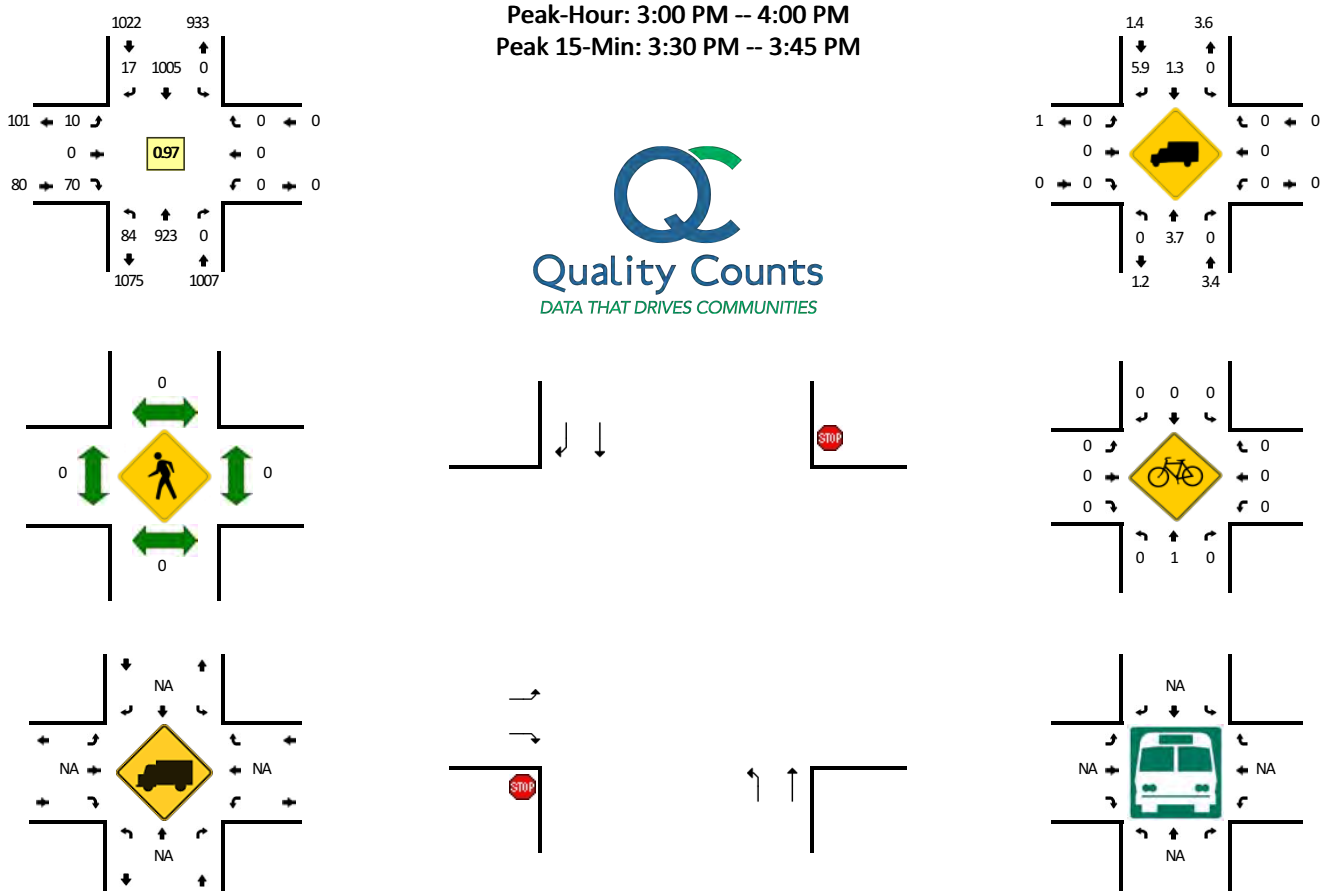
Type of peak hour being reported: System Peak

Method for determining peak hour: Total Entering Volume

LOCATION: Queen Kaahumanu Hwy -- Hualalai Rd (Northern Most)
CITY/STATE: Kailua, HI

QC JOB #: 15039902
DATE: Thu, Aug 29 2019

Peak-Hour: 3:00 PM -- 4:00 PM
Peak 15-Min: 3:30 PM -- 3:45 PM



15-Min Count Period Beginning At	Queen Kaahumanu Hwy (Northbound)				Queen Kaahumanu Hwy (Southbound)				Hualalai Rd (Northern Most) (Eastbound)				Hualalai Rd (Northern Most) (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:00 PM	27	219	0	0	0	247	5	0	3	0	24	0	0	0	0	0	525	
3:15 PM	9	227	0	0	0	259	4	0	4	0	18	0	0	0	0	0	521	
3:30 PM	22	261	0	0	0	242	3	0	0	0	18	0	0	0	0	0	546	
3:45 PM	26	216	0	0	0	257	5	0	3	0	10	0	0	0	0	0	517	2109
4:00 PM	14	205	0	0	0	268	4	0	1	0	31	0	0	0	0	0	523	2107
4:15 PM	22	221	0	0	0	226	4	0	3	0	23	0	0	0	0	0	499	2085
4:30 PM	14	198	0	0	0	200	2	0	5	0	21	0	0	0	0	0	440	1979
4:45 PM	24	218	0	0	0	232	1	0	5	0	27	0	0	0	0	0	507	1969
5:00 PM	12	178	0	0	0	257	6	0	3	0	30	0	0	0	0	0	486	1932
5:15 PM	17	209	0	0	0	252	2	0	4	0	29	0	0	0	0	0	513	1946
5:30 PM	16	195	0	0	0	225	3	0	0	0	11	0	0	0	0	0	450	1956
5:45 PM	13	141	0	0	0	252	3	0	0	0	16	0	0	0	0	0	425	1874

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	88	1044	0	0	0	968	12	0	0	0	72	0	0	0	0	0	2184
Heavy Trucks	0	56	0		0	8	0		0	0	0		0	0	0		64
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 9/12/2019 10:43 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

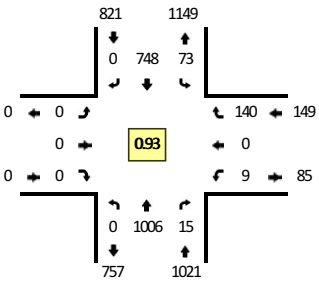
Type of peak hour being reported: System Peak

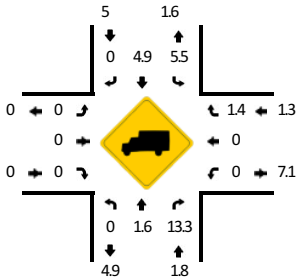
Method for determining peak hour: Total Entering Volume

LOCATION: Queen Kaahumanu Hwy -- Hualalai Rd (Southern Most)
CITY/STATE: Kailua, HI

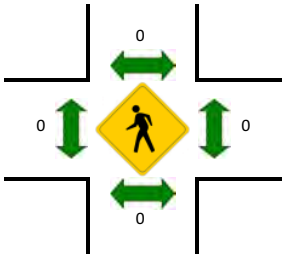
QC JOB #: 15039911
DATE: Thu, Aug 29 2019

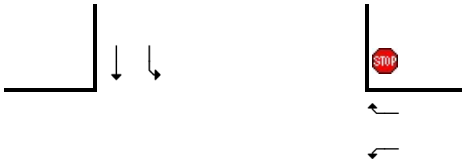
Peak-Hour: 7:00 AM -- 8:00 AM
Peak 15-Min: 7:30 AM -- 7:45 AM

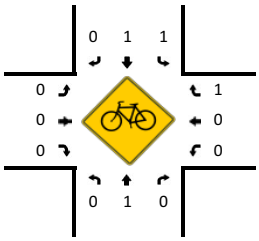


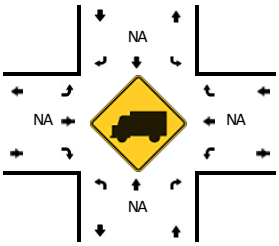


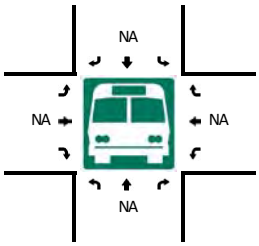
Quality Counts
DATA THAT DRIVES COMMUNITIES











15-Min Count Period Beginning At	Queen Kaahumanu Hwy (Northbound)				Queen Kaahumanu Hwy (Southbound)				Hualalai Rd (Southern Most) (Eastbound)				Hualalai Rd (Southern Most) (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	0	241	3	0	9	183	0	0	0	0	0	0	0	0	12	0	448	
7:15 AM	0	267	3	0	23	191	0	3	0	0	0	0	1	0	35	0	523	
7:30 AM	0	267	8	0	23	193	0	0	0	0	0	0	7	0	37	0	535	
7:45 AM	0	231	1	0	15	181	0	0	0	0	0	0	1	0	56	0	485	1991
8:00 AM	0	239	0	0	5	172	0	1	0	0	0	0	2	0	20	0	439	1982
8:15 AM	0	260	1	0	5	172	0	0	0	0	0	0	1	0	13	0	452	1911
8:30 AM	0	249	1	0	5	192	0	0	0	0	0	0	2	0	17	0	466	1842
8:45 AM	0	282	0	0	11	177	0	0	0	0	0	0	1	0	10	0	481	1838

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	0	1068	32	0	92	772	0	0	0	0	0	0	28	0	148	0	2140
Heavy Trucks	0	4	4		8	32	0		0	0	0		0	0	4		52
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		1	0	0		0	0	0		0	0	1		2
Railroad																	
Stopped Buses																	

Comments:

Report generated on 9/12/2019 10:40 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

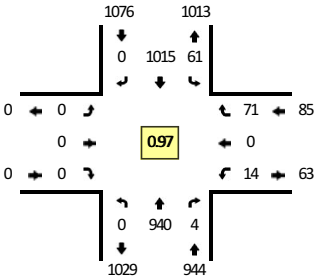
Type of peak hour being reported: System Peak

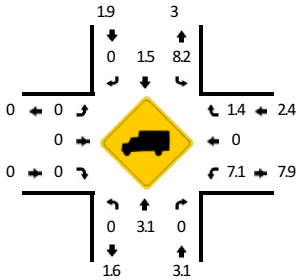
Method for determining peak hour: Total Entering Volume

LOCATION: Queen Kaahumanu Hwy -- Hualalai Rd (Southern Most)
CITY/STATE: Kailua, HI

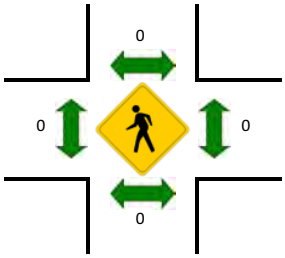
QC JOB #: 15039912
DATE: Thu, Aug 29 2019

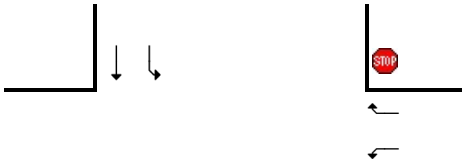
Peak-Hour: 3:00 PM -- 4:00 PM
Peak 15-Min: 3:00 PM -- 3:15 PM

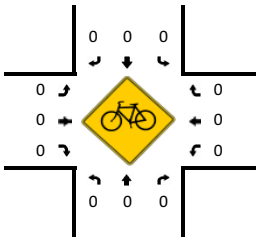


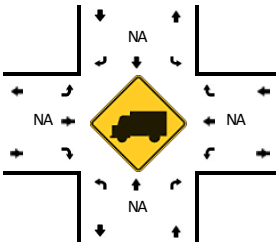


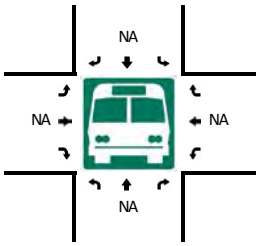
Quality Counts
DATA THAT DRIVES COMMUNITIES











15-Min Count Period Beginning At	Queen Kaahumanu Hwy (Northbound)				Queen Kaahumanu Hwy (Southbound)				Hualalai Rd (Southern Most) (Eastbound)				Hualalai Rd (Southern Most) (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:00 PM	0	242	0	0	14	258	0	1	0	0	0	0	5	0	21	0	541	
3:15 PM	0	217	2	0	17	266	0	0	0	0	0	0	4	0	13	0	519	
3:30 PM	0	259	1	0	14	246	0	0	0	0	0	0	1	0	19	0	540	
3:45 PM	0	222	1	0	14	245	0	1	0	0	0	0	4	0	18	0	505	2105
4:00 PM	0	202	0	0	25	272	0	0	0	0	0	0	1	0	11	0	511	2075
4:15 PM	0	242	1	0	10	244	0	0	0	0	0	0	2	0	6	0	505	2061
4:30 PM	0	207	2	0	14	206	0	0	0	0	0	0	1	0	11	0	441	1962
4:45 PM	0	213	5	0	15	250	0	0	0	0	0	0	0	0	14	0	497	1954
5:00 PM	0	199	1	0	18	265	0	0	0	0	0	0	0	0	12	0	495	1938
5:15 PM	0	205	0	0	25	256	0	0	0	0	0	0	1	0	16	0	503	1936
5:30 PM	0	198	1	0	6	246	0	0	0	0	0	0	2	0	5	0	458	1953
5:45 PM	0	163	1	0	7	247	0	1	0	0	0	0	0	0	2	0	421	1877

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	0	968	0	0	56	1032	0	4	0	0	0	0	20	0	84	0	2164
Heavy Trucks	0	12	0		4	20	0		0	0	0		0	0	0		36
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 9/12/2019 10:43 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

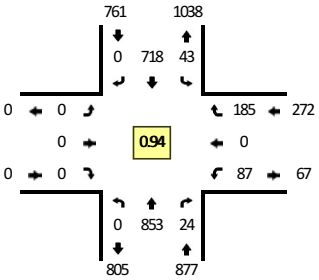
Type of peak hour being reported: System Peak

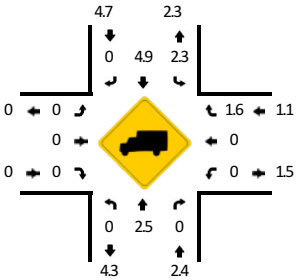
Method for determining peak hour: Total Entering Volume

LOCATION: Queen Kaahumanu Hwy -- Puapuaanui St
CITY/STATE: Kailua, HI

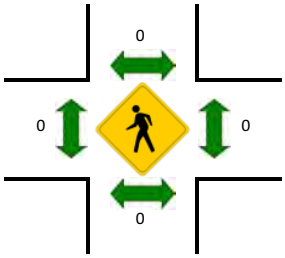
QC JOB #: 15039905
DATE: Thu, Aug 29 2019

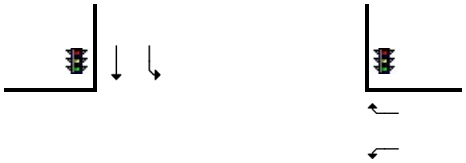
Peak-Hour: 7:00 AM -- 8:00 AM
Peak 15-Min: 7:15 AM -- 7:30 AM

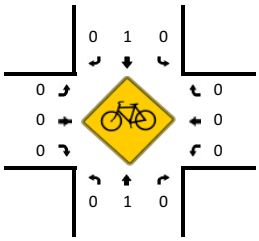


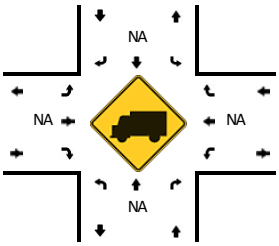


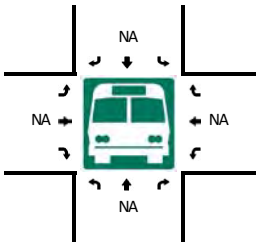
Quality Counts
DATA THAT DRIVES COMMUNITIES











15-Min Count Period Beginning At	Queen Kaahumanu Hwy (Northbound)				Queen Kaahumanu Hwy (Southbound)				Puapuaanui St (Eastbound)				Puapuaanui St (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	0	224	5	0	12	171	0	0	0	0	0	0	11	0	27	0	450	
7:15 AM	0	246	3	0	8	184	0	0	0	0	0	0	20	0	48	0	509	
7:30 AM	0	209	4	0	12	188	0	0	0	0	0	0	28	0	48	0	489	
7:45 AM	0	174	12	0	11	175	0	0	0	0	0	0	28	0	62	0	462	1910
8:00 AM	0	218	10	0	9	165	0	0	0	0	0	0	18	0	39	0	459	1919
8:15 AM	0	213	15	0	19	154	0	0	0	0	0	0	9	0	30	0	440	1850
8:30 AM	0	220	11	0	16	179	0	0	0	0	0	0	11	0	31	0	468	1829
8:45 AM	0	245	11	0	14	159	0	0	0	0	0	0	17	0	23	0	469	1836

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	0	984	12	0	32	736	0	0	0	0	0	0	80	0	192	0	2036
Heavy Trucks	0	20	0		4	20	0		0	0	0		0	0	8		52
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 9/12/2019 10:40 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

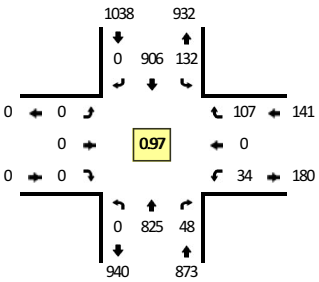
Type of peak hour being reported: System Peak

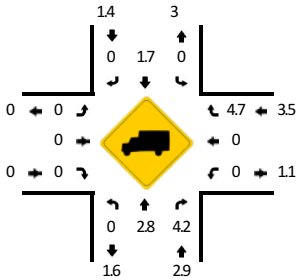
Method for determining peak hour: Total Entering Volume

LOCATION: Queen Kaahumanu Hwy -- Puapuaanui St
CITY/STATE: Kailua, HI

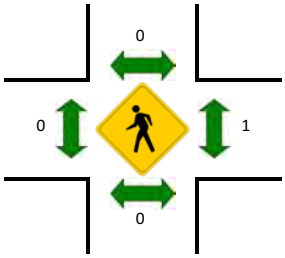
QC JOB #: 15039906
DATE: Thu, Aug 29 2019

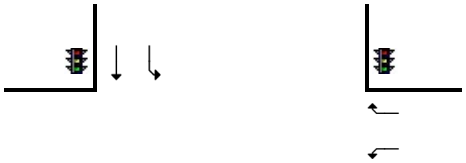
Peak-Hour: 3:00 PM -- 4:00 PM
Peak 15-Min: 3:30 PM -- 3:45 PM

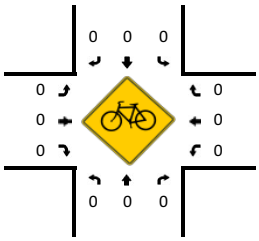


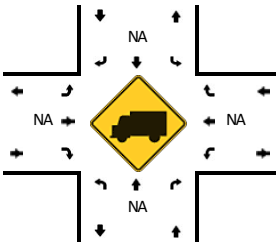


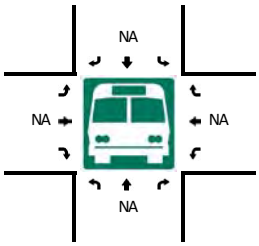
Quality Counts
DATA THAT DRIVES COMMUNITIES











15-Min Count Period Beginning At	Queen Kaahumanu Hwy (Northbound)				Queen Kaahumanu Hwy (Southbound)				Puapuaanui St (Eastbound)				Puapuaanui St (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:00 PM	0	199	14	0	37	231	0	0	0	0	0	0	7	0	23	0	511	
3:15 PM	0	205	14	0	27	243	0	0	0	0	0	0	12	0	23	0	524	
3:30 PM	0	230	12	0	37	213	0	0	0	0	0	0	9	0	27	0	528	
3:45 PM	0	191	8	0	31	219	0	0	0	0	0	0	6	0	34	0	489	2052
4:00 PM	0	192	7	0	34	235	0	0	0	0	0	0	12	0	16	0	496	2037
4:15 PM	0	207	15	0	38	209	0	0	0	0	0	0	11	0	35	0	515	2028
4:30 PM	0	187	10	0	22	192	0	0	0	0	0	0	4	0	12	0	427	1927
4:45 PM	0	208	15	0	30	217	0	0	0	0	0	0	13	0	29	0	512	1950
5:00 PM	0	159	7	0	49	218	0	0	0	0	0	0	4	0	17	0	454	1908
5:15 PM	0	195	11	0	36	219	0	0	0	0	0	0	7	0	23	0	491	1884
5:30 PM	0	177	16	0	24	220	0	0	0	0	0	0	10	0	22	0	469	1926
5:45 PM	0	131	8	0	29	221	0	0	0	0	0	0	7	0	23	0	419	1833

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	0	920	48	0	148	852	0	0	0	0	0	0	36	0	108	0	2112
Heavy Trucks	0	28	4		0	0	0		0	0	0		0	0	12		44
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 9/12/2019 10:43 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

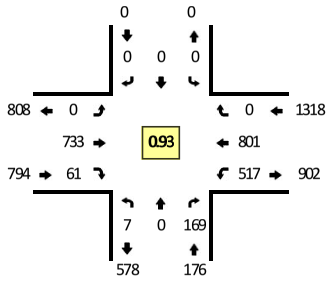
Type of peak hour being reported: User-Defined

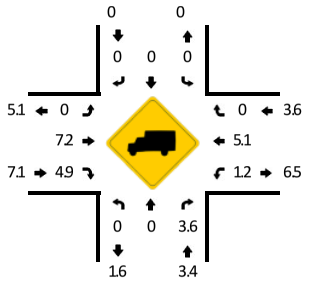
Method for determining peak hour: Total Entering Volume

LOCATION: Kuakini Hwy -- Hawaii Belt Rd
CITY/STATE: Hawaii, HI

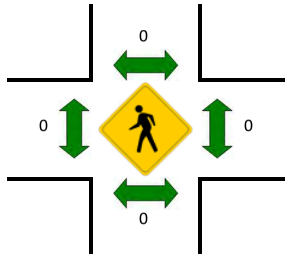
QC JOB #: 14972605
DATE: Tue, Apr 30 2019

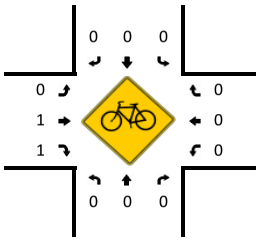
Peak-Hour: 7:20 AM -- 8:20 AM
Peak 15-Min: 7:30 AM -- 7:45 AM

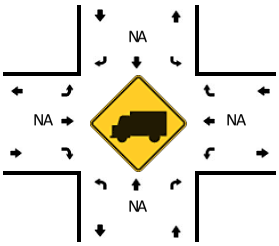


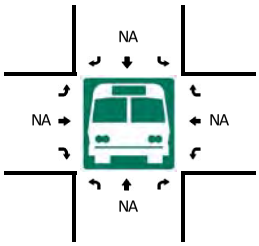


Quality Counts
DATA THAT DRIVES COMMUNITIES









15-Min Count Period Beginning At	Kuakini Hwy (Northbound)				Kuakini Hwy (Southbound)				Hawaii Belt Rd (Eastbound)				Hawaii Belt Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:45 AM	2	0	37	0	0	0	0	0	0	158	0	0	71	244	0	0	512	
7:00 AM	0	0	34	0	0	0	0	0	0	206	3	0	65	240	0	0	548	
7:15 AM	3	0	45	0	0	0	0	0	0	204	12	0	85	234	0	0	583	
7:30 AM	3	0	44	0	0	0	0	0	0	208	17	0	114	218	0	0	604	2247
7:45 AM	1	0	46	0	0	0	0	0	0	150	20	0	189	156	0	0	562	2297
8:00 AM	1	0	36	0	0	0	0	0	0	163	12	0	118	207	0	0	537	2286
8:15 AM	0	0	35	0	0	0	0	0	0	178	12	0	90	233	0	0	548	2251
8:30 AM	2	0	55	0	0	0	0	0	0	192	12	0	70	230	0	0	561	2208

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	12	0	176	0	0	0	0	0	0	832	68	0	456	872	0	0	2416
Heavy Trucks	0	0	8		0	0	0		0	56	8		0	24	0		96
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	1	1		0	0	0		2
Railroad																	
Stopped Buses																	

Comments:

Report generated on 5/13/2019 3:10 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

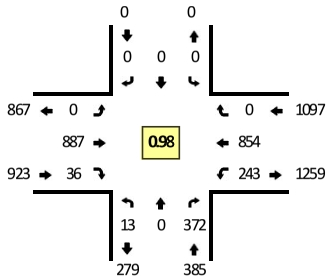
Type of peak hour being reported: User-Defined

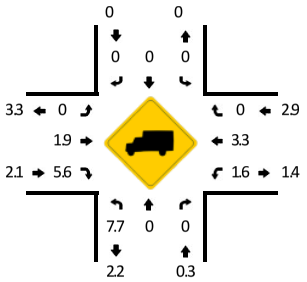
Method for determining peak hour: Total Entering Volume

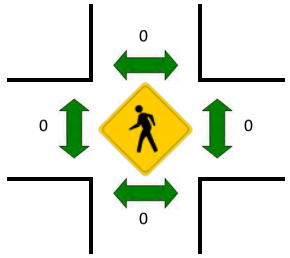
LOCATION: Kuakini Hwy -- Hawaii Belt Rd
CITY/STATE: Hawaii, HI

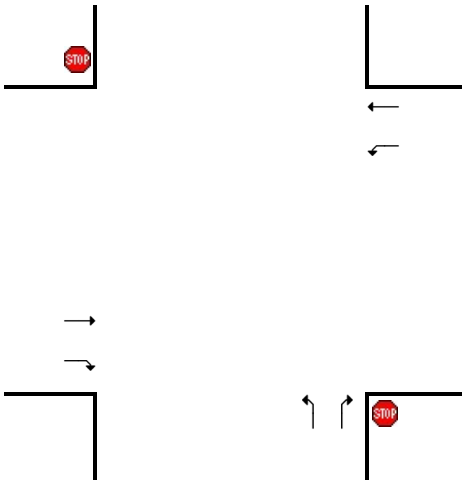
QC JOB #: 14972606
DATE: Tue, Apr 30 2019

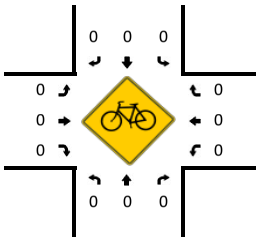
Peak-Hour: 3:45 PM -- 4:45 PM
Peak 15-Min: 4:15 PM -- 4:30 PM

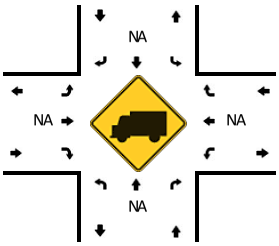


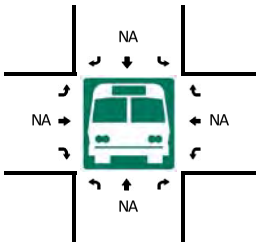












15-Min Count Period Beginning At	Kuakini Hwy (Northbound)				Kuakini Hwy (Southbound)				Hawaii Belt Rd (Eastbound)				Hawaii Belt Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:00 PM	5	0	76	0	0	0	0	0	0	221	13	0	60	227	0	0	602	
3:15 PM	6	0	75	0	0	0	0	0	0	234	19	0	59	213	0	0	606	
3:30 PM	3	0	86	0	0	0	0	0	0	203	15	0	48	217	0	0	572	
3:45 PM	0	0	78	0	0	0	0	0	0	223	8	0	57	217	0	0	583	2363
4:00 PM	3	0	87	0	0	0	0	0	0	229	10	0	60	216	0	0	605	2366
4:15 PM	4	0	101	0	0	0	0	0	0	221	16	0	55	214	0	0	611	2371
4:30 PM	6	0	106	0	0	0	0	0	0	214	2	0	71	207	0	0	606	2405
4:45 PM	1	0	112	0	0	0	0	0	0	208	7	0	78	225	0	0	631	2453
5:00 PM	2	0	108	0	0	0	0	0	0	225	9	0	66	181	0	1	592	2440
5:15 PM	1	0	97	0	0	0	0	0	0	219	11	0	39	171	0	0	538	2367
5:30 PM	0	0	102	0	0	0	0	0	0	223	7	0	54	134	0	0	520	2281
5:45 PM	2	0	76	0	0	0	0	0	0	203	13	0	58	176	0	0	528	2178

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	16	0	404	0	0	0	0	0	0	884	64	0	220	856	0	0	2444
Heavy Trucks	0	0	0		0	0	0		0	16	8		4	28	0		56
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 5/13/2019 3:06 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

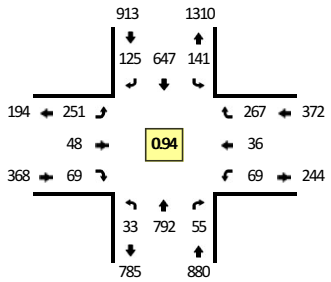
Type of peak hour being reported: System Peak

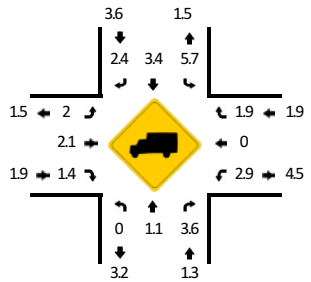
Method for determining peak hour: Total Entering Volume

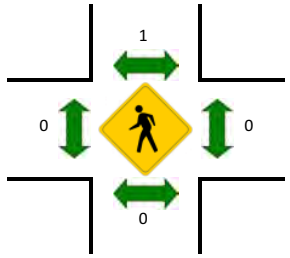
LOCATION: Kuakini Hwy -- Lako St
CITY/STATE: Holualoa, HI

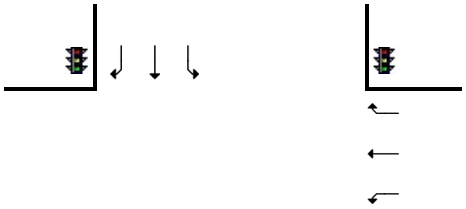
QC JOB #: 15039907
DATE: Thu, Aug 29 2019

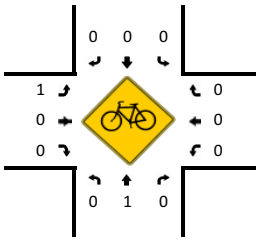
Peak-Hour: 7:00 AM -- 8:00 AM
Peak 15-Min: 7:45 AM -- 8:00 AM

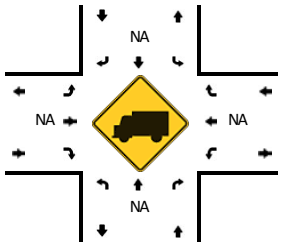


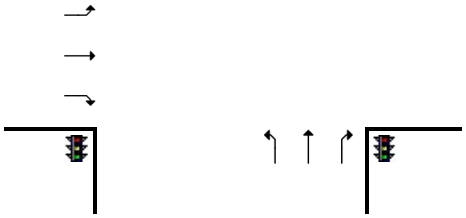


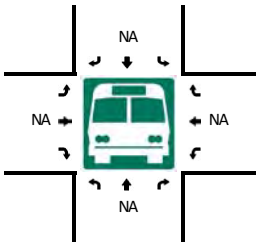












15-Min Count Period Beginning At	Kuakini Hwy (Northbound)				Kuakini Hwy (Southbound)				Lako St (Eastbound)				Lako St (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	13	221	15	0	34	152	28	0	41	4	13	0	9	6	53	0	589	
7:15 AM	8	188	14	0	36	154	35	0	66	9	21	0	17	7	61	0	616	
7:30 AM	6	202	15	0	34	171	36	0	67	11	19	0	16	10	67	0	654	
7:45 AM	6	181	11	0	37	170	26	0	77	24	16	0	27	13	86	0	674	2533
8:00 AM	3	206	17	0	37	145	24	0	55	18	11	0	13	7	65	0	601	2545
8:15 AM	6	219	12	0	19	165	16	0	44	6	6	0	14	12	51	0	570	2499
8:30 AM	4	220	16	0	30	180	22	0	42	9	10	0	15	6	70	0	624	2469
8:45 AM	9	216	20	0	36	150	28	0	35	10	9	0	13	8	64	0	598	2393

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	24	724	44	0	148	680	104	0	308	96	64	0	108	52	344	0	2696
Heavy Trucks	0	8	4		16	40	4		0	0	0		0	0	8		80
Pedestrians		0				0				0				0			0
Bicycles	0	1	0		0	0	0		1	0	0		0	0	0		2
Railroad																	
Stopped Buses																	

Comments:

Report generated on 9/12/2019 10:40 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

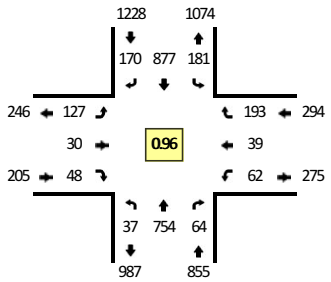
Type of peak hour being reported: System Peak

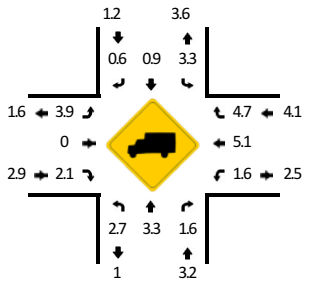
Method for determining peak hour: Total Entering Volume

LOCATION: Kuakini Hwy -- Lako St
CITY/STATE: Holualoa, HI

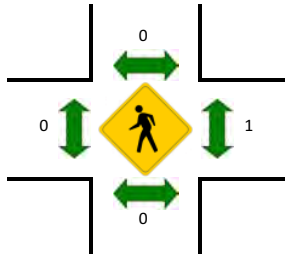
QC JOB #: 15039908
DATE: Thu, Aug 29 2019

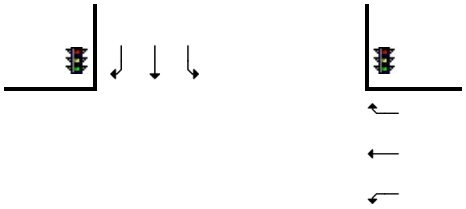
Peak-Hour: 3:00 PM -- 4:00 PM
Peak 15-Min: 3:15 PM -- 3:30 PM

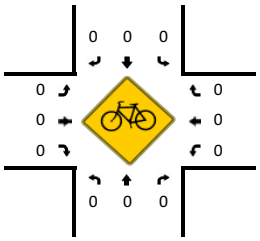


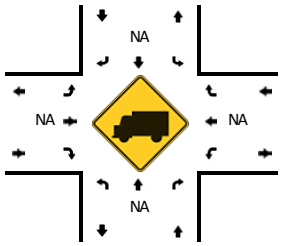


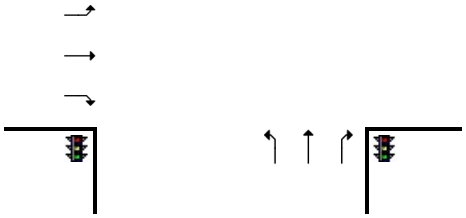
Quality Counts
DATA THAT DRIVES COMMUNITIES

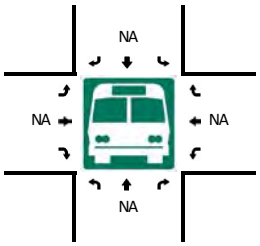












15-Min Count Period Beginning At	Kuakini Hwy (Northbound)				Kuakini Hwy (Southbound)				Lako St (Eastbound)				Lako St (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:00 PM	13	190	20	0	42	216	38	0	27	5	10	0	23	9	51	0	644	
3:15 PM	7	192	18	0	51	243	45	0	28	8	14	0	12	9	46	0	673	
3:30 PM	12	196	17	0	41	211	41	0	39	8	7	0	16	11	63	0	662	
3:45 PM	5	176	9	0	47	207	46	0	33	9	17	0	11	10	33	0	603	2582
4:00 PM	13	181	12	0	57	220	33	0	33	10	12	0	17	8	35	0	631	2569
4:15 PM	19	201	22	0	51	223	60	0	25	9	14	0	21	11	43	0	699	2595
4:30 PM	10	177	20	0	42	202	39	0	31	10	7	0	20	8	41	0	607	2540
4:45 PM	12	199	22	0	52	240	41	0	30	10	7	0	18	8	36	0	675	2612
5:00 PM	10	168	20	0	30	225	57	0	31	6	8	0	7	8	39	0	609	2590
5:15 PM	12	177	13	0	55	242	53	0	28	11	13	0	10	10	34	0	658	2549
5:30 PM	6	167	9	0	60	209	44	0	20	11	6	0	11	11	38	0	592	2534
5:45 PM	5	136	12	0	32	215	50	0	28	15	10	0	13	7	23	0	546	2405

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	28	768	72	0	204	972	180	0	112	32	56	0	48	36	184	0	2692
Heavy Trucks	0	16	0		4	8	0		16	0	0		0	0	12		56
Pedestrians		0				0				0				4			4
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 9/12/2019 10:43 AM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

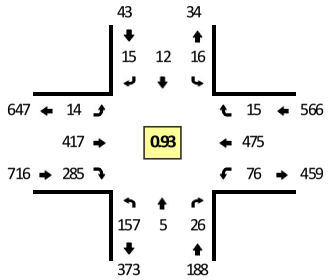
Type of peak hour being reported: User-Defined

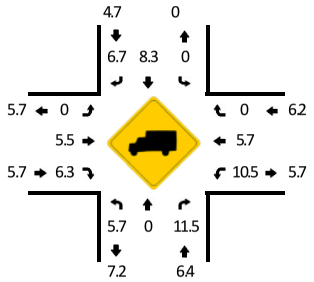
Method for determining peak hour: Total Entering Volume

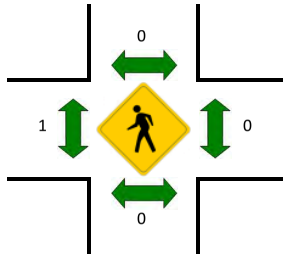
LOCATION: Kamehameha III Rd -- Hawaii Belt Rd
CITY/STATE: Hawaii, HI

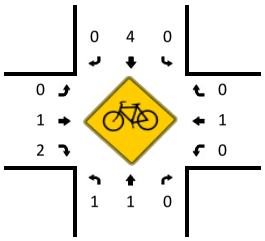
QC JOB #: 14972607
DATE: Tue, Apr 30 2019

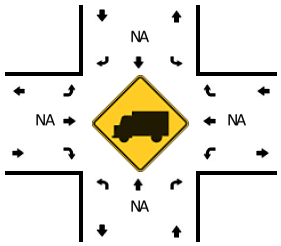
Peak-Hour: 7:20 AM -- 8:20 AM
Peak 15-Min: 7:30 AM -- 7:45 AM

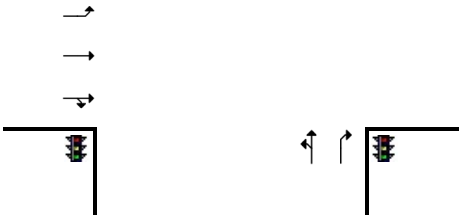


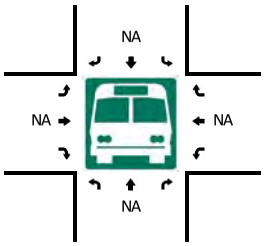












15-Min Count Period Beginning At	Kamehameha III Rd (Northbound)				Kamehameha III Rd (Southbound)				Hawaii Belt Rd (Eastbound)				Hawaii Belt Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:45 AM	33	0	2	0	5	1	1	0	3	88	48	0	11	170	3	0	365	
7:00 AM	41	0	0	0	1	2	2	0	3	117	41	0	5	156	3	0	371	
7:15 AM	38	2	5	0	3	2	2	0	4	133	59	0	6	125	2	0	381	
7:30 AM	36	1	10	0	8	4	6	0	4	111	88	0	22	107	3	0	400	1517
7:45 AM	37	2	6	0	4	2	3	0	5	93	78	0	25	99	6	0	360	1512
8:00 AM	41	1	6	0	1	4	4	0	3	84	58	0	17	124	4	0	347	1488
8:15 AM	51	1	7	0	3	4	3	0	1	82	61	0	20	152	3	0	388	1495
8:30 AM	34	1	10	0	2	2	4	0	2	96	55	0	7	115	1	0	329	1424

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	144	4	40	0	32	16	24	0	16	444	352	0	88	428	12	0	1600
Heavy Trucks	0	0	8		0	0	0		0	32	4		24	24	0		92
Pedestrians		0				0				4				0			4
Bicycles	0	1	0		0	0	0		0	0	0		0	0	0		1
Railroad																	
Stopped Buses																	

Comments:

Report generated on 5/13/2019 3:10 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

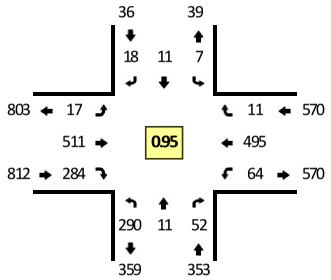
Type of peak hour being reported: User-Defined

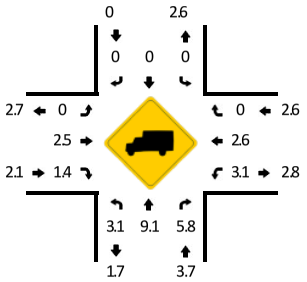
Method for determining peak hour: Total Entering Volume

LOCATION: Kamehameha III Rd -- Hawaii Belt Rd
CITY/STATE: Hawaii, HI

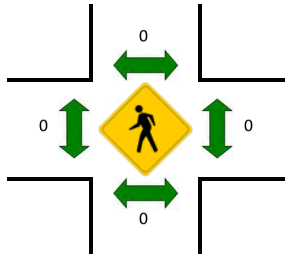
QC JOB #: 14972608
DATE: Tue, Apr 30 2019

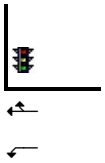
Peak-Hour: 3:45 PM -- 4:45 PM
Peak 15-Min: 4:30 PM -- 4:45 PM

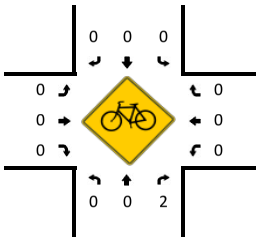


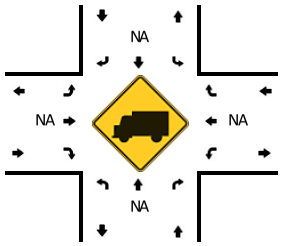


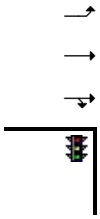
Quality Counts
DATA THAT DRIVES COMMUNITIES

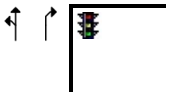


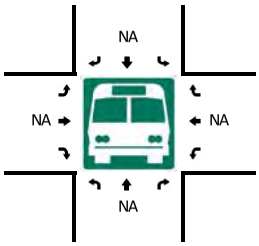












15-Min Count Period Beginning At	Kamehameha III Rd (Northbound)				Kamehameha III Rd (Southbound)				Hawaii Belt Rd (Eastbound)				Hawaii Belt Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:00 PM	75	3	14	0	4	2	6	0	6	129	60	0	16	143	3	0	461	
3:15 PM	47	10	22	0	4	6	5	0	5	140	71	0	25	131	3	0	469	
3:30 PM	65	6	21	0	1	1	5	0	4	122	70	0	14	139	4	0	452	
3:45 PM	74	4	12	0	2	2	6	0	6	112	78	0	18	114	3	0	431	1813
4:00 PM	78	1	12	0	1	6	4	0	4	124	74	0	17	118	2	0	441	1793
4:15 PM	68	5	12	0	0	3	5	0	1	134	62	0	13	126	4	0	433	1757
4:30 PM	70	1	16	0	4	0	3	0	6	141	70	0	16	137	2	0	466	1771
4:45 PM	72	3	14	0	2	4	4	0	5	105	50	0	18	115	2	0	394	1734
5:00 PM	48	4	25	0	0	3	2	0	5	123	90	0	23	119	1	0	443	1736
5:15 PM	56	5	19	0	2	4	2	0	3	108	75	0	11	101	1	0	387	1690
5:30 PM	46	3	20	0	1	2	4	0	4	141	71	0	8	81	0	0	381	1605
5:45 PM	36	1	14	0	3	4	2	0	2	116	41	0	9	67	1	0	296	1507

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	280	4	64	0	16	0	12	0	24	564	280	0	64	548	8	0	1864
Heavy Trucks	4	0	4		0	0	0		0	12	4		0	12	0		36
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 5/13/2019 3:06 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

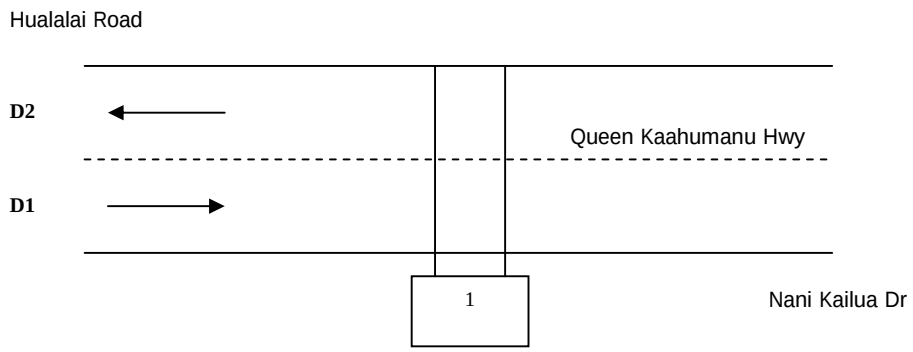
Traffic Data Service

Traffic Station Sketch

N

Island: Hawaii
Area: Kona

Section ID/Station #: B71001112038



	Meter #	File Name	GPS
1.	bw67	D0910037_B71001112038	19.63455, -155.9779
2.		D0910038_B71001112038	

Station Description:
Queen Kaahumanu Hwy: Hualalai Road to Nani Kailua Dr

Survey Beginning Date/Time: 9/10/15@ 0000		Survey Ending Date/Time: 9/11/15@ 2400

Survey Method:	Road Tube	Data Type:	Class
Survey Crew:	LM		C1B
Sketch Updated:		By:	SR
Remarks:	1302		

FACILITY NAME	JURI	FUNC CLASS	AREA TYPE	ROUTE NO.	ROUTE MILE
Queen Kaahumanu Hwy		14		0110	

D1= Direction to End
D2= Direction to Begin

D1: Nani Kailua Dr/ Palani Rd (Rte 190)
D2: Hualalai Road / Kamehameha Ave (Rte 19)

Run Date: 2016/05/18

Hawaii Department of Transportation
Highways Division — Highways Planning Survey Section
2015 Program Count - Summary

Site ID: B71001112038 **Town:** Hawaii **DIR 1:** +MP **DIR 2:** -MP **Final AADT:** 25900
Functional Class: URBAN:PRINCIPAL ARTERIAL - OTHER **Count Type:** CLASS **Counter Type:** Tube **Route No:** 11
Location: Queen Kaahumanu Hwy - Hualalai Rd to Nani Kailua Dr

TIME-AM	DIR 1	DIR 2	TOTAL	TIME-AM	DIR 1	DIR 2	TOTAL	TIME-PM	DIR 1	DIR 2	TOTAL	TIME-PM	DIR 1	DIR 2	TOTAL
DATE : 09/10/2015															
12:00-12:15	20	18	38	06:00-06:15	62	184	246	12:00-12:15	203	233	436	06:00-06:15	240	193	433
12:15-12:30	17	5	22	06:15-06:30	95	223	318	12:15-12:30	226	228	454	06:15-06:30	235	168	403
12:30-12:45	19	7	26	06:30-06:45	108	276	384	12:30-12:45	229	244	473	06:30-06:45	226	175	401
12:45-01:00	15	11	26	06:45-07:00	121	284	405	12:45-01:00	217	275	492	06:45-07:00	211	161	372
01:00-01:15	12	3	15	07:00-07:15	168	242	410	01:00-01:15	211	248	459	07:00-07:15	201	129	330
01:15-01:30	8	9	17	07:15-07:30	233	279	512	01:15-01:30	225	213	438	07:15-07:30	177	98	275
01:30-01:45	8	6	14	07:30-07:45	190	278	468	01:30-01:45	217	209	426	07:30-07:45	172	82	254
01:45-02:00	8	11	19	07:45-08:00	184	263	447	01:45-02:00	256	264	520	07:45-08:00	137	78	215
02:00-02:15	6	4	10	08:00-08:15	157	298	455	02:00-02:15	248	254	502	08:00-08:15	134	113	247
02:15-02:30	9	3	12	08:15-08:30	172	273	445	02:15-02:30	254	267	521	08:15-08:30	119	69	188
02:30-02:45	4	4	8	08:30-08:45	136	274	410	02:30-02:45	243	238	481	08:30-08:45	131	77	208
02:45-03:00	4	6	10	08:45-09:00	155	278	433	02:45-03:00	259	271	530	08:45-09:00	93	75	168
03:00-03:15	2	9	11	09:00-09:15	170	229	399	03:00-03:15	261	225	486	09:00-09:15	108	70	178
03:15-03:30	4	8	12	09:15-09:30	153	254	407	03:15-03:30	262	253	515	09:15-09:30	111	55	166
03:30-03:45	8	10	18	09:30-09:45	187	227	414	03:30-03:45	237	239	476	09:30-09:45	108	52	160
03:45-04:00	4	24	28	09:45-10:00	175	273	448	03:45-04:00	244	270	514	09:45-10:00	106	47	153
04:00-04:15	4	23	27	10:00-10:15	162	256	418	04:00-04:15	222	240	462	10:00-10:15	92	41	133
04:15-04:30	12	33	45	10:15-10:30	178	266	444	04:15-04:30	226	248	474	10:15-10:30	93	54	147
04:30-04:45	6	39	45	10:30-10:45	188	263	451	04:30-04:45	249	252	501	10:30-10:45	81	44	125
04:45-05:00	14	69	83	10:45-11:00	202	277	479	04:45-05:00	259	237	496	10:45-11:00	66	39	105
05:00-05:15	14	62	76	11:00-11:15	197	216	413	05:00-05:15	252	194	446	11:00-11:15	61	27	88
05:15-05:30	23	97	120	11:15-11:30	203	197	400	05:15-05:30	233	222	455	11:15-11:30	53	29	82
05:30-05:45	37	127	164	11:30-11:45	210	222	432	05:30-05:45	217	176	393	11:30-11:45	40	24	64
05:45-06:00	40	152	192	11:45-12:00	242	207	449	05:45-06:00	223	196	419	11:45-12:00	37	14	51

AM COMMUTER PERIOD (05:00-09:00)	DIR 1	DIR 2	
TWO DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:15 AM to 08:15 AM		
AM - PEAK HR VOLUME	764	1118	1882
AM - K FACTOR (%)			6.86
AM - D (%)	40.60	59.40	100.00
DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:00 AM to 08:00 AM	08:00 AM to 09:00 AM	
AM - PEAK HR VOLUME	775	1123	

PM COMMUTER PERIOD (15:00-19:00)	DIR 1	DIR 2	
TWO DIRECTIONAL PEAK			
PM - PEAK HR TIME	03:00 PM to 04:00 PM		
PM - PEAK HR VOLUME	1004	987	1991
PM - K FACTOR (%)			7.26
PM - D (%)	50.43	49.57	100.00
DIRECTIONAL PEAK			
PM - PEAK HR TIME	03:00 PM to 04:00 PM	03:45 PM to 04:45 PM	
PM - PEAK HR VOLUME	1004	1010	

AM PERIOD (00:00-12:00)			
TWO DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:15 AM to 08:15 AM		
AM - PEAK HR VOLUME	764	1118	1882
AM - K FACTOR (%)			6.86
AM - D (%)	40.60	59.40	100.00

PM PERIOD (12:00-24:00)			
TWO DIRECTIONAL PEAK			
PM - PEAK HR TIME	02:00 PM to 03:00 PM		
PM - PEAK HR VOLUME	1004	1030	2034
PM - K FACTOR (%)			7.41
PM - D (%)	49.36	50.64	100.00

NON-COMMUTER PERIOD (09:00-15:00)			
TWO DIRECTIONAL PEAK			
PEAK HR TIME	02:00 PM to 03:00 PM		
PEAK HR VOLUME	1004	1030	2034
DIRECTIONAL PEAK			
PEAK HR TIME	02:00 PM to 03:00 PM	10:00 AM to 11:00 AM	
PEAK HR VOLUME	1004	1062	

6-HR, 12-HR, 24-HR PERIODS	DIR 1	DIR 2	Total
AM 6-HR PERIOD (06:00-12:00)	4,048	6,039	10,087
AM 12-HR PERIOD (00:00-12:00)	4,346	6,779	11,125
PM 6-HR PERIOD (12:00-18:00)	5,673	5,696	11,369
PM 12-HR PERIOD (12:00-24:00)	8,705	7,610	16,315
24 HOUR PERIOD	13,051	14,389	27,440
D (%)	47.56	52.44	100.00

Run Date: 2016/05/18

Hawaii Department of Transportation
Highways Division — Highways Planning Survey Section
2015 Program Count - Summary

Site ID: B71001112038 **Town:** Hawaii **DIR 1:** +MP **DIR 2:** -MP **Final AADT:** 25900
Functional Class: URBAN:PRINCIPAL ARTERIAL - OTHER **Count Type:** CLASS **Counter Type:** Tube **Route No:** 11
Location: Queen Kaahumanu Hwy - Hualalai Rd to Nani Kailua Dr

TIME-AM	DIR 1	DIR 2	TOTAL	TIME-AM	DIR 1	DIR 2	TOTAL	TIME-PM	DIR 1	DIR 2	TOTAL	TIME-PM	DIR 1	DIR 2	TOTAL
DATE : 09/11/2015															
12:00-12:15	17	6	23	06:00-06:15	69	181	250	12:00-12:15	191	203	394	06:00-06:15	220	159	379
12:15-12:30	10	9	19	06:15-06:30	88	220	308	12:15-12:30	194	214	408	06:15-06:30	204	143	347
12:30-12:45	9	7	16	06:30-06:45	102	254	356	12:30-12:45	218	190	408	06:30-06:45	162	122	284
12:45-01:00	8	5	13	06:45-07:00	136	271	407	12:45-01:00	214	209	423	06:45-07:00	176	130	306
01:00-01:15	7	2	9	07:00-07:15	174	263	437	01:00-01:15	210	202	412	07:00-07:15	173	133	306
01:15-01:30	5	4	9	07:15-07:30	214	287	501	01:15-01:30	230	209	439	07:15-07:30	155	106	261
01:30-01:45	3	2	5	07:30-07:45	195	299	494	01:30-01:45	231	208	439	07:30-07:45	151	87	238
01:45-02:00	2	5	7	07:45-08:00	174	258	432	01:45-02:00	242	192	434	07:45-08:00	139	102	241
02:00-02:15	1	7	8	08:00-08:15	154	280	434	02:00-02:15	210	203	413	08:00-08:15	131	71	202
02:15-02:30	6	5	11	08:15-08:30	188	276	464	02:15-02:30	241	227	468	08:15-08:30	132	72	204
02:30-02:45	4	6	10	08:30-08:45	161	242	403	02:30-02:45	241	229	470	08:30-08:45	145	64	209
02:45-03:00	11	2	13	08:45-09:00	168	237	405	02:45-03:00	230	260	490	08:45-09:00	131	88	219
03:00-03:15	9	10	19	09:00-09:15	196	242	438	03:00-03:15	218	260	478	09:00-09:15	110	54	164
03:15-03:30	5	10	15	09:15-09:30	151	234	385	03:15-03:30	224	265	489	09:15-09:30	97	57	154
03:30-03:45	7	21	28	09:30-09:45	185	264	449	03:30-03:45	220	254	474	09:30-09:45	82	66	148
03:45-04:00	1	18	19	09:45-10:00	170	261	431	03:45-04:00	190	223	413	09:45-10:00	89	30	119
04:00-04:15	7	19	26	10:00-10:15	156	249	405	04:00-04:15	195	218	413	10:00-10:15	74	51	125
04:15-04:30	2	27	29	10:15-10:30	176	267	443	04:15-04:30	219	256	475	10:15-10:30	62	39	101
04:30-04:45	15	45	60	10:30-10:45	168	257	425	04:30-04:45	239	228	467	10:30-10:45	66	39	105
04:45-05:00	12	66	78	10:45-11:00	206	246	452	04:45-05:00	257	249	506	10:45-11:00	51	26	77
05:00-05:15	10	68	78	11:00-11:15	164	243	407	05:00-05:15	253	229	482	11:00-11:15	46	38	84
05:15-05:30	23	102	125	11:15-11:30	204	249	453	05:15-05:30	248	190	438	11:15-11:30	28	26	54
05:30-05:45	33	130	163	11:30-11:45	230	235	465	05:30-05:45	250	199	449	11:30-11:45	30	26	56
05:45-06:00	39	161	200	11:45-12:00	191	230	421	05:45-06:00	215	175	390	11:45-12:00	30	26	56

AM COMMUTER PERIOD (05:00-09:00)	DIR 1	DIR 2	
TWO DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:00 AM to 08:00 AM		
AM - PEAK HR VOLUME	757	1107	1864
AM - K FACTOR (%)			7.13
AM - D (%)	40.61	59.39	100.00
DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:00 AM to 08:00 AM	07:15 AM to 08:15 AM	
AM - PEAK HR VOLUME	757	1124	

PM COMMUTER PERIOD (15:00-19:00)	DIR 1	DIR 2	
TWO DIRECTIONAL PEAK			
PM - PEAK HR TIME	04:15 PM to 05:15 PM		
PM - PEAK HR VOLUME	968	962	1930
PM - K FACTOR (%)			7.38
PM - D (%)	50.16	49.84	100.00
DIRECTIONAL PEAK			
PM - PEAK HR TIME	04:45 PM to 05:45 PM	03:00 PM to 04:00 PM	
PM - PEAK HR VOLUME	1008	1002	

AM PERIOD (00:00-12:00)			
TWO DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:00 AM to 08:00 AM		
AM - PEAK HR VOLUME	757	1107	1864
AM - K FACTOR (%)			7.13
AM - D (%)	40.61	59.39	100.00

PM PERIOD (12:00-24:00)			
TWO DIRECTIONAL PEAK			
PM - PEAK HR TIME	02:45 PM to 03:45 PM		
PM - PEAK HR VOLUME	892	1039	1931
PM - K FACTOR (%)			7.38
PM - D (%)	46.19	53.81	100.00

NON-COMMUTER PERIOD (09:00-15:00)			
TWO DIRECTIONAL PEAK			
PEAK HR TIME	02:00 PM to 03:00 PM		
PEAK HR VOLUME	922	919	1841
DIRECTIONAL PEAK			
PEAK HR TIME	01:45 PM to 02:45 PM	09:30 AM to 10:30 AM	
PEAK HR VOLUME	934	1041	

6-HR, 12-HR, 24-HR PERIODS	DIR 1	DIR 2	Total
AM 6-HR PERIOD (06:00-12:00)	4,020	6,045	10,065
AM 12-HR PERIOD (00:00-12:00)	4,266	6,782	11,048
PM 6-HR PERIOD (12:00-18:00)	5,380	5,292	10,672
PM 12-HR PERIOD (12:00-24:00)	8,064	7,047	15,111
24 HOUR PERIOD	12,330	13,829	26,159
D (%)	47.13	52.87	100.00

Run Date: 2016/05/19

Hawaii Department of Transportation
Highways Division
Highways Planning Survey Section

Vehicle Classification Data Summary
2015

Site ID:	**B71001112038**	**Route No:**	**11**	**Date From:**	2015/09/10 0:00
Town:	**Hawaii**	**Direction:**	+MP	**Date To:**	2015/09/11 23:45
Location:	**Queen Kaahumanu Hwy - Hualalai Rd to Nani Kailua Dr**				

Functional Classification: 14 URBAN:PRINCIPAL ARTERIAL - OTHER

REPORT TOTALS - 48 HOURS RECORDED

	VOLUME	%	NUMBER OF AXLES
Cycles	263	0.49%	525
PC	45148	84.23%	90296
2A-4T	7438	13.88%	14876
LIGHT VEHICLE TOTALS	52849	98.60%	105697
	HEAVY VEHICLES		
Bus	85	0.16%	213
SINGLE UNIT TRUCK			
2A-6T	96	0.18%	192
3A-SU	164	0.31%	492
4A-SU	29	0.05%	116
SINGLE-TRAILER TRUCKS			
4A-ST	266	0.50%	1064
5A-ST	50	0.09%	250
6A-ST	30	0.06%	180
MULTI-TRAILER TRUCKS			
5A-MT	12	0.02%	60
6A-MT	1	0.00%	6
7A-MT	15	0.03%	105
HEAVY VEHICLE TOTALS	748	1.40%	2678
CLASSIFIED VEHICLES TOTALS	53597 (A)	100.00%	108375 (B)
UNCLASSIFIED VEHICLES TOTALS	2	0.00%	

AXLE CORRECTION FACTOR (A/C) = 0.989

ROADTUBE EQUIVALENT(B/2) = 54187 (C)

PEAK HOUR VOLUME : 2034 2015/09/10 14:00	**PEAK HOUR TRUCK VOLUME**	**% TOTAL PEAK HOUR VOLUME**	**24 HOUR TRUCK VOLUME**	**AADT**	**% OF AADT**	**HPMS K-FACTOR (PEAK/AADT) (ITEM 66)**
SINGLE UNIT TRUCKS (TYPE 4-7)	**10**	**(65A-1) 0.49%**	**187**	**25900**	**(65A-2) 0.72%**	**7.85%**
COMBINATION (TYPE 8-13)	**10**	**(65B-1) 0.49%**	**187**		**(65B-2) 0.72%**	**7.85%**

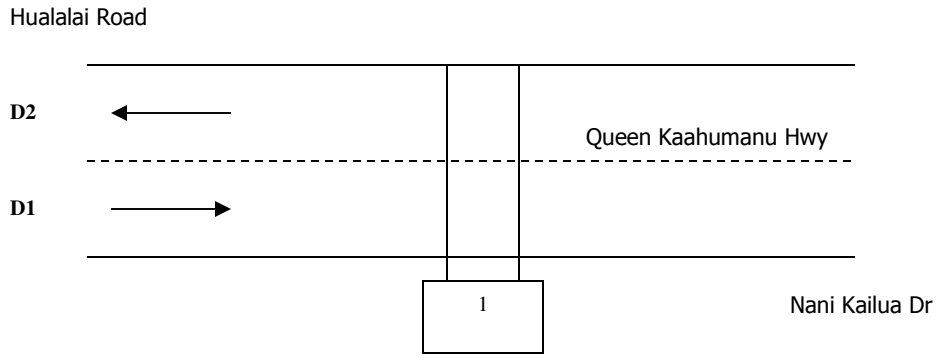
Traffic Data Service

Traffic Station Sketch

N

Island: Hawaii
Area: Kona

Section ID/Station #: B71001112038



Meter #	File Name	GPS
1. bw67	D0503007_B71001112038	19.63455, -155.9779
2.	D0503008_B71001112038	

Station Description:
Queen Kaahumanu Hwy: Hualalai Road to Nani Kailua Dr

Survey Beginning Date/Time: 5/3/16 @ 0000		Survey Ending Date/Time: 5/4/16 @ 2400

Survey Method:	Road Tube	Data Type:	Class
Survey Crew:	LM		C1B
Sketch Updated:		By:	SR
Remarks:	1302		

FACILITY NAME	JURI	FUNC CLASS	AREA TYPE	ROUTE NO.	ROUTE MILE
Queen Kaahumanu Hwy		11		0110	

D1= Direction to End — D1: Nani Kailua Dr/ Palani Rd (Rte 190)
D2= Direction to Begin — D2: Hualalai Road / Kamehameha Ave (Rte 19)

Run Date: 2017/08/08

Hawaii Department of Transportation
Highways Division — Highways Planning Survey Section
2016 Program Count - Summary

Site ID: B71001112038 **Town:** Hawaii **DIR 1:** +MP **DIR 2:** -MP **Final AADT:** 25800
Functional Class: URBAN:PRINCIPAL ARTERIAL - OTHER **Count Type:** CLASS **Counter Type:** Tube **Route No:** 11
Location: Queen Kaahumanu Hwy - Hualalai Rd to Nani Kailua Dr

TIME-AM	DIR 1	DIR 2	TOTAL	TIME-AM	DIR 1	DIR 2	TOTAL	TIME-PM	DIR 1	DIR 2	TOTAL	TIME-PM	DIR 1	DIR 2	TOTAL
DATE : 05/03/2016															
12:00-12:15	19	5	24	06:00-06:15	69	205	274	12:00-12:15	212	188	400	06:00-06:15	194	131	325
12:15-12:30	16	3	19	06:15-06:30	79	226	305	12:15-12:30	220	202	422	06:15-06:30	229	127	356
12:30-12:45	14	5	19	06:30-06:45	117	292	409	12:30-12:45	215	200	415	06:30-06:45	178	138	316
12:45-01:00	7	7	14	06:45-07:00	140	242	382	12:45-01:00	214	205	419	06:45-07:00	184	127	311
01:00-01:15	6	4	10	07:00-07:15	180	270	450	01:00-01:15	234	188	422	07:00-07:15	153	109	262
01:15-01:30	4	2	6	07:15-07:30	211	252	463	01:15-01:30	210	174	384	07:15-07:30	151	106	257
01:30-01:45	9	3	12	07:30-07:45	197	261	458	01:30-01:45	233	191	424	07:30-07:45	168	102	270
01:45-02:00	7	5	12	07:45-08:00	180	262	442	01:45-02:00	225	213	438	07:45-08:00	149	69	218
02:00-02:15	4	6	10	08:00-08:15	144	267	411	02:00-02:15	246	224	470	08:00-08:15	114	69	183
02:15-02:30	7	5	12	08:15-08:30	154	262	416	02:15-02:30	239	217	456	08:15-08:30	111	76	187
02:30-02:45	3	5	8	08:30-08:45	163	258	421	02:30-02:45	245	213	458	08:30-08:45	132	64	196
02:45-03:00	4	5	9	08:45-09:00	149	267	416	02:45-03:00	233	291	524	08:45-09:00	104	55	159
03:00-03:15	5	8	13	09:00-09:15	142	253	395	03:00-03:15	223	260	483	09:00-09:15	95	53	148
03:15-03:30	5	11	16	09:15-09:30	178	230	408	03:15-03:30	258	228	486	09:15-09:30	95	43	138
03:30-03:45	5	17	22	09:30-09:45	179	266	445	03:30-03:45	235	258	493	09:30-09:45	83	52	135
03:45-04:00	6	20	26	09:45-10:00	163	210	373	03:45-04:00	262	246	508	09:45-10:00	103	41	144
04:00-04:15	7	19	26	10:00-10:15	171	198	369	04:00-04:15	249	246	495	10:00-10:15	76	35	111
04:15-04:30	6	27	33	10:15-10:30	161	213	374	04:15-04:30	239	229	468	10:15-10:30	66	35	101
04:30-04:45	6	49	55	10:30-10:45	157	216	373	04:30-04:45	278	209	487	10:30-10:45	46	39	85
04:45-05:00	13	56	69	10:45-11:00	195	198	393	04:45-05:00	236	213	449	10:45-11:00	51	20	71
05:00-05:15	23	73	96	11:00-11:15	214	206	420	05:00-05:15	245	179	424	11:00-11:15	47	23	70
05:15-05:30	26	73	99	11:15-11:30	195	201	396	05:15-05:30	251	166	417	11:15-11:30	58	14	72
05:30-05:45	41	140	181	11:30-11:45	198	243	441	05:30-05:45	260	178	438	11:30-11:45	27	15	42
05:45-06:00	54	180	234	11:45-12:00	187	182	369	05:45-06:00	228	174	402	11:45-12:00	21	9	30

AM COMMUTER PERIOD (05:00-09:00)	DIR 1	DIR 2	
TWO DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:00 AM to 08:00 AM		
AM - PEAK HR VOLUME	768	1045	1813
AM - K FACTOR (%)			7.08
AM - D (%)	42.36	57.64	100.00
DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:00 AM to 08:00 AM	06:30 AM to 07:30 AM	
AM - PEAK HR VOLUME	768	1056	

PM COMMUTER PERIOD (15:00-19:00)	DIR 1	DIR 2	
TWO DIRECTIONAL PEAK			
PM - PEAK HR TIME	03:15 PM to 04:15 PM		
PM - PEAK HR VOLUME	1004	978	1982
PM - K FACTOR (%)			7.74
PM - D (%)	50.66	49.34	100.00
DIRECTIONAL PEAK			
PM - PEAK HR TIME	03:45 PM to 04:45 PM	03:00 PM to 04:00 PM	
PM - PEAK HR VOLUME	1028	992	

AM PERIOD (00:00-12:00)			
TWO DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:00 AM to 08:00 AM		
AM - PEAK HR VOLUME	768	1045	1813
AM - K FACTOR (%)			7.08
AM - D (%)	42.36	57.64	100.00

PM PERIOD (12:00-24:00)			
TWO DIRECTIONAL PEAK			
PM - PEAK HR TIME	02:45 PM to 03:45 PM		
PM - PEAK HR VOLUME	949	1037	1986
PM - K FACTOR (%)			7.76
PM - D (%)	47.78	52.22	100.00

NON-COMMUTER PERIOD (09:00-15:00)			
TWO DIRECTIONAL PEAK			
PEAK HR TIME	02:00 PM to 03:00 PM		
PEAK HR VOLUME	963	945	1908
DIRECTIONAL PEAK			
PEAK HR TIME	02:00 PM to 03:00 PM	09:00 AM to 10:00 AM	
PEAK HR VOLUME	963	959	

6-HR, 12-HR, 24-HR PERIODS	DIR 1	DIR 2	Total
AM 6-HR PERIOD (06:00-12:00)	3,923	5,680	9,603
AM 12-HR PERIOD (00:00-12:00)	4,220	6,408	10,628
PM 6-HR PERIOD (12:00-18:00)	5,690	5,092	10,782
PM 12-HR PERIOD (12:00-24:00)	8,325	6,644	14,969
24 HOUR PERIOD	12,545	13,052	25,597
D (%)	49.01	50.99	100.00

Run Date: 2017/08/08

Hawaii Department of Transportation
Highways Division — Highways Planning Survey Section
2016 Program Count - Summary

Site ID: B71001112038 **Town:** Hawaii **DIR 1:** +MP **DIR 2:** -MP **Final AADT:** 25800
Functional Class: URBAN:PRINCIPAL ARTERIAL - OTHER **Count Type:** CLASS **Counter Type:** Tube **Route No:** 11
Location: Queen Kaahumanu Hwy - Hualalai Rd to Nani Kailua Dr

TIME-AM	DIR 1	DIR 2	TOTAL	TIME-AM	DIR 1	DIR 2	TOTAL	TIME-PM	DIR 1	DIR 2	TOTAL	TIME-PM	DIR 1	DIR 2	TOTAL
DATE : 05/04/2016															
12:00-12:15	13	2	15	06:00-06:15	63	185	248	12:00-12:15	241	185	426	06:00-06:15	209	143	352
12:15-12:30	12	8	20	06:15-06:30	97	255	352	12:15-12:30	253	224	477	06:15-06:30	200	169	369
12:30-12:45	9	4	13	06:30-06:45	122	249	371	12:30-12:45	259	198	457	06:30-06:45	183	139	322
12:45-01:00	12	5	17	06:45-07:00	138	242	380	12:45-01:00	229	219	448	06:45-07:00	187	86	273
01:00-01:15	11	6	17	07:00-07:15	193	278	471	01:00-01:15	227	205	432	07:00-07:15	161	88	249
01:15-01:30	8	1	9	07:15-07:30	197	284	481	01:15-01:30	213	216	429	07:15-07:30	148	102	250
01:30-01:45	6	7	13	07:30-07:45	203	292	495	01:30-01:45	236	202	438	07:30-07:45	141	79	220
01:45-02:00	6	3	9	07:45-08:00	168	265	433	01:45-02:00	213	215	428	07:45-08:00	134	86	220
02:00-02:15	0	6	6	08:00-08:15	148	249	397	02:00-02:15	219	215	434	08:00-08:15	127	70	197
02:15-02:30	5	11	16	08:15-08:30	154	253	407	02:15-02:30	245	236	481	08:15-08:30	130	69	199
02:30-02:45	8	5	13	08:30-08:45	155	233	388	02:30-02:45	226	233	459	08:30-08:45	125	67	192
02:45-03:00	6	3	9	08:45-09:00	147	234	381	02:45-03:00	230	258	488	08:45-09:00	105	65	170
03:00-03:15	7	7	14	09:00-09:15	169	207	376	03:00-03:15	245	220	465	09:00-09:15	127	63	190
03:15-03:30	7	7	14	09:15-09:30	136	231	367	03:15-03:30	262	212	474	09:15-09:30	102	57	159
03:30-03:45	5	17	22	09:30-09:45	197	227	424	03:30-03:45	238	197	435	09:30-09:45	93	50	143
03:45-04:00	3	21	24	09:45-10:00	168	239	407	03:45-04:00	257	217	474	09:45-10:00	92	28	120
04:00-04:15	8	12	20	10:00-10:15	155	214	369	04:00-04:15	256	227	483	10:00-10:15	66	38	104
04:15-04:30	4	40	44	10:15-10:30	167	262	429	04:15-04:30	215	231	446	10:15-10:30	69	30	99
04:30-04:45	11	50	61	10:30-10:45	180	242	422	04:30-04:45	275	221	496	10:30-10:45	63	27	90
04:45-05:00	15	64	79	10:45-11:00	203	191	394	04:45-05:00	260	213	473	10:45-11:00	49	15	64
05:00-05:15	26	75	101	11:00-11:15	202	209	411	05:00-05:15	249	197	446	11:00-11:15	42	14	56
05:15-05:30	21	88	109	11:15-11:30	200	173	373	05:15-05:30	253	175	428	11:15-11:30	57	23	80
05:30-05:45	38	127	165	11:30-11:45	210	207	417	05:30-05:45	251	151	402	11:30-11:45	25	13	38
05:45-06:00	46	178	224	11:45-12:00	228	189	417	05:45-06:00	240	179	419	11:45-12:00	35	8	43

AM COMMUTER PERIOD (05:00-09:00)	DIR 1	DIR 2	
TWO DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:00 AM to 08:00 AM		
AM - PEAK HR VOLUME	761	1119	1880
AM - K FACTOR (%)			7.32
AM - D (%)	40.48	59.52	100.00
DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:00 AM to 08:00 AM	07:00 AM to 08:00 AM	
AM - PEAK HR VOLUME	761	1119	

PM COMMUTER PERIOD (15:00-19:00)	DIR 1	DIR 2	
TWO DIRECTIONAL PEAK			
PM - PEAK HR TIME	03:45 PM to 04:45 PM		
PM - PEAK HR VOLUME	1003	896	1899
PM - K FACTOR (%)			7.39
PM - D (%)	52.82	47.18	100.00
DIRECTIONAL PEAK			
PM - PEAK HR TIME	04:30 PM to 05:30 PM	03:45 PM to 04:45 PM	
PM - PEAK HR VOLUME	1037	896	

AM PERIOD (00:00-12:00)			
TWO DIRECTIONAL PEAK			
AM - PEAK HR TIME	07:00 AM to 08:00 AM		
AM - PEAK HR VOLUME	761	1119	1880
AM - K FACTOR (%)			7.32
AM - D (%)	40.48	59.52	100.00

PM PERIOD (12:00-24:00)			
TWO DIRECTIONAL PEAK			
PM - PEAK HR TIME	03:45 PM to 04:45 PM		
PM - PEAK HR VOLUME	1003	896	1899
PM - K FACTOR (%)			7.39
PM - D (%)	52.82	47.18	100.00

NON-COMMUTER PERIOD (09:00-15:00)			
TWO DIRECTIONAL PEAK			
PEAK HR TIME	02:00 PM to 03:00 PM		
PEAK HR VOLUME	920	942	1862
DIRECTIONAL PEAK			
PEAK HR TIME	12:00 PM to 01:00 PM	09:45 AM to 10:45 AM	
PEAK HR VOLUME	982	957	

6-HR, 12-HR, 24-HR PERIODS	DIR 1	DIR 2	Total
AM 6-HR PERIOD (06:00-12:00)	4,000	5,610	9,610
AM 12-HR PERIOD (00:00-12:00)	4,287	6,357	10,644
PM 6-HR PERIOD (12:00-18:00)	5,792	5,046	10,838
PM 12-HR PERIOD (12:00-24:00)	8,462	6,575	15,037
24 HOUR PERIOD	12,749	12,932	25,681
D (%)	49.64	50.36	100.00

Run Date: 2017/08/08

Hawaii Department of Transportation
Highways Division
Highways Planning Survey Section

Vehicle Classification Data Summary
2016

Site ID: B71001112038 **Route No:** 11 **Date From:** 2016/05/03 0:00

Town: Hawaii **Direction:** +MP **Date To:** 2016/05/04 23:45

Location: Queen Kaahumanu Hwy - Hualalai Rd to Nani Kailua Dr

Functional Classification: 14 URBAN:PRINCIPAL ARTERIAL - OTHER

REPORT TOTALS - 48 HOURS RECORDED

	VOLUME	%	NUMBER OF AXLES
Cycles	338	0.66%	677
PC	35846	69.91%	71692
2A-4T	14198	27.69%	28396
LIGHT VEHICLE TOTALS	50382	98.25%	100765
HEAVY VEHICLES			
Bus	234	0.46%	585
SINGLE UNIT TRUCK			
2A-6T	157	0.31%	314
3A-SU	145	0.28%	435
4A-SU	31	0.06%	124
SINGLE-TRAILER TRUCKS			
4A-ST	153	0.30%	612
5A-ST	95	0.19%	475
6A-ST	31	0.06%	186
MULTI-TRAILER TRUCKS			
5A-MT	14	0.03%	70
6A-MT	1	0.00%	6
7A-MT	33	0.06%	231
HEAVY VEHICLE TOTALS	894	1.74%	3038
CLASSIFIED VEHICLES TOTALS	51277 (A)	100.00%	103803 (B)
UNCLASSIFIED VEHICLES TOTALS	1	0.00%	

AXLE CORRECTION FACTOR (A/C) = 0.988

ROADTUBE EQUIVALENT(B/2) = 51901 (C)

PEAK HOUR VOLUME : 1970 2016/05/03 15:00	PEAK HOUR TRUCK VOLUME	% TOTAL PEAK HOUR VOLUME	24 HOUR TRUCK VOLUME	AADT	% OF AADT	HPMS K-FACTOR (PEAK/AADT) (ITEM 66)
SINGLE UNIT TRUCKS (TYPE 4-7)	33	(65A-1) 1.68%	283	25800	(65A-2) 1.10%	7.64%
COMBINATION (TYPE 8-13)	27	(65B-1) 1.37%	163		(65B-2) 0.63%	7.64%

Appendix B

Bus Route Schedule and Map

KONA/HILO BUS SCHEDULE

Operates Monday through Saturday

Effective 3/6/2017

KONA TO HILO

Fujihara store	Honaunau	Capt. Cook Yano Hall	Kealakekua Konawaena	Kainaliu Honalo	Sheraton Keauhou Resort	Ali'i Drive	Kona Commons	Kmart	Ali'i Drive	Matsuyama Store	HCC Palamanui Campus	Waikoloa Pyramid Stone	Four Seasons Resorts	Hilton Waikoloa	Marriott	Orchid @ Mauna Lani	Mauna Lani Bay	Hapuna Prince
5:45	**5:55**	**6:00**	**6:05**	**6:10**	**6:20**	**6:30**	---	**6:45**	---	**6:55**	---	**7:30**	---	---	---	---	---	---
---	---	---	---	---	---	**6:35**	**6:40**	**6:45**	---	---	**7:05**	---	**7:35**	**8:00**	**8:05**	**8:15**	**8:20**	---
---	---	---	---	---	---	---	4:00	4:03	4:13	4:20	---	4:55	---	---	---	---	---	---

Waimea - Pukalani Road Bus Shelter	Honokaa 76 Service Station	Paauilo	Laupahoehoe	Papaaloa	Ninole	Hakalau	Honomu Plantation Store	Pepeekeo	Papaikou	Mooheau Bus Terminal	Aupuni Center	Hilo Shopping Center	UH-Hilo	Hawaii Community College	Prince Kuhio Plaza
7:45	**8:30**	**8:35**	**8:55**	**9:00**	**9:05**	**9:15**	**9:25**	**9:30**	**9:35**	**9:45**	**9:55**	**9:57**	**10:00**	**10:02**	**10:05**
8:50	***9:15**	**9:20**	**9:35**	**9:40**	**9:45**	**9:50**	---	**9:55**	**10:00**	**10:05**	---	---	---	---	---
5:15	5:45	5:50	6:10	6:15	6:20	6:30	---	6:45	6:50	7:00	---	---	---	---	---

*Honokaa Gym Complex
Upper Parking Lot

HILO TO KONA

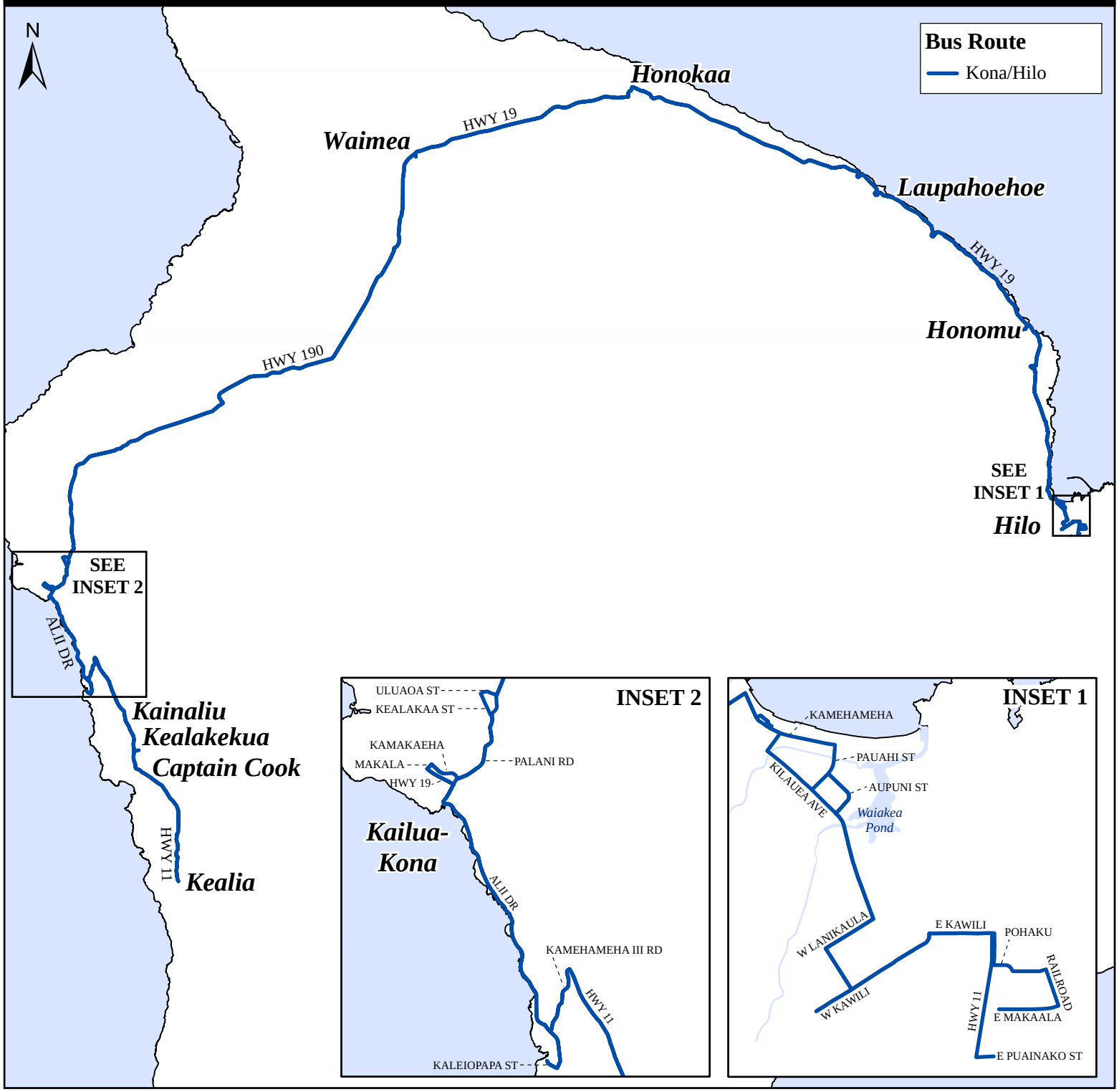
Prince Kuhio Plaza	Hawaii Community College	UH- Hilo	Hilo Shopping Center	Aupuni Center	Mooheau Bus Terminal/*Bayfront Parking Lot	Papaikou	Honomu Plantation Store	Hakalau	Ninole	Papaaloa	Laupahoehoe	Paauilo	Honokaa Blane's Drive Inn	Waimea - Pukalani Road Bus Shelter
---	---	---	---	---	***3:40**	**3:45**	---	**4:00**	**4:05**	**4:25**	**4:30**	**4:45**	**4:50***	**5:10**
9:00	**9:05**	**9:08**	**9:10**	**9:13**	**9:15**	**9:25**	**9:35**	**9:40**	**9:45**	**9:50**	**9:55**	**10:05**	**10:20**	**10:45**
1:10	1:12	1:15	1:17	1:20	1:30	1:40	1:50	1:55	2:00	2:05	2:10	2:25	2:40	3:20

*Honokaa Gym Complex
Upper Parking lot

Mauna Kea Beach Resort	Hapuna Prince	Orchid @ Mauna Lani	Mauna Lani Bay	Hilton Waikoloa	Marriott	Waikoloa Pyramid Stone	Matsuyama Store	Kealakehe	Kmart Macy's	Ali'i Drive	Kona Commons	Kmart Macy's	Sheraton Keauhou	Kainaliu Honalo	Kealakekua Konawaena	Capt. Cook Manago Hotel	Honaunau	Kealia Fujihara Store
5:30	**5:35**	**5:40**	**5:45**	**5:55**	6:00	---	---	---	---	6:35	6:40	6:45	---	---	---	---	---	---
---	---	---	---	---	---	**11:05**	**11:35**	---	**11:45**	---	**11:50**	---	---	---	---	---	---	---
---	---	---	---	---	---	3:45	4:15	4:20	4:25	4:30	---	---	---*	5:05	(5:10)	5:15	5:20	5:30

BOLD = MORNINGS

KONA/HILO



COUNTY OF HAWAII MASS TRANSIT AGENCY 961-8744 KONA TO HILO BUS SCHEDULE

In consideration of others and for your safety:

1. Shirts and footwear are required.
2. No flammable, explosive or toxic material.
3. No smoking, consumption of food or beverage.
4. Discarding of litter.
5. Expectorating or spitting.
6. The playing of radios, tape players, dvd players, and cell phones are prohibited without headphones.
7. Refrain from horseplaying, yelling or talking loudly.
8. The following items are prohibited unless prior permission is granted:
   a. Bodyboards
9. **$1.00 charge for pets (except service animals) provided they are kept in an enclosed container or cage**
10. **$1.00 charge per item larger than 16” x 10”or more than one item that cannot fit underneath your seat. $1.00 charge for bicycle.**
11. Please utilize designated bus stop zones whenever possible.

How to board the bus:

1. Wait on the proper side of the roadway for the bus.
2. Flag the bus (please call for bus stop information).
3. Wait until the bus makes a complete stop.
4. Boarding will be denied if passengers appear to be intoxicated on liquor or drugs; engaged in activities that violate any other law or ordinance.

How to exit the bus:

1. Before reaching your desired “get off” spot, pull cord located by the window of the bus.
2. Remain seated until the bus comes to a complete stop.
3. Exit from front of bus.

DISCLAIMER: The County of Hawaii will not be responsible for any inconvenience, expense, or damages resulting from the failure to depart or arrive at stated times or for any items brought on the bus.

For more information visit www.heleonbus.org

County of Hawaii is an Equal Opportunity Employer and Provider

7/9/09

Appendix C

Analysis Reports – Existing Conditions (2019)

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	71	457	218	163	678	23	243	192	109	20	321	177
Future Volume (veh/h)	71	457	218	163	678	23	243	192	109	20	321	177
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1737	1767	1737	1841	1811	1841	1841	1870	1856	1870	1870	1870
Adj Flow Rate, veh/h	72	466	0	166	692	0	248	196	0	20	328	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	11	9	11	4	6	4	4	2	3	2	2	2
Cap, veh/h	161	1537		249	1656		344	780		40	500	
Arrive On Green	0.05	0.46	0.00	0.07	0.48	0.00	0.10	0.22	0.00	0.02	0.14	0.00
Sat Flow, veh/h	3209	3357	1472	3401	3441	1560	3401	3554	1572	1781	3554	1585
Grp Volume(v), veh/h	72	466	0	166	692	0	248	196	0	20	328	0
Grp Sat Flow(s),veh/h/ln	1605	1678	1472	1700	1721	1560	1700	1777	1572	1781	1777	1585
Q Serve(g_s), s	1.7	6.9	0.0	3.8	10.4	0.0	5.6	3.6	0.0	0.9	6.9	0.0
Cycle Q Clear(g_c), s	1.7	6.9	0.0	3.8	10.4	0.0	5.6	3.6	0.0	0.9	6.9	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	161	1537		249	1656		344	780		40	500	
V/C Ratio(X)	0.45	0.30		0.67	0.42		0.72	0.25		0.50	0.66	
Avail Cap(c_a), veh/h	251	1537		445	1656		613	2108		123	1714	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	36.6	13.5	0.0	35.8	13.4	0.0	34.6	25.6	0.0	38.4	32.3	0.0
Incr Delay (d2), s/veh	1.9	0.5	0.0	3.1	0.8	0.0	2.8	0.2	0.0	9.3	1.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.7	2.5	0.0	1.6	3.8	0.0	2.4	1.5	0.0	0.5	3.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	38.6	14.1	0.0	38.9	14.2	0.0	37.4	25.8	0.0	47.7	33.7	0.0
LnGrp LOS	D	B		D	B		D	C		D	C	
Approach Vol, veh/h		538	A		858	A		444	A		348	A
Approach Delay, s/veh		17.3			18.9			32.3			34.5	
Approach LOS		B			B			C			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.3	21.9	10.3	40.9	12.5	15.7	8.5	42.7
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.5	47.1	10.4	34.0	14.3	38.3	6.2	38.2
Max Q Clear Time (g_c+I1), s	2.9	5.6	5.8	8.9	7.6	8.9	3.7	12.4
Green Ext Time (p_c), s	0.0	1.3	0.2	3.1	0.5	2.2	0.0	4.9

Intersection Summary	
HCM 6th Ctrl Delay	23.7
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	107	359	124	52	600	467	146	337	42	362	339	124
Future Volume (vph)	107	359	124	52	600	467	146	337	42	362	339	124
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (prot)	3099	3282	1516	3303	3406	1548	1564	3348	1487	1595	3174	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (perm)	3099	3282	1516	3303	3406	1548	1564	3348	1487	1595	3174	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	110	370	128	54	619	481	151	347	43	373	349	128
RTOR Reduction (vph)	0	0	86	0	0	336	0	0	35	0	23	0
Lane Group Flow (vph)	110	370	42	54	619	145	136	362	8	283	544	0
Confl. Peds. (#/hr)			2	2			4		3	3		4
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	13%	10%	5%	6%	6%	3%	5%	3%	7%	3%	4%	5%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	6.6	30.6	30.6	4.1	28.1	28.1	17.5	17.5	17.5	23.1	23.1	
Effective Green, g (s)	6.6	30.6	30.6	4.1	28.1	28.1	17.5	17.5	17.5	23.1	23.1	
Actuated g/C Ratio	0.07	0.33	0.33	0.04	0.30	0.30	0.19	0.19	0.19	0.25	0.25	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	219	1076	497	145	1025	466	293	627	278	394	785	
v/s Ratio Prot	c0.04	0.11		0.02	c0.18		0.09	c0.11		c0.18	0.17	
v/s Ratio Perm			0.03			0.09			0.01			
v/c Ratio	0.50	0.34	0.08	0.37	0.60	0.31	0.46	0.58	0.03	0.72	0.69	
Uniform Delay, d1	41.8	23.7	21.7	43.3	27.8	25.1	33.7	34.5	31.0	32.1	31.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.8	0.9	0.3	1.6	2.6	1.7	1.2	1.3	0.0	6.2	2.7	
Delay (s)	43.6	24.6	22.0	45.0	30.5	26.9	34.9	35.8	31.0	38.3	34.6	
Level of Service	D	C	C	D	C	C	C	D	C	D	C	
Approach Delay (s)		27.5			29.7			35.2			35.8	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	31.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	93.3	Sum of lost time (s)	18.0
Intersection Capacity Utilization	68.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	10.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	44	48	164	985	776	30
Future Vol, veh/h	44	48	164	985	776	30
Conflicting Peds, #/hr	0	0	0	0	0	1
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	2	6	2
Mvmt Flow	47	52	176	1059	834	32

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2246	-	835	0	-	0
Stage 1	835	-	-	-	-	-
Stage 2	1411	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	~ 46	0	798	-	-	-
Stage 1	426	0	-	-	-	-
Stage 2	225	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 36	-	797	-	-	-
Mov Cap-2 Maneuver	~ 36	-	-	-	-	-
Stage 1	331	-	-	-	-	-
Stage 2	225	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	$ 429	1.5	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	797	-	36	-	-	-
HCM Lane V/C Ratio	0.221	-	1.314	-	-	-
HCM Control Delay (s)	10.8	-	$ 429	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	0.8	-	5	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection	
Int Delay, s/veh	3.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	9	140	1006	15	73	748
Future Vol, veh/h	9	140	1006	15	73	748
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	13	6	5
Mvmt Flow	10	151	1082	16	78	804

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2050	1090	0	0	1082	0
Stage 1	1090	-	-	-	-	-
Stage 2	960	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	61	262	-	-	630	-
Stage 1	322	-	-	-	-	-
Stage 2	372	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	53	262	-	-	630	-
Mov Cap-2 Maneuver	53	-	-	-	-	-
Stage 1	322	-	-	-	-	-
Stage 2	326	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	38.9	0	1
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	53	262	630	-
HCM Lane V/C Ratio	-	-	0.183	0.575	0.125	-
HCM Control Delay (s)	-	-	87.5	35.8	11.5	-
HCM Lane LOS	-	-	F	E	B	-
HCM 95th %tile Q(veh)	-	-	0.6	3.3	0.4	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	87	185	853	24	43	718
Future Volume (veh/h)	87	185	853	24	43	718
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1870	1856	1870	1870	1826
Adj Flow Rate, veh/h	93	0	907	0	46	764
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	3	2	2	5
Cap, veh/h	120		1409		65	1536
Arrive On Green	0.07	0.00	0.76	0.00	0.04	0.84
Sat Flow, veh/h	1781	1585	1856	1585	1781	1826
Grp Volume(v), veh/h	93	0	907	0	46	764
Grp Sat Flow(s),veh/h/ln	1781	1585	1856	1585	1781	1826
Q Serve(g_s), s	5.1	0.0	22.7	0.0	2.5	11.3
Cycle Q Clear(g_c), s	5.1	0.0	22.7	0.0	2.5	11.3
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	120		1409		65	1536
V/C Ratio(X)	0.78		0.64		0.71	0.50
Avail Cap(c_a), veh/h	325		1409		117	1536
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	45.3	0.0	5.6	0.0	47.0	2.1
Incr Delay (d2), s/veh	10.2	0.0	2.3	0.0	13.4	1.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	0.0	7.5	0.0	1.4	2.4
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	55.4	0.0	7.9	0.0	60.4	3.3
LnGrp LOS	E		A		E	A
Approach Vol, veh/h	93	A	907	A		810
Approach Delay, s/veh	55.4		7.9			6.5
Approach LOS	E		A			A

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	8.1	79.4			87.5	11.1
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	6.5	72.0			83.0	18.0
Max Q Clear Time (g_c+I1), s	4.5	24.7			13.3	7.1
Green Ext Time (p_c), s	0.0	9.3			7.0	0.1

Intersection Summary	
HCM 6th Ctrl Delay	9.7
HCM 6th LOS	A

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	7.7

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	7	169	517	801	733	61
Future Vol, veh/h	7	169	517	801	733	61
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	4	2	5	5	7
Mvmt Flow	8	182	556	861	788	66

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2761	-	788	0	-	0
Stage 1	788	-	-	-	-	-
Stage 2	1973	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	22	0	831	-	-	-
Stage 1	448	0	-	-	-	-
Stage 2	118	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 7	-	831	-	-	-
Mov Cap-2 Maneuver	~ 7	-	-	-	-	-
Stage 1	148	-	-	-	-	-
Stage 2	118	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, $	1035.4	6.9	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	831	-	7	-	-	-
HCM Lane V/C Ratio	0.669	-	1.075	-	-	-
HCM Control Delay (s)	17.6	$	1035.4	0	-	-
HCM Lane LOS	C	-	F	A	-	-
HCM 95th %tile Q(veh)	5.3	-	1.7	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	251	48	69	69	36	267	33	792	55	141	647	125
Future Volume (veh/h)	251	48	69	69	36	267	33	792	55	141	647	125
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1856	1870	1870	1870	1870	1841	1811	1856	1870
Adj Flow Rate, veh/h	267	51	0	73	38	0	35	843	0	150	688	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	3	2	2	2	2	4	6	3	2
Cap, veh/h	303	318		110	116		344	971		258	1016	
Arrive On Green	0.17	0.17	0.00	0.06	0.06	0.00	0.03	0.52	0.00	0.06	0.55	0.00
Sat Flow, veh/h	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Grp Volume(v), veh/h	267	51	0	73	38	0	35	843	0	150	688	0
Grp Sat Flow(s),veh/h/ln	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Q Serve(g_s), s	14.0	2.2	0.0	3.9	1.9	0.0	0.9	37.7	0.0	3.8	25.5	0.0
Cycle Q Clear(g_c), s	14.0	2.2	0.0	3.9	1.9	0.0	0.9	37.7	0.0	3.8	25.5	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	303	318		110	116		344	971		258	1016	
V/C Ratio(X)	0.88	0.16		0.66	0.33		0.10	0.87		0.58	0.68	
Avail Cap(c_a), veh/h	336	353		333	353		381	971		270	1016	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	38.7	33.8	0.0	43.8	42.9	0.0	12.7	20.1	0.0	19.0	15.5	0.0
Incr Delay (d2), s/veh	21.5	0.2	0.0	6.7	1.6	0.0	0.1	10.4	0.0	2.9	3.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	7.8	1.0	0.0	1.9	0.9	0.0	0.3	17.9	0.0	1.7	11.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	60.2	34.1	0.0	50.5	44.5	0.0	12.8	30.4	0.0	21.9	19.2	0.0
LnGrp LOS	E	C		D	D		B	C		C	B	
Approach Vol, veh/h		318	A		111	A		878	A		838	A
Approach Delay, s/veh		56.0			48.4			29.7			19.6	
Approach LOS		E			D			C			B	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	10.2	54.1		20.7	7.5	56.8		10.4
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	6.4	49.6		18.0	5.0	51.0		18.0
Max Q Clear Time (g_c+I1), s	5.8	39.7		16.0	2.9	27.5		5.9
Green Ext Time (p_c), s	0.0	4.4		0.2	0.0	5.1		0.2

Intersection Summary	
HCM 6th Ctrl Delay	30.6
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	157	5	26	16	12	15	76	475	15	14	417	285
Future Volume (veh/h)	157	5	26	16	12	15	76	475	15	14	417	285
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.95	1.00		0.98	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1722	1781	1781	1781	1752	1811	1811	1870	1811	1811
Adj Flow Rate, veh/h	169	5	0	17	13	16	82	511	16	15	448	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	2	12	8	8	8	10	6	6	2	6	6
Cap, veh/h	230	7		26	20	24	103	933	29	32	1690	
Arrive On Green	0.13	0.13	0.00	0.04	0.04	0.04	0.06	0.53	0.53	0.02	0.49	0.00
Sat Flow, veh/h	1732	51	1459	598	457	563	1668	1745	55	1781	3532	0
Grp Volume(v), veh/h	174	0	0	46	0	0	82	0	527	15	448	0
Grp Sat Flow(s),veh/h/ln	1784	0	1459	1618	0	0	1668	0	1800	1781	1721	0
Q Serve(g_s), s	6.2	0.0	0.0	1.9	0.0	0.0	3.2	0.0	12.8	0.6	5.1	0.0
Cycle Q Clear(g_c), s	6.2	0.0	0.0	1.9	0.0	0.0	3.2	0.0	12.8	0.6	5.1	0.0
Prop In Lane	0.97		1.00	0.37		0.35	1.00		0.03	1.00		0.00
Lane Grp Cap(c), veh/h	237	0		70	0	0	103	0	962	32	1690	
V/C Ratio(X)	0.73	0.00		0.66	0.00	0.00	0.79	0.00	0.55	0.46	0.27	
Avail Cap(c_a), veh/h	696	0		622	0	0	229	0	962	137	1690	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	27.7	0.0	0.0	31.3	0.0	0.0	30.7	0.0	10.2	32.3	9.9	0.0
Incr Delay (d2), s/veh	4.4	0.0	0.0	10.2	0.0	0.0	12.8	0.0	2.2	9.9	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.8	0.0	0.0	0.9	0.0	0.0	1.6	0.0	4.3	0.3	1.6	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	32.0	0.0	0.0	41.4	0.0	0.0	43.5	0.0	12.4	42.2	10.3	0.0
LnGrp LOS	C	A		D	A	A	D	A	B	D	B	
Approach Vol, veh/h		174	A		46			609			463	A
Approach Delay, s/veh		32.0			41.4			16.6			11.3	
Approach LOS		C			D			B			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		13.3	8.6	37.1		7.4	5.7	40.0				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		25.9	9.1	31.5		25.5	5.1	35.5				
Max Q Clear Time (g_c+I1), s		8.2	5.2	7.1		3.9	2.6	14.8				
Green Ext Time (p_c), s		0.8	0.0	2.7		0.2	0.0	3.0				

Intersection Summary	
HCM 6th Ctrl Delay	17.7
HCM 6th LOS	B

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	260	877	503	223	609	41	227	283	247	51	313	107
Future Volume (veh/h)	260	877	503	223	609	41	227	283	247	51	313	107
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1856	1856	1870	1870	1841	1870	1856	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	265	895	0	228	621	0	232	289	0	52	319	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	3	3	2	2	4	2	3	2	2	2	2	2
Cap, veh/h	357	1578		316	1521		319	691		76	512	
Arrive On Green	0.10	0.45	0.00	0.09	0.43	0.00	0.09	0.19	0.00	0.04	0.14	0.00
Sat Flow, veh/h	3428	3526	1585	3456	3497	1585	3428	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	265	895	0	228	621	0	232	289	0	52	319	0
Grp Sat Flow(s),veh/h/ln	1714	1763	1585	1728	1749	1585	1714	1777	1585	1781	1777	1585
Q Serve(g_s), s	6.0	15.1	0.0	5.2	9.8	0.0	5.3	5.7	0.0	2.3	6.8	0.0
Cycle Q Clear(g_c), s	6.0	15.1	0.0	5.2	9.8	0.0	5.3	5.7	0.0	2.3	6.8	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	357	1578		316	1521		319	691		76	512	
V/C Ratio(X)	0.74	0.57		0.72	0.41		0.73	0.42		0.68	0.62	
Avail Cap(c_a), veh/h	533	1578		451	1521		448	1838		197	1767	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	35.0	16.5	0.0	35.5	15.6	0.0	35.5	28.4	0.0	38.0	32.4	0.0
Incr Delay (d2), s/veh	3.1	1.5	0.0	3.2	0.8	0.0	3.6	0.4	0.0	10.3	1.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	5.9	0.0	2.2	3.8	0.0	2.3	2.4	0.0	1.2	2.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	38.0	17.9	0.0	38.8	16.4	0.0	39.1	28.8	0.0	48.3	33.6	0.0
LnGrp LOS	D	B		D	B		D	C		D	C	
Approach Vol, veh/h		1160	A		849	A		521	A		371	A
Approach Delay, s/veh		22.5			22.4			33.4			35.7	
Approach LOS		C			C			C			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	7.9	20.2	11.8	40.5	12.0	16.1	12.9	39.5
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	8.9	41.6	10.5	36.0	10.5	40.0	12.5	34.0
Max Q Clear Time (g_c+I1), s	4.3	7.7	7.2	17.1	7.3	8.8	8.0	11.8
Green Ext Time (p_c), s	0.0	2.0	0.2	6.0	0.2	2.2	0.4	4.2

Intersection Summary	
HCM 6th Ctrl Delay	26.1
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	190	663	291	72	548	314	126	318	34	348	342	190
Future Volume (vph)	190	663	291	72	548	314	126	318	34	348	342	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	0.98	1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3335	3539	1583	3433	3471	1561	1595	3382	1537	1610	3193	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3335	3539	1583	3433	3471	1561	1595	3382	1537	1610	3193	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	194	677	297	73	559	320	129	324	35	355	349	194
RTOR Reduction (vph)	0	0	197	0	0	228	0	0	29	0	47	0
Lane Group Flow (vph)	194	677	100	73	559	92	116	337	6	302	549	0
Confl. Peds. (#/hr)	1					1	4		7	7		4
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	5%	2%	2%	2%	4%	2%	3%	2%	3%	2%	2%	2%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	8.6	32.3	32.3	3.9	27.6	27.6	16.9	16.9	16.9	24.4	24.4	
Effective Green, g (s)	8.6	32.3	32.3	3.9	27.6	27.6	16.9	16.9	16.9	24.4	24.4	
Actuated g/C Ratio	0.09	0.34	0.34	0.04	0.29	0.29	0.18	0.18	0.18	0.26	0.26	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	300	1196	535	140	1003	451	282	598	271	411	815	
v/s Ratio Prot	c0.06	c0.19		0.02	0.16		0.07	c0.10		c0.19	0.17	
v/s Ratio Perm			0.06			0.06			0.00			
v/c Ratio	0.65	0.57	0.19	0.52	0.56	0.21	0.41	0.56	0.02	0.73	0.67	
Uniform Delay, d1	42.0	25.9	22.3	44.9	28.8	25.7	34.9	35.9	32.5	32.6	32.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	4.7	1.9	0.8	3.5	2.2	1.0	1.0	1.2	0.0	6.7	2.2	
Delay (s)	46.7	27.8	23.1	48.4	31.0	26.7	35.9	37.1	32.5	39.3	34.2	
Level of Service	D	C	C	D	C	C	D	D	C	D	C	
Approach Delay (s)		29.8			30.9			36.5			35.9	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	32.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	95.5	Sum of lost time (s)	18.0
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	10	70	84	923	1005	17
Future Vol, veh/h	10	70	84	923	1005	17
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	4	2	6
Mvmt Flow	10	72	87	952	1036	18

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2162	-	1036	0	-	0
Stage 1	1036	-	-	-	-	-
Stage 2	1126	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	52	0	671	-	-	-
Stage 1	342	0	-	-	-	-
Stage 2	310	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	45	-	671	-	-	-
Mov Cap-2 Maneuver	45	-	-	-	-	-
Stage 1	298	-	-	-	-	-
Stage 2	310	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	107.3	0.9	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	671	-	45	-	-	-
HCM Lane V/C Ratio	0.129	-	0.229	-	-	-
HCM Control Delay (s)	11.2	-	107.3	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	0.4	-	0.8	-	-	-

Intersection	
Int Delay, s/veh	1.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	14	71	940	4	61	1015
Future Vol, veh/h	14	71	940	4	61	1015
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	7	2	3	2	8	2
Mvmt Flow	14	73	969	4	63	1046

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2143	971	0	0	969	0
Stage 1	971	-	-	-	-	-
Stage 2	1172	-	-	-	-	-
Critical Hdwy	6.47	6.22	-	-	4.18	-
Critical Hdwy Stg 1	5.47	-	-	-	-	-
Critical Hdwy Stg 2	5.47	-	-	-	-	-
Follow-up Hdwy	3.563	3.318	-	-	2.272	-
Pot Cap-1 Maneuver	52	307	-	-	688	-
Stage 1	360	-	-	-	-	-
Stage 2	288	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	47	307	-	-	688	-
Mov Cap-2 Maneuver	47	-	-	-	-	-
Stage 1	360	-	-	-	-	-
Stage 2	262	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	35.6	0	0.6
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	47	307	688	-
HCM Lane V/C Ratio	-	-	0.307	0.238	0.091	-
HCM Control Delay (s)	-	-	112.5	20.4	10.8	-
HCM Lane LOS	-	-	F	C	B	-
HCM 95th %tile Q(veh)	-	-	1.1	0.9	0.3	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	34	107	825	48	132	906
Future Volume (veh/h)	34	107	825	48	132	906
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1826	1856	1841	1870	1870
Adj Flow Rate, veh/h	35	0	851	0	136	934
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	5	3	4	2	2
Cap, veh/h	57		1358		168	1634
Arrive On Green	0.03	0.00	0.73	0.00	0.09	0.87
Sat Flow, veh/h	1781	1547	1856	1560	1781	1870
Grp Volume(v), veh/h	35	0	851	0	136	934
Grp Sat Flow(s),veh/h/ln	1781	1547	1856	1560	1781	1870
Q Serve(g_s), s	1.8	0.0	21.6	0.0	7.1	12.0
Cycle Q Clear(g_c), s	1.8	0.0	21.6	0.0	7.1	12.0
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	57		1358		168	1634
V/C Ratio(X)	0.62		0.63		0.81	0.57
Avail Cap(c_a), veh/h	337		1358		253	1634
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	45.4	0.0	6.3	0.0	42.2	1.5
Incr Delay (d2), s/veh	10.5	0.0	2.2	0.0	11.0	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	0.0	7.4	0.0	3.6	1.5
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	56.0	0.0	8.5	0.0	53.1	3.0
LnGrp LOS	E		A		D	A
Approach Vol, veh/h	35	A	851	A		1070
Approach Delay, s/veh	56.0		8.5			9.4
Approach LOS	E		A			A

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	13.5	74.0			87.5	7.5
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	13.5	65.0			83.0	18.0
Max Q Clear Time (g_c+I1), s	9.1	23.6			14.0	3.8
Green Ext Time (p_c), s	0.1	8.1			10.2	0.0

Intersection Summary	
HCM 6th Ctrl Delay	9.8
HCM 6th LOS	A

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	2.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	13	372	243	854	887	36
Future Vol, veh/h	13	372	243	854	887	36
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	8	2	2	3	2	6
Mvmt Flow	13	380	248	871	905	37

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2272	-	905	0	-	0
Stage 1	905	-	-	-	-	-
Stage 2	1367	-	-	-	-	-
Critical Hdwy	6.48	-	4.12	-	-	-
Critical Hdwy Stg 1	5.48	-	-	-	-	-
Critical Hdwy Stg 2	5.48	-	-	-	-	-
Follow-up Hdwy	3.572	-	2.218	-	-	-
Pot Cap-1 Maneuver	43	0	752	-	-	-
Stage 1	385	0	-	-	-	-
Stage 2	230	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	29	-	752	-	-	-
Mov Cap-2 Maneuver	29	-	-	-	-	-
Stage 1	258	-	-	-	-	-
Stage 2	230	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	208.2	2.7	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	752	-	29	-	-	-
HCM Lane V/C Ratio	0.33	-	0.457	-	-	-
HCM Control Delay (s)	12.1	-	208.2	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	1.4	-	1.5	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	127	30	48	62	39	193	37	754	64	181	877	170
Future Volume (veh/h)	127	30	48	62	39	193	37	754	64	181	877	170
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1826	1826	1856	1856	1870	1856	1870	1870
Adj Flow Rate, veh/h	132	31	0	65	41	0	39	785	0	189	914	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	4	2	2	2	5	5	3	3	2	3	2	2
Cap, veh/h	173	184		102	104		277	1050		373	1119	
Arrive On Green	0.10	0.10	0.00	0.06	0.06	0.00	0.04	0.57	0.00	0.07	0.60	0.00
Sat Flow, veh/h	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Grp Volume(v), veh/h	132	31	0	65	41	0	39	785	0	189	914	0
Grp Sat Flow(s),veh/h/ln	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Q Serve(g_s), s	6.3	1.3	0.0	3.0	1.8	0.0	0.8	27.2	0.0	3.7	32.8	0.0
Cycle Q Clear(g_c), s	6.3	1.3	0.0	3.0	1.8	0.0	0.8	27.2	0.0	3.7	32.8	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	173	184		102	104		277	1050		373	1119	
V/C Ratio(X)	0.76	0.17		0.64	0.39		0.14	0.75		0.51	0.82	
Avail Cap(c_a), veh/h	370	395		376	385		318	1050		426	1119	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.5	35.2	0.0	39.4	38.8	0.0	12.6	13.9	0.0	12.4	13.5	0.0
Incr Delay (d2), s/veh	6.9	0.4	0.0	6.6	2.4	0.0	0.2	4.9	0.0	1.1	6.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.0	0.6	0.0	1.5	0.9	0.0	0.3	11.5	0.0	1.3	13.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	44.3	35.7	0.0	45.9	41.2	0.0	12.8	18.8	0.0	13.5	20.1	0.0
LnGrp LOS	D	D		D	D		B	B		B	C	
Approach Vol, veh/h		163	A		106	A		824	A		1103	A
Approach Delay, s/veh		42.7			44.1			18.5			19.0	
Approach LOS		D			D			B			B	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	10.3	52.7		12.9	7.5	55.5		9.4
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	8.3	47.7		18.0	5.0	51.0		18.0
Max Q Clear Time (g_c+I1), s	5.7	29.2		8.3	2.8	34.8		5.0
Green Ext Time (p_c), s	0.1	5.6		0.3	0.0	6.6		0.2

Intersection Summary	
HCM 6th Ctrl Delay	21.8
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	290	11	52	7	11	18	64	495	11	17	511	284
Future Volume (veh/h)	290	11	52	7	11	18	64	495	11	17	511	284
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1767	1767	1811	1870	1870	1870	1856	1856	1856	1870	1870	1870
Adj Flow Rate, veh/h	305	12	0	7	12	19	67	521	12	18	538	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	9	9	6	2	2	2	3	3	3	2	2	2
Cap, veh/h	364	14		11	20	31	89	862	20	37	1592	
Arrive On Green	0.22	0.22	0.00	0.04	0.04	0.04	0.05	0.48	0.48	0.02	0.45	0.00
Sat Flow, veh/h	1622	64	1535	313	537	851	1767	1806	42	1781	3647	0
Grp Volume(v), veh/h	317	0	0	38	0	0	67	0	533	18	538	0
Grp Sat Flow(s),veh/h/ln	1686	0	1535	1702	0	0	1767	0	1848	1781	1777	0
Q Serve(g_s), s	13.4	0.0	0.0	1.6	0.0	0.0	2.8	0.0	15.8	0.7	7.4	0.0
Cycle Q Clear(g_c), s	13.4	0.0	0.0	1.6	0.0	0.0	2.8	0.0	15.8	0.7	7.4	0.0
Prop In Lane	0.96		1.00	0.18		0.50	1.00		0.02	1.00		0.00
Lane Grp Cap(c), veh/h	378	0		62	0	0	89	0	882	37	1592	
V/C Ratio(X)	0.84	0.00		0.61	0.00	0.00	0.75	0.00	0.60	0.48	0.34	
Avail Cap(c_a), veh/h	584	0		580	0	0	168	0	882	122	1592	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	27.7	0.0	0.0	35.5	0.0	0.0	35.1	0.0	14.3	36.2	13.4	0.0
Incr Delay (d2), s/veh	6.4	0.0	0.0	9.4	0.0	0.0	12.1	0.0	3.1	9.5	0.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.8	0.0	0.0	0.8	0.0	0.0	1.4	0.0	6.2	0.4	2.6	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	34.1	0.0	0.0	44.9	0.0	0.0	47.2	0.0	17.4	45.7	14.0	0.0
LnGrp LOS	C	A		D	A	A	D	A	B	D	B	
Approach Vol, veh/h		317	A		38			600			556	A
Approach Delay, s/veh		34.1			44.9			20.7			15.0	
Approach LOS		C			D			C			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		21.3	8.3	38.0		7.2	6.1	40.2				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		25.9	7.1	33.5		25.5	5.1	35.5				
Max Q Clear Time (g_c+I1), s		15.4	4.8	9.4		3.6	2.7	17.8				
Green Ext Time (p_c), s		1.4	0.0	3.3		0.1	0.0	2.9				

Intersection Summary	
HCM 6th Ctrl Delay	22.0
HCM 6th LOS	C

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Appendix D

Analysis Reports – Future Without Project Conditions
(2024)

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	75	480	229	171	713	24	255	202	115	21	337	186
Future Volume (veh/h)	75	480	229	171	713	24	255	202	115	21	337	186
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1737	1767	1737	1841	1811	1841	1841	1870	1856	1870	1870	1870
Adj Flow Rate, veh/h	77	490	0	174	728	0	260	206	0	21	344	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	11	9	11	4	6	4	4	2	3	2	2	2
Cap, veh/h	164	1512		257	1634		355	807		41	518	
Arrive On Green	0.05	0.45	0.00	0.08	0.47	0.00	0.10	0.23	0.00	0.02	0.15	0.00
Sat Flow, veh/h	3209	3357	1472	3401	3441	1560	3401	3554	1572	1781	3554	1585
Grp Volume(v), veh/h	77	490	0	174	728	0	260	206	0	21	344	0
Grp Sat Flow(s),veh/h/ln	1605	1678	1472	1700	1721	1560	1700	1777	1572	1781	1777	1585
Q Serve(g_s), s	1.9	7.6	0.0	4.0	11.3	0.0	6.0	3.8	0.0	0.9	7.4	0.0
Cycle Q Clear(g_c), s	1.9	7.6	0.0	4.0	11.3	0.0	6.0	3.8	0.0	0.9	7.4	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	164	1512		257	1634		355	807		41	518	
V/C Ratio(X)	0.47	0.32		0.68	0.45		0.73	0.26		0.51	0.66	
Avail Cap(c_a), veh/h	247	1512		440	1634		605	2081		122	1692	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.1	14.2	0.0	36.2	14.1	0.0	34.9	25.5	0.0	38.8	32.5	0.0
Incr Delay (d2), s/veh	2.1	0.6	0.0	3.1	0.9	0.0	2.9	0.2	0.0	9.2	1.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	2.8	0.0	1.7	4.2	0.0	2.6	1.6	0.0	0.5	3.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.2	14.8	0.0	39.3	14.9	0.0	37.8	25.7	0.0	48.1	34.0	0.0
LnGrp LOS	D	B		D	B		D	C		D	C	
Approach Vol, veh/h		567	A		902	A		466	A		365	A
Approach Delay, s/veh		18.1			19.6			32.5			34.8	
Approach LOS		B			B			C			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.4	22.8	10.6	40.7	12.9	16.2	8.6	42.7
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.5	47.1	10.4	34.0	14.3	38.3	6.2	38.2
Max Q Clear Time (g_c+I1), s	2.9	5.8	6.0	9.6	8.0	9.4	3.9	13.3
Green Ext Time (p_c), s	0.0	1.4	0.2	3.3	0.5	2.4	0.0	5.2

Intersection Summary	
HCM 6th Ctrl Delay	24.3
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	112	377	130	55	631	491	153	354	44	380	356	130
Future Volume (vph)	112	377	130	55	631	491	153	354	44	380	356	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (prot)	3099	3282	1516	3303	3406	1548	1564	3348	1487	1595	3174	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (perm)	3099	3282	1516	3303	3406	1548	1564	3348	1487	1595	3174	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	115	389	134	57	651	506	158	365	45	392	367	134
RTOR Reduction (vph)	0	0	91	0	0	356	0	0	36	0	22	0
Lane Group Flow (vph)	115	389	43	57	651	150	142	381	9	298	573	0
Confl. Peds. (#/hr)			2	2			4		3	3		4
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	13%	10%	5%	6%	6%	3%	5%	3%	7%	3%	4%	5%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	6.6	30.6	30.6	4.1	28.1	28.1	18.1	18.1	18.1	24.1	24.1	
Effective Green, g (s)	6.6	30.6	30.6	4.1	28.1	28.1	18.1	18.1	18.1	24.1	24.1	
Actuated g/C Ratio	0.07	0.32	0.32	0.04	0.30	0.30	0.19	0.19	0.19	0.25	0.25	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	215	1058	488	142	1008	458	298	638	283	405	806	
v/s Ratio Prot	c0.04	0.12		0.02	c0.19		0.09	c0.11		c0.19	0.18	
v/s Ratio Perm			0.03			0.10			0.01			
v/c Ratio	0.53	0.37	0.09	0.40	0.65	0.33	0.48	0.60	0.03	0.74	0.71	
Uniform Delay, d1	42.7	24.7	22.4	44.2	29.1	26.0	34.2	35.1	31.3	32.5	32.2	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	2.5	1.0	0.4	1.9	3.2	1.9	1.2	1.5	0.0	6.8	3.0	
Delay (s)	45.2	25.7	22.8	46.1	32.3	27.9	35.4	36.6	31.3	39.3	35.2	
Level of Service	D	C	C	D	C	C	D	D	C	D	D	
Approach Delay (s)		28.6			31.1			35.9			36.6	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	32.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	94.9	Sum of lost time (s)	18.0
Intersection Capacity Utilization	70.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	14.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	46	50	172	1035	816	32
Future Vol, veh/h	46	50	172	1035	816	32
Conflicting Peds, #/hr	0	0	0	0	0	1
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	2	6	2
Mvmt Flow	49	54	185	1113	877	34

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2361	-	878	0	-	0
Stage 1	878	-	-	-	-	-
Stage 2	1483	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	~ 39	0	769	-	-	-
Stage 1	406	0	-	-	-	-
Stage 2	208	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 30	-	768	-	-	-
Mov Cap-2 Maneuver	~ 30	-	-	-	-	-
Stage 1	308	-	-	-	-	-
Stage 2	208	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s$	603.1	1.6	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	768	-	30	-	-	-
HCM Lane V/C Ratio	0.241	-	1.649	-	-	-
HCM Control Delay (s)	11.2	-	$ 603.1	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	0.9	-	5.7	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection	
Int Delay, s/veh	4

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	9	147	1057	16	77	786
Future Vol, veh/h	9	147	1057	16	77	786
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	13	6	5
Mvmt Flow	10	158	1137	17	83	845

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2157	1146	0	0	1137	0
Stage 1	1146	-	-	-	-	-
Stage 2	1011	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	52	243	-	-	600	-
Stage 1	303	-	-	-	-	-
Stage 2	352	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	45	243	-	-	600	-
Mov Cap-2 Maneuver	45	-	-	-	-	-
Stage 1	303	-	-	-	-	-
Stage 2	303	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	47.3	0	1.1
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	45	243	600	-
HCM Lane V/C Ratio	-	-	0.215	0.65	0.138	-
HCM Control Delay (s)	-	-	105.7	43.7	12	-
HCM Lane LOS	-	-	F	E	B	-
HCM 95th %tile Q(veh)	-	-	0.7	4	0.5	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	91	194	897	25	45	755
Future Volume (veh/h)	91	194	897	25	45	755
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1870	1856	1870	1870	1826
Adj Flow Rate, veh/h	97	0	954	0	48	803
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	3	2	2	5
Cap, veh/h	125		1404		66	1532
Arrive On Green	0.07	0.00	0.76	0.00	0.04	0.84
Sat Flow, veh/h	1781	1585	1856	1585	1781	1826
Grp Volume(v), veh/h	97	0	954	0	48	803
Grp Sat Flow(s),veh/h/ln	1781	1585	1856	1585	1781	1826
Q Serve(g_s), s	5.3	0.0	25.5	0.0	2.6	12.5
Cycle Q Clear(g_c), s	5.3	0.0	25.5	0.0	2.6	12.5
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	125		1404		66	1532
V/C Ratio(X)	0.78		0.68		0.73	0.52
Avail Cap(c_a), veh/h	324		1404		117	1532
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	45.2	0.0	6.0	0.0	47.1	2.3
Incr Delay (d2), s/veh	9.9	0.0	2.7	0.0	14.1	1.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.7	0.0	8.5	0.0	1.4	2.8
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	55.2	0.0	8.7	0.0	61.3	3.6
LnGrp LOS	E		A		E	A
Approach Vol, veh/h	97	A	954	A		851
Approach Delay, s/veh	55.2		8.7			6.8
Approach LOS	E		A			A

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	8.2	79.3			87.5	11.4
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	6.5	72.0			83.0	18.0
Max Q Clear Time (g_c+I1), s	4.6	27.5			14.5	7.3
Green Ext Time (p_c), s	0.0	10.2			7.6	0.1

Intersection Summary	
HCM 6th Ctrl Delay	10.2
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	9.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	7	178	543	842	770	64
Future Vol, veh/h	7	178	543	842	770	64
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	4	2	5	5	7
Mvmt Flow	8	191	584	905	828	69

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2901	-	828	0	-	0
Stage 1	828	-	-	-	-	-
Stage 2	2073	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	17	0	803	-	-	-
Stage 1	429	0	-	-	-	-
Stage 2	105	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 5	-	803	-	-	-
Mov Cap-2 Maneuver	~ 5	-	-	-	-	-
Stage 1	117	-	-	-	-	-
Stage 2	105	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, $	1546.3	8	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	803	-	5	-	-	-
HCM Lane V/C Ratio	0.727	-	1.505	-	-	-
HCM Control Delay (s)	20.4	$	1546.3	0	-	-
HCM Lane LOS	C	-	F	A	-	-
HCM 95th %tile Q(veh)	6.5	-	1.8	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	264	50	73	73	38	281	35	832	58	148	680	131
Future Volume (veh/h)	264	50	73	73	38	281	35	832	58	148	680	131
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1856	1870	1870	1870	1870	1841	1811	1856	1870
Adj Flow Rate, veh/h	281	53	0	78	40	0	37	885	0	157	723	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	3	2	2	2	2	4	6	3	2
Cap, veh/h	314	330		115	122		313	955		225	1003	
Arrive On Green	0.18	0.18	0.00	0.07	0.07	0.00	0.03	0.51	0.00	0.06	0.54	0.00
Sat Flow, veh/h	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Grp Volume(v), veh/h	281	53	0	78	40	0	37	885	0	157	723	0
Grp Sat Flow(s),veh/h/ln	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Q Serve(g_s), s	15.0	2.3	0.0	4.2	2.0	0.0	0.9	42.7	0.0	4.1	28.5	0.0
Cycle Q Clear(g_c), s	15.0	2.3	0.0	4.2	2.0	0.0	0.9	42.7	0.0	4.1	28.5	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	314	330		115	122		313	955		225	1003	
V/C Ratio(X)	0.89	0.16		0.68	0.33		0.12	0.93		0.70	0.72	
Avail Cap(c_a), veh/h	330	347		328	347		346	955		231	1003	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	39.1	33.9	0.0	44.4	43.3	0.0	13.9	22.1	0.0	21.5	16.8	0.0
Incr Delay (d2), s/veh	24.6	0.2	0.0	6.7	1.5	0.0	0.2	16.0	0.0	8.7	4.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.6	1.1	0.0	2.0	1.0	0.0	0.4	21.6	0.0	2.3	12.5	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	63.7	34.1	0.0	51.1	44.9	0.0	14.1	38.0	0.0	30.1	21.3	0.0
LnGrp LOS	E	C		D	D		B	D		C	C	
Approach Vol, veh/h		334	A		118	A		922	A		880	A
Approach Delay, s/veh		59.0			49.0			37.1			22.9	
Approach LOS		E			D			D			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	10.5	54.1		21.6	7.7	57.0		10.8
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	6.4	49.6		18.0	5.0	51.0		18.0
Max Q Clear Time (g_c+I1), s	6.1	44.7		17.0	2.9	30.5		6.2
Green Ext Time (p_c), s	0.0	2.7		0.1	0.0	5.2		0.3

Intersection Summary	
HCM 6th Ctrl Delay	35.4
HCM 6th LOS	D

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	165	5	27	17	13	16	80	499	16	15	438	300
Future Volume (veh/h)	165	5	27	17	13	16	80	499	16	15	438	300
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.95	1.00		0.98	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1722	1781	1781	1781	1752	1811	1811	1870	1811	1811
Adj Flow Rate, veh/h	177	5	0	18	14	17	86	537	17	16	471	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	2	12	8	8	8	10	6	6	2	6	6
Cap, veh/h	239	7		27	21	25	108	924	29	34	1665	
Arrive On Green	0.14	0.14	0.00	0.04	0.04	0.04	0.06	0.53	0.53	0.02	0.48	0.00
Sat Flow, veh/h	1735	49	1459	595	462	562	1668	1745	55	1781	3532	0
Grp Volume(v), veh/h	182	0	0	49	0	0	86	0	554	16	471	0
Grp Sat Flow(s),veh/h/ln	1784	0	1459	1618	0	0	1668	0	1800	1781	1721	0
Q Serve(g_s), s	6.6	0.0	0.0	2.0	0.0	0.0	3.4	0.0	14.0	0.6	5.5	0.0
Cycle Q Clear(g_c), s	6.6	0.0	0.0	2.0	0.0	0.0	3.4	0.0	14.0	0.6	5.5	0.0
Prop In Lane	0.97		1.00	0.37		0.35	1.00		0.03	1.00		0.00
Lane Grp Cap(c), veh/h	246	0		72	0	0	108	0	953	34	1665	
V/C Ratio(X)	0.74	0.00		0.68	0.00	0.00	0.79	0.00	0.58	0.47	0.28	
Avail Cap(c_a), veh/h	689	0		616	0	0	226	0	953	136	1665	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	27.7	0.0	0.0	31.5	0.0	0.0	30.9	0.0	10.7	32.5	10.3	0.0
Incr Delay (d2), s/veh	4.3	0.0	0.0	10.6	0.0	0.0	12.2	0.0	2.6	9.6	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.0	0.0	0.0	1.0	0.0	0.0	1.6	0.0	4.8	0.3	1.7	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	32.0	0.0	0.0	42.1	0.0	0.0	43.1	0.0	13.3	42.1	10.8	0.0
LnGrp LOS	C	A		D	A	A	D	A	B	D	B	
Approach Vol, veh/h		182	A		49			640			487	A
Approach Delay, s/veh		32.0			42.1			17.3			11.8	
Approach LOS		C			D			B			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		13.8	8.9	36.9		7.5	5.8	40.0				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		25.9	9.1	31.5		25.5	5.1	35.5				
Max Q Clear Time (g_c+I1), s		8.6	5.4	7.5		4.0	2.6	16.0				
Green Ext Time (p_c), s		0.9	0.0	2.9		0.2	0.0	3.2				

Intersection Summary	
HCM 6th Ctrl Delay	18.2
HCM 6th LOS	B

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	273	922	529	234	640	43	239	297	260	54	329	112
Future Volume (veh/h)	273	922	529	234	640	43	239	297	260	54	329	112
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1856	1856	1870	1870	1841	1870	1856	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	279	941	0	239	653	0	244	303	0	55	336	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	3	3	2	2	4	2	3	2	2	2	2	2
Cap, veh/h	369	1553		325	1493		330	717		78	530	
Arrive On Green	0.11	0.44	0.00	0.09	0.43	0.00	0.10	0.20	0.00	0.04	0.15	0.00
Sat Flow, veh/h	3428	3526	1585	3456	3497	1585	3428	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	279	941	0	239	653	0	244	303	0	55	336	0
Grp Sat Flow(s),veh/h/ln	1714	1763	1585	1728	1749	1585	1714	1777	1585	1781	1777	1585
Q Serve(g_s), s	6.5	16.7	0.0	5.5	10.8	0.0	5.7	6.1	0.0	2.5	7.3	0.0
Cycle Q Clear(g_c), s	6.5	16.7	0.0	5.5	10.8	0.0	5.7	6.1	0.0	2.5	7.3	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	369	1553		325	1493		330	717		78	530	
V/C Ratio(X)	0.76	0.61		0.73	0.44		0.74	0.42		0.71	0.63	
Avail Cap(c_a), veh/h	524	1553		444	1493		440	1808		194	1739	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	35.4	17.5	0.0	36.0	16.5	0.0	36.0	28.5	0.0	38.6	32.7	0.0
Incr Delay (d2), s/veh	3.9	1.8	0.0	4.1	0.9	0.0	4.5	0.4	0.0	11.2	1.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.8	6.5	0.0	2.4	4.2	0.0	2.5	2.6	0.0	1.3	3.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.3	19.2	0.0	40.1	17.4	0.0	40.5	28.9	0.0	49.8	33.9	0.0
LnGrp LOS	D	B		D	B		D	C		D	C	
Approach Vol, veh/h		1220	A		892	A		547	A		391	A
Approach Delay, s/veh		23.8			23.5			34.0			36.2	
Approach LOS		C			C			C			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.1	21.0	12.2	40.5	12.4	16.7	13.3	39.4
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	8.9	41.6	10.5	36.0	10.5	40.0	12.5	34.0
Max Q Clear Time (g_c+I1), s	4.5	8.1	7.5	18.7	7.7	9.3	8.5	12.8
Green Ext Time (p_c), s	0.0	2.1	0.2	6.1	0.2	2.3	0.4	4.4

Intersection Summary	
HCM 6th Ctrl Delay	27.1
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	200	697	306	76	576	330	132	334	36	366	359	200
Future Volume (vph)	200	697	306	76	576	330	132	334	36	366	359	200
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	0.98	1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3335	3539	1583	3433	3471	1561	1595	3382	1537	1610	3193	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3335	3539	1583	3433	3471	1561	1595	3382	1537	1610	3193	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	204	711	312	78	588	337	135	341	37	373	366	204
RTOR Reduction (vph)	0	0	208	0	0	241	0	0	30	0	46	0
Lane Group Flow (vph)	204	711	104	78	588	96	121	355	7	317	580	0
Confl. Peds. (#/hr)	1					1	4		7	7		4
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	5%	2%	2%	2%	4%	2%	3%	2%	3%	2%	2%	2%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	8.6	32.2	32.2	3.9	27.5	27.5	17.4	17.4	17.4	25.4	25.4	
Effective Green, g (s)	8.6	32.2	32.2	3.9	27.5	27.5	17.4	17.4	17.4	25.4	25.4	
Actuated g/C Ratio	0.09	0.33	0.33	0.04	0.28	0.28	0.18	0.18	0.18	0.26	0.26	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	295	1176	526	138	985	443	286	607	275	422	836	
v/s Ratio Prot	c0.06	c0.20		0.02	0.17		0.08	c0.10		c0.20	0.18	
v/s Ratio Perm			0.07			0.06			0.00			
v/c Ratio	0.69	0.60	0.20	0.57	0.60	0.22	0.42	0.58	0.02	0.75	0.69	
Uniform Delay, d1	42.9	27.0	23.1	45.7	29.9	26.5	35.3	36.4	32.8	32.8	32.2	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	6.8	2.3	0.8	5.2	2.7	1.1	1.0	1.4	0.0	7.4	2.5	
Delay (s)	49.7	29.3	24.0	50.9	32.6	27.6	36.3	37.9	32.8	40.2	34.8	
Level of Service	D	C	C	D	C	C	D	D	C	D	C	
Approach Delay (s)		31.4			32.3			37.1			36.6	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	33.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	96.9	Sum of lost time (s)	18.0
Intersection Capacity Utilization	74.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	1.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	11	74	88	970	1056	18
Future Vol, veh/h	11	74	88	970	1056	18
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	4	2	6
Mvmt Flow	11	76	91	1000	1089	19

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2271	-	1089	0	-	0
Stage 1	1089	-	-	-	-	-
Stage 2	1182	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	44	0	641	-	-	-
Stage 1	323	0	-	-	-	-
Stage 2	291	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	38	-	641	-	-	-
Mov Cap-2 Maneuver	38	-	-	-	-	-
Stage 1	277	-	-	-	-	-
Stage 2	291	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	135.9	1	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	641	-	38	-	-	-
HCM Lane V/C Ratio	0.142	-	0.298	-	-	-
HCM Control Delay (s)	11.5	-	135.9	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	0.5	-	1	-	-	-

Intersection	
Int Delay, s/veh	2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	15	75	988	4	64	1067
Future Vol, veh/h	15	75	988	4	64	1067
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	7	2	3	2	8	2
Mvmt Flow	15	77	1019	4	66	1100

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2253	1021	0	0	1019	0
Stage 1	1021	-	-	-	-	-
Stage 2	1232	-	-	-	-	-
Critical Hdwy	6.47	6.22	-	-	4.18	-
Critical Hdwy Stg 1	5.47	-	-	-	-	-
Critical Hdwy Stg 2	5.47	-	-	-	-	-
Follow-up Hdwy	3.563	3.318	-	-	2.272	-
Pot Cap-1 Maneuver	44	287	-	-	658	-
Stage 1	340	-	-	-	-	-
Stage 2	269	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	40	287	-	-	658	-
Mov Cap-2 Maneuver	40	-	-	-	-	-
Stage 1	340	-	-	-	-	-
Stage 2	242	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	42.3	0	0.6
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	40	287	658	-
HCM Lane V/C Ratio	-	-	0.387	0.269	0.1	-
HCM Control Delay (s)	-	-	143.3	22.1	11.1	-
HCM Lane LOS	-	-	F	C	B	-
HCM 95th %tile Q(veh)	-	-	1.3	1.1	0.3	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	36	112	867	50	139	952
Future Volume (veh/h)	36	112	867	50	139	952
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1826	1856	1841	1870	1870
Adj Flow Rate, veh/h	37	0	894	0	143	981
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	5	3	4	2	2
Cap, veh/h	58		1348		176	1632
Arrive On Green	0.03	0.00	0.73	0.00	0.10	0.87
Sat Flow, veh/h	1781	1547	1856	1560	1781	1870
Grp Volume(v), veh/h	37	0	894	0	143	981
Grp Sat Flow(s),veh/h/ln	1781	1547	1856	1560	1781	1870
Q Serve(g_s), s	2.0	0.0	24.2	0.0	7.5	13.4
Cycle Q Clear(g_c), s	2.0	0.0	24.2	0.0	7.5	13.4
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	58		1348		176	1632
V/C Ratio(X)	0.63		0.66		0.81	0.60
Avail Cap(c_a), veh/h	337		1348		253	1632
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	45.4	0.0	6.9	0.0	42.0	1.6
Incr Delay (d2), s/veh	10.8	0.0	2.6	0.0	12.4	1.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	0.0	8.5	0.0	3.9	1.8
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	56.2	0.0	9.4	0.0	54.4	3.3
LnGrp LOS	E		A		D	A
Approach Vol, veh/h	37	A	894	A		1124
Approach Delay, s/veh	56.2		9.4			9.8
Approach LOS	E		A			A

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	13.9	73.6			87.5	7.6
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	13.5	65.0			83.0	18.0
Max Q Clear Time (g_c+I1), s	9.5	26.2			15.4	4.0
Green Ext Time (p_c), s	0.1	8.8			11.3	0.0

Intersection Summary	
HCM 6th Ctrl Delay	10.5
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	3.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	14	391	255	898	932	38
Future Vol, veh/h	14	391	255	898	932	38
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	8	2	2	3	2	6
Mvmt Flow	14	399	260	916	951	39

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2387	-	951	0	-	0
Stage 1	951	-	-	-	-	-
Stage 2	1436	-	-	-	-	-
Critical Hdwy	6.48	-	4.12	-	-	-
Critical Hdwy Stg 1	5.48	-	-	-	-	-
Critical Hdwy Stg 2	5.48	-	-	-	-	-
Follow-up Hdwy	3.572	-	2.218	-	-	-
Pot Cap-1 Maneuver	36	0	722	-	-	-
Stage 1	366	0	-	-	-	-
Stage 2	212	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	23	-	722	-	-	-
Mov Cap-2 Maneuver	23	-	-	-	-	-
Stage 1	234	-	-	-	-	-
Stage 2	212	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s$	302.1	2.8	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	722	-	23	-	-	-
HCM Lane V/C Ratio	0.36	-	0.621	-	-	-
HCM Control Delay (s)	12.8	-	$ 302.1	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	1.6	-	1.8	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	133	32	50	65	41	203	39	792	67	190	922	179
Future Volume (veh/h)	133	32	50	65	41	203	39	792	67	190	922	179
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1826	1826	1856	1856	1870	1856	1870	1870
Adj Flow Rate, veh/h	139	33	0	68	43	0	41	825	0	198	960	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	4	2	2	2	5	5	3	3	2	3	2	2
Cap, veh/h	180	192		105	108		242	1037		343	1109	
Arrive On Green	0.10	0.10	0.00	0.06	0.06	0.00	0.04	0.56	0.00	0.07	0.59	0.00
Sat Flow, veh/h	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Grp Volume(v), veh/h	139	33	0	68	43	0	41	825	0	198	960	0
Grp Sat Flow(s),veh/h/ln	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Q Serve(g_s), s	6.6	1.4	0.0	3.2	2.0	0.0	0.8	30.4	0.0	4.0	37.0	0.0
Cycle Q Clear(g_c), s	6.6	1.4	0.0	3.2	2.0	0.0	0.8	30.4	0.0	4.0	37.0	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	180	192		105	108		242	1037		343	1109	
V/C Ratio(X)	0.77	0.17		0.65	0.40		0.17	0.80		0.58	0.87	
Avail Cap(c_a), veh/h	367	391		373	382		281	1037		389	1109	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.6	35.3	0.0	39.6	39.0	0.0	14.5	15.1	0.0	14.4	14.7	0.0
Incr Delay (d2), s/veh	6.8	0.4	0.0	6.5	2.4	0.0	0.3	6.3	0.0	1.6	9.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.1	0.6	0.0	1.6	0.9	0.0	0.3	13.2	0.0	1.8	16.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	44.5	35.7	0.0	46.1	41.4	0.0	14.8	21.4	0.0	16.0	23.8	0.0
LnGrp LOS	D	D		D	D		B	C		B	C	
Approach Vol, veh/h		172	A		111	A		866	A		1158	A
Approach Delay, s/veh		42.8			44.3			21.1			22.5	
Approach LOS		D			D			C			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	10.5	52.6		13.3	7.6	55.5		9.6
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	8.3	47.7		18.0	5.0	51.0		18.0
Max Q Clear Time (g_c+I1), s	6.0	32.4		8.6	2.8	39.0		5.2
Green Ext Time (p_c), s	0.1	5.5		0.3	0.0	5.9		0.3

Intersection Summary	
HCM 6th Ctrl Delay	24.5
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	305	12	55	7	12	19	67	520	12	18	537	298
Future Volume (veh/h)	305	12	55	7	12	19	67	520	12	18	537	298
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1767	1767	1811	1870	1870	1870	1856	1856	1856	1870	1870	1870
Adj Flow Rate, veh/h	321	13	0	7	13	20	71	547	13	19	565	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	9	9	6	2	2	2	3	3	3	2	2	2
Cap, veh/h	379	15		11	21	32	91	849	20	39	1566	
Arrive On Green	0.23	0.23	0.00	0.04	0.04	0.04	0.05	0.47	0.47	0.02	0.44	0.00
Sat Flow, veh/h	1620	66	1535	298	553	851	1767	1805	43	1781	3647	0
Grp Volume(v), veh/h	334	0	0	40	0	0	71	0	560	19	565	0
Grp Sat Flow(s),veh/h/ln	1686	0	1535	1702	0	0	1767	0	1848	1781	1777	0
Q Serve(g_s), s	14.4	0.0	0.0	1.8	0.0	0.0	3.0	0.0	17.5	0.8	8.0	0.0
Cycle Q Clear(g_c), s	14.4	0.0	0.0	1.8	0.0	0.0	3.0	0.0	17.5	0.8	8.0	0.0
Prop In Lane	0.96		1.00	0.17		0.50	1.00		0.02	1.00		0.00
Lane Grp Cap(c), veh/h	394	0		64	0	0	91	0	869	39	1566	
V/C Ratio(X)	0.85	0.00		0.63	0.00	0.00	0.78	0.00	0.64	0.49	0.36	
Avail Cap(c_a), veh/h	574	0		571	0	0	165	0	869	119	1566	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	27.8	0.0	0.0	36.1	0.0	0.0	35.6	0.0	15.3	36.8	14.1	0.0
Incr Delay (d2), s/veh	7.9	0.0	0.0	9.7	0.0	0.0	13.4	0.0	3.7	9.3	0.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	6.4	0.0	0.0	0.9	0.0	0.0	1.6	0.0	7.0	0.4	2.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	35.7	0.0	0.0	45.7	0.0	0.0	49.0	0.0	19.0	46.1	14.8	0.0
LnGrp LOS	D	A		D	A	A	D	A	B	D	B	
Approach Vol, veh/h		334	A		40			631			584	A
Approach Delay, s/veh		35.7			45.7			22.4			15.8	
Approach LOS		D			D			C			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		22.3	8.4	38.0		7.4	6.2	40.3				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		25.9	7.1	33.5		25.5	5.1	35.5				
Max Q Clear Time (g_c+I1), s		16.4	5.0	10.0		3.8	2.8	19.5				
Green Ext Time (p_c), s		1.4	0.0	3.5		0.1	0.0	3.0				

Intersection Summary	
HCM 6th Ctrl Delay	23.3
HCM 6th LOS	C

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Appendix E

Analysis Reports – Future With Project Conditions (2024)

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	75	484	229	172	734	29	255	202	116	21	337	186
Future Volume (veh/h)	75	484	229	172	734	29	255	202	116	21	337	186
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1737	1767	1737	1841	1811	1841	1841	1870	1856	1870	1870	1870
Adj Flow Rate, veh/h	77	494	0	176	749	0	260	206	0	21	344	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	11	9	11	4	6	4	4	2	3	2	2	2
Cap, veh/h	164	1509		259	1634		355	807		41	518	
Arrive On Green	0.05	0.45	0.00	0.08	0.47	0.00	0.10	0.23	0.00	0.02	0.15	0.00
Sat Flow, veh/h	3209	3357	1472	3401	3441	1560	3401	3554	1572	1781	3554	1585
Grp Volume(v), veh/h	77	494	0	176	749	0	260	206	0	21	344	0
Grp Sat Flow(s),veh/h/ln	1605	1678	1472	1700	1721	1560	1700	1777	1572	1781	1777	1585
Q Serve(g_s), s	1.9	7.6	0.0	4.1	11.8	0.0	6.0	3.8	0.0	0.9	7.4	0.0
Cycle Q Clear(g_c), s	1.9	7.6	0.0	4.1	11.8	0.0	6.0	3.8	0.0	0.9	7.4	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	164	1509		259	1634		355	807		41	518	
V/C Ratio(X)	0.47	0.33		0.68	0.46		0.73	0.26		0.51	0.66	
Avail Cap(c_a), veh/h	247	1509		440	1634		605	2081		122	1692	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.1	14.3	0.0	36.2	14.2	0.0	34.9	25.5	0.0	38.8	32.5	0.0
Incr Delay (d2), s/veh	2.1	0.6	0.0	3.1	0.9	0.0	2.9	0.2	0.0	9.2	1.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	2.8	0.0	1.7	4.3	0.0	2.6	1.6	0.0	0.5	3.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.2	14.9	0.0	39.3	15.1	0.0	37.8	25.7	0.0	48.1	34.0	0.0
LnGrp LOS	D	B		D	B		D	C		D	C	
Approach Vol, veh/h		571	A		925	A		466	A		365	A
Approach Delay, s/veh		18.1			19.7			32.5			34.8	
Approach LOS		B			B			C			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.4	22.8	10.6	40.7	12.9	16.2	8.6	42.7
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.5	47.1	10.4	34.0	14.3	38.3	6.2	38.2
Max Q Clear Time (g_c+I1), s	2.9	5.8	6.1	9.6	8.0	9.4	3.9	13.8
Green Ext Time (p_c), s	0.0	1.4	0.2	3.3	0.5	2.4	0.0	5.4

Intersection Summary	
HCM 6th Ctrl Delay	24.2
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	112	382	130	57	658	512	153	354	45	385	356	130
Future Volume (vph)	112	382	130	57	658	512	153	354	45	385	356	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (prot)	3099	3282	1516	3303	3406	1548	1564	3348	1487	1595	3174	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (perm)	3099	3282	1516	3303	3406	1548	1564	3348	1487	1595	3174	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	115	394	134	59	678	528	158	365	46	397	367	134
RTOR Reduction (vph)	0	0	91	0	0	373	0	0	37	0	21	0
Lane Group Flow (vph)	115	394	43	59	678	155	142	381	9	298	579	0
Confl. Peds. (#/hr)			2	2			4		3	3		4
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	13%	10%	5%	6%	6%	3%	5%	3%	7%	3%	4%	5%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	6.6	30.5	30.5	4.1	28.0	28.0	18.1	18.1	18.1	24.7	24.7	
Effective Green, g (s)	6.6	30.5	30.5	4.1	28.0	28.0	18.1	18.1	18.1	24.7	24.7	
Actuated g/C Ratio	0.07	0.32	0.32	0.04	0.29	0.29	0.19	0.19	0.19	0.26	0.26	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	214	1049	484	141	999	454	296	635	282	412	821	
v/s Ratio Prot	c0.04	0.12		0.02	c0.20		0.09	c0.11		c0.19	0.18	
v/s Ratio Perm			0.03			0.10			0.01			
v/c Ratio	0.54	0.38	0.09	0.42	0.68	0.34	0.48	0.60	0.03	0.72	0.70	
Uniform Delay, d1	42.9	25.1	22.7	44.5	29.7	26.5	34.5	35.3	31.5	32.2	32.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	2.6	1.0	0.4	2.0	3.7	2.0	1.2	1.5	0.0	6.2	2.8	
Delay (s)	45.5	26.1	23.1	46.5	33.4	28.5	35.7	36.9	31.5	38.4	34.8	
Level of Service	D	C	C	D	C	C	D	D	C	D	C	
Approach Delay (s)		29.0			32.0			36.1			36.0	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	33.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	95.4	Sum of lost time (s)	18.0
Intersection Capacity Utilization	70.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	17.7

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	46	51	180	1086	827	32
Future Vol, veh/h	46	51	180	1086	827	32
Conflicting Peds, #/hr	0	0	0	0	0	1
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	2	6	2
Mvmt Flow	49	55	194	1168	889	34

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2446	-	890	0	-	0
Stage 1	890	-	-	-	-	-
Stage 2	1556	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	~ 34	0	761	-	-	-
Stage 1	401	0	-	-	-	-
Stage 2	191	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 25	-	760	-	-	-
Mov Cap-2 Maneuver	~ 25	-	-	-	-	-
Stage 1	298	-	-	-	-	-
Stage 2	191	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s$	789.5	1.6	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	760	-	25	-	-	-
HCM Lane V/C Ratio	0.255	-	1.978	-	-	-
HCM Control Delay (s)	11.3	-	$ 789.5	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	1	-	6.1	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection	
Int Delay, s/veh	4.5

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	9	147	1117	16	77	798
Future Vol, veh/h	9	147	1117	16	77	798
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	13	6	5
Mvmt Flow	10	158	1201	17	83	858

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2234	1210	0	0	1201	0
Stage 1	1210	-	-	-	-	-
Stage 2	1024	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	47	223	-	-	567	-
Stage 1	282	-	-	-	-	-
Stage 2	347	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	40	223	-	-	567	-
Mov Cap-2 Maneuver	40	-	-	-	-	-
Stage 1	282	-	-	-	-	-
Stage 2	296	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	56.8	0	1.1
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	40	223	567	-
HCM Lane V/C Ratio	-	-	0.242	0.709	0.146	-
HCM Control Delay (s)	-	-	121.6	52.8	12.4	-
HCM Lane LOS	-	-	F	F	B	-
HCM 95th %tile Q(veh)	-	-	0.8	4.6	0.5	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	92	194	957	27	45	767
Future Volume (veh/h)	92	194	957	27	45	767
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1870	1856	1870	1870	1826
Adj Flow Rate, veh/h	98	0	1018	0	48	816
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	3	2	2	5
Cap, veh/h	126		1403		66	1531
Arrive On Green	0.07	0.00	0.76	0.00	0.04	0.84
Sat Flow, veh/h	1781	1585	1856	1585	1781	1826
Grp Volume(v), veh/h	98	0	1018	0	48	816
Grp Sat Flow(s),veh/h/ln	1781	1585	1856	1585	1781	1826
Q Serve(g_s), s	5.4	0.0	29.4	0.0	2.6	12.9
Cycle Q Clear(g_c), s	5.4	0.0	29.4	0.0	2.6	12.9
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	126		1403		66	1531
V/C Ratio(X)	0.78		0.73		0.73	0.53
Avail Cap(c_a), veh/h	324		1403		117	1531
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	45.2	0.0	6.5	0.0	47.2	2.3
Incr Delay (d2), s/veh	9.9	0.0	3.3	0.0	14.2	1.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.7	0.0	9.9	0.0	1.4	2.9
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	55.1	0.0	9.8	0.0	61.3	3.7
LnGrp LOS	E		A		E	A
Approach Vol, veh/h	98	A	1018	A		864
Approach Delay, s/veh	55.1		9.8			6.9
Approach LOS	E		A			A

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	8.2	79.3			87.5	11.5
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	6.5	72.0			83.0	18.0
Max Q Clear Time (g_c+I1), s	4.6	31.4			14.9	7.4
Green Ext Time (p_c), s	0.0	11.4			7.9	0.1

Intersection Summary	
HCM 6th Ctrl Delay	10.8
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	11.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	7	178	543	856	797	66
Future Vol, veh/h	7	178	543	856	797	66
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	4	2	5	5	7
Mvmt Flow	8	191	584	920	857	71

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2945	-	857	0	-	0
Stage 1	857	-	-	-	-	-
Stage 2	2088	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	16	0	783	-	-	-
Stage 1	416	0	-	-	-	-
Stage 2	104	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 4	-	783	-	-	-
Mov Cap-2 Maneuver	~ 4	-	-	-	-	-
Stage 1	106	-	-	-	-	-
Stage 2	104	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, $	1998.6	8.5	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	783	-	4	-	-	-
HCM Lane V/C Ratio	0.746	-	1.882	-	-	-
HCM Control Delay (s)	21.8	$	1998.6	0	-	-
HCM Lane LOS	C	-	F	A	-	-
HCM 95th %tile Q(veh)	6.9	-	1.9	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	267	50	73	73	38	284	35	841	58	152	699	135
Future Volume (veh/h)	267	50	73	73	38	284	35	841	58	152	699	135
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1856	1870	1870	1870	1870	1841	1811	1856	1870
Adj Flow Rate, veh/h	284	53	0	78	40	0	37	895	0	162	744	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	3	2	2	2	2	4	6	3	2
Cap, veh/h	316	332		115	122		298	952		218	1002	
Arrive On Green	0.18	0.18	0.00	0.07	0.07	0.00	0.03	0.51	0.00	0.06	0.54	0.00
Sat Flow, veh/h	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Grp Volume(v), veh/h	284	53	0	78	40	0	37	895	0	162	744	0
Grp Sat Flow(s),veh/h/ln	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Q Serve(g_s), s	15.2	2.3	0.0	4.2	2.0	0.0	0.9	43.9	0.0	4.3	30.0	0.0
Cycle Q Clear(g_c), s	15.2	2.3	0.0	4.2	2.0	0.0	0.9	43.9	0.0	4.3	30.0	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	316	332		115	122		298	952		218	1002	
V/C Ratio(X)	0.90	0.16		0.68	0.33		0.12	0.94		0.74	0.74	
Avail Cap(c_a), veh/h	329	345		326	345		331	952		222	1002	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	39.2	33.9	0.0	44.5	43.5	0.0	14.4	22.5	0.0	21.9	17.2	0.0
Incr Delay (d2), s/veh	25.3	0.2	0.0	6.7	1.5	0.0	0.2	17.9	0.0	12.3	5.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.8	1.1	0.0	2.0	1.0	0.0	0.4	22.6	0.0	2.5	13.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	64.5	34.1	0.0	51.3	45.1	0.0	14.6	40.4	0.0	34.2	22.2	0.0
LnGrp LOS	E	C		D	D		B	D		C	C	
Approach Vol, veh/h		337	A		118	A		932	A		906	A
Approach Delay, s/veh		59.7			49.2			39.4			24.3	
Approach LOS		E			D			D			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	10.7	54.1		21.8	7.7	57.1		10.9
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	6.4	49.6		18.0	5.0	51.0		18.0
Max Q Clear Time (g_c+I1), s	6.3	45.9		17.2	2.9	32.0		6.2
Green Ext Time (p_c), s	0.0	2.1		0.1	0.0	5.3		0.3

Intersection Summary	
HCM 6th Ctrl Delay	36.9
HCM 6th LOS	D

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	167	5	27	17	13	16	80	505	16	15	449	307
Future Volume (veh/h)	167	5	27	17	13	16	80	505	16	15	449	307
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.95	1.00		0.98	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1722	1781	1781	1781	1752	1811	1811	1870	1811	1811
Adj Flow Rate, veh/h	180	5	0	18	14	17	86	543	17	16	483	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	2	12	8	8	8	10	6	6	2	6	6
Cap, veh/h	243	7		27	21	25	108	922	29	34	1661	
Arrive On Green	0.14	0.14	0.00	0.04	0.04	0.04	0.06	0.53	0.53	0.02	0.48	0.00
Sat Flow, veh/h	1735	48	1459	595	462	561	1668	1745	55	1781	3532	0
Grp Volume(v), veh/h	185	0	0	49	0	0	86	0	560	16	483	0
Grp Sat Flow(s),veh/h/ln	1784	0	1459	1618	0	0	1668	0	1800	1781	1721	0
Q Serve(g_s), s	6.7	0.0	0.0	2.0	0.0	0.0	3.4	0.0	14.3	0.6	5.7	0.0
Cycle Q Clear(g_c), s	6.7	0.0	0.0	2.0	0.0	0.0	3.4	0.0	14.3	0.6	5.7	0.0
Prop In Lane	0.97		1.00	0.37		0.35	1.00		0.03	1.00		0.00
Lane Grp Cap(c), veh/h	250	0		72	0	0	108	0	951	34	1661	
V/C Ratio(X)	0.74	0.00		0.68	0.00	0.00	0.79	0.00	0.59	0.47	0.29	
Avail Cap(c_a), veh/h	688	0		614	0	0	226	0	951	135	1661	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	27.7	0.0	0.0	31.6	0.0	0.0	31.0	0.0	10.8	32.6	10.5	0.0
Incr Delay (d2), s/veh	4.3	0.0	0.0	10.6	0.0	0.0	12.2	0.0	2.7	9.6	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.0	0.0	0.0	1.0	0.0	0.0	1.6	0.0	5.0	0.3	1.8	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	32.0	0.0	0.0	42.2	0.0	0.0	43.1	0.0	13.5	42.2	10.9	0.0
LnGrp LOS	C	A		D	A	A	D	A	B	D	B	
Approach Vol, veh/h		185	A		49			646			499	A
Approach Delay, s/veh		32.0			42.2			17.5			11.9	
Approach LOS		C			D			B			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		13.9	8.9	36.9		7.5	5.8	40.0				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		25.9	9.1	31.5		25.5	5.1	35.5				
Max Q Clear Time (g_c+I1), s		8.7	5.4	7.7		4.0	2.6	16.3				
Green Ext Time (p_c), s		0.9	0.0	2.9		0.2	0.0	3.2				

Intersection Summary	
HCM 6th Ctrl Delay	18.3
HCM 6th LOS	B

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	29	61	849	14	13	846
Future Vol, veh/h	29	61	849	14	13	846
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	Yield	-	None
Storage Length	0	0	-	585	695	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	32	66	923	15	14	920

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1871	923	0	0	923	0
Stage 1	923	-	-	-	-	-
Stage 2	948	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	79	327	-	-	740	-
Stage 1	387	-	-	-	-	-
Stage 2	377	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	77	327	-	-	740	-
Mov Cap-2 Maneuver	77	-	-	-	-	-
Stage 1	387	-	-	-	-	-
Stage 2	370	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	38.8	0	0.2
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	77	327	740	-
HCM Lane V/C Ratio	-	-	0.409	0.203	0.019	-
HCM Control Delay (s)	-	-	81	18.8	10	-
HCM Lane LOS	-	-	F	C	A	-
HCM 95th %tile Q(veh)	-	-	1.6	0.7	0.1	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	273	941	529	235	654	48	239	297	265	55	329	112
Future Volume (veh/h)	273	941	529	235	654	48	239	297	265	55	329	112
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1856	1856	1870	1870	1841	1870	1856	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	279	960	0	240	667	0	244	303	0	56	336	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	3	3	2	2	4	2	3	2	2	2	2	2
Cap, veh/h	369	1552		326	1493		330	715		78	530	
Arrive On Green	0.11	0.44	0.00	0.09	0.43	0.00	0.10	0.20	0.00	0.04	0.15	0.00
Sat Flow, veh/h	3428	3526	1585	3456	3497	1585	3428	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	279	960	0	240	667	0	244	303	0	56	336	0
Grp Sat Flow(s),veh/h/ln	1714	1763	1585	1728	1749	1585	1714	1777	1585	1781	1777	1585
Q Serve(g_s), s	6.5	17.1	0.0	5.5	11.0	0.0	5.7	6.1	0.0	2.5	7.3	0.0
Cycle Q Clear(g_c), s	6.5	17.1	0.0	5.5	11.0	0.0	5.7	6.1	0.0	2.5	7.3	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	369	1552		326	1493		330	715		78	530	
V/C Ratio(X)	0.76	0.62		0.74	0.45		0.74	0.42		0.71	0.63	
Avail Cap(c_a), veh/h	524	1552		444	1493		440	1808		194	1738	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	35.4	17.6	0.0	36.0	16.6	0.0	36.0	28.5	0.0	38.6	32.7	0.0
Incr Delay (d2), s/veh	3.9	1.9	0.0	4.2	1.0	0.0	4.5	0.4	0.0	11.4	1.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.8	6.7	0.0	2.4	4.3	0.0	2.5	2.6	0.0	1.3	3.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.3	19.5	0.0	40.2	17.6	0.0	40.5	28.9	0.0	50.0	34.0	0.0
LnGrp LOS	D	B		D	B		D	C		D	C	
Approach Vol, veh/h		1239	A		907	A		547	A		392	A
Approach Delay, s/veh		23.9			23.6			34.1			36.2	
Approach LOS		C			C			C			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.1	21.0	12.2	40.5	12.4	16.7	13.3	39.4
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	8.9	41.6	10.5	36.0	10.5	40.0	12.5	34.0
Max Q Clear Time (g_c+I1), s	4.5	8.1	7.5	19.1	7.7	9.3	8.5	13.0
Green Ext Time (p_c), s	0.0	2.1	0.2	6.2	0.2	2.3	0.4	4.4

Intersection Summary	
HCM 6th Ctrl Delay	27.2
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	200	722	306	79	596	341	132	334	37	379	359	200
Future Volume (vph)	200	722	306	79	596	341	132	334	37	379	359	200
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	0.98	1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (prot)	3335	3539	1583	3433	3471	1561	1595	3382	1537	1610	3193	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (perm)	3335	3539	1583	3433	3471	1561	1595	3382	1537	1610	3193	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	204	737	312	81	608	348	135	341	38	387	366	204
RTOR Reduction (vph)	0	0	209	0	0	249	0	0	31	0	44	0
Lane Group Flow (vph)	204	737	103	81	608	99	121	355	7	321	592	0
Confl. Peds. (#/hr)	1					1	4		7	7		4
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	5%	2%	2%	2%	4%	2%	3%	2%	3%	2%	2%	2%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	8.6	32.2	32.2	3.9	27.5	27.5	17.4	17.4	17.4	25.6	25.6	
Effective Green, g (s)	8.6	32.2	32.2	3.9	27.5	27.5	17.4	17.4	17.4	25.6	25.6	
Actuated g/C Ratio	0.09	0.33	0.33	0.04	0.28	0.28	0.18	0.18	0.18	0.26	0.26	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	295	1173	524	137	983	442	285	606	275	424	841	
v/s Ratio Prot	c0.06	c0.21		0.02	0.18		0.08	c0.10		c0.20	0.19	
v/s Ratio Perm			0.07			0.06			0.00			
v/c Ratio	0.69	0.63	0.20	0.59	0.62	0.22	0.42	0.59	0.02	0.76	0.70	
Uniform Delay, d1	43.0	27.4	23.2	45.8	30.2	26.6	35.4	36.5	32.9	32.9	32.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	6.8	2.6	0.8	6.7	2.9	1.2	1.0	1.5	0.0	7.5	2.7	
Delay (s)	49.8	30.0	24.1	52.5	33.2	27.8	36.4	38.0	32.9	40.4	35.0	
Level of Service	D	C	C	D	C	C	D	D	C	D	D	
Approach Delay (s)		31.7			32.9			37.2			36.8	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	34.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	97.1	Sum of lost time (s)	18.0
Intersection Capacity Utilization	74.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	1.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	11	77	91	1004	1096	18
Future Vol, veh/h	11	77	91	1004	1096	18
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	4	2	6
Mvmt Flow	11	79	94	1035	1130	19

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2353	-	1130	0	-	0
Stage 1	1130	-	-	-	-	-
Stage 2	1223	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	39	0	618	-	-	-
Stage 1	308	0	-	-	-	-
Stage 2	278	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	33	-	618	-	-	-
Mov Cap-2 Maneuver	33	-	-	-	-	-
Stage 1	261	-	-	-	-	-
Stage 2	278	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	163.1	1	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	618	-	33	-	-	-
HCM Lane V/C Ratio	0.152	-	0.344	-	-	-
HCM Control Delay (s)	11.9	-	163.1	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	0.5	-	1.1	-	-	-

Intersection	
Int Delay, s/veh	2.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	15	75	1025	4	64	1110
Future Vol, veh/h	15	75	1025	4	64	1110
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	7	2	3	2	8	2
Mvmt Flow	15	77	1057	4	66	1144

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2335	1059	0	0	1057	0
Stage 1	1059	-	-	-	-	-
Stage 2	1276	-	-	-	-	-
Critical Hdwy	6.47	6.22	-	-	4.18	-
Critical Hdwy Stg 1	5.47	-	-	-	-	-
Critical Hdwy Stg 2	5.47	-	-	-	-	-
Follow-up Hdwy	3.563	3.318	-	-	2.272	-
Pot Cap-1 Maneuver	39	273	-	-	636	-
Stage 1	326	-	-	-	-	-
Stage 2	256	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	35	273	-	-	636	-
Mov Cap-2 Maneuver	35	-	-	-	-	-
Stage 1	326	-	-	-	-	-
Stage 2	229	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	48.2	0	0.6
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	35	273	636	-
HCM Lane V/C Ratio	-	-	0.442	0.283	0.104	-
HCM Control Delay (s)	-	-	172.6	23.3	11.3	-
HCM Lane LOS	-	-	F	C	B	-
HCM 95th %tile Q(veh)	-	-	1.5	1.1	0.3	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	38	112	904	52	139	995
Future Volume (veh/h)	38	112	904	52	139	995
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1826	1856	1841	1870	1870
Adj Flow Rate, veh/h	39	0	932	0	143	1026
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	5	3	4	2	2
Cap, veh/h	60		1347		176	1630
Arrive On Green	0.03	0.00	0.73	0.00	0.10	0.87
Sat Flow, veh/h	1781	1547	1856	1560	1781	1870
Grp Volume(v), veh/h	39	0	932	0	143	1026
Grp Sat Flow(s),veh/h/ln	1781	1547	1856	1560	1781	1870
Q Serve(g_s), s	2.1	0.0	26.4	0.0	7.5	14.8
Cycle Q Clear(g_c), s	2.1	0.0	26.4	0.0	7.5	14.8
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	60		1347		176	1630
V/C Ratio(X)	0.65		0.69		0.81	0.63
Avail Cap(c_a), veh/h	337		1347		253	1630
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	45.4	0.0	7.2	0.0	42.1	1.7
Incr Delay (d2), s/veh	11.1	0.0	2.9	0.0	12.5	1.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.1	0.0	9.3	0.0	3.9	2.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	56.5	0.0	10.1	0.0	54.5	3.6
LnGrp LOS	E		B		D	A
Approach Vol, veh/h	39	A	932	A		1169
Approach Delay, s/veh	56.5		10.1			9.8
Approach LOS	E		B			A

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	13.9	73.6			87.5	7.7
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	13.5	65.0			83.0	18.0
Max Q Clear Time (g_c+I1), s	9.5	28.4			16.8	4.1
Green Ext Time (p_c), s	0.1	9.4			12.5	0.0

Intersection Summary	
HCM 6th Ctrl Delay	10.8
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	3.7

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	14	391	255	939	944	38
Future Vol, veh/h	14	391	255	939	944	38
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	8	2	2	3	2	6
Mvmt Flow	14	399	260	958	963	39

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2441	-	963	0	-	0
Stage 1	963	-	-	-	-	-
Stage 2	1478	-	-	-	-	-
Critical Hdwy	6.48	-	4.12	-	-	-
Critical Hdwy Stg 1	5.48	-	-	-	-	-
Critical Hdwy Stg 2	5.48	-	-	-	-	-
Follow-up Hdwy	3.572	-	2.218	-	-	-
Pot Cap-1 Maneuver	33	0	715	-	-	-
Stage 1	361	0	-	-	-	-
Stage 2	203	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	21	-	715	-	-	-
Mov Cap-2 Maneuver	21	-	-	-	-	-
Stage 1	230	-	-	-	-	-
Stage 2	203	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s$	344.6	2.8	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	715	-	21	-	-	-
HCM Lane V/C Ratio	0.364	-	0.68	-	-	-
HCM Control Delay (s)	12.9	-	$ 344.6	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	1.7	-	1.9	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	138	32	50	65	41	210	39	821	67	192	930	181
Future Volume (veh/h)	138	32	50	65	41	210	39	821	67	192	930	181
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1826	1826	1856	1856	1870	1856	1870	1870
Adj Flow Rate, veh/h	144	33	0	68	43	0	41	855	0	200	969	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	4	2	2	2	5	5	3	3	2	3	2	2
Cap, veh/h	185	198		105	108		234	1032		322	1105	
Arrive On Green	0.11	0.11	0.00	0.06	0.06	0.00	0.04	0.56	0.00	0.07	0.59	0.00
Sat Flow, veh/h	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Grp Volume(v), veh/h	144	33	0	68	43	0	41	855	0	200	969	0
Grp Sat Flow(s),veh/h/ln	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Q Serve(g_s), s	6.9	1.4	0.0	3.2	2.0	0.0	0.8	32.8	0.0	4.0	38.0	0.0
Cycle Q Clear(g_c), s	6.9	1.4	0.0	3.2	2.0	0.0	0.8	32.8	0.0	4.0	38.0	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	185	198		105	108		234	1032		322	1105	
V/C Ratio(X)	0.78	0.17		0.65	0.40		0.18	0.83		0.62	0.88	
Avail Cap(c_a), veh/h	365	390		371	381		272	1032		366	1105	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.6	35.2	0.0	39.7	39.1	0.0	15.0	15.8	0.0	15.9	15.0	0.0
Incr Delay (d2), s/veh	6.9	0.4	0.0	6.5	2.4	0.0	0.4	7.7	0.0	2.6	9.9	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.3	0.6	0.0	1.6	0.9	0.0	0.3	14.5	0.0	2.1	17.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	44.5	35.5	0.0	46.2	41.5	0.0	15.3	23.5	0.0	18.5	24.9	0.0
LnGrp LOS	D	D		D	D		B	C		B	C	
Approach Vol, veh/h		177	A		111	A		896	A		1169	A
Approach Delay, s/veh		42.8			44.4			23.1			23.8	
Approach LOS		D			D			C			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	10.6	52.5		13.6	7.6	55.5		9.6
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	8.3	47.7		18.0	5.0	51.0		18.0
Max Q Clear Time (g_c+I1), s	6.0	34.8		8.9	2.8	40.0		5.2
Green Ext Time (p_c), s	0.1	5.3		0.3	0.0	5.6		0.3

Intersection Summary	
HCM 6th Ctrl Delay	25.9
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	315	12	55	7	12	20	67	538	12	18	542	301
Future Volume (veh/h)	315	12	55	7	12	20	67	538	12	18	542	301
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1767	1767	1811	1870	1870	1870	1856	1856	1856	1870	1870	1870
Adj Flow Rate, veh/h	332	13	0	7	13	21	71	566	13	19	571	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	9	9	6	2	2	2	3	3	3	2	2	2
Cap, veh/h	389	15		11	20	33	91	842	19	39	1551	
Arrive On Green	0.24	0.24	0.00	0.04	0.04	0.04	0.05	0.47	0.47	0.02	0.44	0.00
Sat Flow, veh/h	1622	64	1535	290	539	870	1767	1807	41	1781	3647	0
Grp Volume(v), veh/h	345	0	0	41	0	0	71	0	579	19	571	0
Grp Sat Flow(s),veh/h/ln	1686	0	1535	1699	0	0	1767	0	1848	1781	1777	0
Q Serve(g_s), s	15.0	0.0	0.0	1.8	0.0	0.0	3.0	0.0	18.7	0.8	8.3	0.0
Cycle Q Clear(g_c), s	15.0	0.0	0.0	1.8	0.0	0.0	3.0	0.0	18.7	0.8	8.3	0.0
Prop In Lane	0.96		1.00	0.17		0.51	1.00		0.02	1.00		0.00
Lane Grp Cap(c), veh/h	404	0		65	0	0	91	0	862	39	1551	
V/C Ratio(X)	0.85	0.00		0.64	0.00	0.00	0.78	0.00	0.67	0.49	0.37	
Avail Cap(c_a), veh/h	569	0		564	0	0	163	0	862	118	1551	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	27.9	0.0	0.0	36.4	0.0	0.0	36.0	0.0	15.9	37.1	14.5	0.0
Incr Delay (d2), s/veh	8.8	0.0	0.0	9.9	0.0	0.0	13.4	0.0	4.2	9.3	0.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	6.8	0.0	0.0	0.9	0.0	0.0	1.6	0.0	7.6	0.4	3.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	36.7	0.0	0.0	46.3	0.0	0.0	49.3	0.0	20.1	46.5	15.2	0.0
LnGrp LOS	D	A		D	A	A	D	A	C	D	B	
Approach Vol, veh/h		345	A		41			650			590	A
Approach Delay, s/veh		36.7			46.3			23.3			16.2	
Approach LOS		D			D			C			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		22.9	8.5	38.0		7.4	6.2	40.3				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		25.9	7.1	33.5		25.5	5.1	35.5				
Max Q Clear Time (g_c+I1), s		17.0	5.0	10.3		3.8	2.8	20.7				
Green Ext Time (p_c), s		1.4	0.0	3.5		0.1	0.0	3.0				

Intersection Summary	
HCM 6th Ctrl Delay	24.1
HCM 6th LOS	C

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	1.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	12	39	912	41	45	988
Future Vol, veh/h	12	39	912	41	45	988
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	Yield	-	None
Storage Length	0	0	-	585	695	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	13	42	991	45	49	1074

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2163	991	0	0	991	0
Stage 1	991	-	-	-	-	-
Stage 2	1172	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	52	299	-	-	698	-
Stage 1	359	-	-	-	-	-
Stage 2	294	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	48	299	-	-	698	-
Mov Cap-2 Maneuver	48	-	-	-	-	-
Stage 1	359	-	-	-	-	-
Stage 2	273	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	39.4	0	0.5
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	48	299	698	-
HCM Lane V/C Ratio	-	-	0.272	0.142	0.07	-
HCM Control Delay (s)	-	-	105.9	19	10.5	-
HCM Lane LOS	-	-	F	C	B	-
HCM 95th %tile Q(veh)	-	-	0.9	0.5	0.2	-

Arterial Level of Service: NB Queen Kaahumanu Hwy

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Lako Street	III	30	41.2	75.9	117.1	0.32	10.0	F
Puapuaanui St	III	30	107.6	15.5	123.1	0.90	26.2	B
Total	III		148.8	91.4	240.2	1.22	18.3	C

Arterial Level of Service: SB Queen Kaahumanu Hwy

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Puapuaanui St	III	30	94.3	5.6	99.9	0.79	28.3	B
Lako Street	III	30	107.6	31.9	139.5	0.90	23.1	C
Total	III		201.9	37.5	239.4	1.68	25.3	B

Arterial Level of Service: NB Queen Kaahumanu Hwy

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Lako Street	III	30	41.2	46.5	87.7	0.32	13.3	E
Puapuaanui St	III	30	107.6	17.1	124.7	0.90	25.9	B
Total	III		148.8	63.6	212.4	1.22	20.7	C

Arterial Level of Service: SB Queen Kaahumanu Hwy

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Puapuaanui St	III	30	94.3	5.9	100.2	0.79	28.2	B
Lako Street	III	30	107.6	38.1	145.7	0.90	22.1	C
Total	III		201.9	44.0	245.9	1.68	24.6	B

Appendix F

Analysis Reports – Future Without Project Conditions
(2029)

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	78	505	241	180	749	25	268	212	120	22	355	196
Future Volume (veh/h)	78	505	241	180	749	25	268	212	120	22	355	196
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1737	1767	1737	1841	1811	1841	1841	1870	1856	1870	1870	1870
Adj Flow Rate, veh/h	80	515	0	184	764	0	273	216	0	22	362	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	11	9	11	4	6	4	4	2	3	2	2	2
Cap, veh/h	165	1481		267	1612		367	836		43	538	
Arrive On Green	0.05	0.44	0.00	0.08	0.47	0.00	0.11	0.24	0.00	0.02	0.15	0.00
Sat Flow, veh/h	3209	3357	1472	3401	3441	1560	3401	3554	1572	1781	3554	1585
Grp Volume(v), veh/h	80	515	0	184	764	0	273	216	0	22	362	0
Grp Sat Flow(s),veh/h/ln	1605	1678	1472	1700	1721	1560	1700	1777	1572	1781	1777	1585
Q Serve(g_s), s	2.0	8.3	0.0	4.3	12.4	0.0	6.3	4.0	0.0	1.0	7.8	0.0
Cycle Q Clear(g_c), s	2.0	8.3	0.0	4.3	12.4	0.0	6.3	4.0	0.0	1.0	7.8	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	165	1481		267	1612		367	836		43	538	
V/C Ratio(X)	0.49	0.35		0.69	0.47		0.74	0.26		0.51	0.67	
Avail Cap(c_a), veh/h	244	1481		434	1612		597	2053		120	1669	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.6	15.0	0.0	36.6	14.8	0.0	35.3	25.4	0.0	39.3	32.7	0.0
Incr Delay (d2), s/veh	2.2	0.6	0.0	3.2	1.0	0.0	3.0	0.2	0.0	9.2	1.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	3.0	0.0	1.8	4.6	0.0	2.7	1.7	0.0	0.5	3.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.8	15.7	0.0	39.8	15.8	0.0	38.3	25.5	0.0	48.5	34.2	0.0
LnGrp LOS	D	B		D	B		D	C		D	C	
Approach Vol, veh/h		595	A		948	A		489	A		384	A
Approach Delay, s/veh		18.9			20.5			32.6			35.0	
Approach LOS		B			C			C			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.5	23.7	10.9	40.5	13.3	16.8	8.7	42.7
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.5	47.1	10.4	34.0	14.3	38.3	6.2	38.2
Max Q Clear Time (g_c+I1), s	3.0	6.0	6.3	10.3	8.3	9.8	4.0	14.4
Green Ext Time (p_c), s	0.0	1.5	0.2	3.4	0.5	2.5	0.0	5.4

Intersection Summary	
HCM 6th Ctrl Delay	24.9
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	118	397	137	57	633	516	161	372	46	400	374	137
Future Volume (vph)	118	397	137	57	633	516	161	372	46	400	374	137
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (prot)	3099	3282	1516	3303	3406	1548	1564	3347	1487	1595	3174	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (perm)	3099	3282	1516	3303	3406	1548	1564	3347	1487	1595	3174	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	122	409	141	59	653	532	166	384	47	412	386	141
RTOR Reduction (vph)	0	0	97	0	0	379	0	0	38	0	22	0
Lane Group Flow (vph)	122	409	44	59	653	153	149	401	9	313	604	0
Confl. Peds. (#/hr)			2	2			4		3	3		4
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	13%	10%	5%	6%	6%	3%	5%	3%	7%	3%	4%	5%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	6.6	30.4	30.4	4.1	27.9	27.9	18.9	18.9	18.9	25.5	25.5	
Effective Green, g (s)	6.6	30.4	30.4	4.1	27.9	27.9	18.9	18.9	18.9	25.5	25.5	
Actuated g/C Ratio	0.07	0.31	0.31	0.04	0.29	0.29	0.20	0.20	0.20	0.26	0.26	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	211	1029	475	139	980	445	305	652	290	419	835	
v/s Ratio Prot	c0.04	0.12		0.02	c0.19		0.10	c0.12		c0.20	0.19	
v/s Ratio Perm			0.03			0.10			0.01			
v/c Ratio	0.58	0.40	0.09	0.42	0.67	0.34	0.49	0.62	0.03	0.75	0.72	
Uniform Delay, d1	43.8	26.1	23.5	45.2	30.4	27.3	34.7	35.7	31.6	32.7	32.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	3.8	1.1	0.4	2.1	3.6	2.1	1.2	1.7	0.0	7.1	3.1	
Delay (s)	47.6	27.2	23.9	47.3	34.0	29.4	35.9	37.4	31.6	39.9	35.6	
Level of Service	D	C	C	D	C	C	D	D	C	D	D	
Approach Delay (s)		30.2			32.6			36.6			37.0	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	34.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	96.9	Sum of lost time (s)	18.0
Intersection Capacity Utilization	71.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	20.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	49	53	181	1088	857	33
Future Vol, veh/h	49	53	181	1088	857	33
Conflicting Peds, #/hr	0	0	0	0	0	1
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	2	6	2
Mvmt Flow	53	57	195	1170	922	35

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2483	-	923	0	-	0
Stage 1	923	-	-	-	-	-
Stage 2	1560	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	~ 33	0	740	-	-	-
Stage 1	387	0	-	-	-	-
Stage 2	190	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 24	-	739	-	-	-
Mov Cap-2 Maneuver	~ 24	-	-	-	-	-
Stage 1	284	-	-	-	-	-
Stage 2	190	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	$ 893.5	1.7	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	739	-	24	-	-	-
HCM Lane V/C Ratio	0.263	-	2.195	-	-	-
HCM Control Delay (s)	11.6	-	$ 893.5	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	1.1	-	6.6	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection	
Int Delay, s/veh	5.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	10	155	1111	17	81	826
Future Vol, veh/h	10	155	1111	17	81	826
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	13	6	5
Mvmt Flow	11	167	1195	18	87	888

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2266	1204	0	0	1195	0
Stage 1	1204	-	-	-	-	-
Stage 2	1062	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	45	224	-	-	570	-
Stage 1	284	-	-	-	-	-
Stage 2	332	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	38	224	-	-	570	-
Mov Cap-2 Maneuver	38	-	-	-	-	-
Stage 1	284	-	-	-	-	-
Stage 2	281	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	61.4	0	1.1
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	38	224	570	-
HCM Lane V/C Ratio	-	-	0.283	0.744	0.153	-
HCM Control Delay (s)	-	-	133.6	56.7	12.5	-
HCM Lane LOS	-	-	F	F	B	-
HCM 95th %tile Q(veh)	-	-	0.9	5.1	0.5	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	96	204	942	27	47	793
Future Volume (veh/h)	96	204	942	27	47	793
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1870	1856	1870	1870	1826
Adj Flow Rate, veh/h	102	0	1002	0	50	844
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	3	2	2	5
Cap, veh/h	131		1397		67	1527
Arrive On Green	0.07	0.00	0.75	0.00	0.04	0.84
Sat Flow, veh/h	1781	1585	1856	1585	1781	1826
Grp Volume(v), veh/h	102	0	1002	0	50	844
Grp Sat Flow(s),veh/h/ln	1781	1585	1856	1585	1781	1826
Q Serve(g_s), s	5.6	0.0	28.8	0.0	2.8	14.0
Cycle Q Clear(g_c), s	5.6	0.0	28.8	0.0	2.8	14.0
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	131		1397		67	1527
V/C Ratio(X)	0.78		0.72		0.74	0.55
Avail Cap(c_a), veh/h	323		1397		117	1527
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	45.2	0.0	6.6	0.0	47.3	2.5
Incr Delay (d2), s/veh	9.7	0.0	3.2	0.0	15.0	1.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.8	0.0	9.8	0.0	1.5	3.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	54.9	0.0	9.8	0.0	62.3	3.9
LnGrp LOS	D		A		E	A
Approach Vol, veh/h	102	A	1002	A		894
Approach Delay, s/veh	54.9		9.8			7.2
Approach LOS	D		A			A

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	8.2	79.3			87.5	11.8
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	6.5	72.0			83.0	18.0
Max Q Clear Time (g_c+I1), s	4.8	30.8			16.0	7.6
Green Ext Time (p_c), s	0.0	11.1			8.4	0.2

Intersection Summary	
HCM 6th Ctrl Delay	10.9
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	16.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	8	187	571	885	810	67
Future Vol, veh/h	8	187	571	885	810	67
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	4	2	5	5	7
Mvmt Flow	9	201	614	952	871	72

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	3051	-	871	0	-	0
Stage 1	871	-	-	-	-	-
Stage 2	2180	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	14	0	774	-	-	-
Stage 1	410	0	-	-	-	-
Stage 2	93	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 3	-	774	-	-	-
Mov Cap-2 Maneuver	~ 3	-	-	-	-	-
Stage 1	85	-	-	-	-	-
Stage 2	93	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, $	2938.5	9.8	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	774	-	3	-	-	-
HCM Lane V/C Ratio	0.793	-	2.867	-	-	-
HCM Control Delay (s)	25	$	2938.5	0	-	-
HCM Lane LOS	C	-	F	A	-	-
HCM 95th %tile Q(veh)	8.2	-	2.2	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	277	53	76	76	40	295	36	875	61	156	715	138
Future Volume (veh/h)	277	53	76	76	40	295	36	875	61	156	715	138
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1856	1870	1870	1870	1870	1841	1811	1856	1870
Adj Flow Rate, veh/h	295	56	0	81	43	0	38	931	0	166	761	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	3	2	2	2	2	4	6	3	2
Cap, veh/h	325	341		119	126		281	941		191	993	
Arrive On Green	0.18	0.18	0.00	0.07	0.07	0.00	0.03	0.50	0.00	0.06	0.53	0.00
Sat Flow, veh/h	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Grp Volume(v), veh/h	295	56	0	81	43	0	38	931	0	166	761	0
Grp Sat Flow(s),veh/h/ln	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Q Serve(g_s), s	16.0	2.5	0.0	4.4	2.2	0.0	1.0	48.6	0.0	4.8	31.9	0.0
Cycle Q Clear(g_c), s	16.0	2.5	0.0	4.4	2.2	0.0	1.0	48.6	0.0	4.8	31.9	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	325	341		119	126		281	941		191	993	
V/C Ratio(X)	0.91	0.16		0.68	0.34		0.14	0.99		0.87	0.77	
Avail Cap(c_a), veh/h	325	341		323	341		313	941		191	993	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	39.5	34.0	0.0	45.0	43.9	0.0	15.3	24.3	0.0	24.3	18.1	0.0
Incr Delay (d2), s/veh	27.8	0.2	0.0	6.7	1.6	0.0	0.2	27.0	0.0	32.3	5.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.4	1.1	0.0	2.1	1.1	0.0	0.4	27.0	0.0	3.6	14.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	67.3	34.2	0.0	51.7	45.5	0.0	15.5	51.3	0.0	56.6	23.7	0.0
LnGrp LOS	E	C		D	D		B	D		E	C	
Approach Vol, veh/h		351	A		124	A		969	A		927	A
Approach Delay, s/veh		62.0			49.5			49.9			29.6	
Approach LOS		E			D			D			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	10.9	54.1		22.5	7.7	57.3		11.1
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	6.4	49.6		18.0	5.0	51.0		18.0
Max Q Clear Time (g_c+I1), s	6.8	50.6		18.0	3.0	33.9		6.4
Green Ext Time (p_c), s	0.0	0.0		0.0	0.0	5.2		0.3

Intersection Summary	
HCM 6th Ctrl Delay	43.7
HCM 6th LOS	D

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	173	6	29	18	13	17	84	525	17	15	461	315
Future Volume (veh/h)	173	6	29	18	13	17	84	525	17	15	461	315
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.95	1.00		0.98	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1722	1781	1781	1781	1752	1811	1811	1870	1811	1811
Adj Flow Rate, veh/h	186	6	0	19	14	18	90	565	18	16	496	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	2	12	8	8	8	10	6	6	2	6	6
Cap, veh/h	249	8		27	20	26	114	915	29	34	1638	
Arrive On Green	0.14	0.14	0.00	0.05	0.05	0.05	0.07	0.52	0.52	0.02	0.48	0.00
Sat Flow, veh/h	1728	56	1459	602	444	570	1668	1744	56	1781	3532	0
Grp Volume(v), veh/h	192	0	0	51	0	0	90	0	583	16	496	0
Grp Sat Flow(s),veh/h/ln	1784	0	1459	1616	0	0	1668	0	1800	1781	1721	0
Q Serve(g_s), s	7.0	0.0	0.0	2.1	0.0	0.0	3.6	0.0	15.4	0.6	6.0	0.0
Cycle Q Clear(g_c), s	7.0	0.0	0.0	2.1	0.0	0.0	3.6	0.0	15.4	0.6	6.0	0.0
Prop In Lane	0.97		1.00	0.37		0.35	1.00		0.03	1.00		0.00
Lane Grp Cap(c), veh/h	258	0		74	0	0	114	0	944	34	1638	
V/C Ratio(X)	0.75	0.00		0.69	0.00	0.00	0.79	0.00	0.62	0.47	0.30	
Avail Cap(c_a), veh/h	683	0		609	0	0	224	0	944	134	1638	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	27.7	0.0	0.0	31.8	0.0	0.0	31.1	0.0	11.3	32.8	10.9	0.0
Incr Delay (d2), s/veh	4.3	0.0	0.0	11.0	0.0	0.0	11.6	0.0	3.0	9.6	0.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.1	0.0	0.0	1.0	0.0	0.0	1.7	0.0	5.4	0.3	1.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	32.0	0.0	0.0	42.8	0.0	0.0	42.7	0.0	14.3	42.5	11.3	0.0
LnGrp LOS	C	A		D	A	A	D	A	B	D	B	
Approach Vol, veh/h		192	A		51			673			512	A
Approach Delay, s/veh		32.0			42.8			18.1			12.3	
Approach LOS		C			D			B			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		14.3	9.1	36.7		7.6	5.8	40.0				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		25.9	9.1	31.5		25.5	5.1	35.5				
Max Q Clear Time (g_c+I1), s		9.0	5.6	8.0		4.1	2.6	17.4				
Green Ext Time (p_c), s		0.9	0.1	3.0		0.2	0.0	3.3				

Intersection Summary	
HCM 6th Ctrl Delay	18.8
HCM 6th LOS	B

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	287	969	556	246	673	45	251	313	273	56	346	118
Future Volume (veh/h)	287	969	556	246	673	45	251	313	273	56	346	118
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1856	1856	1870	1870	1841	1870	1856	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	293	989	0	251	687	0	256	319	0	57	353	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	3	3	2	2	4	2	3	2	2	2	2	2
Cap, veh/h	381	1527		336	1466		340	743		78	548	
Arrive On Green	0.11	0.43	0.00	0.10	0.42	0.00	0.10	0.21	0.00	0.04	0.15	0.00
Sat Flow, veh/h	3428	3526	1585	3456	3497	1585	3428	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	293	989	0	251	687	0	256	319	0	57	353	0
Grp Sat Flow(s),veh/h/ln	1714	1763	1585	1728	1749	1585	1714	1777	1585	1781	1777	1585
Q Serve(g_s), s	6.9	18.4	0.0	5.9	11.8	0.0	6.0	6.5	0.0	2.6	7.8	0.0
Cycle Q Clear(g_c), s	6.9	18.4	0.0	5.9	11.8	0.0	6.0	6.5	0.0	2.6	7.8	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	381	1527		336	1466		340	743		78	548	
V/C Ratio(X)	0.77	0.65		0.75	0.47		0.75	0.43		0.73	0.64	
Avail Cap(c_a), veh/h	516	1527		437	1466		433	1779		191	1710	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	35.9	18.6	0.0	36.5	17.5	0.0	36.5	28.6	0.0	39.2	33.0	0.0
Incr Delay (d2), s/veh	4.8	2.1	0.0	5.1	1.1	0.0	5.5	0.4	0.0	12.0	1.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.0	7.3	0.0	2.6	4.6	0.0	2.7	2.7	0.0	1.4	3.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	40.7	20.7	0.0	41.6	18.5	0.0	42.0	28.9	0.0	51.3	34.3	0.0
LnGrp LOS	D	C		D	B		D	C		D	C	
Approach Vol, veh/h		1282	A		938	A		575	A		410	A
Approach Delay, s/veh		25.3			24.7			34.8			36.7	
Approach LOS		C			C			C			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.2	21.9	12.6	40.5	12.7	17.3	13.7	39.3
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	8.9	41.6	10.5	36.0	10.5	40.0	12.5	34.0
Max Q Clear Time (g_c+I1), s	4.6	8.5	7.9	20.4	8.0	9.8	8.9	13.8
Green Ext Time (p_c), s	0.0	2.2	0.2	6.2	0.2	2.5	0.3	4.5

Intersection Summary	
HCM 6th Ctrl Delay	28.3
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	210	732	321	80	605	347	139	351	38	384	378	210
Future Volume (vph)	210	732	321	80	605	347	139	351	38	384	378	210
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	0.98	1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3335	3539	1583	3433	3471	1561	1595	3383	1537	1610	3193	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3335	3539	1583	3433	3471	1561	1595	3383	1537	1610	3193	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	214	747	328	82	617	354	142	358	39	392	386	214
RTOR Reduction (vph)	0	0	221	0	0	255	0	0	32	0	45	0
Lane Group Flow (vph)	214	747	107	82	617	99	128	372	7	333	614	0
Confl. Peds. (#/hr)	1					1	4		7	7		4
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	5%	2%	2%	2%	4%	2%	3%	2%	3%	2%	2%	2%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	8.6	32.2	32.2	3.9	27.5	27.5	18.1	18.1	18.1	26.2	26.2	
Effective Green, g (s)	8.6	32.2	32.2	3.9	27.5	27.5	18.1	18.1	18.1	26.2	26.2	
Actuated g/C Ratio	0.09	0.33	0.33	0.04	0.28	0.28	0.18	0.18	0.18	0.27	0.27	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	291	1158	518	136	970	436	293	622	282	428	850	
v/s Ratio Prot	c0.06	c0.21		0.02	0.18		0.08	c0.11		c0.21	0.19	
v/s Ratio Perm			0.07			0.06			0.00			
v/c Ratio	0.74	0.65	0.21	0.60	0.64	0.23	0.44	0.60	0.03	0.78	0.72	
Uniform Delay, d1	43.8	28.2	23.9	46.5	31.1	27.3	35.6	36.8	32.9	33.4	32.8	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	9.3	2.8	0.9	7.3	3.2	1.2	1.0	1.6	0.0	8.7	3.0	
Delay (s)	53.1	31.0	24.8	53.8	34.2	28.5	36.7	38.4	33.0	42.1	35.8	
Level of Service	D	C	C	D	C	C	D	D	C	D	D	
Approach Delay (s)		33.1			33.8			37.6			37.9	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	35.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	98.4	Sum of lost time (s)	18.0
Intersection Capacity Utilization	75.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	1.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	11	77	93	1020	1110	19
Future Vol, veh/h	11	77	93	1020	1110	19
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	4	2	6
Mvmt Flow	11	79	96	1052	1144	20

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2388	-	1144	0	-	0
Stage 1	1144	-	-	-	-	-
Stage 2	1244	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	37	0	611	-	-	-
Stage 1	304	0	-	-	-	-
Stage 2	272	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	31	-	611	-	-	-
Mov Cap-2 Maneuver	31	-	-	-	-	-
Stage 1	256	-	-	-	-	-
Stage 2	272	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	177.1	1	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	611	-	31	-	-	-
HCM Lane V/C Ratio	0.157	-	0.366	-	-	-
HCM Control Delay (s)	12	-	177.1	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	0.6	-	1.2	-	-	-

Intersection	
Int Delay, s/veh	2.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	15	78	1038	4	67	1121
Future Vol, veh/h	15	78	1038	4	67	1121
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	7	2	3	2	8	2
Mvmt Flow	15	80	1070	4	69	1156

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2366	1072	0	0	1070	0
Stage 1	1072	-	-	-	-	-
Stage 2	1294	-	-	-	-	-
Critical Hdwy	6.47	6.22	-	-	4.18	-
Critical Hdwy Stg 1	5.47	-	-	-	-	-
Critical Hdwy Stg 2	5.47	-	-	-	-	-
Follow-up Hdwy	3.563	3.318	-	-	2.272	-
Pot Cap-1 Maneuver	37	268	-	-	629	-
Stage 1	322	-	-	-	-	-
Stage 2	251	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	33	268	-	-	629	-
Mov Cap-2 Maneuver	33	-	-	-	-	-
Stage 1	322	-	-	-	-	-
Stage 2	223	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	50.5	0	0.6
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	33	268	629	-
HCM Lane V/C Ratio	-	-	0.469	0.3	0.11	-
HCM Control Delay (s)	-	-	187.7	24.1	11.4	-
HCM Lane LOS	-	-	F	C	B	-
HCM 95th %tile Q(veh)	-	-	1.6	1.2	0.4	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	38	118	911	53	146	1001
Future Volume (veh/h)	38	118	911	53	146	1001
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1826	1856	1841	1870	1870
Adj Flow Rate, veh/h	39	0	939	0	151	1032
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	5	3	4	2	2
Cap, veh/h	60		1338		184	1630
Arrive On Green	0.03	0.00	0.72	0.00	0.10	0.87
Sat Flow, veh/h	1781	1547	1856	1560	1781	1870
Grp Volume(v), veh/h	39	0	939	0	151	1032
Grp Sat Flow(s),veh/h/ln	1781	1547	1856	1560	1781	1870
Q Serve(g_s), s	2.1	0.0	27.2	0.0	7.9	15.0
Cycle Q Clear(g_c), s	2.1	0.0	27.2	0.0	7.9	15.0
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	60		1338		184	1630
V/C Ratio(X)	0.65		0.70		0.82	0.63
Avail Cap(c_a), veh/h	337		1338		253	1630
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	45.4	0.0	7.5	0.0	41.8	1.7
Incr Delay (d2), s/veh	11.1	0.0	3.1	0.0	14.0	1.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.1	0.0	9.7	0.0	4.2	2.1
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	56.5	0.0	10.6	0.0	55.9	3.6
LnGrp LOS	E		B		E	A
Approach Vol, veh/h	39	A	939	A		1183
Approach Delay, s/veh	56.5		10.6			10.3
Approach LOS	E		B			B

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	14.3	73.2			87.5	7.7
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	13.5	65.0			83.0	18.0
Max Q Clear Time (g_c+I1), s	9.9	29.2			17.0	4.1
Green Ext Time (p_c), s	0.1	9.4			12.7	0.0

Intersection Summary	
HCM 6th Ctrl Delay	11.3
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	4.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	14	411	268	943	980	40
Future Vol, veh/h	14	411	268	943	980	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	8	2	2	3	2	6
Mvmt Flow	14	419	273	962	1000	41

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2508	-	1000	0	-	0
Stage 1	1000	-	-	-	-	-
Stage 2	1508	-	-	-	-	-
Critical Hdwy	6.48	-	4.12	-	-	-
Critical Hdwy Stg 1	5.48	-	-	-	-	-
Critical Hdwy Stg 2	5.48	-	-	-	-	-
Follow-up Hdwy	3.572	-	2.218	-	-	-
Pot Cap-1 Maneuver	30	0	692	-	-	-
Stage 1	347	0	-	-	-	-
Stage 2	196	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	18	-	692	-	-	-
Mov Cap-2 Maneuver	18	-	-	-	-	-
Stage 1	210	-	-	-	-	-
Stage 2	196	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s$	429.8	3	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	692	-	18	-	-	-
HCM Lane V/C Ratio	0.395	-	0.794	-	-	-
HCM Control Delay (s)	13.6	-	$ 429.8	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	1.9	-	2.1	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	140	33	53	68	43	213	41	833	71	200	969	188
Future Volume (veh/h)	140	33	53	68	43	213	41	833	71	200	969	188
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1826	1826	1856	1856	1870	1856	1870	1870
Adj Flow Rate, veh/h	146	34	0	71	45	0	43	868	0	208	1009	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	4	2	2	2	5	5	3	3	2	3	2	2
Cap, veh/h	187	200		109	112		206	1024		312	1099	
Arrive On Green	0.11	0.11	0.00	0.06	0.06	0.00	0.04	0.55	0.00	0.07	0.59	0.00
Sat Flow, veh/h	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Grp Volume(v), veh/h	146	34	0	71	45	0	43	868	0	208	1009	0
Grp Sat Flow(s),veh/h/ln	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Q Serve(g_s), s	7.0	1.4	0.0	3.4	2.1	0.0	0.9	34.2	0.0	4.3	41.9	0.0
Cycle Q Clear(g_c), s	7.0	1.4	0.0	3.4	2.1	0.0	0.9	34.2	0.0	4.3	41.9	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	187	200		109	112		206	1024		312	1099	
V/C Ratio(X)	0.78	0.17		0.65	0.40		0.21	0.85		0.67	0.92	
Avail Cap(c_a), veh/h	364	388		369	379		243	1024		352	1099	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.8	35.3	0.0	39.8	39.2	0.0	16.9	16.4	0.0	16.9	16.0	0.0
Incr Delay (d2), s/veh	6.9	0.4	0.0	6.4	2.3	0.0	0.5	8.7	0.0	4.1	13.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.3	0.7	0.0	1.7	1.0	0.0	0.4	15.4	0.0	2.5	19.6	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	44.7	35.7	0.0	46.3	41.6	0.0	17.4	25.1	0.0	21.0	29.5	0.0
LnGrp LOS	D	D		D	D		B	C		C	C	
Approach Vol, veh/h		180	A		116	A		911	A		1217	A
Approach Delay, s/veh		43.0			44.4			24.7			28.1	
Approach LOS		D			D			C			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	10.8	52.4		13.8	7.7	55.5		9.8
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	8.3	47.7		18.0	5.0	51.0		18.0
Max Q Clear Time (g_c+I1), s	6.3	36.2		9.0	2.9	43.9		5.4
Green Ext Time (p_c), s	0.1	5.0		0.3	0.0	4.2		0.3

Intersection Summary	
HCM 6th Ctrl Delay	28.7
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	320	12	57	8	12	20	71	547	12	19	564	314
Future Volume (veh/h)	320	12	57	8	12	20	71	547	12	19	564	314
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1767	1767	1811	1870	1870	1870	1856	1856	1856	1870	1870	1870
Adj Flow Rate, veh/h	337	13	0	8	13	21	75	576	13	20	594	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	9	9	6	2	2	2	3	3	3	2	2	2
Cap, veh/h	393	15		12	20	33	96	840	19	40	1537	
Arrive On Green	0.24	0.24	0.00	0.04	0.04	0.04	0.05	0.46	0.46	0.02	0.43	0.00
Sat Flow, veh/h	1623	63	1535	324	527	851	1767	1807	41	1781	3647	0
Grp Volume(v), veh/h	350	0	0	42	0	0	75	0	589	20	594	0
Grp Sat Flow(s),veh/h/ln	1685	0	1535	1701	0	0	1767	0	1848	1781	1777	0
Q Serve(g_s), s	15.4	0.0	0.0	1.9	0.0	0.0	3.2	0.0	19.4	0.9	8.8	0.0
Cycle Q Clear(g_c), s	15.4	0.0	0.0	1.9	0.0	0.0	3.2	0.0	19.4	0.9	8.8	0.0
Prop In Lane	0.96		1.00	0.19		0.50	1.00		0.02	1.00		0.00
Lane Grp Cap(c), veh/h	408	0		65	0	0	96	0	859	40	1537	
V/C Ratio(X)	0.86	0.00		0.64	0.00	0.00	0.78	0.00	0.69	0.50	0.39	
Avail Cap(c_a), veh/h	564	0		560	0	0	162	0	859	117	1537	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	28.1	0.0	0.0	36.7	0.0	0.0	36.1	0.0	16.3	37.4	15.0	0.0
Incr Delay (d2), s/veh	9.4	0.0	0.0	10.1	0.0	0.0	12.7	0.0	4.4	9.2	0.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	7.0	0.0	0.0	0.9	0.0	0.0	1.7	0.0	7.9	0.5	3.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	37.5	0.0	0.0	46.8	0.0	0.0	48.8	0.0	20.7	46.6	15.7	0.0
LnGrp LOS	D	A		D	A	A	D	A	C	D	B	
Approach Vol, veh/h		350	A		42			664			614	A
Approach Delay, s/veh		37.5			46.8			23.9			16.7	
Approach LOS		D			D			C			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		23.2	8.7	38.0		7.5	6.2	40.5				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		25.9	7.1	33.5		25.5	5.1	35.5				
Max Q Clear Time (g_c+I1), s		17.4	5.2	10.8		3.9	2.9	21.4				
Green Ext Time (p_c), s		1.4	0.0	3.7		0.1	0.0	3.0				

Intersection Summary	
HCM 6th Ctrl Delay	24.7
HCM 6th LOS	C

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Appendix G

Analysis Reports – Future With Project Conditions (2029)

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	78	512	241	181	787	34	268	212	122	22	355	196
Future Volume (veh/h)	78	512	241	181	787	34	268	212	122	22	355	196
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1737	1767	1737	1841	1811	1841	1841	1870	1856	1870	1870	1870
Adj Flow Rate, veh/h	80	522	0	185	803	0	273	216	0	22	362	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	11	9	11	4	6	4	4	2	3	2	2	2
Cap, veh/h	165	1480		268	1612		367	836		43	538	
Arrive On Green	0.05	0.44	0.00	0.08	0.47	0.00	0.11	0.24	0.00	0.02	0.15	0.00
Sat Flow, veh/h	3209	3357	1472	3401	3441	1560	3401	3554	1572	1781	3554	1585
Grp Volume(v), veh/h	80	522	0	185	803	0	273	216	0	22	362	0
Grp Sat Flow(s),veh/h/ln	1605	1678	1472	1700	1721	1560	1700	1777	1572	1781	1777	1585
Q Serve(g_s), s	2.0	8.4	0.0	4.3	13.2	0.0	6.3	4.0	0.0	1.0	7.8	0.0
Cycle Q Clear(g_c), s	2.0	8.4	0.0	4.3	13.2	0.0	6.3	4.0	0.0	1.0	7.8	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	165	1480		268	1612		367	836		43	538	
V/C Ratio(X)	0.49	0.35		0.69	0.50		0.74	0.26		0.51	0.67	
Avail Cap(c_a), veh/h	244	1480		434	1612		597	2053		120	1669	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.6	15.1	0.0	36.6	15.0	0.0	35.3	25.4	0.0	39.3	32.7	0.0
Incr Delay (d2), s/veh	2.2	0.7	0.0	3.2	1.1	0.0	3.0	0.2	0.0	9.2	1.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	3.1	0.0	1.9	4.9	0.0	2.7	1.7	0.0	0.5	3.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.8	15.7	0.0	39.7	16.1	0.0	38.3	25.5	0.0	48.5	34.2	0.0
LnGrp LOS	D	B		D	B		D	C		D	C	
Approach Vol, veh/h		602	A		988	A		489	A		384	A
Approach Delay, s/veh		18.9			20.5			32.6			35.0	
Approach LOS		B			C			C			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.5	23.7	10.9	40.5	13.3	16.8	8.7	42.7
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.5	47.1	10.4	34.0	14.3	38.3	6.2	38.2
Max Q Clear Time (g_c+I1), s	3.0	6.0	6.3	10.4	8.3	9.8	4.0	15.2
Green Ext Time (p_c), s	0.0	1.5	0.2	3.5	0.5	2.5	0.0	5.7

Intersection Summary	
HCM 6th Ctrl Delay	24.8
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	118	406	137	61	711	554	161	372	47	409	374	137
Future Volume (vph)	118	406	137	61	711	554	161	372	47	409	374	137
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (prot)	3099	3282	1516	3303	3406	1548	1564	3347	1487	1595	3174	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (perm)	3099	3282	1516	3303	3406	1548	1564	3347	1487	1595	3174	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	122	419	141	63	733	571	166	384	48	422	386	141
RTOR Reduction (vph)	0	0	97	0	0	407	0	0	39	0	21	0
Lane Group Flow (vph)	122	419	44	63	733	164	149	401	9	316	612	0
Confl. Peds. (#/hr)			2	2			4		3	3		4
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	13%	10%	5%	6%	6%	3%	5%	3%	7%	3%	4%	5%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	6.6	30.4	30.4	4.1	27.9	27.9	18.9	18.9	18.9	25.7	25.7	
Effective Green, g (s)	6.6	30.4	30.4	4.1	27.9	27.9	18.9	18.9	18.9	25.7	25.7	
Actuated g/C Ratio	0.07	0.31	0.31	0.04	0.29	0.29	0.19	0.19	0.19	0.26	0.26	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	210	1027	474	139	978	444	304	651	289	422	840	
v/s Ratio Prot	c0.04	0.13		0.02	c0.22		0.10	c0.12		c0.20	0.19	
v/s Ratio Perm			0.03			0.11			0.01			
v/c Ratio	0.58	0.41	0.09	0.45	0.75	0.37	0.49	0.62	0.03	0.75	0.73	
Uniform Delay, d1	43.9	26.3	23.6	45.4	31.4	27.6	34.8	35.8	31.7	32.7	32.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	4.0	1.2	0.4	2.3	5.3	2.4	1.2	1.7	0.0	7.1	3.2	
Delay (s)	48.0	27.5	24.0	47.7	36.7	29.9	36.1	37.5	31.7	39.9	35.7	
Level of Service	D	C	C	D	D	C	D	D	C	D	D	
Approach Delay (s)		30.4			34.4			36.7			37.1	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	34.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	97.1	Sum of lost time (s)	18.0
Intersection Capacity Utilization	71.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	28.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	49	54	196	1178	876	33
Future Vol, veh/h	49	54	196	1178	876	33
Conflicting Peds, #/hr	0	0	0	0	0	1
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	2	6	2
Mvmt Flow	53	58	211	1267	942	35

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2632	-	943	0	-	0
Stage 1	943	-	-	-	-	-
Stage 2	1689	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	~ 26	0	727	-	-	-
Stage 1	379	0	-	-	-	-
Stage 2	164	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 18	-	726	-	-	-
Mov Cap-2 Maneuver	~ 18	-	-	-	-	-
Stage 1	268	-	-	-	-	-
Stage 2	164	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, $	1310.5	1.7	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	726	-	18	-	-	-
HCM Lane V/C Ratio	0.29	-	2.927	-	-	-
HCM Control Delay (s)	12	$	1310.5	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	1.2	-	7.1	-	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	6.8

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	10	155	1216	17	81	846
Future Vol, veh/h	10	155	1216	17	81	846
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	13	6	5
Mvmt Flow	11	167	1308	18	87	910

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2401	1317	0	0	1308	0
Stage 1	1317	-	-	-	-	-
Stage 2	1084	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	37	193	-	-	516	-
Stage 1	250	-	-	-	-	-
Stage 2	324	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	31	193	-	-	516	-
Mov Cap-2 Maneuver	31	-	-	-	-	-
Stage 1	250	-	-	-	-	-
Stage 2	269	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	89	0	1.2
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	31	193	516	-
HCM Lane V/C Ratio	-	-	0.347	0.864	0.169	-
HCM Control Delay (s)	-	-	173.5	83.5	13.4	-
HCM Lane LOS	-	-	F	F	B	-
HCM 95th %tile Q(veh)	-	-	1.1	6.4	0.6	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	98	204	1047	30	47	813
Future Volume (veh/h)	98	204	1047	30	47	813
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1870	1856	1870	1870	1826
Adj Flow Rate, veh/h	104	0	1114	0	50	865
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	3	2	2	5
Cap, veh/h	130		1446		64	1557
Arrive On Green	0.07	0.00	0.78	0.00	0.04	0.85
Sat Flow, veh/h	1781	1585	1856	1585	1781	1826
Grp Volume(v), veh/h	104	0	1114	0	50	865
Grp Sat Flow(s),veh/h/ln	1781	1585	1856	1585	1781	1826
Q Serve(g_s), s	6.9	0.0	40.1	0.0	3.4	16.0
Cycle Q Clear(g_c), s	6.9	0.0	40.1	0.0	3.4	16.0
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	130		1446		64	1557
V/C Ratio(X)	0.80		0.77		0.78	0.56
Avail Cap(c_a), veh/h	265		1446		96	1557
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	55.1	0.0	7.4	0.0	57.7	2.5
Incr Delay (d2), s/veh	10.7	0.0	4.0	0.0	20.2	1.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.5	0.0	14.2	0.0	1.9	4.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	65.9	0.0	11.4	0.0	78.0	3.9
LnGrp LOS	E		B		E	A
Approach Vol, veh/h	104	A	1114	A		915
Approach Delay, s/veh	65.9		11.4			8.0
Approach LOS	E		B			A

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	8.9	98.6			107.5	13.3
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	6.5	92.0			103.0	18.0
Max Q Clear Time (g_c+I1), s	5.4	42.1			18.0	8.9
Green Ext Time (p_c), s	0.0	14.6			8.8	0.1

Intersection Summary	
HCM 6th Ctrl Delay	12.6
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	21.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	8	187	574	910	837	69
Future Vol, veh/h	8	187	574	910	837	69
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	4	2	5	5	7
Mvmt Flow	9	201	617	978	900	74

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	3112	-	900	0	-	0
Stage 1	900	-	-	-	-	-
Stage 2	2212	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	13	0	755	-	-	-
Stage 1	397	0	-	-	-	-
Stage 2	89	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 2	-	755	-	-	-
Mov Cap-2 Maneuver	~ 2	-	-	-	-	-
Stage 1	73	-	-	-	-	-
Stage 2	89	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, $	4556.6	10.6	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	755	-	2	-	-	-
HCM Lane V/C Ratio	0.817	-	4.301	-	-	-
HCM Control Delay (s)	27.4	$	4556.6	0	-	-
HCM Lane LOS	D	-	F	A	-	-
HCM 95th %tile Q(veh)	8.9	-	2.3	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	282	53	76	92	43	303	36	890	61	160	734	142
Future Volume (veh/h)	282	53	76	92	43	303	36	890	61	160	734	142
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1856	1870	1870	1870	1870	1841	1811	1856	1870
Adj Flow Rate, veh/h	300	56	0	98	46	0	38	947	0	170	781	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	3	2	2	2	2	4	6	3	2
Cap, veh/h	313	329		131	139		291	1008		202	1055	
Arrive On Green	0.18	0.18	0.00	0.07	0.07	0.00	0.03	0.54	0.00	0.06	0.57	0.00
Sat Flow, veh/h	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Grp Volume(v), veh/h	300	56	0	98	46	0	38	947	0	170	781	0
Grp Sat Flow(s),veh/h/ln	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Q Serve(g_s), s	19.9	3.0	0.0	6.5	2.8	0.0	1.1	56.3	0.0	5.1	37.3	0.0
Cycle Q Clear(g_c), s	19.9	3.0	0.0	6.5	2.8	0.0	1.1	56.3	0.0	5.1	37.3	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	313	329		131	139		291	1008		202	1055	
V/C Ratio(X)	0.96	0.17		0.75	0.33		0.13	0.94		0.84	0.74	
Avail Cap(c_a), veh/h	313	329		275	291		312	1008		221	1055	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	48.6	41.7	0.0	54.0	52.3	0.0	16.4	25.6	0.0	27.1	19.1	0.0
Incr Delay (d2), s/veh	39.8	0.2	0.0	8.1	1.4	0.0	0.2	17.1	0.0	23.0	4.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.2	1.4	0.0	3.2	1.4	0.0	0.5	28.5	0.0	3.9	16.7	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	88.4	41.9	0.0	62.1	53.6	0.0	16.6	42.8	0.0	50.2	23.8	0.0
LnGrp LOS	F	D		E	D		B	D		D	C	
Approach Vol, veh/h		356	A		144	A		985	A		951	A
Approach Delay, s/veh		81.1			59.4			41.7			28.5	
Approach LOS		F			E			D			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	11.6	68.6		25.4	8.1	72.2		13.3
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	8.5	64.1		20.9	5.0	67.6		18.5
Max Q Clear Time (g_c+I1), s	7.1	58.3		21.9	3.1	39.3		8.5
Green Ext Time (p_c), s	0.1	3.3		0.0	0.0	6.5		0.3

Intersection Summary	
HCM 6th Ctrl Delay	43.4
HCM 6th LOS	D

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	177	6	29	18	13	17	84	536	17	16	481	329
Future Volume (veh/h)	177	6	29	18	13	17	84	536	17	16	481	329
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.94	1.00		0.98	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1722	1781	1781	1781	1752	1811	1811	1870	1811	1811
Adj Flow Rate, veh/h	190	6	0	19	14	18	90	576	18	17	517	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	2	12	8	8	8	10	6	6	2	6	6
Cap, veh/h	240	8		24	18	23	114	1052	33	34	1905	
Arrive On Green	0.14	0.14	0.00	0.04	0.04	0.04	0.07	0.60	0.60	0.02	0.55	0.00
Sat Flow, veh/h	1729	55	1459	600	442	568	1668	1745	55	1781	3532	0
Grp Volume(v), veh/h	196	0	0	51	0	0	90	0	594	17	517	0
Grp Sat Flow(s),veh/h/ln	1784	0	1459	1610	0	0	1668	0	1800	1781	1721	0
Q Serve(g_s), s	9.6	0.0	0.0	2.8	0.0	0.0	4.8	0.0	17.7	0.9	7.1	0.0
Cycle Q Clear(g_c), s	9.6	0.0	0.0	2.8	0.0	0.0	4.8	0.0	17.7	0.9	7.1	0.0
Prop In Lane	0.97		1.00	0.37		0.35	1.00		0.03	1.00		0.00
Lane Grp Cap(c), veh/h	248	0		65	0	0	114	0	1085	34	1905	
V/C Ratio(X)	0.79	0.00		0.79	0.00	0.00	0.79	0.00	0.55	0.50	0.27	
Avail Cap(c_a), veh/h	527	0		454	0	0	266	0	1085	104	1905	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.7	0.0	0.0	43.0	0.0	0.0	41.5	0.0	10.6	43.9	10.6	0.0
Incr Delay (d2), s/veh	5.6	0.0	0.0	18.8	0.0	0.0	11.4	0.0	2.0	10.7	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.5	0.0	0.0	1.5	0.0	0.0	2.2	0.0	6.3	0.5	2.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	43.3	0.0	0.0	61.8	0.0	0.0	52.9	0.0	12.6	54.6	11.0	0.0
LnGrp LOS	D	A		E	A	A	D	A	B	D	B	
Approach Vol, veh/h		196	A		51			684			534	A
Approach Delay, s/veh		43.3			61.8			17.9			12.3	
Approach LOS		D			E			B			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		17.0	10.7	54.6		8.1	6.2	59.0				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		26.7	14.4	45.4		25.5	5.3	54.5				
Max Q Clear Time (g_c+I1), s		11.6	6.8	9.1		4.8	2.9	19.7				
Green Ext Time (p_c), s		0.9	0.1	3.4		0.2	0.0	3.9				

Intersection Summary	
HCM 6th Ctrl Delay	20.8
HCM 6th LOS	C

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	3.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	29	108	918	25	22	911
Future Vol, veh/h	29	108	918	25	22	911
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	Yield	-	None
Storage Length	0	0	-	585	695	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	32	117	998	27	24	990

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2036	998	0	0	998	0
Stage 1	998	-	-	-	-	-
Stage 2	1038	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	62	296	-	-	693	-
Stage 1	357	-	-	-	-	-
Stage 2	341	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	60	296	-	-	693	-
Mov Cap-2 Maneuver	60	-	-	-	-	-
Stage 1	357	-	-	-	-	-
Stage 2	329	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	44.6	0	0.2
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	60	296	693	-
HCM Lane V/C Ratio	-	-	0.525	0.397	0.035	-
HCM Control Delay (s)	-	-	118.2	24.9	10.4	-
HCM Lane LOS	-	-	F	C	B	-
HCM 95th %tile Q(veh)	-	-	2.1	1.8	0.1	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	287	1003	556	248	697	54	251	313	283	58	346	118
Future Volume (veh/h)	287	1003	556	248	697	54	251	313	283	58	346	118
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1856	1856	1870	1870	1841	1870	1856	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	293	1023	0	253	711	0	256	319	0	59	353	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	3	3	2	2	4	2	3	2	2	2	2	2
Cap, veh/h	381	1526		337	1466		340	741		80	547	
Arrive On Green	0.11	0.43	0.00	0.10	0.42	0.00	0.10	0.21	0.00	0.04	0.15	0.00
Sat Flow, veh/h	3428	3526	1585	3456	3497	1585	3428	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	293	1023	0	253	711	0	256	319	0	59	353	0
Grp Sat Flow(s),veh/h/ln	1714	1763	1585	1728	1749	1585	1714	1777	1585	1781	1777	1585
Q Serve(g_s), s	6.9	19.3	0.0	5.9	12.3	0.0	6.0	6.5	0.0	2.7	7.8	0.0
Cycle Q Clear(g_c), s	6.9	19.3	0.0	5.9	12.3	0.0	6.0	6.5	0.0	2.7	7.8	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	381	1526		337	1466		340	741		80	547	
V/C Ratio(X)	0.77	0.67		0.75	0.48		0.75	0.43		0.74	0.64	
Avail Cap(c_a), veh/h	515	1526		436	1466		433	1777		191	1709	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	35.9	18.8	0.0	36.5	17.6	0.0	36.5	28.6	0.0	39.2	33.0	0.0
Incr Delay (d2), s/veh	4.9	2.4	0.0	5.2	1.1	0.0	5.6	0.4	0.0	12.6	1.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.0	7.7	0.0	2.7	4.8	0.0	2.7	2.7	0.0	1.4	3.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	40.8	21.2	0.0	41.8	18.8	0.0	42.0	29.0	0.0	51.8	34.3	0.0
LnGrp LOS	D	C		D	B		D	C		D	C	
Approach Vol, veh/h		1316	A		964	A		575	A		412	A
Approach Delay, s/veh		25.6			24.8			34.8			36.8	
Approach LOS		C			C			C			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.2	21.8	12.6	40.5	12.7	17.3	13.7	39.4
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	8.9	41.6	10.5	36.0	10.5	40.0	12.5	34.0
Max Q Clear Time (g_c+I1), s	4.7	8.5	7.9	21.3	8.0	9.8	8.9	14.3
Green Ext Time (p_c), s	0.0	2.2	0.2	6.2	0.2	2.5	0.3	4.7

Intersection Summary	
HCM 6th Ctrl Delay	28.4
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	210	777	321	85	640	367	139	351	40	408	378	210
Future Volume (vph)	210	777	321	85	640	367	139	351	40	408	378	210
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	0.98	1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (prot)	3335	3539	1583	3433	3471	1561	1595	3383	1537	1610	3194	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (perm)	3335	3539	1583	3433	3471	1561	1595	3383	1537	1610	3194	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	214	793	328	87	653	374	142	358	41	416	386	214
RTOR Reduction (vph)	0	0	221	0	0	270	0	0	34	0	42	0
Lane Group Flow (vph)	214	793	107	87	653	104	128	372	7	341	633	0
Confl. Peds. (#/hr)	1					1	4		7	7		4
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	5%	2%	2%	2%	4%	2%	3%	2%	3%	2%	2%	2%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	8.6	32.2	32.2	3.9	27.5	27.5	18.1	18.1	18.1	26.8	26.8	
Effective Green, g (s)	8.6	32.2	32.2	3.9	27.5	27.5	18.1	18.1	18.1	26.8	26.8	
Actuated g/C Ratio	0.09	0.33	0.33	0.04	0.28	0.28	0.18	0.18	0.18	0.27	0.27	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	289	1151	514	135	964	433	291	618	281	435	864	
v/s Ratio Prot	c0.06	c0.22		0.03	0.19		0.08	c0.11		c0.21	0.20	
v/s Ratio Perm			0.07			0.07			0.00			
v/c Ratio	0.74	0.69	0.21	0.64	0.68	0.24	0.44	0.60	0.03	0.78	0.73	
Uniform Delay, d1	44.1	29.0	24.2	46.9	31.8	27.7	35.9	37.1	33.2	33.4	32.8	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	9.8	3.4	0.9	10.1	3.8	1.3	1.1	1.7	0.0	9.0	3.2	
Delay (s)	53.9	32.4	25.1	57.0	35.6	29.0	37.0	38.8	33.3	42.4	36.1	
Level of Service	D	C	C	E	D	C	D	D	C	D	D	
Approach Delay (s)		34.1			35.1			38.0			38.2	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	35.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	99.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	76.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	1.6

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	11	82	98	1079	1181	19
Future Vol, veh/h	11	82	98	1079	1181	19
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	4	2	6
Mvmt Flow	11	85	101	1112	1218	20

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2532	-	1218	0	-	0
Stage 1	1218	-	-	-	-	-
Stage 2	1314	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	30	0	572	-	-	-
Stage 1	280	0	-	-	-	-
Stage 2	251	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	25	-	572	-	-	-
Mov Cap-2 Maneuver	25	-	-	-	-	-
Stage 1	230	-	-	-	-	-
Stage 2	251	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	237	1.1	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	572	-	25	-	-	-
HCM Lane V/C Ratio	0.177	-	0.454	-	-	-
HCM Control Delay (s)	12.6	-	237	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	0.6	-	1.4	-	-	-

Intersection	
Int Delay, s/veh	2.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	15	78	1103	4	67	1197
Future Vol, veh/h	15	78	1103	4	67	1197
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	7	2	3	2	8	2
Mvmt Flow	15	80	1137	4	69	1234

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2511	1139	0	0	1137	0
Stage 1	1139	-	-	-	-	-
Stage 2	1372	-	-	-	-	-
Critical Hdwy	6.47	6.22	-	-	4.18	-
Critical Hdwy Stg 1	5.47	-	-	-	-	-
Critical Hdwy Stg 2	5.47	-	-	-	-	-
Follow-up Hdwy	3.563	3.318	-	-	2.272	-
Pot Cap-1 Maneuver	30	245	-	-	593	-
Stage 1	298	-	-	-	-	-
Stage 2	230	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	27	245	-	-	593	-
Mov Cap-2 Maneuver	27	-	-	-	-	-
Stage 1	298	-	-	-	-	-
Stage 2	203	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	62.9	0	0.6
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	27	245	593	-
HCM Lane V/C Ratio	-	-	0.573	0.328	0.116	-
HCM Control Delay (s)	-	-	251	26.7	11.9	-
HCM Lane LOS	-	-	F	D	B	-
HCM 95th %tile Q(veh)	-	-	1.8	1.4	0.4	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	41	118	976	57	146	1077
Future Volume (veh/h)	41	118	976	57	146	1077
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1826	1856	1841	1870	1870
Adj Flow Rate, veh/h	42	0	1006	0	151	1110
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	5	3	4	2	2
Cap, veh/h	57		1392		180	1665
Arrive On Green	0.03	0.00	0.75	0.00	0.10	0.89
Sat Flow, veh/h	1781	1547	1856	1560	1781	1870
Grp Volume(v), veh/h	42	0	1006	0	151	1110
Grp Sat Flow(s),veh/h/ln	1781	1547	1856	1560	1781	1870
Q Serve(g_s), s	2.7	0.0	34.2	0.0	9.6	18.5
Cycle Q Clear(g_c), s	2.7	0.0	34.2	0.0	9.6	18.5
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	57		1392		180	1665
V/C Ratio(X)	0.74		0.72		0.84	0.67
Avail Cap(c_a), veh/h	277		1392		239	1665
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	55.5	0.0	7.9	0.0	51.1	1.7
Incr Delay (d2), s/veh	16.7	0.0	3.3	0.0	17.9	2.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.5	0.0	12.6	0.0	5.2	2.8
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	72.2	0.0	11.1	0.0	69.0	3.8
LnGrp LOS	E		B		E	A
Approach Vol, veh/h	42	A	1006	A		1261
Approach Delay, s/veh	72.2		11.1			11.7
Approach LOS	E		B			B

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	16.2	91.3			107.5	8.2
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	15.5	83.0			103.0	18.0
Max Q Clear Time (g_c+I1), s	11.6	36.2			20.5	4.7
Green Ext Time (p_c), s	0.1	11.4			15.5	0.0

Intersection Summary	
HCM 6th Ctrl Delay	12.5
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	4.6

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	14	411	269	1017	992	40
Future Vol, veh/h	14	411	269	1017	992	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	8	2	2	3	2	6
Mvmt Flow	14	419	274	1038	1012	41

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2598	-	1012	0	-	0
Stage 1	1012	-	-	-	-	-
Stage 2	1586	-	-	-	-	-
Critical Hdwy	6.48	-	4.12	-	-	-
Critical Hdwy Stg 1	5.48	-	-	-	-	-
Critical Hdwy Stg 2	5.48	-	-	-	-	-
Follow-up Hdwy	3.572	-	2.218	-	-	-
Pot Cap-1 Maneuver	26	0	685	-	-	-
Stage 1	342	0	-	-	-	-
Stage 2	179	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	16	-	685	-	-	-
Mov Cap-2 Maneuver	16	-	-	-	-	-
Stage 1	205	-	-	-	-	-
Stage 2	179	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	$ 507.5	2.9	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	685	-	16	-	-	-
HCM Lane V/C Ratio	0.401	-	0.893	-	-	-
HCM Control Delay (s)	13.7	-	$ 507.5	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	1.9	-	2.2	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	149	33	53	75	44	228	41	885	71	202	977	190
Future Volume (veh/h)	149	33	53	75	44	228	41	885	71	202	977	190
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1826	1826	1856	1856	1870	1856	1870	1870
Adj Flow Rate, veh/h	155	34	0	78	46	0	43	922	0	210	1018	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	4	2	2	2	5	5	3	3	2	3	2	2
Cap, veh/h	187	200		110	113		234	1125		307	1191	
Arrive On Green	0.11	0.11	0.00	0.06	0.06	0.00	0.03	0.61	0.00	0.06	0.64	0.00
Sat Flow, veh/h	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Grp Volume(v), veh/h	155	34	0	78	46	0	43	922	0	210	1018	0
Grp Sat Flow(s),veh/h/ln	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Q Serve(g_s), s	9.7	1.8	0.0	4.8	2.7	0.0	1.0	43.4	0.0	4.8	48.4	0.0
Cycle Q Clear(g_c), s	9.7	1.8	0.0	4.8	2.7	0.0	1.0	43.4	0.0	4.8	48.4	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	187	200		110	113		234	1125		307	1191	
V/C Ratio(X)	0.83	0.17		0.71	0.41		0.18	0.82		0.68	0.85	
Avail Cap(c_a), veh/h	283	302		288	295		255	1125		374	1191	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	48.8	45.3	0.0	51.3	50.3	0.0	17.3	17.2	0.0	20.1	16.1	0.0
Incr Delay (d2), s/veh	11.6	0.4	0.0	8.0	2.3	0.0	0.4	6.7	0.0	3.8	7.9	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.8	0.9	0.0	2.4	1.3	0.0	0.5	19.1	0.0	3.4	21.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	60.4	45.7	0.0	59.3	52.7	0.0	17.7	23.9	0.0	23.9	24.1	0.0
LnGrp LOS	E	D		E	D		B	C		C	C	
Approach Vol, veh/h		189	A		124	A		965	A		1228	A
Approach Delay, s/veh		57.8			56.8			23.6			24.0	
Approach LOS		E			E			C			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	11.6	72.1		16.4	8.2	75.5		11.4
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	11.3	64.7		18.0	5.0	71.0		18.0
Max Q Clear Time (g_c+I1), s	6.8	45.4		11.7	3.0	50.4		6.8
Green Ext Time (p_c), s	0.2	7.3		0.3	0.0	8.8		0.3

Intersection Summary	
HCM 6th Ctrl Delay	28.0
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	339	12	57	8	12	21	71	579	12	19	574	319
Future Volume (veh/h)	339	12	57	8	12	21	71	579	12	19	574	319
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1767	1767	1811	1870	1870	1870	1856	1856	1856	1870	1870	1870
Adj Flow Rate, veh/h	357	13	0	8	13	22	75	609	13	20	604	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	9	9	6	2	2	2	3	3	3	2	2	2
Cap, veh/h	406	15		11	18	31	96	915	20	38	1680	
Arrive On Green	0.25	0.25	0.00	0.04	0.04	0.04	0.05	0.51	0.51	0.02	0.47	0.00
Sat Flow, veh/h	1626	59	1535	316	513	869	1767	1810	39	1781	3647	0
Grp Volume(v), veh/h	370	0	0	43	0	0	75	0	622	20	604	0
Grp Sat Flow(s),veh/h/ln	1685	0	1535	1698	0	0	1767	0	1849	1781	1777	0
Q Serve(g_s), s	20.2	0.0	0.0	2.4	0.0	0.0	4.0	0.0	24.0	1.1	10.4	0.0
Cycle Q Clear(g_c), s	20.2	0.0	0.0	2.4	0.0	0.0	4.0	0.0	24.0	1.1	10.4	0.0
Prop In Lane	0.96		1.00	0.19		0.51	1.00		0.02	1.00		0.00
Lane Grp Cap(c), veh/h	421	0		60	0	0	96	0	935	38	1680	
V/C Ratio(X)	0.88	0.00		0.71	0.00	0.00	0.78	0.00	0.67	0.52	0.36	
Avail Cap(c_a), veh/h	578	0		452	0	0	164	0	935	95	1680	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	34.6	0.0	0.0	45.8	0.0	0.0	44.8	0.0	17.7	46.4	16.1	0.0
Incr Delay (d2), s/veh	11.3	0.0	0.0	14.4	0.0	0.0	12.6	0.0	3.7	10.5	0.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.4	0.0	0.0	1.2	0.0	0.0	2.0	0.0	10.0	0.6	3.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	45.9	0.0	0.0	60.1	0.0	0.0	57.3	0.0	21.4	57.0	16.7	0.0
LnGrp LOS	D	A		E	A	A	E	A	C	E	B	
Approach Vol, veh/h		370	A		43			697			624	A
Approach Delay, s/veh		45.9			60.1			25.3			18.0	
Approach LOS		D			E			C			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		28.4	9.7	49.8		7.9	6.6	53.0				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		32.9	8.9	44.7		25.5	5.1	48.5				
Max Q Clear Time (g_c+I1), s		22.2	6.0	12.4		4.4	3.1	26.0				
Green Ext Time (p_c), s		1.7	0.0	4.0		0.1	0.0	3.8				

Intersection Summary	
HCM 6th Ctrl Delay	27.9
HCM 6th LOS	C

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	2.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	12	68	1031	74	79	1118
Future Vol, veh/h	12	68	1031	74	79	1118
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	Yield	-	None
Storage Length	0	0	-	585	695	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	13	74	1121	80	86	1215

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2508	1121	0	0	1121	0
Stage 1	1121	-	-	-	-	-
Stage 2	1387	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	31	251	-	-	623	-
Stage 1	311	-	-	-	-	-
Stage 2	232	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	27	251	-	-	623	-
Mov Cap-2 Maneuver	27	-	-	-	-	-
Stage 1	311	-	-	-	-	-
Stage 2	200	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	55.7	0	0.8
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	27	251	623	-
HCM Lane V/C Ratio	-	-	0.483	0.294	0.138	-
HCM Control Delay (s)	-	-	228.2	25.2	11.7	-
HCM Lane LOS	-	-	F	D	B	-
HCM 95th %tile Q(veh)	-	-	1.5	1.2	0.5	-

Arterial Level of Service: NB Queen Kaahumanu Hwy

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Lako Street	III	30	41.2	71.0	112.2	0.32	10.4	E
Puapuaanui St	III	30	107.6	16.7	124.3	0.90	26.0	B
Total	III		148.8	87.7	236.5	1.22	18.6	C

Arterial Level of Service: SB Queen Kaahumanu Hwy

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Puapuaanui St	III	30	94.3	5.8	100.1	0.79	28.2	B
Lako Street	III	30	107.6	32.4	140.0	0.90	23.0	C
Total	III		201.9	38.2	240.1	1.68	25.2	B

Arterial Level of Service: NB Queen Kaahumanu Hwy

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Lako Street	III	30	41.2	48.8	90.0	0.32	13.0	E
Puapuaanui St	III	30	107.6	18.1	125.7	0.90	25.7	B
Total	III		148.8	66.9	215.7	1.22	20.4	C

Arterial Level of Service: SB Queen Kaahumanu Hwy

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Puapuaanui St	III	30	94.3	6.2	100.5	0.79	28.1	B
Lako Street	III	30	107.6	39.2	146.8	0.90	22.0	C
Total	III		201.9	45.4	247.3	1.68	24.5	B

Appendix H

Analysis Reports – Future Without Project Conditions
(2039)

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	87	558	266	199	827	28	297	234	133	24	392	216
Future Volume (veh/h)	87	558	266	199	827	28	297	234	133	24	392	216
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1737	1767	1737	1841	1811	1841	1841	1870	1856	1870	1870	1870
Adj Flow Rate, veh/h	89	569	0	203	844	0	303	239	0	24	400	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	11	9	11	4	6	4	4	2	3	2	2	2
Cap, veh/h	167	1420		285	1565		394	900		45	579	
Arrive On Green	0.05	0.42	0.00	0.08	0.45	0.00	0.12	0.25	0.00	0.03	0.16	0.00
Sat Flow, veh/h	3209	3357	1472	3401	3441	1560	3401	3554	1572	1781	3554	1585
Grp Volume(v), veh/h	89	569	0	203	844	0	303	239	0	24	400	0
Grp Sat Flow(s),veh/h/ln	1605	1678	1472	1700	1721	1560	1700	1777	1572	1781	1777	1585
Q Serve(g_s), s	2.3	9.9	0.0	4.9	14.9	0.0	7.3	4.5	0.0	1.1	8.9	0.0
Cycle Q Clear(g_c), s	2.3	9.9	0.0	4.9	14.9	0.0	7.3	4.5	0.0	1.1	8.9	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	167	1420		285	1565		394	900		45	579	
V/C Ratio(X)	0.53	0.40		0.71	0.54		0.77	0.27		0.53	0.69	
Avail Cap(c_a), veh/h	237	1420		421	1565		579	1993		117	1620	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	38.8	16.8	0.0	37.5	16.5	0.0	36.0	25.1	0.0	40.4	33.2	0.0
Incr Delay (d2), s/veh	2.6	0.8	0.0	3.3	1.3	0.0	3.7	0.2	0.0	9.2	1.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	3.7	0.0	2.1	5.7	0.0	3.2	1.9	0.0	0.6	3.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	41.4	17.7	0.0	40.8	17.9	0.0	39.7	25.3	0.0	49.6	34.6	0.0
LnGrp LOS	D	B		D	B		D	C		D	C	
Approach Vol, veh/h		658	A		1047	A		542	A		424	A
Approach Delay, s/veh		20.9			22.3			33.3			35.5	
Approach LOS		C			C			C			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.6	25.8	11.5	40.0	14.2	18.2	8.9	42.7
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.5	47.1	10.4	34.0	14.3	38.3	6.2	38.2
Max Q Clear Time (g_c+I1), s	3.1	6.5	6.9	11.9	9.3	10.9	4.3	16.9
Green Ext Time (p_c), s	0.0	1.7	0.2	3.8	0.5	2.8	0.0	5.9

Intersection Summary	
HCM 6th Ctrl Delay	26.3
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	131	438	151	63	732	570	178	411	51	442	414	151
Future Volume (vph)	131	438	151	63	732	570	178	411	51	442	414	151
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (prot)	3099	3282	1516	3303	3406	1548	1564	3348	1487	1595	3174	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (perm)	3099	3282	1516	3303	3406	1548	1564	3348	1487	1595	3174	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	135	452	156	65	755	588	184	424	53	456	427	156
RTOR Reduction (vph)	0	0	109	0	0	408	0	0	42	0	22	0
Lane Group Flow (vph)	135	452	47	65	755	180	166	442	11	347	670	0
Confl. Peds. (#/hr)			2	2			4		3	3		4
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	13%	10%	5%	6%	6%	3%	5%	3%	7%	3%	4%	5%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	6.6	30.4	30.4	4.1	27.9	27.9	20.5	20.5	20.5	27.6	27.6	
Effective Green, g (s)	6.6	30.4	30.4	4.1	27.9	27.9	20.5	20.5	20.5	27.6	27.6	
Actuated g/C Ratio	0.07	0.30	0.30	0.04	0.28	0.28	0.20	0.20	0.20	0.27	0.27	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	203	991	458	134	944	429	318	682	303	437	870	
v/s Ratio Prot	c0.04	0.14		0.02	c0.22		0.11	c0.13		c0.22	0.21	
v/s Ratio Perm			0.03			0.12			0.01			
v/c Ratio	0.67	0.46	0.10	0.49	0.80	0.42	0.52	0.65	0.04	0.79	0.77	
Uniform Delay, d1	45.9	28.4	25.3	47.2	33.8	29.7	35.7	36.7	32.1	33.9	33.6	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	8.0	1.5	0.5	2.8	7.1	3.0	1.5	2.1	0.0	9.6	4.3	
Delay (s)	53.9	29.9	25.7	50.0	40.8	32.7	37.2	38.9	32.2	43.4	37.8	
Level of Service	D	C	C	D	D	C	D	D	C	D	D	
Approach Delay (s)		33.4			37.9			37.9			39.7	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	37.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	100.6	Sum of lost time (s)	18.0
Intersection Capacity Utilization	73.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	41

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	54	59	200	1202	947	37
Future Vol, veh/h	54	59	200	1202	947	37
Conflicting Peds, #/hr	0	0	0	0	0	1
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	2	6	2
Mvmt Flow	58	63	215	1292	1018	40

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2741	-	1019	0	-	0
Stage 1	1019	-	-	-	-	-
Stage 2	1722	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	~ 22	0	681	-	-	-
Stage 1	348	0	-	-	-	-
Stage 2	158	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 15	-	680	-	-	-
Mov Cap-2 Maneuver	~ 15	-	-	-	-	-
Stage 1	238	-	-	-	-	-
Stage 2	158	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, $	1804.9	1.8	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	680	-	15	-	-	-
HCM Lane V/C Ratio	0.316	-	3.871	-	-	-
HCM Control Delay (s)	12.7	$	1804.9	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	1.4	-	8.1	-	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	9.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	11	171	1228	18	89	913
Future Vol, veh/h	11	171	1228	18	89	913
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	13	6	5
Mvmt Flow	12	184	1320	19	96	982

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2504	1330	0	0	1320	0
Stage 1	1330	-	-	-	-	-
Stage 2	1174	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	32	189	-	-	511	-
Stage 1	247	-	-	-	-	-
Stage 2	294	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	26	189	-	-	511	-
Mov Cap-2 Maneuver	26	-	-	-	-	-
Stage 1	247	-	-	-	-	-
Stage 2	239	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	116.7	0	1.2
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	26	189	511	-
HCM Lane V/C Ratio	-	-	0.455	0.973	0.187	-
HCM Control Delay (s)	-	-	229.1	109.5	13.7	-
HCM Lane LOS	-	-	F	F	B	-
HCM 95th %tile Q(veh)	-	-	1.4	8	0.7	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	106	226	1041	29	52	876
Future Volume (veh/h)	106	226	1041	29	52	876
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1870	1856	1870	1870	1826
Adj Flow Rate, veh/h	113	0	1107	0	55	932
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	3	2	2	5
Cap, veh/h	143		1382		71	1515
Arrive On Green	0.08	0.00	0.75	0.00	0.04	0.83
Sat Flow, veh/h	1781	1585	1856	1585	1781	1826
Grp Volume(v), veh/h	113	0	1107	0	55	932
Grp Sat Flow(s),veh/h/ln	1781	1585	1856	1585	1781	1826
Q Serve(g_s), s	6.2	0.0	37.7	0.0	3.1	17.8
Cycle Q Clear(g_c), s	6.2	0.0	37.7	0.0	3.1	17.8
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	143		1382		71	1515
V/C Ratio(X)	0.79		0.80		0.78	0.62
Avail Cap(c_a), veh/h	321		1382		116	1515
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	45.2	0.0	8.1	0.0	47.6	3.0
Incr Delay (d2), s/veh	9.3	0.0	5.0	0.0	16.5	1.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.1	0.0	13.5	0.0	1.7	4.3
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	54.5	0.0	13.0	0.0	64.1	4.8
LnGrp LOS	D		B		E	A
Approach Vol, veh/h	113	A	1107	A		987
Approach Delay, s/veh	54.5		13.0			8.1
Approach LOS	D		B			A

Timer - Assigned Phs	1	2				6	8
Phs Duration (G+Y+Rc), s	8.5	79.0				87.5	12.5
Change Period (Y+Rc), s	4.5	4.5				4.5	4.5
Max Green Setting (Gmax), s	6.5	72.0				83.0	18.0
Max Q Clear Time (g_c+I1), s	5.1	39.7				19.8	8.2
Green Ext Time (p_c), s	0.0	12.5				10.1	0.2

Intersection Summary	
HCM 6th Ctrl Delay	13.0
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	11.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	9	206	631	977	894	74
Future Vol, veh/h	9	206	631	977	894	74
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	4	2	5	5	7
Mvmt Flow	10	222	678	1051	961	80

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	3368	-	961	0	-	0
Stage 1	961	-	-	-	-	-
Stage 2	2407	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	~ 9	0	716	-	-	-
Stage 1	371	0	-	-	-	-
Stage 2	71	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	0	-	716	-	-	-
Mov Cap-2 Maneuver	0	-	-	-	-	-
Stage 1	20	-	-	-	-	-
Stage 2	71	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s		18.1	0
HCM LOS	-		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	716	-	-	-	-	-
HCM Lane V/C Ratio	0.948	-	-	-	-	-
HCM Control Delay (s)	46	-	-	0	-	-
HCM Lane LOS	E	-	-	A	-	-
HCM 95th %tile Q(veh)	13.8	-	-	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	306	59	84	84	44	326	40	966	67	172	789	153
Future Volume (veh/h)	306	59	84	84	44	326	40	966	67	172	789	153
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1856	1870	1870	1870	1870	1841	1811	1856	1870
Adj Flow Rate, veh/h	326	63	0	89	47	0	43	1028	0	183	839	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	3	2	2	2	2	4	6	3	2
Cap, veh/h	323	339		128	135		228	935		184	983	
Arrive On Green	0.18	0.18	0.00	0.07	0.07	0.00	0.03	0.50	0.00	0.06	0.53	0.00
Sat Flow, veh/h	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Grp Volume(v), veh/h	326	63	0	89	47	0	43	1028	0	183	839	0
Grp Sat Flow(s),veh/h/ln	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Q Serve(g_s), s	18.0	2.8	0.0	4.9	2.4	0.0	1.1	49.6	0.0	6.3	38.5	0.0
Cycle Q Clear(g_c), s	18.0	2.8	0.0	4.9	2.4	0.0	1.1	49.6	0.0	6.3	38.5	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	323	339		128	135		228	935		184	983	
V/C Ratio(X)	1.01	0.19		0.70	0.35		0.19	1.10		0.99	0.85	
Avail Cap(c_a), veh/h	323	339		321	339		255	935		184	983	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	40.6	34.4	0.0	44.9	43.8	0.0	17.8	24.8	0.0	28.1	20.0	0.0
Incr Delay (d2), s/veh	52.2	0.3	0.0	6.7	1.5	0.0	0.4	60.3	0.0	64.8	9.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.5	1.3	0.0	2.4	1.2	0.0	0.5	36.0	0.0	7.8	18.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	92.7	34.6	0.0	51.6	45.3	0.0	18.2	85.1	0.0	93.0	29.4	0.0
LnGrp LOS	F	C		D	D		B	F		F	C	
Approach Vol, veh/h		389	A		136	A		1071	A		1022	A
Approach Delay, s/veh		83.3			49.4			82.4			40.8	
Approach LOS		F			D			F			D	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	10.9	54.1		22.5	8.0	57.0		11.7
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	6.4	49.6		18.0	5.0	51.0		18.0
Max Q Clear Time (g_c+I1), s	8.3	51.6		20.0	3.1	40.5		6.9
Green Ext Time (p_c), s	0.0	0.0		0.0	0.0	4.5		0.3

Intersection Summary	
HCM 6th Ctrl Delay	64.6
HCM 6th LOS	E

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	192	6	32	20	15	18	93	580	18	17	509	348
Future Volume (veh/h)	192	6	32	20	15	18	93	580	18	17	509	348
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.95	1.00		0.98	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1722	1781	1781	1781	1752	1811	1811	1870	1811	1811
Adj Flow Rate, veh/h	206	6	0	22	16	19	100	624	19	18	547	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	2	12	8	8	8	10	6	6	2	6	6
Cap, veh/h	271	8		30	22	26	126	897	27	38	1580	
Arrive On Green	0.16	0.16	0.00	0.05	0.05	0.05	0.08	0.51	0.51	0.02	0.46	0.00
Sat Flow, veh/h	1733	50	1459	626	455	540	1668	1747	53	1781	3532	0
Grp Volume(v), veh/h	212	0	0	57	0	0	100	0	643	18	547	0
Grp Sat Flow(s),veh/h/ln	1784	0	1459	1621	0	0	1668	0	1800	1781	1721	0
Q Serve(g_s), s	7.9	0.0	0.0	2.4	0.0	0.0	4.1	0.0	18.7	0.7	7.1	0.0
Cycle Q Clear(g_c), s	7.9	0.0	0.0	2.4	0.0	0.0	4.1	0.0	18.7	0.7	7.1	0.0
Prop In Lane	0.97		1.00	0.39		0.33	1.00		0.03	1.00		0.00
Lane Grp Cap(c), veh/h	279	0		78	0	0	126	0	925	38	1580	
V/C Ratio(X)	0.76	0.00		0.73	0.00	0.00	0.79	0.00	0.70	0.48	0.35	
Avail Cap(c_a), veh/h	669	0		598	0	0	220	0	925	131	1580	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	27.9	0.0	0.0	32.4	0.0	0.0	31.4	0.0	12.7	33.4	12.0	0.0
Incr Delay (d2), s/veh	4.2	0.0	0.0	12.3	0.0	0.0	10.6	0.0	4.3	9.1	0.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.5	0.0	0.0	1.2	0.0	0.0	1.9	0.0	6.9	0.4	2.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	32.1	0.0	0.0	44.7	0.0	0.0	42.0	0.0	17.0	42.6	12.6	0.0
LnGrp LOS	C	A		D	A	A	D	A	B	D	B	
Approach Vol, veh/h		212	A		57			743			565	A
Approach Delay, s/veh		32.1			44.7			20.4			13.6	
Approach LOS		C			D			C			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		15.3	9.7	36.2		7.8	6.0	40.0				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		25.9	9.1	31.5		25.5	5.1	35.5				
Max Q Clear Time (g_c+I1), s		9.9	6.1	9.1		4.4	2.7	20.7				
Green Ext Time (p_c), s		1.0	0.1	3.3		0.2	0.0	3.5				

Intersection Summary	
HCM 6th Ctrl Delay	20.4
HCM 6th LOS	C

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	317	1070	614	272	743	50	277	345	301	62	382	131
Future Volume (veh/h)	317	1070	614	272	743	50	277	345	301	62	382	131
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1856	1856	1870	1870	1841	1870	1856	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	323	1092	0	278	758	0	283	352	0	63	390	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	3	3	2	2	4	2	3	2	2	2	2	2
Cap, veh/h	406	1472		358	1409		362	798		81	585	
Arrive On Green	0.12	0.42	0.00	0.10	0.40	0.00	0.11	0.22	0.00	0.05	0.16	0.00
Sat Flow, veh/h	3428	3526	1585	3456	3497	1585	3428	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	323	1092	0	278	758	0	283	352	0	63	390	0
Grp Sat Flow(s),veh/h/ln	1714	1763	1585	1728	1749	1585	1714	1777	1585	1781	1777	1585
Q Serve(g_s), s	7.9	22.5	0.0	6.8	14.2	0.0	6.9	7.4	0.0	3.0	8.9	0.0
Cycle Q Clear(g_c), s	7.9	22.5	0.0	6.8	14.2	0.0	6.9	7.4	0.0	3.0	8.9	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	406	1472		358	1409		362	798		81	585	
V/C Ratio(X)	0.80	0.74		0.78	0.54		0.78	0.44		0.78	0.67	
Avail Cap(c_a), veh/h	497	1472		421	1409		418	1715		184	1649	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.0	21.2	0.0	37.7	19.6	0.0	37.6	28.8	0.0	40.7	33.8	0.0
Incr Delay (d2), s/veh	7.2	3.4	0.0	7.6	1.5	0.0	8.2	0.4	0.0	14.5	1.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.6	9.3	0.0	3.2	5.7	0.0	3.3	3.1	0.0	1.6	3.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	44.2	24.6	0.0	45.3	21.1	0.0	45.8	29.2	0.0	55.2	35.1	0.0
LnGrp LOS	D	C		D	C		D	C		E	D	
Approach Vol, veh/h		1415	A		1036	A		635	A		453	A
Approach Delay, s/veh		29.1			27.6			36.6			37.9	
Approach LOS		C			C			D			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.4	23.9	13.4	40.5	13.6	18.7	14.7	39.2
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	8.9	41.6	10.5	36.0	10.5	40.0	12.5	34.0
Max Q Clear Time (g_c+I1), s	5.0	9.4	8.8	24.5	8.9	10.9	9.9	16.2
Green Ext Time (p_c), s	0.0	2.5	0.2	5.7	0.2	2.7	0.3	4.8

Intersection Summary	
HCM 6th Ctrl Delay	31.1
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	232	809	355	88	669	383	154	388	41	425	417	232
Future Volume (vph)	232	809	355	88	669	383	154	388	41	425	417	232
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	0.98	1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3335	3539	1583	3433	3471	1561	1595	3382	1537	1610	3193	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3335	3539	1583	3433	3471	1561	1595	3382	1537	1610	3193	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	237	826	362	90	683	391	157	396	42	434	426	237
RTOR Reduction (vph)	0	0	248	0	0	286	0	0	34	0	45	0
Lane Group Flow (vph)	237	826	114	90	683	105	141	412	8	369	683	0
Confl. Peds. (#/hr)	1					1	4		7	7		4
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	5%	2%	2%	2%	4%	2%	3%	2%	3%	2%	2%	2%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	8.6	32.0	32.0	3.9	27.3	27.3	19.5	19.5	19.5	28.3	28.3	
Effective Green, g (s)	8.6	32.0	32.0	3.9	27.3	27.3	19.5	19.5	19.5	28.3	28.3	
Actuated g/C Ratio	0.08	0.31	0.31	0.04	0.27	0.27	0.19	0.19	0.19	0.28	0.28	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	282	1113	498	131	931	419	305	648	294	448	888	
v/s Ratio Prot	c0.07	c0.23		0.03	0.20		0.09	c0.12		c0.23	0.21	
v/s Ratio Perm			0.07			0.07			0.01			
v/c Ratio	0.84	0.74	0.23	0.69	0.73	0.25	0.46	0.64	0.03	0.82	0.77	
Uniform Delay, d1	45.9	31.2	25.7	48.3	33.9	29.2	36.5	37.8	33.4	34.4	33.7	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	19.6	4.5	1.1	13.9	5.1	1.4	1.1	2.0	0.0	11.7	4.1	
Delay (s)	65.5	35.6	26.8	62.2	39.0	30.6	37.6	39.9	33.4	46.0	37.8	
Level of Service	E	D	C	E	D	C	D	D	C	D	D	
Approach Delay (s)		38.4			38.0			38.9			40.5	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	38.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	101.7	Sum of lost time (s)	18.0
Intersection Capacity Utilization	78.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	2.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	12	85	102	1126	1226	21
Future Vol, veh/h	12	85	102	1126	1226	21
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	4	2	6
Mvmt Flow	12	88	105	1161	1264	22

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2635	-	1264	0	-	0
Stage 1	1264	-	-	-	-	-
Stage 2	1371	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	26	0	550	-	-	-
Stage 1	266	0	-	-	-	-
Stage 2	236	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	21	-	550	-	-	-
Mov Cap-2 Maneuver	21	-	-	-	-	-
Stage 1	215	-	-	-	-	-
Stage 2	236	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s$	316.3	1.1	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	550	-	21	-	-	-
HCM Lane V/C Ratio	0.191	-	0.589	-	-	-
HCM Control Delay (s)	13.1	-	$ 316.3	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	0.7	-	1.7	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection	
Int Delay, s/veh	3.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	17	87	1147	5	74	1238
Future Vol, veh/h	17	87	1147	5	74	1238
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	7	2	3	2	8	2
Mvmt Flow	18	90	1182	5	76	1276

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2613	1185	0	0	1182	0
Stage 1	1185	-	-	-	-	-
Stage 2	1428	-	-	-	-	-
Critical Hdwy	6.47	6.22	-	-	4.18	-
Critical Hdwy Stg 1	5.47	-	-	-	-	-
Critical Hdwy Stg 2	5.47	-	-	-	-	-
Follow-up Hdwy	3.563	3.318	-	-	2.272	-
Pot Cap-1 Maneuver	26	230	-	-	570	-
Stage 1	284	-	-	-	-	-
Stage 2	216	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	23	230	-	-	570	-
Mov Cap-2 Maneuver	23	-	-	-	-	-
Stage 1	284	-	-	-	-	-
Stage 2	187	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	81.9	0	0.7
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	23	230	570	-
HCM Lane V/C Ratio	-	-	0.762	0.39	0.134	-
HCM Control Delay (s)	-	-	$ 345.7	30.3	12.3	-
HCM Lane LOS	-	-	F	D	B	-
HCM 95th %tile Q(veh)	-	-	2.2	1.7	0.5	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	41	131	1007	59	161	1105
Future Volume (veh/h)	41	131	1007	59	161	1105
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1826	1856	1841	1870	1870
Adj Flow Rate, veh/h	42	0	1038	0	166	1139
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	5	3	4	2	2
Cap, veh/h	63		1320		200	1628
Arrive On Green	0.04	0.00	0.71	0.00	0.11	0.87
Sat Flow, veh/h	1781	1547	1856	1560	1781	1870
Grp Volume(v), veh/h	42	0	1038	0	166	1139
Grp Sat Flow(s),veh/h/ln	1781	1547	1856	1560	1781	1870
Q Serve(g_s), s	2.2	0.0	35.0	0.0	8.7	19.2
Cycle Q Clear(g_c), s	2.2	0.0	35.0	0.0	8.7	19.2
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	63		1320		200	1628
V/C Ratio(X)	0.67		0.79		0.83	0.70
Avail Cap(c_a), veh/h	336		1320		252	1628
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	45.5	0.0	9.0	0.0	41.5	2.0
Incr Delay (d2), s/veh	11.7	0.0	4.8	0.0	16.9	2.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.2	0.0	13.0	0.0	4.7	2.8
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	57.1	0.0	13.8	0.0	58.4	4.6
LnGrp LOS	E		B		E	A
Approach Vol, veh/h	42	A	1038	A		1305
Approach Delay, s/veh	57.1		13.8			11.4
Approach LOS	E		B			B

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	15.2	72.3			87.5	7.9
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	13.5	65.0			83.0	18.0
Max Q Clear Time (g_c+I1), s	10.7	37.0			21.2	4.2
Green Ext Time (p_c), s	0.1	10.5			16.1	0.0

Intersection Summary	
HCM 6th Ctrl Delay	13.3
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	8.6

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	16	454	297	1042	1082	44
Future Vol, veh/h	16	454	297	1042	1082	44
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	8	2	2	3	2	6
Mvmt Flow	16	463	303	1063	1104	45

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2773	-	1104	0	-	0
Stage 1	1104	-	-	-	-	-
Stage 2	1669	-	-	-	-	-
Critical Hdwy	6.48	-	4.12	-	-	-
Critical Hdwy Stg 1	5.48	-	-	-	-	-
Critical Hdwy Stg 2	5.48	-	-	-	-	-
Follow-up Hdwy	3.572	-	2.218	-	-	-
Pot Cap-1 Maneuver	20	0	632	-	-	-
Stage 1	309	0	-	-	-	-
Stage 2	163	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 10	-	632	-	-	-
Mov Cap-2 Maneuver	~ 10	-	-	-	-	-
Stage 1	161	-	-	-	-	-
Stage 2	163	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	$ 1041	3.5	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	632	-	10	-	-	-
HCM Lane V/C Ratio	0.48	-	1.633	-	-	-
HCM Control Delay (s)	15.8	-	$ 1041	0	-	-
HCM Lane LOS	C	-	F	A	-	-
HCM 95th %tile Q(veh)	2.6	-	2.9	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	155	37	59	76	48	235	45	920	78	221	1070	207
Future Volume (veh/h)	155	37	59	76	48	235	45	920	78	221	1070	207
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1826	1826	1856	1856	1870	1856	1870	1870
Adj Flow Rate, veh/h	161	39	0	79	50	0	47	958	0	230	1115	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	4	2	2	2	5	5	3	3	2	3	2	2
Cap, veh/h	202	215		118	121		147	979		256	1087	
Arrive On Green	0.11	0.11	0.00	0.07	0.07	0.00	0.04	0.53	0.00	0.09	0.58	0.00
Sat Flow, veh/h	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Grp Volume(v), veh/h	161	39	0	79	50	0	47	958	0	230	1115	0
Grp Sat Flow(s),veh/h/ln	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Q Serve(g_s), s	8.1	1.7	0.0	3.9	2.4	0.0	1.1	45.5	0.0	6.8	52.5	0.0
Cycle Q Clear(g_c), s	8.1	1.7	0.0	3.9	2.4	0.0	1.1	45.5	0.0	6.8	52.5	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	202	215		118	121		147	979		256	1087	
V/C Ratio(X)	0.80	0.18		0.67	0.41		0.32	0.98		0.90	1.03	
Avail Cap(c_a), veh/h	349	373		355	364		177	979		256	1087	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	39.0	36.1	0.0	41.2	40.5	0.0	21.3	20.8	0.0	25.7	18.9	0.0
Incr Delay (d2), s/veh	7.1	0.4	0.0	6.4	2.3	0.0	1.2	23.9	0.0	31.2	34.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.8	0.8	0.0	1.9	1.1	0.0	0.5	24.3	0.0	4.7	30.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	46.1	36.5	0.0	47.7	42.8	0.0	22.6	44.8	0.0	57.0	52.9	0.0
LnGrp LOS	D	D		D	D		C	D		E	F	
Approach Vol, veh/h		200	A		129	A		1005	A		1345	A
Approach Delay, s/veh		44.2			45.8			43.7			53.6	
Approach LOS		D			D			D			D	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	12.8	52.2		14.9	8.0	57.0		10.5
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	8.3	47.7		18.0	5.0	51.0		18.0
Max Q Clear Time (g_c+I1), s	8.8	47.5		10.1	3.1	54.5		5.9
Green Ext Time (p_c), s	0.0	0.1		0.4	0.0	0.0		0.3

Intersection Summary	
HCM 6th Ctrl Delay	48.8
HCM 6th LOS	D

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	354	13	63	9	13	22	78	604	13	21	624	347
Future Volume (veh/h)	354	13	63	9	13	22	78	604	13	21	624	347
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1767	1767	1811	1870	1870	1870	1856	1856	1856	1870	1870	1870
Adj Flow Rate, veh/h	373	14	0	9	14	23	82	636	14	22	657	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	9	9	6	2	2	2	3	3	3	2	2	2
Cap, veh/h	423	16		13	21	34	105	817	18	43	1479	
Arrive On Green	0.26	0.26	0.00	0.04	0.04	0.04	0.06	0.45	0.45	0.02	0.42	0.00
Sat Flow, veh/h	1624	61	1535	333	518	850	1767	1809	40	1781	3647	0
Grp Volume(v), veh/h	387	0	0	46	0	0	82	0	650	22	657	0
Grp Sat Flow(s),veh/h/ln	1685	0	1535	1701	0	0	1767	0	1848	1781	1777	0
Q Serve(g_s), s	17.7	0.0	0.0	2.1	0.0	0.0	3.7	0.0	23.9	1.0	10.7	0.0
Cycle Q Clear(g_c), s	17.7	0.0	0.0	2.1	0.0	0.0	3.7	0.0	23.9	1.0	10.7	0.0
Prop In Lane	0.96		1.00	0.20		0.50	1.00		0.02	1.00		0.00
Lane Grp Cap(c), veh/h	439	0		68	0	0	105	0	835	43	1479	
V/C Ratio(X)	0.88	0.00		0.68	0.00	0.00	0.78	0.00	0.78	0.51	0.44	
Avail Cap(c_a), veh/h	542	0		539	0	0	156	0	835	113	1479	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	28.6	0.0	0.0	38.1	0.0	0.0	37.3	0.0	18.7	38.8	16.8	0.0
Incr Delay (d2), s/veh	13.4	0.0	0.0	11.2	0.0	0.0	13.7	0.0	7.1	9.1	1.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.5	0.0	0.0	1.1	0.0	0.0	1.9	0.0	10.4	0.5	4.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	41.9	0.0	0.0	49.3	0.0	0.0	51.0	0.0	25.7	47.9	17.8	0.0
LnGrp LOS	D	A		D	A	A	D	A	C	D	B	
Approach Vol, veh/h		387	A		46			732			679	A
Approach Delay, s/veh		41.9			49.3			28.6			18.8	
Approach LOS		D			D			C			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		25.5	9.3	38.0		7.7	6.4	40.8				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		25.9	7.1	33.5		25.5	5.1	35.5				
Max Q Clear Time (g_c+I1), s		19.7	5.7	12.7		4.1	3.0	25.9				
Green Ext Time (p_c), s		1.2	0.0	4.0		0.2	0.0	2.8				

Intersection Summary	
HCM 6th Ctrl Delay	28.3
HCM 6th LOS	C

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Appendix I

Analysis Reports – Future With Project Conditions (2039)

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	87	565	266	200	865	37	297	234	135	24	392	216
Future Volume (veh/h)	87	565	266	200	865	37	297	234	135	24	392	216
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1737	1767	1737	1841	1811	1841	1841	1870	1856	1870	1870	1870
Adj Flow Rate, veh/h	89	577	0	204	883	0	303	239	0	24	400	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	11	9	11	4	6	4	4	2	3	2	2	2
Cap, veh/h	167	1419		286	1565		394	900		45	579	
Arrive On Green	0.05	0.42	0.00	0.08	0.45	0.00	0.12	0.25	0.00	0.03	0.16	0.00
Sat Flow, veh/h	3209	3357	1472	3401	3441	1560	3401	3554	1572	1781	3554	1585
Grp Volume(v), veh/h	89	577	0	204	883	0	303	239	0	24	400	0
Grp Sat Flow(s),veh/h/ln	1605	1678	1472	1700	1721	1560	1700	1777	1572	1781	1777	1585
Q Serve(g_s), s	2.3	10.1	0.0	4.9	15.8	0.0	7.3	4.5	0.0	1.1	8.9	0.0
Cycle Q Clear(g_c), s	2.3	10.1	0.0	4.9	15.8	0.0	7.3	4.5	0.0	1.1	8.9	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	167	1419		286	1565		394	900		45	579	
V/C Ratio(X)	0.53	0.41		0.71	0.56		0.77	0.27		0.53	0.69	
Avail Cap(c_a), veh/h	237	1419		421	1565		579	1993		117	1620	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	38.8	16.9	0.0	37.5	16.8	0.0	36.0	25.1	0.0	40.4	33.2	0.0
Incr Delay (d2), s/veh	2.6	0.9	0.0	3.3	1.5	0.0	3.7	0.2	0.0	9.2	1.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	3.8	0.0	2.1	6.0	0.0	3.2	1.9	0.0	0.6	3.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	41.4	17.8	0.0	40.8	18.3	0.0	39.7	25.3	0.0	49.6	34.6	0.0
LnGrp LOS	D	B		D	B		D	C		D	C	
Approach Vol, veh/h		666	A		1087	A		542	A		424	A
Approach Delay, s/veh		20.9			22.5			33.3			35.5	
Approach LOS		C			C			C			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.6	25.8	11.6	40.0	14.2	18.2	8.9	42.7
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.5	47.1	10.4	34.0	14.3	38.3	6.2	38.2
Max Q Clear Time (g_c+I1), s	3.1	6.5	6.9	12.1	9.3	10.9	4.3	17.8
Green Ext Time (p_c), s	0.0	1.7	0.2	3.8	0.5	2.8	0.0	6.1

Intersection Summary	
HCM 6th Ctrl Delay	26.3
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	131	447	151	67	780	608	178	411	52	451	414	151
Future Volume (vph)	131	447	151	67	780	608	178	411	52	451	414	151
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (prot)	3099	3282	1516	3303	3406	1548	1564	3348	1487	1595	3174	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (perm)	3099	3282	1516	3303	3406	1548	1564	3348	1487	1595	3174	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	135	461	156	69	804	627	184	424	54	465	427	156
RTOR Reduction (vph)	0	0	109	0	0	408	0	0	43	0	21	0
Lane Group Flow (vph)	135	461	47	69	804	219	166	442	11	349	678	0
Confl. Peds. (#/hr)			2	2			4		3	3		4
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	13%	10%	5%	6%	6%	3%	5%	3%	7%	3%	4%	5%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	6.6	30.3	30.3	4.1	27.8	27.8	20.5	20.5	20.5	27.7	27.7	
Effective Green, g (s)	6.6	30.3	30.3	4.1	27.8	27.8	20.5	20.5	20.5	27.7	27.7	
Actuated g/C Ratio	0.07	0.30	0.30	0.04	0.28	0.28	0.20	0.20	0.20	0.28	0.28	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	203	988	456	134	941	427	318	682	303	439	873	
v/s Ratio Prot	c0.04	0.14		0.02	c0.24		0.11	c0.13		c0.22	0.21	
v/s Ratio Perm			0.03			0.14			0.01			
v/c Ratio	0.67	0.47	0.10	0.51	0.85	0.51	0.52	0.65	0.04	0.79	0.78	
Uniform Delay, d1	45.9	28.6	25.3	47.3	34.5	30.7	35.7	36.7	32.1	33.8	33.6	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	8.0	1.6	0.5	3.3	9.8	4.3	1.5	2.1	0.0	9.6	4.4	
Delay (s)	53.9	30.2	25.8	50.6	44.3	35.0	37.2	38.9	32.2	43.4	38.0	
Level of Service	D	C	C	D	D	D	D	D	C	D	D	
Approach Delay (s)		33.5			40.7			37.9			39.8	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	38.6	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	100.6	Sum of lost time (s)	18.0
Intersection Capacity Utilization	74.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	50.6

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	54	60	215	1292	966	37
Future Vol, veh/h	54	60	215	1292	966	37
Conflicting Peds, #/hr	0	0	0	0	0	1
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	2	6	2
Mvmt Flow	58	65	231	1389	1039	40

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2891	-	1040	0	-	0
Stage 1	1040	-	-	-	-	-
Stage 2	1851	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	~ 18	0	669	-	-	-
Stage 1	341	0	-	-	-	-
Stage 2	136	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 12	-	668	-	-	-
Mov Cap-2 Maneuver	~ 12	-	-	-	-	-
Stage 1	223	-	-	-	-	-
Stage 2	136	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, $	2351.6	1.9	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	668	-	12	-	-	-
HCM Lane V/C Ratio	0.346	-	4.839	-	-	-
HCM Control Delay (s)	13.2	$	2351.6	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	1.5	-	8.4	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection	
Int Delay, s/veh	13.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	11	171	1333	18	89	933
Future Vol, veh/h	11	171	1333	18	89	933
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	13	6	5
Mvmt Flow	12	184	1433	19	96	1003

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2638	1443	0	0	1433	0
Stage 1	1443	-	-	-	-	-
Stage 2	1195	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	26	~ 162	-	-	462	-
Stage 1	217	-	-	-	-	-
Stage 2	287	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	21	~ 162	-	-	462	-
Mov Cap-2 Maneuver	21	-	-	-	-	-
Stage 1	217	-	-	-	-	-
Stage 2	227	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	176.9	0	1.3
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	21	162	462	-
HCM Lane V/C Ratio	-	-	0.563	1.135	0.207	-
HCM Control Delay (s)	-	-	$ 308.6	168.4	14.8	-
HCM Lane LOS	-	-	F	F	B	-
HCM 95th %tile Q(veh)	-	-	1.6	9.8	0.8	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	108	226	1146	32	52	896
Future Volume (veh/h)	108	226	1146	32	52	896
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1870	1856	1870	1870	1826
Adj Flow Rate, veh/h	115	0	1219	0	55	953
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	3	2	2	5
Cap, veh/h	142		1428		71	1546
Arrive On Green	0.08	0.00	0.77	0.00	0.04	0.85
Sat Flow, veh/h	1781	1585	1856	1585	1781	1826
Grp Volume(v), veh/h	115	0	1219	0	55	953
Grp Sat Flow(s),veh/h/ln	1781	1585	1856	1585	1781	1826
Q Serve(g_s), s	7.7	0.0	53.6	0.0	3.7	20.4
Cycle Q Clear(g_c), s	7.7	0.0	53.6	0.0	3.7	20.4
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	142		1428		71	1546
V/C Ratio(X)	0.81		0.85		0.78	0.62
Avail Cap(c_a), veh/h	264		1428		81	1546
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	55.1	0.0	9.4	0.0	57.9	3.0
Incr Delay (d2), s/veh	10.5	0.0	6.7	0.0	33.5	1.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.9	0.0	20.1	0.0	2.3	5.4
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	65.6	0.0	16.1	0.0	91.4	4.9
LnGrp LOS	E		B		F	A
Approach Vol, veh/h	115	A	1219	A		1008
Approach Delay, s/veh	65.6		16.1			9.6
Approach LOS	E		B			A

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	9.3	98.2			107.5	14.2
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	5.5	93.0			103.0	18.0
Max Q Clear Time (g_c+I1), s	5.7	55.6			22.4	9.7
Green Ext Time (p_c), s	0.0	16.4			10.8	0.2

Intersection Summary	
HCM 6th Ctrl Delay	15.7
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	12.7

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	9	206	634	1002	921	76
Future Vol, veh/h	9	206	634	1002	921	76
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	4	2	5	5	7
Mvmt Flow	10	222	682	1077	990	82

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	3431	-	990	0	-	0
Stage 1	990	-	-	-	-	-
Stage 2	2441	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	~ 8	0	698	-	-	-
Stage 1	360	0	-	-	-	-
Stage 2	68	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	0	-	698	-	-	-
Mov Cap-2 Maneuver	0	-	-	-	-	-
Stage 1	~ 8	-	-	-	-	-
Stage 2	68	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s		20.5	0
HCM LOS	-		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	698	-	-	-	-	-
HCM Lane V/C Ratio	0.977	-	-	-	-	-
HCM Control Delay (s)	52.8	-	-	0	-	-
HCM Lane LOS	F	-	-	A	-	-
HCM 95th %tile Q(veh)	15	-	-	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	311	59	84	100	47	334	40	981	67	176	808	157
Future Volume (veh/h)	311	59	84	100	47	334	40	981	67	176	808	157
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1856	1870	1870	1870	1870	1841	1811	1856	1870
Adj Flow Rate, veh/h	331	63	0	106	50	0	43	1044	0	187	860	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	3	2	2	2	2	4	6	3	2
Cap, veh/h	319	335		140	148		232	990		168	1039	
Arrive On Green	0.18	0.18	0.00	0.08	0.08	0.00	0.03	0.53	0.00	0.06	0.56	0.00
Sat Flow, veh/h	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Grp Volume(v), veh/h	331	63	0	106	50	0	43	1044	0	187	860	0
Grp Sat Flow(s),veh/h/ln	1781	1870	0	1767	1870	0	1781	1870	1560	1725	1856	1585
Q Serve(g_s), s	21.5	3.4	0.0	7.1	3.0	0.0	1.3	63.5	0.0	7.5	45.6	0.0
Cycle Q Clear(g_c), s	21.5	3.4	0.0	7.1	3.0	0.0	1.3	63.5	0.0	7.5	45.6	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	319	335		140	148		232	990		168	1039	
V/C Ratio(X)	1.04	0.19		0.76	0.34		0.19	1.05		1.11	0.83	
Avail Cap(c_a), veh/h	319	335		287	304		250	990		168	1039	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	49.2	41.8	0.0	54.1	52.3	0.0	19.7	28.2	0.0	37.8	21.7	0.0
Incr Delay (d2), s/veh	60.3	0.3	0.0	8.1	1.3	0.0	0.4	44.2	0.0	103.4	7.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	14.9	1.6	0.0	3.4	1.5	0.0	0.5	39.1	0.0	9.9	21.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	109.6	42.1	0.0	62.3	53.6	0.0	20.1	72.4	0.0	141.3	29.2	0.0
LnGrp LOS	F	D		E	D		C	F		F	C	
Approach Vol, veh/h		394	A		156	A		1087	A		1047	A
Approach Delay, s/veh		98.8			59.5			70.4			49.2	
Approach LOS		F			E			E			D	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	12.0	68.0		26.0	8.3	71.7		14.0
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	7.5	63.5		21.5	5.0	66.0		19.5
Max Q Clear Time (g_c+I1), s	9.5	65.5		23.5	3.3	47.6		9.1
Green Ext Time (p_c), s	0.0	0.0		0.0	0.0	6.4		0.3

Intersection Summary	
HCM 6th Ctrl Delay	65.7
HCM 6th LOS	E

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	196	6	32	20	15	18	93	591	18	18	529	362
Future Volume (veh/h)	196	6	32	20	15	18	93	591	18	18	529	362
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.94	1.00		0.98	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1722	1781	1781	1781	1752	1811	1811	1870	1811	1811
Adj Flow Rate, veh/h	211	6	0	22	16	19	100	635	19	19	569	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	2	12	8	8	8	10	6	6	2	6	6
Cap, veh/h	260	7		28	21	24	125	1035	31	37	1850	
Arrive On Green	0.15	0.15	0.00	0.05	0.05	0.05	0.08	0.59	0.59	0.02	0.54	0.00
Sat Flow, veh/h	1734	49	1459	623	453	538	1668	1748	52	1781	3532	0
Grp Volume(v), veh/h	217	0	0	57	0	0	100	0	654	19	569	0
Grp Sat Flow(s),veh/h/ln	1784	0	1459	1615	0	0	1668	0	1800	1781	1721	0
Q Serve(g_s), s	11.0	0.0	0.0	3.3	0.0	0.0	5.5	0.0	21.8	1.0	8.6	0.0
Cycle Q Clear(g_c), s	11.0	0.0	0.0	3.3	0.0	0.0	5.5	0.0	21.8	1.0	8.6	0.0
Prop In Lane	0.97		1.00	0.39		0.33	1.00		0.03	1.00		0.00
Lane Grp Cap(c), veh/h	267	0		73	0	0	125	0	1066	37	1850	
V/C Ratio(X)	0.81	0.00		0.78	0.00	0.00	0.80	0.00	0.61	0.51	0.31	
Avail Cap(c_a), veh/h	493	0		439	0	0	222	0	1066	97	1850	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	38.6	0.0	0.0	44.3	0.0	0.0	42.6	0.0	12.2	45.4	12.0	0.0
Incr Delay (d2), s/veh	5.9	0.0	0.0	16.2	0.0	0.0	10.9	0.0	2.6	10.5	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.2	0.0	0.0	1.6	0.0	0.0	2.6	0.0	8.0	0.5	3.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	44.4	0.0	0.0	60.4	0.0	0.0	53.6	0.0	14.9	55.9	12.4	0.0
LnGrp LOS	D	A		E	A	A	D	A	B	E	B	
Approach Vol, veh/h		217	A		57			754			588	A
Approach Delay, s/veh		44.4			60.4			20.0			13.8	
Approach LOS		D			E			C			B	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		18.5	11.5	54.9		8.7	6.5	60.0				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		25.9	12.5	48.1		25.5	5.1	55.5				
Max Q Clear Time (g_c+I1), s		13.0	7.5	10.6		5.3	3.0	23.8				
Green Ext Time (p_c), s		0.9	0.1	3.8		0.2	0.0	4.4				

Intersection Summary	
HCM 6th Ctrl Delay	22.5
HCM 6th LOS	C

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	4.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	29	108	1011	25	22	1004
Future Vol, veh/h	29	108	1011	25	22	1004
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	Yield	-	None
Storage Length	0	0	-	585	695	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	32	117	1099	27	24	1091

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2238	1099	0	0	1099	0
Stage 1	1099	-	-	-	-	-
Stage 2	1139	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	47	258	-	-	635	-
Stage 1	319	-	-	-	-	-
Stage 2	305	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	45	258	-	-	635	-
Mov Cap-2 Maneuver	45	-	-	-	-	-
Stage 1	319	-	-	-	-	-
Stage 2	293	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	64	0	0.2
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	45	258	635	-
HCM Lane V/C Ratio	-	-	0.7	0.455	0.038	-
HCM Control Delay (s)	-	-	190.1	30.1	10.9	-
HCM Lane LOS	-	-	F	D	B	-
HCM 95th %tile Q(veh)	-	-	2.7	2.2	0.1	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	317	1104	614	274	767	59	277	345	311	64	382	131
Future Volume (veh/h)	317	1104	614	274	767	59	277	345	311	64	382	131
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1856	1856	1870	1870	1841	1870	1856	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	323	1127	0	280	783	0	283	352	0	65	390	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	3	3	2	2	4	2	3	2	2	2	2	2
Cap, veh/h	406	1471		359	1409		362	792		84	585	
Arrive On Green	0.12	0.42	0.00	0.10	0.40	0.00	0.11	0.22	0.00	0.05	0.16	0.00
Sat Flow, veh/h	3428	3526	1585	3456	3497	1585	3428	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	323	1127	0	280	783	0	283	352	0	65	390	0
Grp Sat Flow(s),veh/h/ln	1714	1763	1585	1728	1749	1585	1714	1777	1585	1781	1777	1585
Q Serve(g_s), s	7.9	23.6	0.0	6.8	14.9	0.0	6.9	7.4	0.0	3.1	8.9	0.0
Cycle Q Clear(g_c), s	7.9	23.6	0.0	6.8	14.9	0.0	6.9	7.4	0.0	3.1	8.9	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	406	1471		359	1409		362	792		84	585	
V/C Ratio(X)	0.80	0.77		0.78	0.56		0.78	0.44		0.77	0.67	
Avail Cap(c_a), veh/h	497	1471		421	1409		417	1714		184	1648	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.0	21.5	0.0	37.7	19.8	0.0	37.6	28.9	0.0	40.7	33.8	0.0
Incr Delay (d2), s/veh	7.2	3.9	0.0	7.8	1.6	0.0	8.2	0.4	0.0	14.0	1.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.6	9.8	0.0	3.2	6.0	0.0	3.3	3.1	0.0	1.7	3.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	44.3	25.4	0.0	45.5	21.4	0.0	45.8	29.3	0.0	54.7	35.1	0.0
LnGrp LOS	D	C		D	C		D	C		D	D	
Approach Vol, veh/h		1450	A		1063	A		635	A		455	A
Approach Delay, s/veh		29.6			27.7			36.7			37.9	
Approach LOS		C			C			D			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.6	23.7	13.5	40.5	13.6	18.7	14.7	39.3
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	8.9	41.6	10.5	36.0	10.5	40.0	12.5	34.0
Max Q Clear Time (g_c+I1), s	5.1	9.4	8.8	25.6	8.9	10.9	9.9	16.9
Green Ext Time (p_c), s	0.0	2.5	0.2	5.5	0.2	2.7	0.3	4.9

Intersection Summary	
HCM 6th Ctrl Delay	31.3
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	232	854	355	93	704	403	154	388	43	449	417	232
Future Volume (vph)	232	854	355	93	704	403	154	388	43	449	417	232
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.91	0.91	1.00	0.91	0.91	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	0.98	1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (prot)	3335	3539	1583	3433	3471	1561	1595	3382	1537	1610	3194	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.99	
Satd. Flow (perm)	3335	3539	1583	3433	3471	1561	1595	3382	1537	1610	3194	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	237	871	362	95	718	411	157	396	44	458	426	237
RTOR Reduction (vph)	0	0	255	0	0	305	0	0	36	0	42	0
Lane Group Flow (vph)	237	871	107	95	718	106	141	412	8	376	703	0
Confl. Peds. (#/hr)	1					1	4		7	7		4
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	5%	2%	2%	2%	4%	2%	3%	2%	3%	2%	2%	2%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			
Actuated Green, G (s)	8.6	29.8	29.8	5.0	26.2	26.2	19.5	19.5	19.5	28.9	28.9	
Effective Green, g (s)	8.6	29.8	29.8	5.0	26.2	26.2	19.5	19.5	19.5	28.9	28.9	
Actuated g/C Ratio	0.08	0.29	0.29	0.05	0.26	0.26	0.19	0.19	0.19	0.29	0.29	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	283	1042	466	169	898	404	307	651	296	459	912	
v/s Ratio Prot	c0.07	c0.25		0.03	0.21		0.09	c0.12		c0.23	0.22	
v/s Ratio Perm			0.07			0.07			0.01			
v/c Ratio	0.84	0.84	0.23	0.56	0.80	0.26	0.46	0.63	0.03	0.82	0.77	
Uniform Delay, d1	45.6	33.4	27.0	47.0	35.0	29.8	36.2	37.6	33.2	33.7	33.1	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	18.9	7.9	1.1	4.2	7.4	1.6	1.1	2.0	0.0	10.9	4.1	
Delay (s)	64.6	41.4	28.1	51.3	42.4	31.4	37.3	39.6	33.2	44.6	37.2	
Level of Service	E	D	C	D	D	C	D	D	C	D	D	
Approach Delay (s)		41.8			39.4			38.6			39.7	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	40.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	101.2	Sum of lost time (s)	18.0
Intersection Capacity Utilization	79.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	2.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	12	90	107	1185	1297	21
Future Vol, veh/h	12	90	107	1185	1297	21
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	140	0	650	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	4	2	6
Mvmt Flow	12	93	110	1222	1337	22

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2779	-	1337	0	-	0
Stage 1	1337	-	-	-	-	-
Stage 2	1442	-	-	-	-	-
Critical Hdwy	6.42	-	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	-	2.218	-	-	-
Pot Cap-1 Maneuver	21	0	516	-	-	-
Stage 1	245	0	-	-	-	-
Stage 2	218	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	17	-	516	-	-	-
Mov Cap-2 Maneuver	17	-	-	-	-	-
Stage 1	193	-	-	-	-	-
Stage 2	218	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s$	425.9	1.1	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	516	-	17	-	-	-
HCM Lane V/C Ratio	0.214	-	0.728	-	-	-
HCM Control Delay (s)	13.9	-	$ 425.9	0	-	-
HCM Lane LOS	B	-	F	A	-	-
HCM 95th %tile Q(veh)	0.8	-	1.9	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection	
Int Delay, s/veh	4.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	17	87	1212	5	74	1314
Future Vol, veh/h	17	87	1212	5	74	1314
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Stop	-	Yield	-	None
Storage Length	0	0	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	7	2	3	2	8	2
Mvmt Flow	18	90	1249	5	76	1355

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2759	1252	0	0	1249	0
Stage 1	1252	-	-	-	-	-
Stage 2	1507	-	-	-	-	-
Critical Hdwy	6.47	6.22	-	-	4.18	-
Critical Hdwy Stg 1	5.47	-	-	-	-	-
Critical Hdwy Stg 2	5.47	-	-	-	-	-
Follow-up Hdwy	3.563	3.318	-	-	2.272	-
Pot Cap-1 Maneuver	21	210	-	-	537	-
Stage 1	263	-	-	-	-	-
Stage 2	197	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	18	210	-	-	537	-
Mov Cap-2 Maneuver	18	-	-	-	-	-
Stage 1	263	-	-	-	-	-
Stage 2	169	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	109.6	0	0.7
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	18	210	537	-
HCM Lane V/C Ratio	-	-	0.974	0.427	0.142	-
HCM Control Delay (s)	-	-	$ 495.2	34.3	12.8	-
HCM Lane LOS	-	-	F	D	B	-
HCM 95th %tile Q(veh)	-	-	2.5	2	0.5	-

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	44	131	1072	63	161	1181
Future Volume (veh/h)	44	131	1072	63	161	1181
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1826	1856	1841	1870	1870
Adj Flow Rate, veh/h	45	0	1105	0	166	1218
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	5	3	4	2	2
Cap, veh/h	58		1412		191	1686
Arrive On Green	0.03	0.00	0.76	0.00	0.11	0.90
Sat Flow, veh/h	1781	1547	1856	1560	1781	1870
Grp Volume(v), veh/h	45	0	1105	0	166	1218
Grp Sat Flow(s),veh/h/ln	1781	1547	1856	1560	1781	1870
Q Serve(g_s), s	3.4	0.0	48.0	0.0	12.5	25.2
Cycle Q Clear(g_c), s	3.4	0.0	48.0	0.0	12.5	25.2
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	58		1412		191	1686
V/C Ratio(X)	0.77		0.78		0.87	0.72
Avail Cap(c_a), veh/h	235		1412		241	1686
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	65.5	0.0	9.6	0.0	60.0	1.9
Incr Delay (d2), s/veh	18.8	0.0	4.4	0.0	22.9	2.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.9	0.0	18.6	0.0	6.9	4.3
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	84.3	0.0	14.0	0.0	82.9	4.6
LnGrp LOS	F		B		F	A
Approach Vol, veh/h	45	A	1105	A		1384
Approach Delay, s/veh	84.3		14.0			14.0
Approach LOS	F		B			B

Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	19.1	108.4			127.5	9.0
Change Period (Y+Rc), s	4.5	4.5			4.5	4.5
Max Green Setting (Gmax), s	18.5	100.0			123.0	18.0
Max Q Clear Time (g_c+I1), s	14.5	50.0			27.2	5.4
Green Ext Time (p_c), s	0.2	14.3			20.6	0.1

Intersection Summary	
HCM 6th Ctrl Delay	15.3
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, WBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	9.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	16	454	298	1116	1094	44
Future Vol, veh/h	16	454	298	1116	1094	44
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	160	0	630	-	-	700
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	8	2	2	3	2	6
Mvmt Flow	16	463	304	1139	1116	45

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2863	-	1116	0	-	0
Stage 1	1116	-	-	-	-	-
Stage 2	1747	-	-	-	-	-
Critical Hdwy	6.48	-	4.12	-	-	-
Critical Hdwy Stg 1	5.48	-	-	-	-	-
Critical Hdwy Stg 2	5.48	-	-	-	-	-
Follow-up Hdwy	3.572	-	2.218	-	-	-
Pot Cap-1 Maneuver	18	0	626	-	-	-
Stage 1	305	0	-	-	-	-
Stage 2	149	0	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 9	-	626	-	-	-
Mov Cap-2 Maneuver	~ 9	-	-	-	-	-
Stage 1	157	-	-	-	-	-
Stage 2	149	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, $	1188.2	3.4	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	626	-	9	-	-	-
HCM Lane V/C Ratio	0.486	-	1.814	-	-	-
HCM Control Delay (s)	16.1	$	1188.2	0	-	-
HCM Lane LOS	C	-	F	A	-	-
HCM 95th %tile Q(veh)	2.7	-	3	-	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	164	37	59	83	49	250	45	972	78	223	1078	209
Future Volume (veh/h)	164	37	59	83	49	250	45	972	78	223	1078	209
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1841	1870	1870	1870	1826	1826	1856	1856	1870	1856	1870	1870
Adj Flow Rate, veh/h	171	39	0	86	51	0	47	1012	0	232	1123	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	4	2	2	2	5	5	3	3	2	3	2	2
Cap, veh/h	196	209		114	116		184	1172		266	1240	
Arrive On Green	0.11	0.11	0.00	0.06	0.06	0.00	0.03	0.63	0.00	0.06	0.66	0.00
Sat Flow, veh/h	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Grp Volume(v), veh/h	171	39	0	86	51	0	47	1012	0	232	1123	0
Grp Sat Flow(s),veh/h/ln	1753	1870	0	1781	1826	0	1767	1856	1585	1767	1870	1585
Q Serve(g_s), s	13.2	2.6	0.0	6.5	3.7	0.0	1.3	60.7	0.0	6.1	69.5	0.0
Cycle Q Clear(g_c), s	13.2	2.6	0.0	6.5	3.7	0.0	1.3	60.7	0.0	6.1	69.5	0.0
Prop In Lane	1.00		0.00	1.00		0.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	196	209		114	116		184	1172		266	1240	
V/C Ratio(X)	0.87	0.19		0.76	0.44		0.26	0.86		0.87	0.91	
Avail Cap(c_a), veh/h	230	245		234	239		195	1172		352	1240	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	60.0	55.3	0.0	63.2	61.9	0.0	25.2	20.5	0.0	29.5	19.5	0.0
Incr Delay (d2), s/veh	25.9	0.4	0.0	9.8	2.6	0.0	0.7	8.5	0.0	16.6	11.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	7.3	1.3	0.0	3.3	1.8	0.0	0.8	27.6	0.0	6.3	31.8	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	85.9	55.7	0.0	73.0	64.5	0.0	25.9	29.0	0.0	46.1	30.6	0.0
LnGrp LOS	F	E		E	E		C	C		D	C	
Approach Vol, veh/h		210	A		137	A		1059	A		1355	A
Approach Delay, s/veh		80.3			69.8			28.9			33.2	
Approach LOS		F			E			C			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	13.0	91.2		19.9	8.7	95.5		13.3
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	15.1	80.9		18.0	5.0	91.0		18.0
Max Q Clear Time (g_c+I1), s	8.1	62.7		15.2	3.3	71.5		8.5
Green Ext Time (p_c), s	0.4	8.2		0.2	0.0	10.0		0.3

Intersection Summary	
HCM 6th Ctrl Delay	37.0
HCM 6th LOS	D

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	373	13	63	9	13	23	78	636	13	21	634	352
Future Volume (veh/h)	373	13	63	9	13	23	78	636	13	21	634	352
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1767	1767	1811	1870	1870	1870	1856	1856	1856	1870	1870	1870
Adj Flow Rate, veh/h	393	14	0	9	14	24	82	669	14	22	667	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	9	9	6	2	2	2	3	3	3	2	2	2
Cap, veh/h	437	16		12	18	31	104	936	20	39	1706	
Arrive On Green	0.27	0.27	0.00	0.04	0.04	0.04	0.06	0.52	0.52	0.02	0.48	0.00
Sat Flow, veh/h	1627	58	1535	325	506	867	1767	1811	38	1781	3647	0
Grp Volume(v), veh/h	407	0	0	47	0	0	82	0	683	22	667	0
Grp Sat Flow(s),veh/h/ln	1685	0	1535	1698	0	0	1767	0	1849	1781	1777	0
Q Serve(g_s), s	26.8	0.0	0.0	3.2	0.0	0.0	5.3	0.0	32.6	1.4	13.8	0.0
Cycle Q Clear(g_c), s	26.8	0.0	0.0	3.2	0.0	0.0	5.3	0.0	32.6	1.4	13.8	0.0
Prop In Lane	0.97		1.00	0.19		0.51	1.00		0.02	1.00		0.00
Lane Grp Cap(c), veh/h	453	0		61	0	0	104	0	956	39	1706	
V/C Ratio(X)	0.90	0.00		0.77	0.00	0.00	0.79	0.00	0.71	0.56	0.39	
Avail Cap(c_a), veh/h	614	0		376	0	0	160	0	956	79	1706	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	40.6	0.0	0.0	55.0	0.0	0.0	53.4	0.0	21.3	55.7	19.2	0.0
Incr Delay (d2), s/veh	13.0	0.0	0.0	18.2	0.0	0.0	13.4	0.0	4.6	12.1	0.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.6	0.0	0.0	1.7	0.0	0.0	2.7	0.0	14.1	0.7	5.5	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	53.5	0.0	0.0	73.2	0.0	0.0	66.8	0.0	25.8	67.8	19.8	0.0
LnGrp LOS	D	A		E	A	A	E	A	C	E	B	
Approach Vol, veh/h		407	A		47			765			689	A
Approach Delay, s/veh		53.5			73.2			30.2			21.4	
Approach LOS		D			E			C			C	

Timer - Assigned Phs	2	3	4	6	7	8
Phs Duration (G+Y+Rc), s	35.4	11.3	59.7	8.6	7.0	64.0
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	41.9	10.4	54.2	25.5	5.1	59.5
Max Q Clear Time (g_c+I1), s	28.8	7.3	15.8	5.2	3.4	34.6
Green Ext Time (p_c), s	2.1	0.0	4.6	0.2	0.0	4.5

Intersection Summary	
HCM 6th Ctrl Delay	33.1
HCM 6th LOS	C

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	2.9

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	12	68	1132	74	79	1225
Future Vol, veh/h	12	68	1132	74	79	1225
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	Yield	-	None
Storage Length	0	0	-	585	695	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	13	74	1230	80	86	1332

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2734	1230	0	0	1230	0
Stage 1	1230	-	-	-	-	-
Stage 2	1504	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	22	217	-	-	567	-
Stage 1	276	-	-	-	-	-
Stage 2	203	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	19	217	-	-	567	-
Mov Cap-2 Maneuver	19	-	-	-	-	-
Stage 1	276	-	-	-	-	-
Stage 2	172	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	81.8	0	0.8
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	19	217	567	-
HCM Lane V/C Ratio	-	-	0.686	0.341	0.151	-
HCM Control Delay (s)	-	-	$ 375.9	29.9	12.5	-
HCM Lane LOS	-	-	F	D	B	-
HCM 95th %tile Q(veh)	-	-	1.9	1.4	0.5	-

Arterial Level of Service: NB Queen Kaahumanu Hwy

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Lako Street	III	30	41.2	111.1	152.3	0.32	7.7	F
Puapuaanui Street	III	30	107.6	21.2	128.8	0.90	25.0	B
Total	III		148.8	132.3	281.1	1.22	15.6	D

Arterial Level of Service: SB Queen Kaahumanu Hwy

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Puapuaanui Street	III	30	94.3	7.0	101.3	0.79	27.9	B
Lako Street	III	30	107.6	41.7	149.3	0.90	21.6	C
Total	III		201.9	48.7	250.6	1.68	24.2	B

Arterial Level of Service: NB Queen Kaahumanu Hwy

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Lako Street	III	30	41.2	65.6	106.8	0.32	10.9	E
Puapuaanui St	III	30	107.6	21.8	129.4	0.90	24.9	B
Total	III		148.8	87.4	236.2	1.22	18.6	C

Arterial Level of Service: SB Queen Kaahumanu Hwy

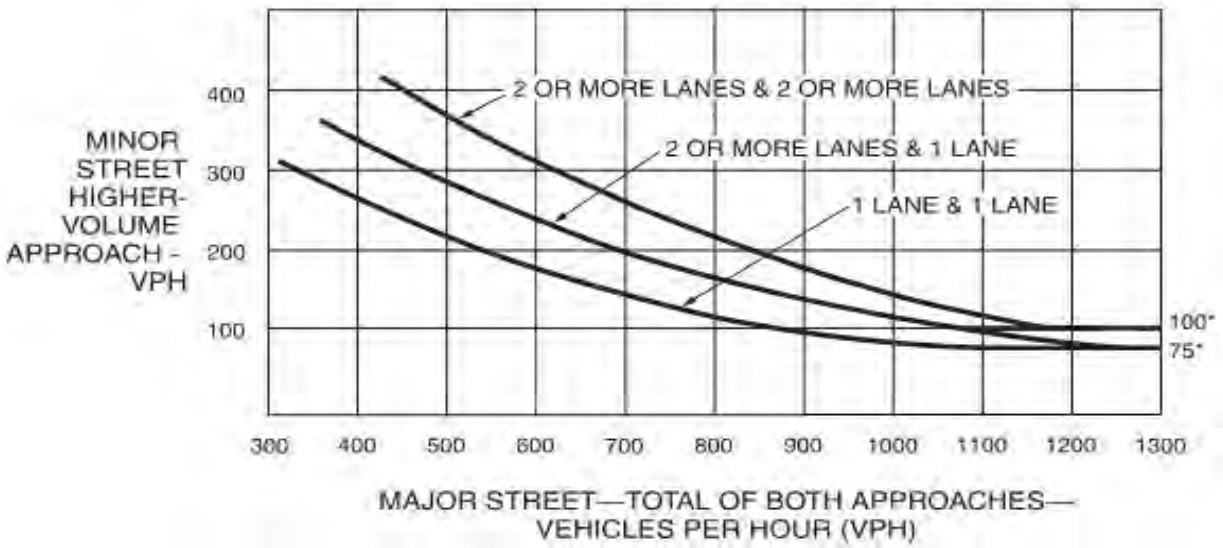
Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Puapuaanui St	III	30	94.3	7.3	101.6	0.79	27.8	B
Lako Street	III	30	107.6	47.5	155.1	0.90	20.8	C
Total	III		201.9	54.8	256.7	1.68	23.6	C

Appendix J

Traffic Signal Warrant Analysis

Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



Option:

13 At an intersection with a high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the "minor-street" volume and the corresponding single direction of opposing traffic on the major street as the "major-street" volume.

For all unsignalized intersections, minor approach is QK left turn onto minor street
For all unsignalized intersections, major approach is QK opposing thru

Use 1 Lane & 1 Lane

Existing	Peak Hour Warrant					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	776	164	YES	1005	84	NO
Hualalai (S)	1006	73	NO	940	61	NO
Kuakini	733	517	YES	887	243	YES
2024 Without Project	**Peak Hour Warrant**					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	816	172	YES	1056	88	YES
Hualalai (S)	1057	77	YES	988	64	NO
Kuakini	842	543	YES	932	255	YES
2024 With Project	**Peak Hour Warrant**					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	827	180	YES	1096	91	YES
Hualalai (S)	1117	77	YES	1025	64	NO
KV Roadway	819	13	NO	912	45	NO
Kuakini	856	543	YES	944	255	YES

2029 Without Project	Peak Hour Warrant					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	857	181	YES	1110	93	YES
Hualalai (S)	1111	81	YES	1038	67	NO
Kuakini	885	571	YES	980	268	YES

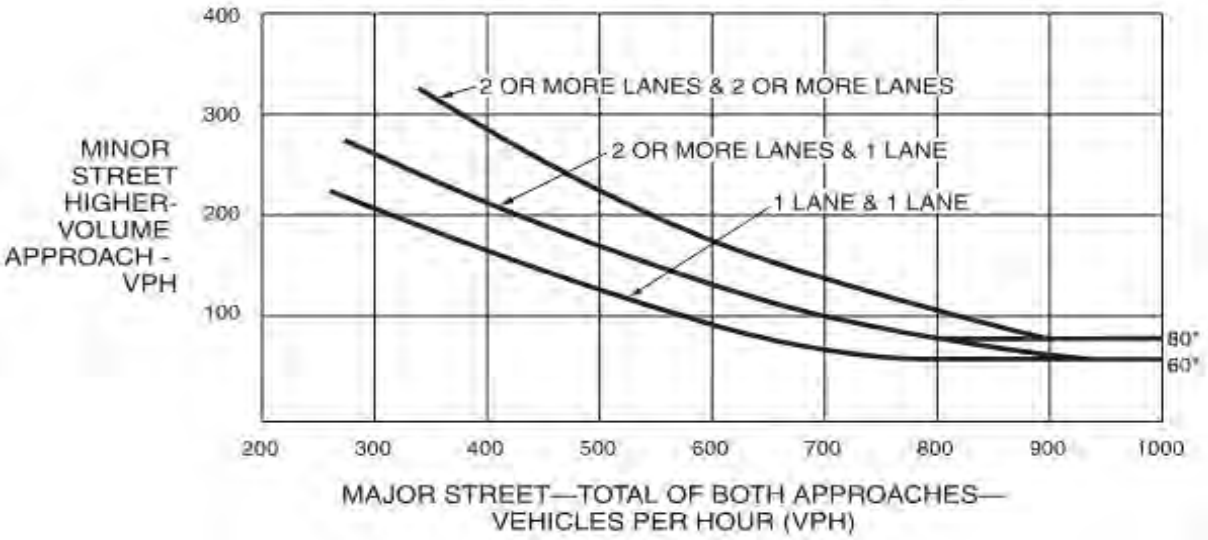
2029 With Project	Peak Hour Warrant					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	876	196	YES	1181	98	YES
Hualalai (S)	1216	81	YES	1103	67	NO
Kuakini	810	579	YES	980	271	YES

2039 Without Project	Peak Hour Warrant					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	947	200	YES	1226	102	YES
Hualalai (S)	1228	89	YES	1147	74	NO
Kuakini	894	631	YES	1082	297	YES

2039 With Project	Peak Hour Warrant					
	AM			PM		
	Major	Minor	Warrant?	Major	Minor	Warrant?
Hualalai (N)	966	215	YES	1297	107	YES
Hualalai (S)	1333	89	YES	1212	74	NO
Kuakini	894	639	YES	1082	300	YES

Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



Option:

13 At an intersection with a high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the "minor-street" volume and the corresponding single direction of opposing traffic on the major street as the "major-street" volume.

Use 1 Lane & 1 Lane

Existing - Hualalai (N)	4-Hour Warrant		
	Major	Minor	Warrant?
6:45-7:45 AM	776	164	YES
7:45-8:45 AM	692	145	YES
3:00-4:00 PM	1005	84	YES
4:00-5:00 PM	926	74	YES
5:00-6:00 PM	986	58	NO
Existing - Hualalai (S)	4-Hour Warrant		
	Major	Minor	Warrant?
6:45-7:45 AM	1006	70	YES
7:45-8:45 AM	1030	26	NO
3:00-4:00 PM	940	59	NO
4:00-5:00 PM	864	64	NO
5:00-6:00 PM	765	56	NO
Existing - Kuakini	4-Hour Warrant		
	Major	Minor	Warrant?
6:45-7:45 AM	776	335	YES
7:45-8:45 AM	683	467	YES
3:00-4:00 PM	881	224	YES
4:00-5:00 PM	872	264	YES
5:00-6:00 PM	870	217	YES

APPENDIX 3: Biological Survey Results

Botanical Survey and Vertebrate Fauna Assessment TMK 3-7-6-21: parcels 16, 17, 18 & 19 (78.324 acres) North Kona District, Island of Hawai‘i

By Ron Terry, Ph.D.
Geometrician Associates, LLC
September 2017

Introduction

This biological survey was prepared for Richard Wheelock, Member, KV3 LLC, to inventory the existing biological environment, assess the potential for biological impacts from proposed development in the survey area, and devise mitigation measures to avoid or minimize any impacts. The land in question ("the survey area") consists of four parcels situated mauka of Queen Ka‘ahumanu Highway, north of the Lako Street intersection, as shown in Figure 1. Two of the parcels are owned by KV3 LLC and are planned for residential and associated uses. The other two parcels are linear drainage ditches owned by the County of Hawai‘i.

The objectives of the botanical survey component of this survey were to 1) describe the vegetation; 2) list all species encountered; 3) determine the likelihood of the presence of rare, threatened or endangered (RTE) plant species; and 4) identify the locations of any RTE individuals found. The area was surveyed by Ron Terry in September 2017. Plant species were identified in the field and, as necessary, collected and keyed out in the laboratory. Special attention was given to the possible presence of any federally listed (USFWS 2017) threatened or endangered plant species, although the habitat did not indicate a high potential for their presence.

The work also included a faunal survey restricted to a tally of birds and introduced mammals, reptiles, or amphibians observed during the botanical fieldwork, as well as one additional one-hour bird observation. The field survey also assessed the general value of the habitat areas for native birds. Although there were no radar or ultrasound observations conducted that might have detected the endangered Hawaiian hoary bat, the general value of the habitat for the Hawaiian hoary bat was evaluated.

Generally not included in the survey was assessment of invertebrates, but the area was searched for the principal plant species in the area known to support the larvae and pupae of the endangered Blackburn's sphinx moth (*Manduca blackburnii*), the one listed endangered insect that is potentially present.

Vegetation: Influences and Previous Studies

The geologic substrate for most of the survey area is soil-covered pahoehoe lava flows from Hualālai dated between 5,000 and 10,000 years ago (Wolfe and Morris 1996). The soil here is classified as Waiaha medial silt loam, 2-10 or 10 to 20 percent slopes, depending on location. This soil forms on ash-covered pahoehoe flows and has a 10-25-inch depth to bedrock. It well drained but also has a high runoff potential (Sato et al

1973). The survey area varies in elevation from 330 to 690 feet above sea level, and receives an average annual rainfall of about 35-38 inches, increasing in the mauka direction (Giambelluca et al 2013).

The pre-human vegetation was likely Lowland Dry/Mesic Forest (per Gagne and Cuddihy 1990). This consisted of an open canopy forest dominated by a wide variety of trees, shrubs, herbs, vines and ferns. It likely had a diverse cover of native dry-forest trees and shrubs including lama (*Diospyros sandwicensis*) and alaheʻe (*Psydrax odoratum*), with a number of other species perhaps including now rare trees such as wiliwili (*Erythrina sandwicensis*), halapepe (*Pleomele sandwicensis*) and uhiuhi (*Mezoneuron kavaiense*). However, the general landscape of the Kailua-Kona area has been radically altered by centuries of settlements, over a century of grazing, and particularly by the development since 1960 of hotels, condominiums, resort homes, commercial facilities and associated infrastructure. Even on properties that experienced no development, introduced plants, animals and pests profoundly altered the biota. Prominent species in the survey area's elevational zone now include the aliens haole koa (*Leucaena leucocephala*), opiuma (*Pithecellobium dulce*), and guinea grass (*Megathyrsus maximus*).

Although the survey area never underwent modern development except on its margins, archaeological studies (SCS 2016) indicate that it was used prior to Western contact for a variety of activities, leaving features associated with agriculture, habitation, burial, and transportation. In more recent times, the survey area was part of a large former cattle ranch and agricultural area started in the early 1900s. The lower portion of the project area is still used to pasture cattle, and extensive fencing, cattle walls, several corrals and cattle chutes are present. The project area and surrounding lands were bulldozed sometime between the 1940s and 1970s. Evidence of bulldozing is visible in aerial photographs as alternating bands of cleared bulldozer tracks and bands of push piles. Archaeologists confirmed that the linear bands evident in aerial imagery are bulldozer-cleared paths and linear piles of bulldozed rock along the cleared bulldozer paths.

RTE plants are well known from certain areas at this elevational zone in Kona, but, with few exceptions, they are generally found further to the north in slightly drier areas with more recent lava (Geometrician Associates 2004, 2005, 2007, 2009a, 2009b, 2014a, 2014b; Gerrish 2006, 2007a, 2007b, 2008, 2009). RTE plants noted in the surveys above in the Kealakehe to Palama Nui area include the endangered plants uhiuhi, koʻokoʻolau (*Bidens micrantha* ssp. *ctenophylla*), halapepe (*Pleomele hawaiiensis*), wahine noho kula (*Isodendrion pyrifolium* – now extinct in the wild) and *Fimbristylis hawaiiensis*; the rare plants ʻohe makai (*Polyscias sandwicensis* and maiapilo (*Capparis sandwichiana*) (both of which we also found to the south on the most recent lava in Kahaluʻu); and the increasingly uncommon wiliwili. No surveys that we have conducted mauka of Kuakini Highway between Palani Road and Honalo – an area with abundant soil that has led to intensive farming, ranching and settlement – have found any RTE plants.

In terms of RTE fauna, the most likely candidate would be the endangered Hawaiian hawk (*Buteo solitarius*). This wide-ranging raptor nests in large trees and forages in forests, farms and even residential neighborhoods, and is seen throughout forested areas of the island. Klavitter (2000) and Gorresen et al. (2008) summarized hawk sightings

around the island, finding instances in this area of Kona, but at generally low densities. According to one study: "Both native and exotic trees are used for nesting, but the majority of nests are built in mature ʻōhi`a trees. Other nest trees include lama, koa, kōlea, eucalyptus, common ironwood, Christmas berry, coconut, macadamia nut, and mango" (USDA-NRCS 2007).

A number of other RTE birds are fairly unlikely to be found in the survey area. The Hawaiian goose or nēnē (*Branta sandvicensis*) is an endemic, federally listed endangered species that is only occasionally observed in urban Kona, although it is more abundant at Big Island Country Club in the Kekaha region of Kona. Some endangered Hawaiian petrels (*Pterodroma sandwichensis* or *ʻuaʻu*) and band-rumped storm-petrels (*Oceanodroma castro*), as well as threatened Newell's shearwaters (*Puffinus auricularis newelli*), may overfly the area between the months of June and October. All three of these pelagic seabird species nest high in the mountains in burrows. There is no suitable nesting habitat for any of these seabird species within or near the survey area. The primary cause of mortality in all these seabird species in Hawaiʻi is thought to be predation by alien mammalian species at the nesting colonies. Collision with man-made structures is another significant cause. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. When disoriented, seabirds may collide with manmade structures. If they are not killed outright, the dazed or injured birds are easy targets for feral mammals (Banko 1980; Day et al 2003). Although not an RTE species, the Hawaiian endemic sub-species of the short-eared owl or pueo (*Asio flammeus sandwichensis*), a protected migratory bird, nests and hunts in tall grasslands and shrublands and could conceivably be occasionally present on the survey area.

The endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), the only native Hawaiian land mammal, is found in most areas on the island of Hawaiʻi and has been observed in the thorny forests of Kona. Hawaiian hoary bats are vulnerable to disturbance during the summer pupping season.

Finally, the one endangered insect found in many parts of Kona is the Blackburn's sphinx moth (*Manduca blackburnii*). It is generally associated with drier environments and ʻaʻa substrates. The native host plant aiea (*Nothocestrum* spp.) is extremely rare, but a substitute host, the prolific weed tree tobacco (*Nicotiana glauca*), quickly colonizes dry, disturbed lava flows. Neither host was considered likely to be within the survey area.

In general, we concluded that the probability of encountering RTE plant or animal species in the survey area was low, because of substrate, topography, elevation, history of grazing and evidence of prior surveys.

Vegetation: Results

Our survey found two vegetation types that were distinguished primarily by management regimes (see Figure 2 for photos). The upper half of the survey area contains very few cattle and is intensely overgrown with guinea grass (Figure 2a). The area could be described as a scattered forest or thick savanna, dominated by koa haole, opiuma and

monkeypod (*Samanea saman*). These four plants compose most of the biomass and cover in this area. The lower half is moderately grazed and has a very similar but slightly more diverse tree flora, with kiawe (*Prosopis pallida*), klu (*Acacia farnesiana*), and several other non-native trees (Figure 2c). The understory contains a great diversity of non-native grasses, herbs, shrubs and vines, along with a very few natives, including ‘uhaloa (*Waltheria indica*) and ‘ilima (*Sida fallax*).

Although a highly intermittent stream traverses the property, no aquatic or true riparian vegetation is present (Figure 2b).

Flora and Rare, Threatened or Endangered Plants

All plant species found in the survey area during the survey are listed in Table 1. Of the 65 species detected, five were indigenous (native to the Hawaiian Islands and elsewhere) and none were endemic (found only in the Hawaiian Islands). All native plants found are very common throughout the island of Hawai‘i and the State, and no rare, threatened or endangered plant species were present. No tree tobacco, significant for its role as a potential host for an endangered moth, was found in the survey area.

Online maps from the U.S. Fish and Wildlife Service (USFWS) depict no critical habitat on or near the survey area (http://ecos.fws.gov/ecp/report/table/critical-habitat.html accessed September 2017).

Birds

The 15 species of birds detected during the survey were all non-native and typical of those found in similar areas of lowland disturbed habitat in Kona (Table 2). Most common were spotted dove (*Streptopelia chinensis*), northern cardinal (*Cardinalis cardinalis*), cattle egret (*Bubulcus ibis*) and parakeet (*Aratinga* sp.), Japanese white-eye (*Zosterops japonicus*) and house finch (*Carpodacus mexicanus*). No native birds were detected, and it is generally poor habitat for most native birds. The short-eared owl may utilize the survey area for foraging. The trees in the survey area are generally too short to serve as typical Hawaiian hawk nests, but it probably forages at least occasionally in the area.

Hawaiian Hoary Bat

Hawaiian hoary bats may very well utilize the survey area, as they have been observed in surrounding and similar areas. This survey took place in daylight, did not use any detection equipment, and was not designed to detect bats. However, the Hawaiian hoary bat should be presumed to be present. Bats may forage for flying insects over portions of the survey area on a seasonal basis, and they may find some of the larger shrubs and trees suitable nesting habitat.

Introduced Mammals, Reptiles, and Amphibians

The only live mammals seen during the survey were cattle (*Bos taurus*), feral pigs (*Sus scrofa* – which were abundant in the survey area), and small Indian mongooses (*Herpestes a. auropunctatus*). It is likely that feral cats (*Felis catus*), mice (*Mus* spp.), rats (*Rattus* spp.) and domestic dogs, (*Canis f. familiaris*) are occasionally present. There are no native terrestrial reptiles or amphibians in Hawai‘i. The only reptile observed during the survey was the day gecko (*Phelsuma* sp.). It is likely that other species of gecko as well as anoles and skinks are present. No amphibians were seen or heard. None of these alien mammals or reptiles have conservation value and all are deleterious to native flora and fauna.

Impacts and Mitigation Measures

As discussed above, no threatened or endangered plant species as listed by the U.S. Fish and Wildlife Service (2017) appear to be present in the survey area, nor are there uniquely valuable habitats. No existing or proposed federally designated critical plant (or animal) habitat is present in the survey area. There appears to be no potential to adversely affect RTE plant species.

If the project incorporates additional outdoor lighting, it may attract threatened and endangered Hawaiian seabirds, which may become disoriented by the lighting, resulting in birds being downed. To avoid the potential downing of these threatened and endangered seabirds due to interaction with outdoor lighting, no construction using unshielded equipment maintenance lighting should be permitted after dark between the months of April and October. All additional permanent lighting should conform to the Hawai‘i County Outdoor Lighting Ordinance (Hawai‘i County Code Chapter 9, Article 14), which requires shielding of exterior lights so as to lower the ambient glare caused by unshielded lighting.

The endangered Hawaiian hoary bat is vulnerable to disturbance while roosting with its juveniles in the pupping season. To minimize impacts, it is recommended that woody plants taller than 15 feet should not be removed or trimmed during the bat birthing and pup rearing season (June 1 through September 15).

No tree tobacco, the principal current host for the endangered Blackburn’s sphinx moth, was observed during our surveys. Because of the weedy, extremely fast-growing and spreading nature of the plant after landclearing and the difficult process necessary to determine if pupae are present in the ground under the plant after larvae have finished their life cycle, it is recommended that the landowner/developer prevent any infestations from growing. Although it is advisable to consult DLNR and or USFWS before removing any plants, juvenile plants less than two feet tall are not generally utilized by the larvae and may be safely removed, subject to discussions with these agencies.

Report Limitations

No biological survey of a large area can claim to have detected every species present. Some plant species are cryptic in juvenile or even mature stages of their life cycle. Dry conditions can render almost undetectable plants that extended rainfall may later invigorate and make obvious. Thick brush can obscure even large, healthy specimens. Birds utilize different patches of habitat during different times of the day and seasons, and only long-term study can determine the exact species composition. The findings of this survey must therefore be interpreted with proper caution; in particular, there is no warranty as to the absence of any particular species.

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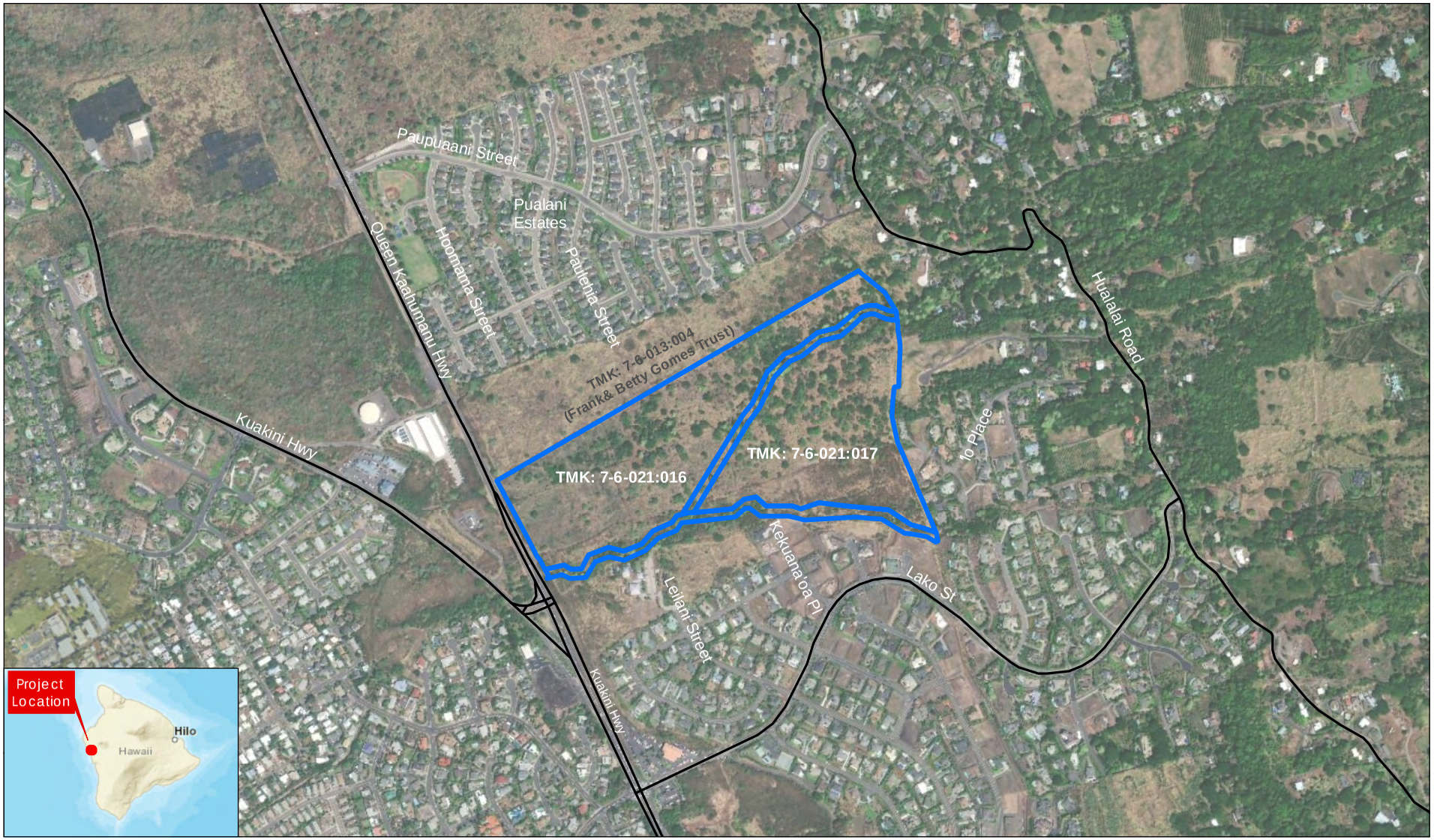

Legend

Project Site

N

Feet

0 500 1,000 1 in = 1,000 feet

Stantec

Kona Three LLC
Royal VIstas Development Project

Kona, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: CJ | 1ST REVIEW: JT | 2ND REVIEW: ML

DATE: 5/19/2020 | PROJECT NO: 185804638

Survey Area Map

V:\2037\Active\185804638\03_data\gis_cad\gis\mxds\Fig1_Project_Location_8x11L.mxd Revised: 2020-05-19 By: chjohnson

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Figure 2. Survey Area Photos

2a. Dense guinea grass/opiuma vegetation of mauka half ▲

▼ 2b. Natural drainageway

Figure 2. Survey Area Photos

2c. Semi-open vegetation of makai half ▲

▼ 2d. Corral and surrounding vegetation

Table 1. Plant Species Observed in Survey Area

Scientific Name	Family	Common Name	Life Form	Status*
FERNS:				
Nephrolepis multiflora	Nephrolepidaceae	Sword Fern	Herb	A
Phymatosorus grossus	Polypodiaceae	Maile Scented Fern	Herb	A
Pteris cretica	Pteridaceae	‘Oali	Fern	I
FLOWERING PLANTS:				
Abutilon grandifolium	Malvaceae	Hairy Abutilon	Herb	A
Acacia farnesiana	Fabaceae	Klu	Shrub	A
Aleurites moluccana	Euphorbiaceae	Kukui	Tree	P
Amaranthus viridis	Amaranthaceae	Slender Amaranth	Herb	A
Bidens alba	Asteraceae	Beggar’s Tick	Herb	A
Bidens cynapiifolia	Asteraceae	Blue Bidens	Herb	A
Bidens pilosa	Asteraceae	Beggar’s Tick	Herb	A
Buddleia asiatica	Scrophulariaceae	Buddleia	Shrub	A
Caesalpinia decapetala	Fabaceae	Wait-a-bit	Vine	A
Chamaecrista nictitans	Fabaceae	Partridge Pea	Pea	A
Chamaesyce hirta	Euphorbiaceae	Garden Spurge	Herb	A
Chamaesyce hypericifolia	Euphorbiaceae	Graceful Spurge	Herb	A
Chloris barbata	Poaceae	Swollen Fingergrass	Herb	A
Coccinia grandis	Cucurbitaceae	Ivy Gourd	Vine	A
Crotalaria sp.	Fabaceae	Rattlebox	Herb	A
Cynodon dactylon	Poaceae	Bermuda Grass	Herb	A
Desmanthus virgatus	Fabaceae	Slender Mimosa	Shrub	A
Desmodium incanum	Fabaceae	Desmodium	Vine	A
Digitaria ciliaris	Poaceae	Crabgrass	Herb	A
Digitaria insularis	Poaceae	Sourgrass	Herb	A
Digitaria setigera	Poaceae	Crabgrass	Herb	A
Dysphania carinata	Chenopodiaceae	Dysphania	Herb	A
Eleusine indica	Poaceae	Goose Grass	Herb	A
Eragrostis tenella	Poaceae	Lovegrass	Herb	A
Hyptis pectinata	Lamiaceae	Comb Hyptis	Shrub	A
Indigofera suffruticosa	Fabaceae	Indigo	Shrub	A
Ipomoea obscura	Convolvulaceae	Obscure Morning Glory	Vine	A
Kalanchoe pinnata	Crassulaceae	Air Plant	Herb	A
Lantana camara	Verbenaceae	Lantana	Shrub	A
Leonotis nepetifolia	Lamiaceae	Lion’s Ear	Herb	A
Leucaena leucocephala	Fabaceae	Haole Koa	Shrub	A
Malvastrum coromandelianum	Malvaceae	False Mallow	Shrub	A
Megathyrsus maximus	Poaceae	Guinea Grass	Herb	A
Melinis repens	Poaceae	Natal Red Top	Herb	A
Merremia tuberosa	Convolvulaceae	Woodrose	Vine	A
Mimosa pudica	Fabaceae	Sensitive Plant	Herb	A
Momordica charantia	Cucurbitaceae	Bitter Gourd	Vine	A

Table 1, continued				
Scientific Name	**Family**	**Common Name**	**Life Form**	**Status***
Paederia foetida	Rubiaceae	Maile Pilau	Vine	A
Parthenium hysterophorus	Asteraceae	Santa Maria	Herb	A
Passiflora edulis	Passifloraceae	Lilikoi	Vine	A
Phyllanthus debilis	Euphorbiaceae	Niruri	Herb	A
Pithecellobium dulce	Fabaceae	Dulce	Tree	A
Plumbago auriculata	Plumbaginaceae	Leadwort	Shrub	A
Plumbago zeylanica	Plumbaginaceae	‘Ilie’e	Herb	I
Portulaca pilosa	Portulacaceae	Hairy Pigweed	Herb	A
Prosopis pallida	Fabaceae	Kiawe	Tree	A
Psidium guajava	Myrtaceae	Common Guava	Tree	A
Rivina humilis	Phytolaccaceae	Coral Berry	Herb	A
Ricinus communis	Euphorbiaceae	Castor Bean	Shrub	A
Schinus terebinthifolius	Anacardiaceae	Christmas Berry	Shrub	A
Samanea saman	Fabaceae	Monkeypod	Tree	A
Senna occidentalis	Fabaceae	Coffee Senna	Shrub	A
Sida fallax	Malvaceae	Ilima	Shrub	I
Sida rhombifolia	Malvaceae	Sida	Herb	A
Sida spinosa	Malvaceae	Sida	Herb	A
Sonchus oleraceus	Asteraceae	Sow Thistle	Herb	A
Solanum americanum	Solanaceae	Popolo	Herb	I
Solanum seaforthianum	Solanaceae	Vining Solanum	Herb	A
Spathodea campanulata	Bignoniaceae	African Tulip	Tree	A
Thevetia peruviana	Apocynaceae	Be-Still Tree	Tree	A
Thunbergia fragrans	Acanthaceae	White Thunbergia	Vine	A
Triumfetta rhomboidea	Tiliaceae	Bur Bush	Shrub	A
Waltheria indica	Sterculiaceae	‘Uhaloa	Shrub	I

* A=Alien E=Endemic I=Indigenous PI= Polynesian END=Federal and State Listed Endangered (none)

Table 2. Bird Species Observed in Survey Area

Scientific name	**Common name**	**Status**
Acridotheres tristis	Common Myna	Alien Resident
Aratinga sp.	Parakeet	Alien Resident
Bubulcus ibis	Cattle Egret	Alien Resident
Cardinalis cardinalis	Northern Cardinal	Alien Resident
Carpodacus mexicanus	House Finch	Alien Resident
Francolinus pondecerianus	Black Francolin	Alien Resident
Geopelia striata	Zebra Dove	Alien Resident
Leiothrix lutea	Red-billed Leiothrix	Alien Resident
Lonchura punctulata	Nutmeg Mannikin	Alien Resident
Padda oryzivora	Java Sparrow	Alien Resident
Passer domesticus	House Sparrow	Alien Resident
Serinus mozambicus	Yellow-Fronted Canary	Alien Resident
Sicalis flaveola	Saffron Finch	Alien Resident
Streptopelia chinensis	Spotted Dove	Alien Resident
Zosterops japonicus	Japanese White-eye	Alien Resident

APPENDIX 4: Cultural Impact Assessment

A CULTURAL IMPACT ASSESSMENT FOR A 78.122-ACRE PROPERTY IN HŌLUALOA 1ST AHUPUA‘A, NORTH KONA DISTRICT, HAWAI‘I ISLAND, HAWAI‘I [TMK: (3) 7-6-021:016-019]

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JUNE 2020
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INTRODUCTION

At the request of property owner Kona Three, LLC, Scientific Consultant Services, Inc. (SCS) conducted a Cultural Impact Assessment (CIA) of a 76.121 acres of land TMK: (3) 7-6-021:016, 017, 018, and 019 located in Hōlualoa 1st Ahupuaʻa, North Kona District, Island of Hawaiʻi, Hawaiʻi (Figure 1 through Figure 4). The owner is proposing to develop the property and contracted the CIA as part of an Environmental Assessment (EA) as required for County of Hawaiʻi Planning Department permit applications. The point of contact (owner) for the project is Mr. Richard Wheelock. The owner's mailing address is 101 Hualālai Street Hilo, HI 96720. Mr. Wheelock can also be contacted by email at richard@eastwestrealty.org or by phone at 808-753-3167.

The Constitution of the State of Hawaiʻi clearly states the duty of the State and its agencies is to preserve, protect, and prevent interference with the traditional and customary rights of native Hawaiians. Article XII, Section 7 requires the State to "protect all rights, customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by *ahupuaʻa* tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778" (2000). In spite of the establishment of the foreign concept of private ownership and western-style government, Kamehameha III (Kauikeaouli) preserved the people's traditional right to subsistence.

As a result, in 1850 the Hawaiian Government confirmed the traditional access rights to native Hawaiian *ahupuaʻa* tenants to gather specific natural resources for customary uses from undeveloped private property and waterways under the Hawaiʻi Revised Statutes (HRS) 7-1. In 1992, the State of Hawaiʻi Supreme Court, reaffirmed HRS 7-1 and expanded it to include, "native Hawaiian rights…may extend beyond the *ahupuaʻa* in which a native Hawaiian resides where such rights have been customarily and traditionally exercised in this manner" (Pele Defense Fund v. Paty, 73 Haw.578, 1992).

Figure 1: 5,500 K-Series Map of Hawai‘i Showing Location of Project Area (National Geographic Topo!, 2003. Data Sources: National Geographic Society, USGS).

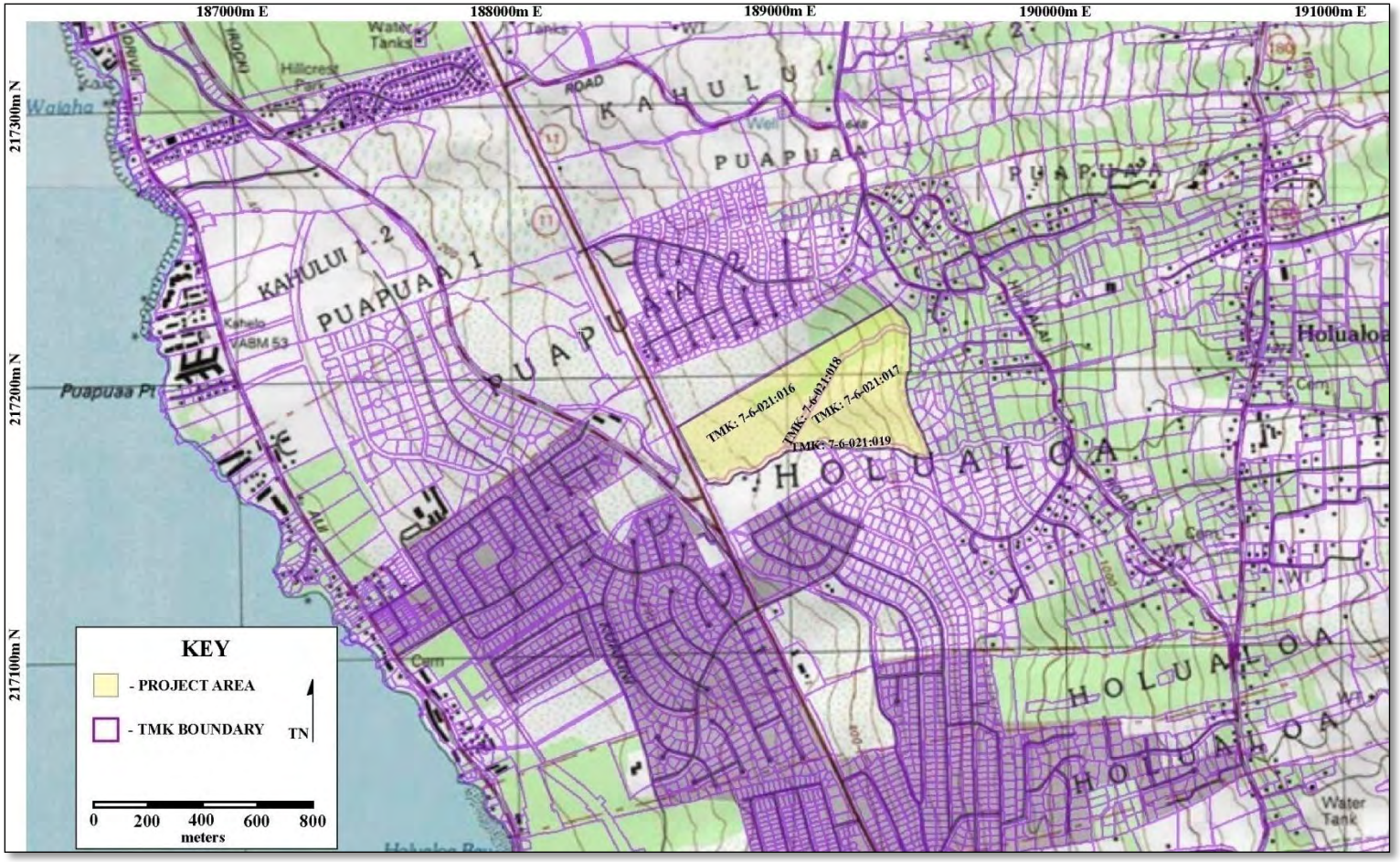

Figure 2: 7.5-Minute Series USGS Topographic Map Showing the Location of Project Areas and TMK Parcels (Kealakekua Quadrangle. ESRI, 2013. Data Sources: National Geographic and County of Hawai‘i Planning Department, 2019).

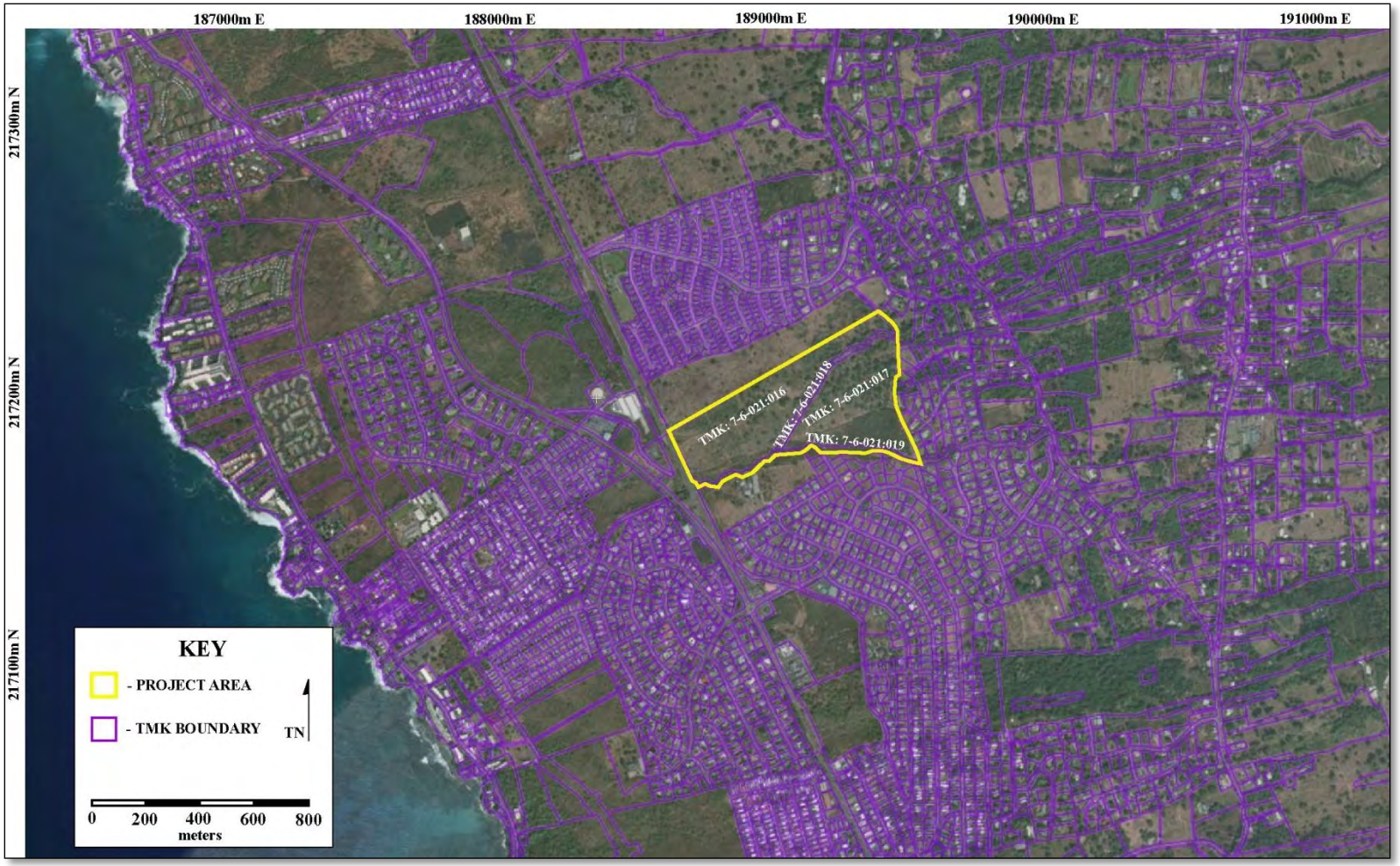

Figure 3: Aerial Photograph Showing Project Area, Hōlualoa, HI, Zone 5 North, 189445 m E, 2171790 m N. (ESRI, 2013 Image. Data Sources: Digital Globe, GeoEye, Earthstar, USDA, and USGS).

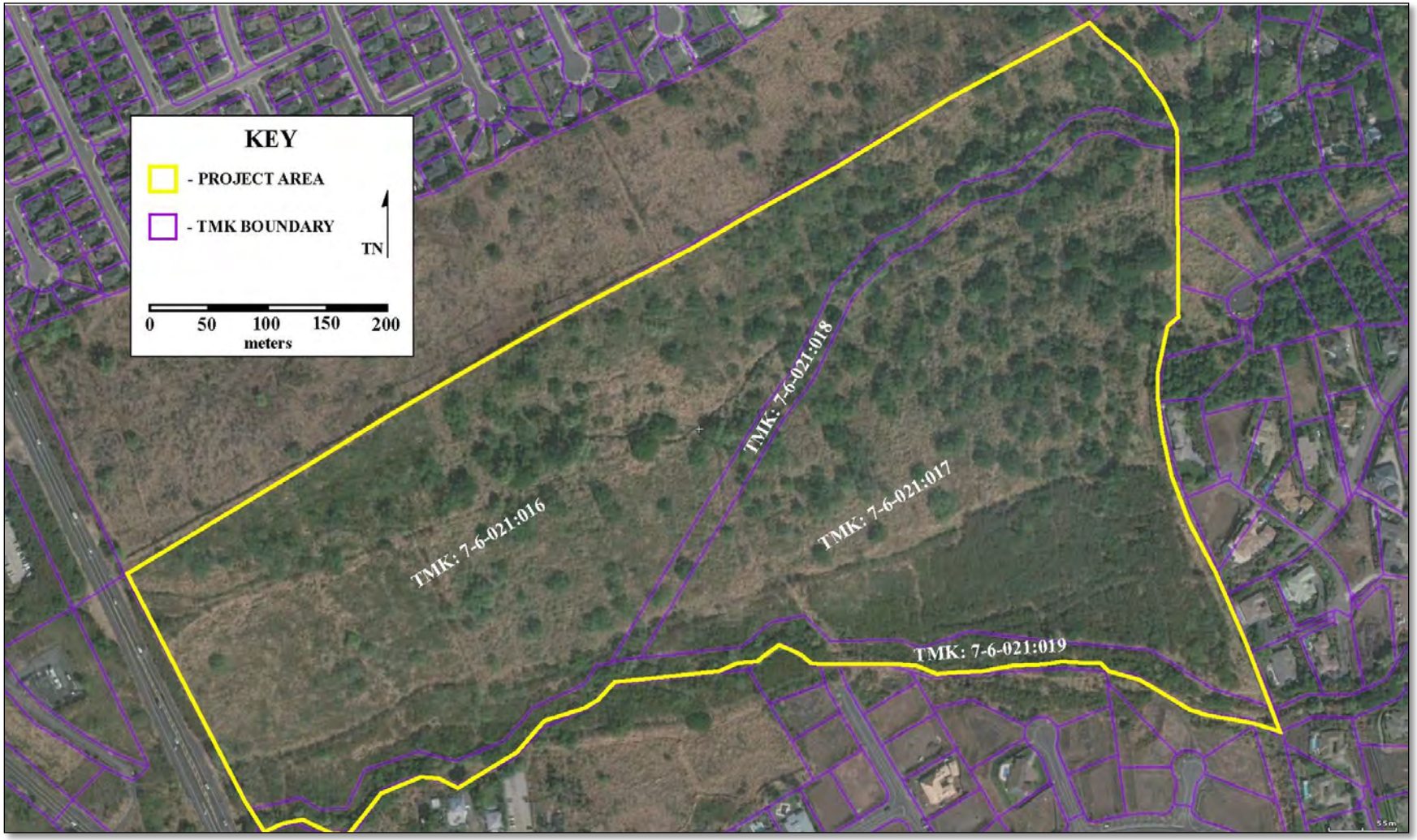

Figure 4: Aerial Photograph Close-Up Showing Project Area, Hōlualoa, HI, Zone 5 North, 189445 m E, 2171790 m N. (ESRI, 2013 Image. Data Sources: Digital Globe, GeoEye, Earthstar, USDA, and USGS).

Act 50, enacted by the Legislature of the State of Hawaii (2000) with House Bill 2895, relating to Environmental Impact Statements, proposes that:

> …there is a need to clarify that the preparation of environmental assessments or environmental impact statements should identify and address effects on Hawai‘i’s culture, and traditional and customary rights… [H.B. NO. 2895].

Act 50 requires state agencies and other developers to assess the effects of proposed land use or shoreline developments on the “cultural practices of the community and State” as part of the HRS Chapter 343 environmental review process (2001).

Its purpose has broadened, “to promote and protect cultural beliefs, practices and resources of native Hawaiians [and] other ethnic groups, and it also amends the definition of ‘significant effect’ to be re-defined as “the sum of effects on the quality of the environment including actions that are…contrary to the State’s environmental policies…or adversely affect the economic welfare, social welfare, or cultural practices of the community and State” (H.B. 2895, Act 50, 2000).

Thus, Act 50 requires an assessment of cultural practices to be included in the Environmental Assessments and the Environmental Impact Statements, and to be taken into consideration during the planning process. The concept of geographical expansion is recognized by using, as an example, “the broad geographical area, e.g. district or *ahupua‘a*” (OEQC 1997). It was decided that the process should identify ‘anthropological’ cultural practices, rather than ‘social’ cultural practices. For example, *limu* (edible seaweed) gathering would be considered an anthropological cultural practice, while a modern-day marathon would be considered a social cultural practice. According to the Guidelines for Assessing Cultural Impacts established by the Hawaii State Office of Environmental Quality Control:

> The types of cultural practices and beliefs subject to assessment may include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs. The types of cultural resources subject to assessment may include traditional cultural properties or other types of historic sites, both manmade and natural, which support such cultural beliefs (OEQC 1997).

This Cultural Impact Assessment involves evaluating the probability of impacts on identified cultural resources, including values, rights, beliefs, objects, records, properties, and stories occurring within the project area and its vicinity (H.B. 2895, Act 50, 2000).

METHODOLOGY

This Cultural Impact Assessment was prepared in accordance with the methodology and content protocol provided in the Guidelines for Assessing Cultural Impacts (OEQC 1997). In outlining the "Cultural Impact Assessment Methodology", the OEQC states: …information may be obtained through scoping, community meetings, ethnographic interviews and oral histories… (1997).

The report contains archival and documentary research, as well as communication with organizations having knowledge of the project area, its cultural resources, and its practices and beliefs. This Cultural Impact Assessment was prepared in accordance with the methodology and content protocol provided in the Guidelines for Assessing Cultural Impacts (OEQC 1997). The assessment concerning cultural impacts should address, but not be limited to, the following matters:

(1) a discussion of the methods applied and results of consultation with individuals and organizations identified by the preparer as being familiar with cultural practices and features associated with the project area, including any constraints of limitations with might have affected the quality of the information obtained;

(2) a description of methods adopted by the preparer to identify, locate, and select the persons interviewed, including a discussion of the level of effort undertaken;

(3) ethnographic and oral history interview procedures, including the circumstances under which the interviews were conducted, and any constraints or limitations which might have affected the quality of the information obtained;

(4) biographical information concerning the individuals and organizations consulted, their particular expertise, and their historical and genealogical relationship to the project area, as well as information concerning the persons submitting information or interviewed, their particular knowledge and cultural expertise, if any, and their historical and genealogical relationship to the project area;

(5) a discussion concerning historical and cultural source materials consulted, the institutions and repositories searched, and the level of effort undertaken, as well as the particular perspective of the authors, if appropriate, any opposing views,

and any other relevant constraints, limitations or biases;

(6) a discussion concerning the cultural resources, practices and beliefs identified, and for the resources and practices, their location within the broad geographical area in which the proposed action is located, as well as their direct or indirect significance or connection to the project site;

(7) a discussion concerning the nature of the cultural practices and beliefs, and the significance of the cultural resources within the project area, affected directly or indirectly by the proposed project;

(8) an explanation of confidential information that has been withheld from public disclosure in the assessment;

(9) a discussion concerning any conflicting information in regard to identified cultural resources, practices and beliefs;

(10) an analysis of the potential effect of any proposed physical alteration on cultural resources, practices or beliefs; the potential of the proposed action to isolate cultural resources, practices or beliefs from their setting; and the potential of the proposed action to introduce elements which may alter the setting in which cultural practices take place, and;

(11) the inclusion of bibliography of references, and attached records of interviews, which were allowed to be disclosed.

Based on the inclusion of the above information, assessments of the potential effects on cultural resources in the project area and recommendations for mitigation of these effects can be proposed.

ARCHIVAL RESEARCH

Archival research focused on a historical documentary study involving both published and unpublished sources. These included legendary accounts of native and early foreign writers; early historical journals and narratives; historic maps and land records such as Land Commission Awards, Royal Patent Grants, and Boundary Commission records; historic accounts, and previous archaeological project reports.

INTERVIEW METHODOLOGY

Interviews are conducted in accordance with applicable state laws and guidelines. Individuals and/or groups who have knowledge of traditional practices and beliefs associated with a project area or who know of historical properties within a project area are sought for consultation. Individuals who have particular knowledge of traditions

passed down from preceding generations and a personal familiarity with the project area are invited to share their relevant information. Often people are recommended for their expertise, and indeed, organizations, such as Hawaiian Civic Clubs, the Island Branch of Office of Hawaiian Affairs (OHA), historical societies, Island Trail clubs, and Planning Commissions are depended upon for their recommendations of suitable informants. These groups are invited to contribute their input, and suggest further avenues of inquiry, as well as specific individuals to interview.

If knowledgeable individuals are identified, personal interviews are sometimes taped and then transcribed. These draft transcripts are returned to each of the participants for their review and comments. After corrections are made, each individual signs a release form, making the information available for this study. When telephone interviews occur, a summary of the information is often sent for correction and approval, or dictated by the informant and then incorporated into the document. Key topics discussed with the interviewees vary from project to project, but usually include: personal association to the *ahupua'a*, land use in the project's vicinity; knowledge of traditional trails, gathering areas, water sources, religious sites; place names and their meanings; stories that were handed down concerning special places or events in the vicinity of the project area; evidence of previous activities identified while in the project vicinity.

In this case, letters with maps and descriptions of the project area were sent to individuals and organizations whose jurisdiction includes knowledge of the area with an invitation for consultation. Consultation was sought from Jordan Kea Calpito, SHPD Burial Sites Specialist; Kamakana Ferreira, OHA Compliance Officer; Nicole Lui, cultural descendant, Sean Naleimaile, State Historic Preservation Division (SHPD) Hawai'i Island Archaeologist; Kekoa Nezara, Kona Hawaiian Civic Club President; Shane Nelson, OHA West Hawai'i Representative; and J, Curtis Tyler III, cultural descendant. Consultation was also conducted via telephone with Gregg Kashiwa who served as the project property manager for parcels 016 and 017 in the early 1980s.

Public notices (Appendix A) were placed in the December 2019 issue of the Office of Hawaiian Affairs (OHA) Ka Wai Ola Newspaper. Public notices were also published in the Honolulu Star-Advertiser, and the West Hawai'i Today on November 17th, 20th and 21st.

If cultural resources are identified based on the information received from these organizations and/or additional informants, an assessment of the potential effects on the identified cultural resources in the project area and recommendations for mitigation of these effects can be proposed. Public notices were not published in local and/or regional publications.

PROJECT AREA NATURAL ENVIRONMENT

The current project area consists of undeveloped land used as cattle pasture for several decades. Prior to that, coffee was grown in the northeast quadrant of the project area. The project area is situated on fairly steeply sloping land with level areas in between elevation breaks. The project area is between 360 and 660 feet (110 to 201 meters) above mean sea level (amsl). The project area lands are part of a large former cattle ranch and agricultural area that was started in the early 1900s. The project area is still used to pasture cattle. The project area lands were bulldozed sometime between the 1940s and 1970s. Evidence of bulldozing is visible in aerial photographs as alternating bands of cleared bulldozer tracks and bands of push pile (see Figure 4). Pedestrian survey confirmed the linear bands in the aerial photographs are bulldozer-cleared paths and linear piles of bulldozed rock along the cleared bulldozer paths. The former Kona Sugar Company railroad bed is present along the eastern edge of the project area.

The project area ground surface is a Hualālai lava flow dating between 5,000 and 10,000 years before present (ybp) (Wolfe and Morris 1996). Soil in the project area is Punalu‘u Series (rPYD series) extremely rocky peat with six to twenty percent slopes (Sato 1973:48). The majority of the project area has been bulldozed in the past and the present ground surface is rocky soil.

Rainfall in the project area is very low, less than thirty inches per year. Parcel 018 and Parcel 019 are seasonal gulches that drain rainfall down slope to the west. This region is extremely dry, hot, and somewhat barren except for thick California grass (*Urochloa mutica*), Guinea grass (*Megathyrsus maximus*), and some *koa haole* (*Leucaena leucocephala*), *kiawe* (*Prosopis pallida*), and *kukui* nut (*Aleurites moluccana*) trees (Starr Environmental 2016).

HISTORICAL AND CULTURAL CONTEXTS

Kona is divided into two sections: North Kona or *Kona ʻākau*, and; South Kona, or *Kona hema* (Maly 1996). *Kona ʻākau* was further subdivided into north (called *Kekaha-wai-ʻole-o-na-Kona*) and south (called *Konakai ʻōpua*) areas, with the division between the two at the *ahupuaʻa* of Keahuolu. The project area is in Hōlualoa 1st Ahupuaʻa (Figure 5) within the area of *Kona kai ʻōpua* in *Kona ʻākau*. Hōlualoa means (literally) "long sled course" (Pukui *et al*. 1974:48). Hōlualoa 1st is a traditional *ahupuaʻa* stretching from the ocean to the foot of Hualālai in the uplands. The coastline of Hōlualoa 1st Ahupuaʻa is primarily low rock cliffs.

Very little is recorded of Hōlualoa Ahupuaʻa in traditional oral accounts. *The Heart Stirring Legend of Ka-Miki*, published in the Hawaiian language newspaper *Ka Hoku o Hawaii* and translated by Maly (1993) contains the only description of Hōlualoa. The legend is set in the 13th century but also reflects more recent influences (Maly and Maly 2002:17).

According to the narrative,

> The lands of Hōlualoa were named for the chief of that name; both Hōlualoa and Puapuaʻa were high chiefs, who controlled the lands from mountain to sea, which bear their names… Kaluaokalani served as a priest of Hōlualoa at the temple of Pākiha. This *heiau* was near the contest field of Hōlualoa… The lands of this region are named for various *aliʻi*, all of whom were related. When the chief Hōlualoa took up the challenge against Kepakaʻiliʻula on behalf of the Kona chiefs, Hōlualoa called upon his god *Kālaipāhoa* to assist him in his battle… Hōlualoa was the first chief to call upon the god *Kālaipāhoa*, and this was the beginning of this god's use by the chiefs of Hawaiʻi [Maly 1993:208-209].

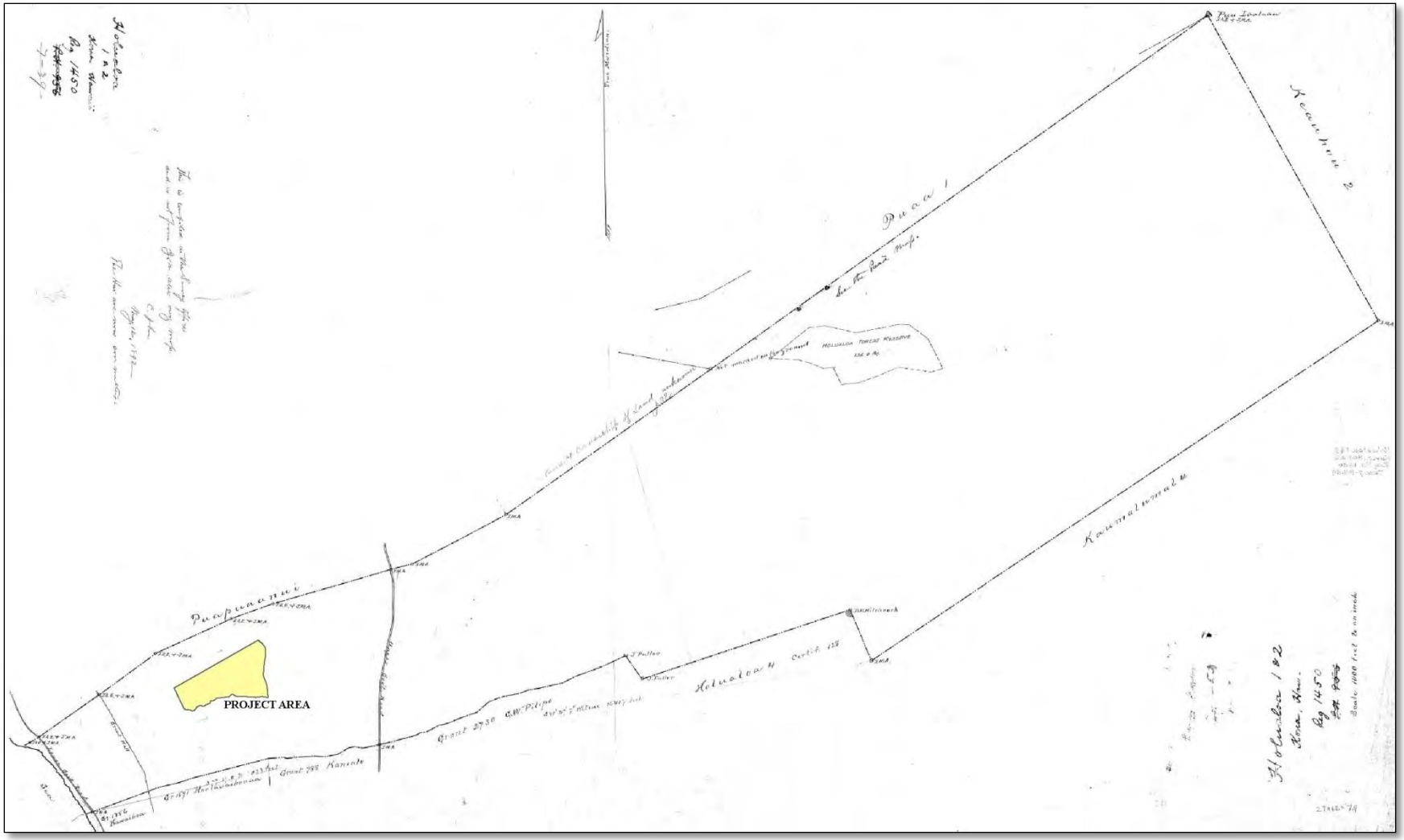

Figure 5: Map of Hōlualoa 1st and 2nd Ahupua‘a Showing Location of Project Area in Red Border (Alexander 1855).

PRE-CONTACT ERA

Hōlualoa, Kona, and much of the leeward side of Hawai‘i Island, while well populated at the time of European Contact, were settled later than the windward side. This in part may be due to the fertile land, numerous streams, and abundant rainfall on the windward side (Maly 1996:3). Many archaeologists believe that Hawai‘i Island was first settled around A.D. 1,000 by people sailing from the Marquesas (Athens et al. 2014; Dye 2011; Kahn et al. 2014; Kirch 2011; Kirch and McCoy 2007; McCoy 2005 and 2007; Mulrooney et al. 2011; Reith et al. 2011; Wilmhurst et al. 2011a and 2011b).

During early settlement of the leeward side permanent habitations were established in Kona concentrated along the shoreline and lowland slopes (Cordy 1981, 1995; Schilt 1984). Informal fields were cleared at higher elevations where rainfall was higher. Between AD 1200 and 1400, habitation and agriculture expanded across the slopes and coastal area of Hualālai (Burtchard 1995; Cordy 1995). The initial construction of the Kona Field System (KFS) began approximately between AD 1400 to 1600 (Schilt 1984). The development of these extensive formal walled fields coincides with a dramatic population increase and with the development of the stratified chiefdom structure which is reflected through large residential complexes and *heiau* (Burtchard 1995; Cordy 1981; Haun *et al*. 1998; Hommon 1986; Schilt 1984). Thus, there was a need to expand the previously limited agricultural base. The royal centers and larger heiau were in place by AD 1600 to 1800 which reflect the growth in power of the rulers and chiefs in the region (Barrera 1971; Hammatt and Folk 1980). Royal centers are located at Kailua, Hōlualoa, Kahalu‘u, Kealakekua, and Hōnaunau (Cordy 1995).

The region of Hōlualoa developed into a royal center in the late 1600s to early 1700s under the reigns of Keakamahana (reigned 1680-1700) and Keakealaniwahine (reigned 1700-1720) (Cordy 2000:244). Many *‘ali‘i* and *konohiki* residences and numerous religious sites are known to have existed here. The majority of the heiau and royal residences were constructed along or near the coast, most notably at Kamoa Point south of the project area. The royal center at Hōlualoa was eclipsed in the second half of the 1700s by the royal center in the Kahalu‘u and Keauhou region.

THE KONA FIELD SYSTEM

The Kona Field System extends north at least to Kau Ahupua‘a and south to Hōnaunau, west from the coastline and east to the forested slopes of Hualālai (Cordy 1995). During his travels in 1823, William Ellis noted the extensive field system divided with “low stone walls, made of fragments of lava”, producing “bananas, sweet potatoes, mountain taro, tapa trees, melons and sugar cane” and “flourishing luxuriantly in every direction” (Handy and Handy 1940:114 and 162). Many of the archaeological projects conducted within Kona deal with components of the Kona Field System (Cordy 1995; Newman 1970; Schilt 1984).

The *kula* zone of the Kona Field System is from sea level to 150 m amsl. This zone is associated with habitations along the shoreline and cultivation of sweet potatoes (*uala*), paper mulberry (*wauke*), and gourds (*ipu*). Clearing mounds, planting depressions, planting mounds, planting terraces, and modified outcrops are common agricultural features in the *kula* zone (Hammatt and Clark 1980; Hammatt and Folk 1980; Haun *et al*. 1998; Schilt 1984). Permanent habitation including royal and high chiefly centers as well as non-agricultural activities such as fishing, ceremonies and burial practices were usually concentrated along the shoreline zone portion of the *kula* zone.

The higher elevation zones are the *kalu‘ulu zone, ‘apa‘a* zone and the *‘ama‘u* zone. The current project area is in the *kalu‘ulu* zone. This wetter region is above 150 m amsl where bread fruit, sweet potatoes (*Ipomoea batatas*), *ki*, (*Cordyline fruticosa*) *wauke* (*Broussonetia papyrifera*), *karo* (*Colocasia esculenta*), sugar cane (*Saccharum* sp.), and other arboreal crops were grown (Kelly 1983, Menzies 1920). The *‘apa‘a* zone is above the *kalu‘ulu* zone. Hawaiians cultivated melons, sweet potatoes, *ti,* bananas, *taro*, *wauke* and sugar cane in fields with low stone walls. The highest zone, the *‘ama‘u* zone, was used to grow bananas and plantains in walled fields. The *‘apa‘a* zone and the *‘ama‘u* zone were also used to collect timber and catch birds therefore temporary habitations were constructed.

POST-CONTACT ERA

During the post-contact era, the Kona Field System was exploited and the planting of coffee, sugar, sisal, citrus, and cotton took over original Hawaiian crops until eventually the land was used for cattle pasture. The first cattle and sheep were brought to the island by Vancouver in 1793 and 1794 (Vancouver 1967). Horses, mules, oxen, goats, and donkeys were brought shortly after. Feral cattle, sheep, and goats overran agricultural fields by 1813 to 1815 (Ellis 1963: 291; Wilkes 1970: 204). By 1848, in the Kona District, a Great Wall (the Kuakini Wall) was constructed from Lanihau to ʻŌnouli to keep them away from homes and agricultural areas (Maly and Maly 2001:286). Formal cattle ranching began in the Kona region in the mid-1800s.

The Kona landscape evolved rapidly with the turn of the century. The rapid growth of the sugar industry produced the Kona Sugar Company in 1899. A railroad was built in 1901 to help sustain this influx in produce. It was later used to haul lumber and freight along with the sugarcane. The rail line was seven miles long and extended from Hōlualoa to Kaʻawaloa (Figure 6). Cotton, tobacco, and sisal were grown in the dryer lands below the railroad (Kelly 1983).

The changing subsistence and trade regimes developed by incoming European and American settlers, as well as other historical factors, caused a depopulation of the coastal areas of Kona. Ranches were established at middle and upper elevations, and farms were established in the uplands where rainfall was higher and the temperatures were cooler. Cattle ranching and clearing for sugar cane and coffee removed many of the endemic species of plants. The suite of vegetation that existed prior to the pre-Contact era were replaced by *koa haole* (*Leucaena leucocephala*), *kiawe* (*Prosopis pallida*), and other newly introduced invasive plant species.

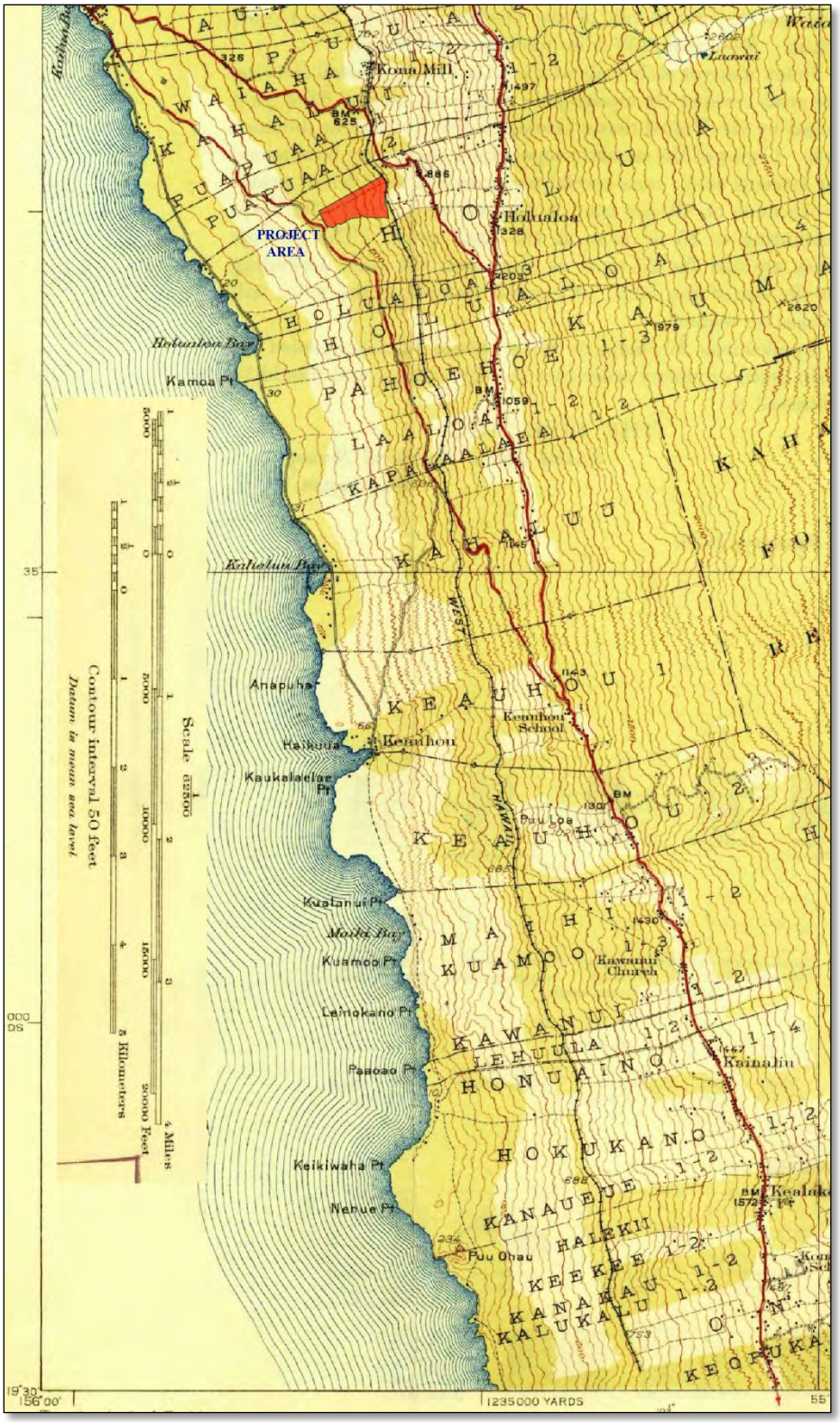

Figure 6: Portion of 15-Minute Series USGS Topographic Map Showing Location of Railroad and Project Area (USGS 1928).

Schools, churches, stores, and other businesses were also established in the uplands. During the late 1800s and early 1900s, coastal Kona was no longer the densely populated sociopolitical center it once was. It became a small cluster of houses along the trail from Kailua Bay to Keauhou (Tomonari-Tuggle 1993:15). Homesteads, ranches, and plantations developed in the uplands during this period as reflected in the pattern of Land Commission Awards (LCA) and Land Grants (LG) recorded during the Māhele (Escott and Escott 2018).

The project area is just *makai* (west) of most of the land commission awards and is at the same elevation as portions of the land grants in the region. Based on historic documents, the project area and surrounding lands were likely being used for subsistence and commercial agriculture, as well as for cattle pasture from the mid to late 1800s. The project area might have been used later than surrounding lands because of its steep slopes and very rocky soil, but based on aerial photographs, the project area was bulldozed sometime around the 1950s through the 1970s in preparation for commercial agriculture.

THE MĀHELE

The Land Commission awarded the majority of Hōlualoa 1st and 2nd Ahupuaʻa to Victoria Kamāmalu Kaʻahumanu IV, *Kuhina Nui* of Hawaiʻi Island and Crown Princess of Hawaiʻi as Land Commission Award (LCA) Number 7713, ʻApana 43 (Figure 7). Several smaller LCA and LG properties were also recorded in the upland region of Hōlualoa 1st and 2nd Ahupuaʻa (Figure 8). Twenty four Land Commission awards were recorded in Hōlualoa 1st Ahupuaʻa, the ahupuaʻa where the project area is located (Table 1).

A portion of LCA #3660 to John G. Munn makes up a thin strip of land located through the center of the current project area. With the notable exception of LCA #3660 and a few other large LCAs, the average award was 2.8 acres, most (n=16) were for less than 3.0 acres. Three Land Grants (LG #1592, 1602, and 3630) were also recorded in Hōlualoa 1st and 2nd Ahupuaʻa. LG #1592 was a 25.0-acre parcel sold to Kealalio and LG #3630 was a 38.2-acre parcel sold to W.H. Cromwell. Almost all of the awards and grants were used as subsistence and commercial farm land, and some were used to pasture cattle (Escott and Escott 2018).

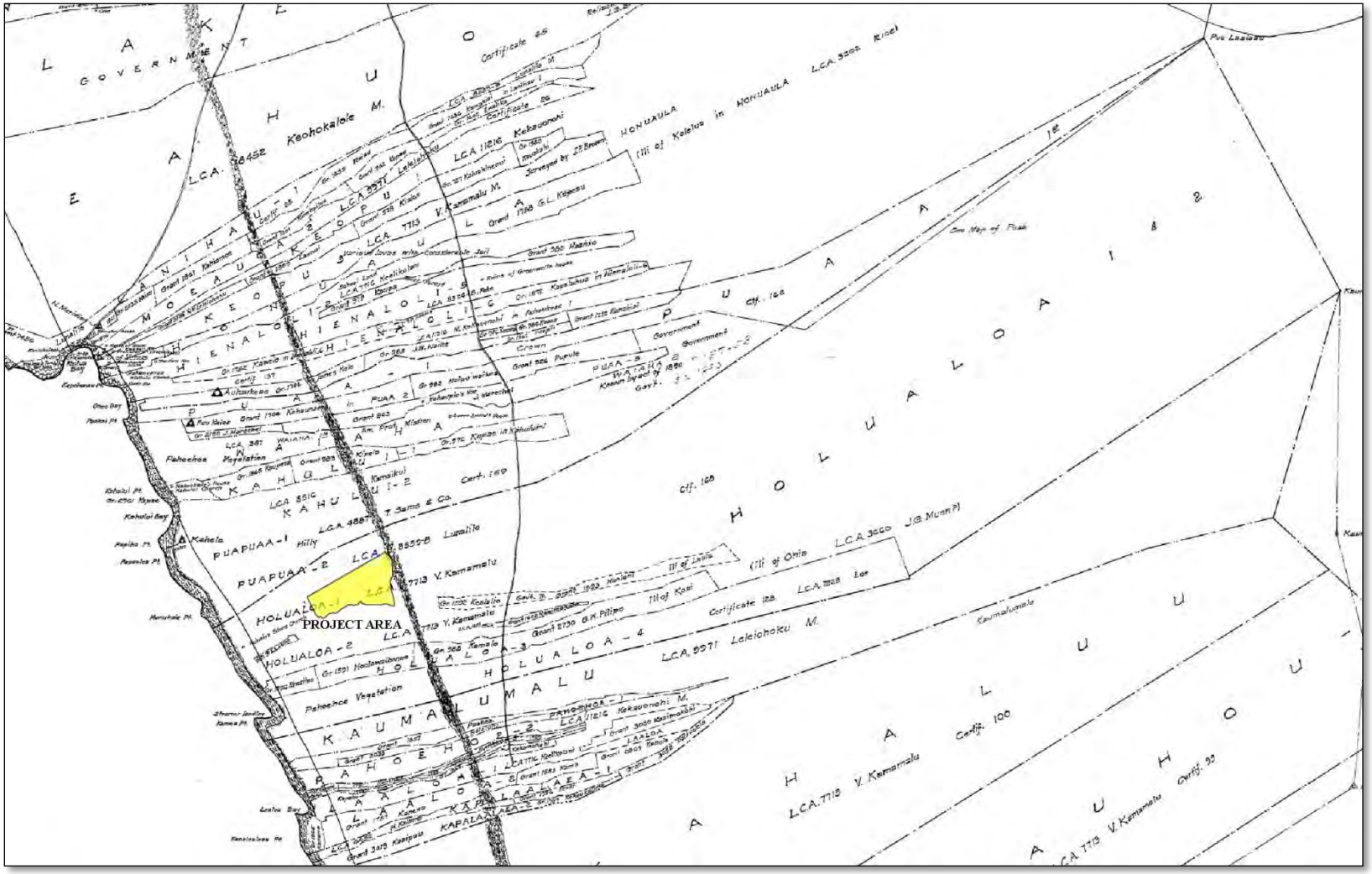

Figure 7: Portion of Kailua Section, North Kona Map Showing Location of LCA 7713 and Project Area in Red Border (Aki 1952).

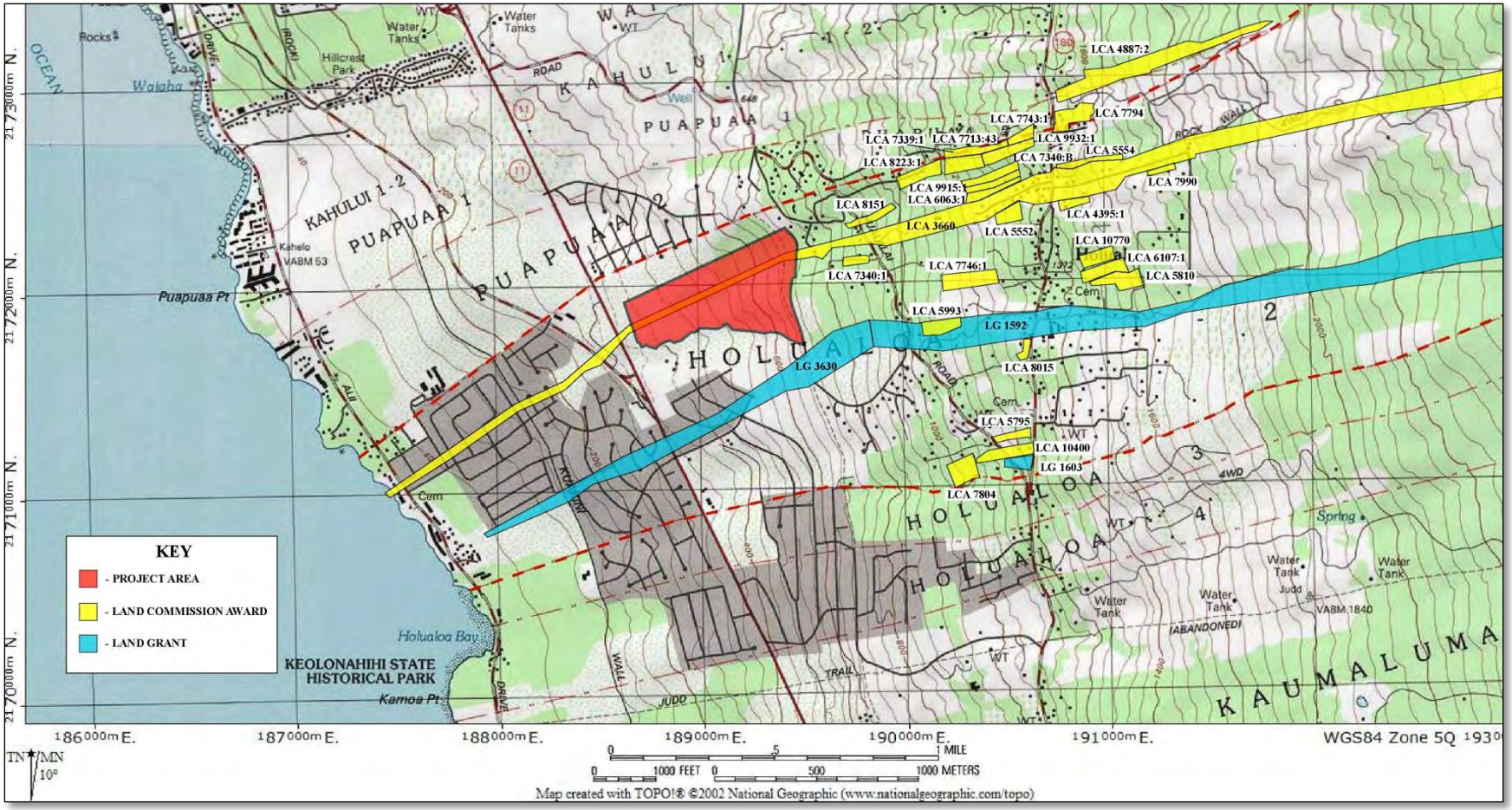

Figure 8: 7.5-Minute Series USGS Topographic Map Showing Location of Land Commission Awards, Land Grants, and the Project Area (National Geographic Topo!, 2003, Kailua Quad. Data Sources: National Geographic Society, USGS).

Table 1: Land Commission Awards Recorded in Hōlualoa 1st and 2nd Ahupuaʻa.

LCA#	AWARDED TO	AHUPUAʻA	ACRES
3660	John G. Munn	Hōlualoa 1st	111.5
4395	Kekoi	Hōlualoa 1st	1.7
5552	Kauila	Hōlualoa 1st	1.9
5554	Keawekolohe	Hōlualoa 1st	11.27
5795	Keliikanakaole	Hōlualoa 2nd	2.2
5810	Kaopukauila	Hōlualoa 1st	1.74
5993	Leipalapala	Hōlualoa 2nd	2.0
6063	Hāna	Hōlualoa 1st	2.9
6107	Naai	Hōlualoa 1st	3.94
7339	Kuaana	Hōlualoa 1st	4.15
7340	Kama 2	Hōlualoa 1st	2.5
7340:B	Kama 1	Hōlualoa 1st	1.3
7443	Kalimapaa	Hōlualoa 1st	1.94
7713	Kamamalu	Hōlualoa 1st & Hōlualoa 2nd	Large
7746	Kamahalo	Hōlualoa 1st	5.0
7794	Kauakini	Hōlualoa 1st	1.8
7990	Pupuka	Hōlualoa 1st	1.1
8015	Aipo	Hōlualoa 2nd	1.4
8151	Hehena	Hōlualoa 1st	2.3
8223	Ikaiaka	Hōlualoa 1st	3.5
9915	Limahana	Hōlualoa 1st	2.42
9932	Lumaawe	Hōlualoa 1st	2.98
10770	Puuone	Hōlualoa 1st	3.06
10400	Naaimakaohi	Hōlualoa 1st & Hōlualoa 2nd	3.5

PREVIOUS ARCHAEOLOGICAL STUDIES

There are at least 26 previous archaeological reports for lands near the current project area, including studies in Puapuaʻa 2nd and Hōlualoa 1st, 2nd, and 3rd Ahupuaʻa (Table 4 and Figure 9). The studies were conducted from the coast to roughly 1,460 ft amsl and encompass the *kula* region (0-500 ft), the *kaluʻulu* region (500-1,000 ft), and the lower portions of the *ʻāpaʻa* region (1,000-2,500 ft). Results of the previous archaeological studies are summarized below by elevation: studies numbered 1 through 15 in Table 2 and Figure 9 are situated from the coast to Queen Kaʻahumanu Highway (0-360 ft amsl), studies 16 through 21 are located from above the Queen Kaʻahumanu Highway to just below Hualālai Road (306-760 ft amsl), and studies 22 through 24 are above Hualālai Road to just above Māmalahoa Highway (1,100-1,460 ft amsl).

Table 2: Inventory of Previous Archaeological Investigations.

Project Number (Figure 8)	Reference	Type of Study	Area in Acres	Results
1	Landrum et al. 1990	Archaeological Inventory Survey	N/A	46 Sites
1	Calis et al. 2004	Archaeological Data Recovery	N/A	10 Sites
2	Carlson & Rosendahl 1990	Archaeological Inventory Survey	65	64 Sites
3	Haun et al. 1998	Archaeological Inventory Survey	15	31 Sites
4	Hammatt & Folk 1981	Archaeological Survey	20	20 Sites
4	Hammatt et al. 1986	Archaeological Survey & Excavations	20	21 Sites
5	Haun & Henry 2001	Archaeological Data Recovery	1.59	1 Site
6	Escott 2013	Archaeological Inventory Survey	1.962	2 Sites
7	Sinoto 1979	Archaeological Reconnaissance Survey	6	Rock Walls
8	Hammatt 1979b	Archaeological Survey	22	3 Sites
9	Hammatt 1979c	Archaeological Survey	23	39 Sites
10	Conolly & Gunness 1979	Archaeological Reconnaissance Survey	46.8	80 Sites
10	Hammatt 1979a	Archaeological Inventory Survey	46.8	11 Sites
10	Hammatt 1980	Archaeological Survey & Excavation	103	88 Sites
11	Nelson et al. 205	Archaeological Inventory Survey	28	22 Sites
12	Rosendhal 1978	Archaeological Reconnaissance Survey	2.5	1 Site

Project Number (Figure 8)	Reference	Type of Study	Area in Acres	Results
12	Soehren 1980a	Archaeological Reconnaissance Survey	n/a	7 Sites
12	Wolforth et al. 2000	Archaeological Inventory Survey	8	7 Sites
13	Barrera 1995	Archaeological Reconnaissance Survey	17	3 + several ag. mounds
13	Haun & Henry 2000	Archaeological Inventory Survey	17	12 (104 Features, 82 of Which Were Agricultural)
14	Rosendahl 1989	Archaeological Field Inspection	6	Modified Outcrops
15	Schilt 1984	Archaeological Study	17	134 Sites
16	Walker & Rosendahl 1988	Archaeological Reconnaissance Survey	104	67 Sites
16	Graves & Goodfellow 1993	Archaeological Data Recovery	104	58 Sites
16	Maly & Rosendahl 2006	Archaeological Preservation Plan	104	67 Sites
17	Hammatt et al. 1992	Archaeological Survey	174	71 Sites
18	Soehren 1980b	Archaeological Reconnaissance Survey	16	1 Site
19	Rechtman 2006	Archaeological Inventory Survey	1.008	2 Sites
20	Rosendahl 1988	Archaeological Reconnaissance Survey	17	17 Sites
20	Fager & Graves 1993	Archaeological Inventory Survey	17	17 Sites
21	Dircks et al. 2013	Archaeological Inventory Survey	10.266	1 Site (149 Historic to Modern Farming Features)
22	Desilets et al. 2004	Archaeological Inventory Survey	11.7	1 Homestead Features
23	Rechtman 2013		29	24 Sites
24	Clark & Rechtman 2006	Archaeological Inventory Survey	2.7	6 Historic Era Sites
25	Escott & Escott 2018	Archaeological Inventory Survey	5.0	22 Pre-Contact and Historic Era Sites
26	Escott & Escott 2020	Archaeological Inventory Survey	73.122	18 Pre-Contact and Historic Era Sites 1 Isolated Find (Petroglyph)

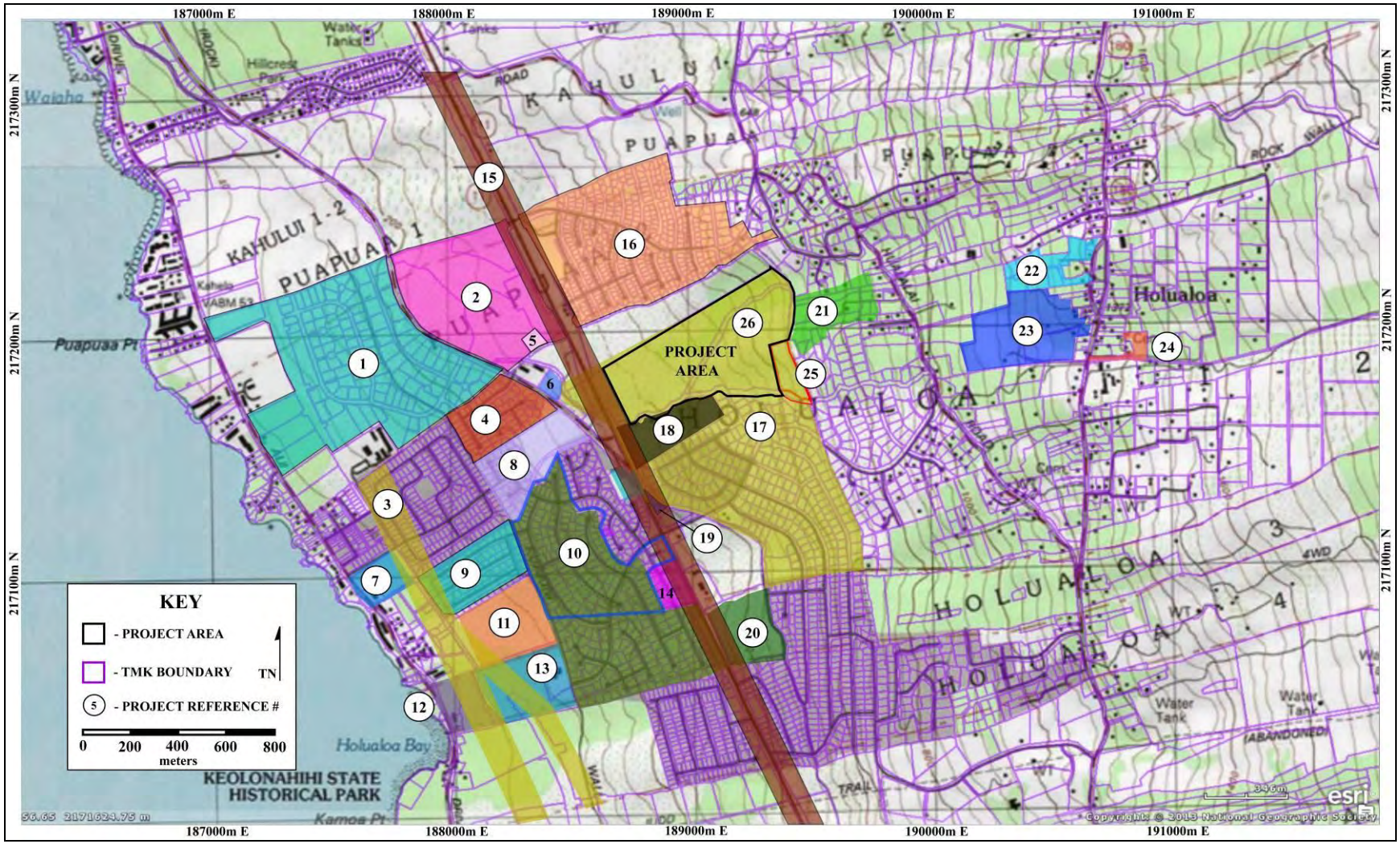

Figure 9: 7.5-Minute Series USGS Topographic Map Showing Location of Previous Archaeological Studies and Project Area (Kealakekua Quad, ESRI, 2013. Data Sources: National Geographic Society, USGS).

REGIONAL PREVIOUS ARCHAEOLOGICAL STUDIES

1. Landrum et al. 1990, and Calis et al. 2004. PHRI, Inc. conducted an archaeological inventory survey (Landrum et al. 1990) and SCS, Inc. conducted data recovery investigations (Calis et al. 2004) at the Kahakai development project. The project area is located within the lower elevations of Puapuaʻa 2nd Ahupuaʻa. Pre-Contact era to early post-Contact era cave shelters, agricultural rock clearing mounds, burials, shrines, and a possible heiau were identified during the AIS study. A heiau complex, several burials, and five permanent habitation sites were recommended for preservation. All of the preservation sites are near the coast.

2. Carleson and Rosendahl 1990. PHRI, Inc. conducted an archaeological inventory survey of 65 acres between Kuakini and Queen Kaʻahumanu highways in Puapuaʻa 2nd Ahupuaʻa. Their study recorded 64 archaeological sites including pre-Contact era habitation, agricultural, and burial sites. Seven sites were assessed as significant and recommended for preservation (Carleson and Rosendahl 1990: 34).

3. Haun et al. 1998. PHRI, Inc. conducted an archaeological inventory survey of the proposed Aliʻi Drive corridor through several ahupuaʻa. Numerous pre-Contact era site complexes were recorded in Puapuaʻa 2nd and Hōlualoa 1st through 4th Ahupuaʻa. The site complexes included a large number of agricultural features, as well as habitation, burial, and ceremonial features.

4. Hammatt and Folk 1981, and Hammatt et al. 1986. Two archaeological surveys were conducted on a 20-acre parcel of below Kuakini Highway. The first study recorded 20 sites, and the second recorded 21 sites. None of the sites were recommended for preservation (Hammatt and Folk 1981: ii, and Hammatt et al. 1986: 87). The report also recommended that the single documented burial be relocated.

5. Haun & Henry 2001. Haun and Associates conducted an archaeological data recovery study at a c-shaped enclosure located on 1.59 acres of land below Queen Kaʻahumanu Highway

6. Escott 2013. SCS conducted an archaeological study on1.962 acres of land near the intersection of Kuakini and Queen Kaʻahumanu highways. Two historic era ranch walls were recorded during the study.

7. Sinoto 1979. Aki Sinoto recorded several Historic era ranch rock walls on a six acre parcel of land just mauka of Ali‘i Drive.

8. Hammatt 1979b. The Archaeological Research Center, Inc. conducted an archaeological survey of 22 acres just south of Kuakini Highway. Three archaeological sites were recorded during the study. None of the sites were recommended for preservation (Hammatt 1979b: ii, and 10).

9. Hammatt 1979c. The Archaeological Research Center, Inc. conducted an archaeological survey of 23 acres located in the near coastal portion of Hōlualoa 1st and 2nd Ahupua‘a. Thirty nine archaeological sites were recorded during the study. The report recommended that all burials, including a known cemetery site be relocated (Hammatt 1979a: 5). None of the remaining sites (pre-Contact era habitation and agriculture sites) were recommended for preservation in place.

10. Conolly and Gunness 1979, and Hammatt 1979a and 1980. The Archaeological Research Center, Inc. conducted an archaeological survey of 103 acres within the near coastal portions of Hōlualoa 1st through 4th Ahupua‘a (Hammatt 1980). One hundred and thirty six archaeological sites were recorded on the project area. They included pre-Contact era habitation, agriculture, burial, and a ceremonial sites. The Hammatt report recommended that a heiau (Site 6661) was significant and should be preserved in place (Hammatt 1980: 4). The report also recommended that the single documented burial be relocated to the perimeter of heiau (Site 6661) and preserved. No other sites were recommended for preservation.

11. Nelson et al. 2005. An archaeological inventory survey was conducted by Rechtman Consulting on 28.0 acres located in the near coastal portion of Hōlualoa 2nd Ahupua‘a. A total of 22 sites containing 150 features were recorded. The sites were primarily pre-Contact era agricultural and habitation sites, though five burial sites, a possible heiau, and a trail were also documented within the project area.

12. Rosendahl 1978, Soehren 1980a, Wolforth et al. 2000. PHRI conducted an archaeological inventory survey of eight acres of coastal Hōlualoa 3rd Ahupua‘a and recorded seven archaeological sites including three Historic era rock walls, three residential sites, and Hikapaia Heiau.

13. Barrera 1995, Haun & Henry 2000. Barrera (1995) recorded a possible burial platform, two habitation site, agricultural rock clearing mounds and modified outcrops during a reconnaissance survey of 17 acres in near coastal Hōlualoa 2nd Ahupuaʻa. Haun and Associates conducted an archaeological inventory survey of the property and recorded 12 sites with 104 features (Haun and Henry 2000:14). The majority of features (n=82) were pre-Contact era agricultural rock clearing mounds. Eleven permanent habitation and one temporary habitation feature were also recorded during the study.

14. Rosendahl 1989. PHRI conducted an archaeological field inspection of 6.0 acres of land just below Queen Kaʻahumanu Highway in Hōlualoa 2nd Ahupuaʻa. Several modified outcrops were recorded in the letter report. There were no other archaeological features identified on the project area.

15. Schilt 1984. The Bishop Museum conducted an archaeological study of the Kuakini Highway Realignment Project located roughly along present day Queen Kaʻahumanu Highway and recorded 39 sites Puapuaʻa 2nd and Hōlualoa 1st and 2nd Ahupuaʻa. Twenty two of the sites were pre-Contact to early post-Contact era agricultural gardens and modified outcrops (rock clearing). There were also traditional habitation platforms and trails, as well as Historic era roads and walls recorded during the study.

16. Walker and Rosendahl 1988, Graves and Goodfellow 1993, and Maly and Rosendahl 2006. An archaeological reconnaissance survey (Walker and Rosendahl 1988), an archaeological data recovery study (Graves and Goodfellow 1993), and an archaeological preservation plan (Maly and Rosendahl 2006) were conducted by PHRI, Inc. for 104 acres in the upland region of Puapuaʻa 2nd Ahupuaʻa. A total of 67 sites were documented within the project area, including traditional (KFS) sites, temporary habitation sites, three burials, and a *heiau*. The archaeological preservation plan recommended that the three burials be relocated to the *heiau* site, and that the *heiau* be preserved as a formal historic preservation area (Maly and Rosendahl 2006).

17. Hammatt et al. 1992. An archaeological survey was conducted by Cultural Surveys Hawaiʻi on 174 acres of land in the upland region of Hōlualoa 1st, 2nd, and 3rd Ahupuaʻa. The project area lands had been heavily bulldozed during the modern era for ranching and agricultural purposes. Despite the bulldozing, seventy one sites were recorded during the study, including temporary habitation features, rock walls, agricultural features, and

three burial sites. Many of the sites were determined to be associated with Historic era ranching and agriculture.

18. Soehren 1980b. Soehren conducted an archaeological reconnaissance survey of 16.0 acres above Queen Ka‘ahumanu Highway in the inland region of Hōlualoa 1st Ahupua‘a (Soehren 1980b). A single enclosure was identified during the survey.

19. Rechtman 2006. An archaeological inventory survey was conducted by Rechtman Consulting, LLC on a roughly one-acre parcel located *makai* of Queen Ka‘ahumanu Highway in Hōlualoa 2nd Ahupua‘a. Two rock walls were recorded on the project area. The report recommended no further work at the wall sites.

20. M. Rosendahl 1988, Fager & Graves 1993. Fager and Graves (1993) conducted an archaeological inventory survey of 17.0 acres just mauka of Queen Ka‘ahumanu Highway in Hōlualoa 3rd Ahupua‘a. Seventeen sites containing 27 pre-Contact to early post-Contact era agricultural features, including rock mounds, modified outcrops, C-shaped enclosures, terraces, walls, and rock enclosures, were recorded.

21. Dircks et al. 2013. Rechtman Consulting conducted an archaeological inventory survey of 10.266 acres of land located between 840 and 920 ft amsl in Hōlualoa 1st and 2nd Ahupua‘a. One Historic era to modern era homestead/agriculture site (Miyose Farm) containing 149 features was recorded during the survey.

22. Desilets et al. 2004. Desilets et al. (2004) conducted an archaeological inventory survey of 11.7 acres of land in the *‘āpa‘a* region of Hōlualoa 1st Ahupua‘a. A single site associated with Historic era and modern era homesteads, commercial agriculture (coffee), and ranching was recorded. Features included rock walls, roads, coffee terraces, and buildings.

23. Rechtman 2013. Rechtman Consulting conducted and archaeological inventory survey of 29 acres of land located in the *‘āpa‘a* region of Hōlualoa 1st Ahupua‘a. Twenty four sites were recorded. The majority of the sites were associated with Historic era and modern era homesteads, commercial agriculture. Features included rock walls, roads, and remnants of structures. A single pre-Contact era to early post-Contact era residential and agricultural site was also recorded.

24. Clark & Rechtman 2006. Rechtman Consulting conducted an archaeological inventory survey of 2.7 acres of land located in the *ʻāpaʻa* region of Hōlualoa 1st Ahupuaʻa. Six sites were recorded, including five ranch walls and an area of coffee terraces.

A number of conclusions can be made from the previous archaeological studies. A primary conclusion is that the majority of habitation features, especially permanent habitation features, are located from the coast to about 360 ft amsl, below the present day Queen Kaʻahumanu Highway. The same is true of ceremonial features, burials, and, to a lesser extent, agricultural features. The density of agricultural features and habitation features, mostly temporary habitation features, in the upland regions between 360 ft amsl and 700 ft amsl is much lower than the site density in the coastal *kula* and lower *kaluʻulu* regions of the KFS. The pre-Contact traditional Hawaiian settlement and agricultural patterns are strongly oriented to the *kula* and lower *kaluʻulu* regions.

Even though cattle ranching and commercial agriculture may have removed some archaeological sites from the ground surface in the *kaluʻulu* region, there appear to be fewer sites than at lower elevations. The majority of sites in the *kaluʻulu* region are KFS agricultural sites including rock clearing mounds, modified outcrops, garden enclosures, and low garden walls. Within the lands of the current project, it is clear that ranching and commercial agricultural practices have removed and damaged many of the pre-Contact era sites from the ground surface (see the Hammatt et al. 1992 summary below). Moreover, many of the sites identified near the current project area are associated with Historic era ranching and commercial agriculture.

A second conclusion is that the establishment of Historic era homesteads, ranches, and commercial agriculture seems to have removed, or obscured, the majority of pre-Contact era sites in the upper *kaluʻulu* and lower *ʻāpaʻa* regions. It might be that pre-Contact uses in these regions did not involve the construction of large or permanent features, as in the lower regions of Kona. It is also likely that Historic era ranching and commercial agriculture in the lower *ʻāpaʻa* region have caused large scale land alterations through the use of bulldozers for pasture and garden. It is possible that traditional features were disassembled to build rock walls and coffee terraces.

CURRENT PROJECT AREA SPECIFIC PREVIOUS ARCHAEOLOGY

26. Hammatt et al. 1992. Lands of the current AIS study were subject to an AIS study conducted by Hammatt et al. (1992). That study encompassed 66.039 acres of land within the current project area located between 320 to 690 feet (98 to 210 meters) amsl [TMK: (3) 7-6-021:016 and 017] (see Figure 9, Project #17). The current project area is located within the northern portion of the Hammatt et al. (1992) project area.

Twenty one archaeological sites and two areas of bulldozed modern planting "terraces" were recorded in the AIS report (Figure 10 and Table 3). Eight of the 21 archaeological sites (SIHP #50-10-37-10015, #50-10-37-10017, #50-10-37-10018, #50-10-37-10020, #50-10-37-10031, #50-10-37-10033, #50-10-37-10034, and #50-10-37-10049, hereafter abbreviated to the last five digits) were recorded by CSH in tabular format only. Written descriptions of the remaining 13 sites are in the CSH AIS report. Excavations were conducted at ten of the 13 sites. The AIS report included plan view figures for four of the 13 sites. At the request of SHPD, additional site documentation for Sites 10011, 10012, 10031, 10049, and 10071 was submitted to SHPD in a letter report (Hammatt and Shideler 2007).

Six of the sites were determined to be pre-Contact era, four associated with habitation, one with agriculture, and one single feature site (Site 10012) contained two burials. Fifteen of the sites were determined to be Historic era sites, the majority associated with coffee agriculture and cattle ranching. Two Historic era habitation sites were also documented in the AIS study.

The burials at Site 10012 were removed and reinterred off-project prior to 1983. The site was further excavated to ensure that all *iwi* had been removed. The site was then back-filled and leveled by bulldozer.

The AIS recommended no further work at all 21 sites documented in the current project area. The Hammatt and Shideler (2007) letter report repeated the AIS recommendation that "all surface sites in the area were documented" in the AIS report and that "significant material from the study area has been recovered and that further investigation would be of minimum productivity" (Hammatt and Shideler 2007:11). However, the authors recommended that the sites should be located to document their current conditions and to document the sites to prevailing SHPD AIS standards.

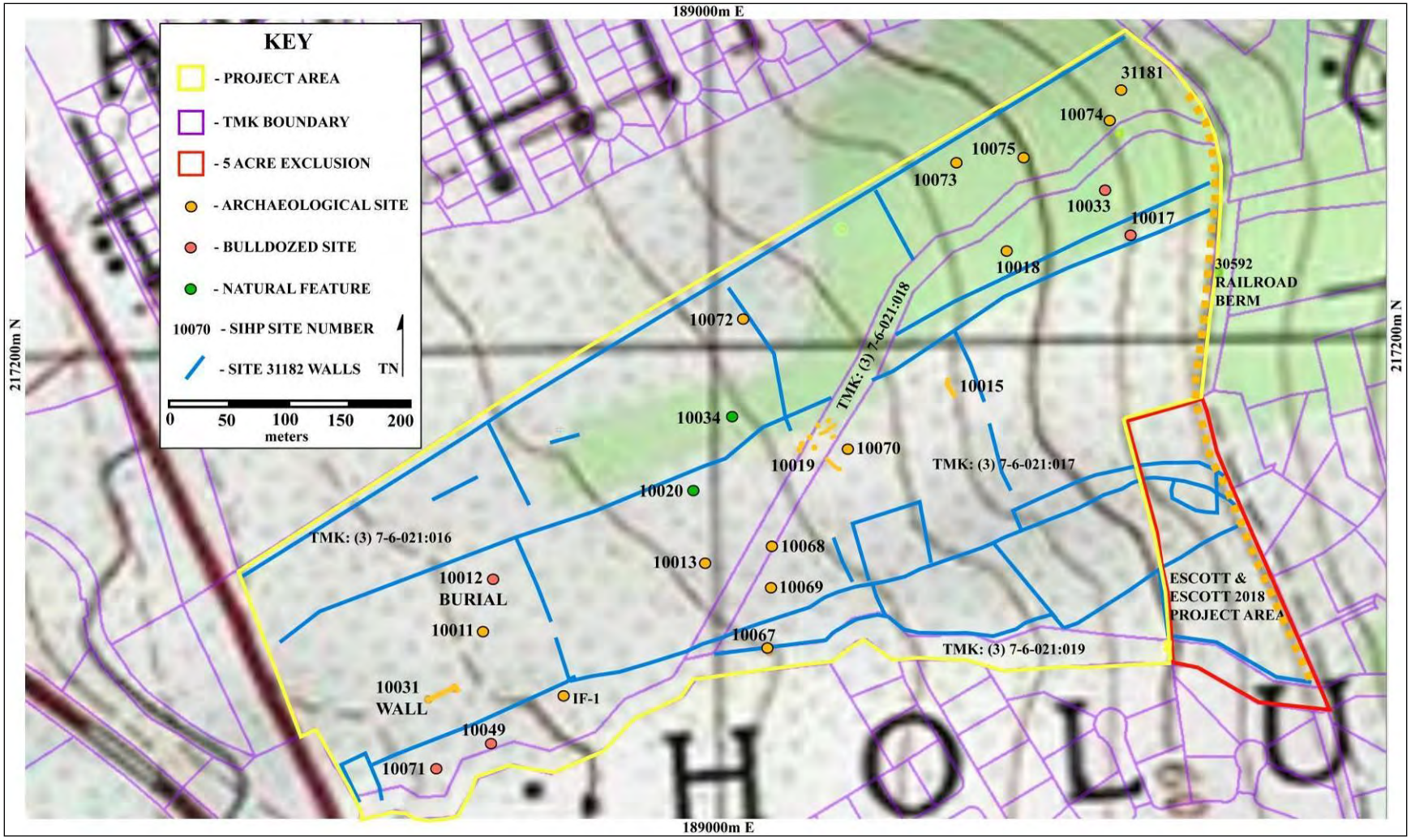

Figure 10: 7.5-Minute Series USGS Topographic Map Showing Location of Northern Portion of Hammatt et al. (1992) Sites and Current Project Area (ESRI, 2011. Sources: National Geographic Society, USGS. Kealakekua Quadrangle).

Table 3: Inventory of Previously Recorded Archaeological Sites (Hammatt et al. 1992; Hammatt and Shideler 2007).

SIHP #	CSH SITE#	TYPE	FUNCTION	AGE	EXCAVATION	CULTURAL MATERIAL
10011	9	Platform	Ag. Clearing	Prehistoric	1.5 m long trench	3 cowrie shells
10012	10	Platform & Wall	Burial	Prehistoric	Entire Feature	Burial reinterred off-project
10013	11	Enclosure & Lava Tube	Habitation	Prehistoric	4.5 m square total	Fire features & Prehistoric artifacts
10015	13	Terrace	Road Bed	Historic		
10017	15	Platform	Cattle Ramp	Historic		
10018	16	Enclosure	Habitation	Historic		
10019	17	6 Rock Mounds	Ag. Clearing	Historic	3 1.0 m wide trenches	Metal File
10020	18	Platform	Ag. Clearing	Historic		
10031	110	Enclosure Wall	Agriculture	Historic		
10033	112	Planting Complex	Coffee Ag	Historic		
10034	113	Platform	Ag. Clearing	Historic		
10049	216	Terraces	Agriculture	Historic		
10067	232	Terraces	Habitation	Prehistoric	1.0 X 1.0 m	VG & a small amount of midden & fire feature
10068	233	Enclosure	Habitation	Prehistoric	0.5 X 0.25 m	small amount of midden
10069	234	Modified Bluff/Platform	Habitation	Historic	0.5 X 0.5 m	VG & a small amount of midden
10070	235	U-Shape Enclosure	Agriculture	Historic	1.0 X 0.5 m	No artifacts
10071	237	Platform	Habitation	Prehistoric		
10072	238	Modified Bluff	Ag. Clearing	Historic	7.0 m square total	No arts Small amount of MS in TU-2
10073	239	Platforms	Ranching/Ag.	Historic		
10074	240	Enclosure	Coffee Work Shed	Historic	1.25 m square total	1 VG, little MS, historic artifacts
10075	241	Enclosure	Pig Pen	Historic		

In a letter to the County of Hawai‘i Department of Planning dated July 30, 2018, (Log. No. 2018.00878 Doc. No. 1807SN01), SHPD requested a new pedestrian survey to identify all archaeological historic properties present on the project area, and to update previous archaeological documentation to include site plans for each site with site boundaries and areas impacted by bulldozing, photographs of all sites and features, an assessment of their integrity, and site significance.

25. Escott & Escott 2018. SCS conducted an archaeological inventory survey on a 5.0-acre portion of Parcel 017 in the southeast portion of the current project area (Escott and Escott 2018) and recorded twenty-two new archaeological sites within the project area (Table 4 and Figure 11). Fifteen of the sites are single-feature sites. The remaining seven agricultural sites contained two to seven features. A majority of the sites are agricultural terraces and complexes dating to the pre-Contact era to the Historic era. The agricultural complexes are located in the lower *kalu‘ulu* zone, between 600 and 700 feet (182 to 213 meters) amsl.

Three of the ranch walls (Site 30595, 30601, and 3065) are the primary dividers of the five-acre project area. These Historic era walls have typical characteristics of ranch walls including cobble core fill and bi-faced inward sloping walls toward the top. They are approximately 1.0 meter tall. Site 30602 and Site 30603 are Historic era ranching and agricultural enclosures constructed along wall Site 30595 and wall Site 30601. These two wall sites are constructed onto the west edge of the Site 30592 railroad berm and post-date the railroad berm.

The northern third of the project area only has two sites (Site 30591 and 30956). Site 30591 is an agricultural complex with six terraces. Portions of the sites were bulldozed in the early Modern era. Both sites date to pre-Contact to early Historic era. The terraces reflect Kona Field System features but are roughly constructed that more closely resemble Historic era commercial agriculture. Site 30956 is a rectangular Historic style hearth.

The middle one third of the project area between wall sites 30595 and 30605 is within the bulldozed “terraces” portion of the project area. Site 30593 is a pre-Contact era to early post-Contact era lava tube burial. The burial will be preserved in place in accordance with a Burial Site Component of a Preservation Plan. Site 30594 is an

agricultural terrace complex that resembles the Kona Field System but is more roughly constructed. Artifacts recovered from subsurface testing at Site 30604 suggest it is a Historic era agricultural terrace.

The southern third of the project area, south of wall Site 30605, contained six primarily agricultural sites (Site 30598, 30600, 30606, 30607, 30610, and 30611) and four Historic era sites (Site 30599, 30608, 30609, and 30612) with functions other than agriculture. The agricultural features included rock walls (Site 30598 and30606), terraces (Site 30600 and 30610), and agricultural complexes with terraces (Site 30607 and 30610). The non-agricultural features included three enclosures (Site 30599, 30608, and 30609), and a refuse disposal area lava blister (Site 30612). The cluster of these sites indicates their use for Historic era commercial agriculture.

Twenty-nine shovel probes and two excavation units tested the sites. Marine shell fragments, a basalt flake and volcanic-glass flakes recovered during testing indicate that Hawaiians likely used the area for limited agricultural purposes. However, the agricultural terraces more closely resemble the remains of Historic era commercial agriculture.

All 22 sites identified during the current AIS study were assessed significant under criterion "d" as they are likely to yield information important to history. The railroad berm is also significant under criteria "a" and "c" as it is associated with events that have made a significant contribution to the broad patterns of our history and it embodies distinctive characteristics of the type, period, and method of railroad bed construction. The railroad berm was recommended for preservation with preservation measures outlined in an archaeological preservation plan (Escott and Mello 2019b). The rest of the sites require no further work.

The burial is also significant under criterion "e" as it has important value to Hawaiian people and people of other ethnic backgrounds in the state. The burial was recommended for preservation in place with preservation treatments outlined in a Burial Site Component of a Preservation Plan (Escott and Mello 2019a).

Table 4: Inventory of Archaeological Sites Identified on the AIS Project Area (Escott and Escott 2018).

Site #	Site Type	Features	Site Function	Age	Testing
30591	Agricultural Complex	6	Agriculture	Pre-Contact to Historic Era	SP-1, 2, 3
30592	Railroad Bed and Berm	1	Transportation	Historic Era	
30593	Lava Tube Burial	1	Burial	Pre-Contact to Early Post-Contact Era	
30594	Agricultural Complex	6	Agriculture	Pre-Contact to Historic Era	SP-1 & 2
30595	Rock Wall	1	Ranching	Historic Era	
30596	Hearth	1	Food Preparation	Historic Era	TU-1
30597	Rock Wall	1	Ranching	Historic Era	
30598	Rock Wall	1	Agriculture/Ranching	Pre-Contact to Historic Era	
30599	Platform & Enclosure	2	Ranching/Agriculture	Historic Era	SP-1 & 2, TU-1
30600	Terrace	1	Agriculture	Historic Era	SP-1
30601	Rock Wall	1	Ranching	Historic Era	
30602	Enclosure	1	Ranching/Agriculture	Historic Era	SP-1, 2, 3 & 4
30603	Enclosure	4	Ranching/Agriculture	Historic Era	SP-1 & 2
30604	Agricultural Complex	4	Agriculture	Pre-Contact to Historic Era	SP-1
30605	Rock Wall	1	Ranching/Agriculture	Historic Era	
30606	Rock Wall	1	Ranching/Agriculture	Pre-Contact to Historic Era	
30607	Agricultural Complex	7	Agriculture	Pre-Contact to Historic Era	SP-1 to SP-10
30608	Enclosure	1	Structure	Historic Era	
30609	Enclosure	1	Structure	Historic Era	
30610	Terrace	1	Agriculture	Pre-Contact to Historic Era	SP-1
30611	Agricultural Complex	3	Agriculture	Pre-Contact to Historic Era	SP-1, 2, 3
30612	Lava Blister	1	Refuse Dump	Historic Era	

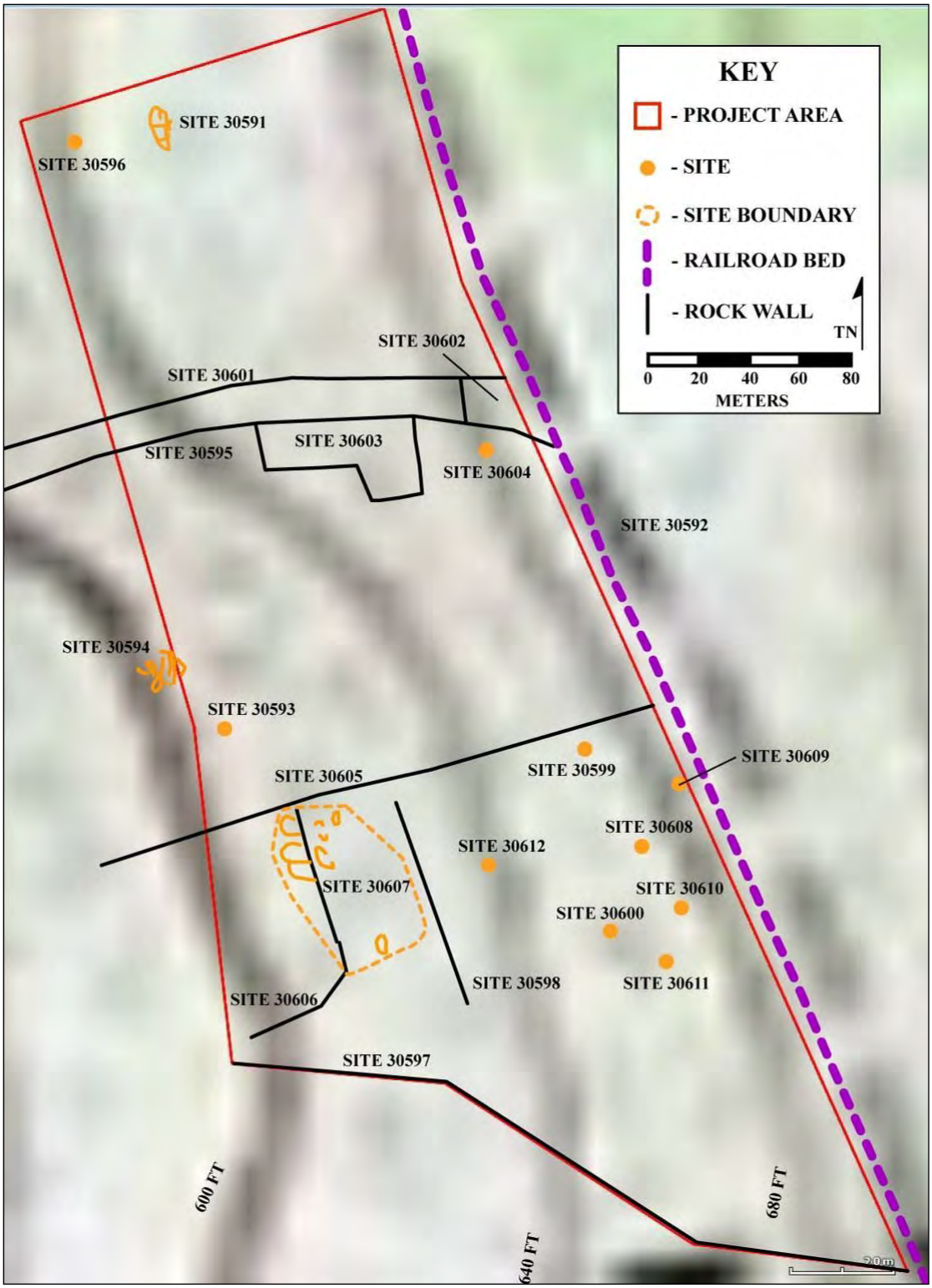

Figure 11: 7.5-Minute Series USGS Topographic Map Showing Locations of Escott and Escott (2018) AIS Project Area Archaeological Sites (ESRI, 2011. Sources: National Geographic Society, USGS. Kealakekua Quadrangle).

26. Escott & Escott 2020. SCS conducted an archaeological inventory survey on a 73.122-acre portion of the current project area in Parcel 016, 017 (por.), 018, and 019 to identify all archaeological historic properties present on the project area, and to update previous archaeological documentation (see Figure 10).

Seventeen of the twenty-one sites previously identified in Hammatt et al. (1992) were located during the course of the archaeological inventory survey study (Figure 10 and Table 5). Two of the previously documented sites (Site 10020 and Site 10034) relocated by SCS are natural bedrock outcrops and one site former burial site (Site 10012). The burials at Site 10012 were reinterred off-project in 1983.

The four remaining previously documented sites (Sites 10017, 10033, 10049, and 10071) were bulldozed prior to the SCS fieldwork and the remains of the sites are no longer present on the ground surface. Three previously undocumented sites were also recorded, including a portion of the railroad berm (Site 30592), a small coffee shed enclosure (31181), and several ranch walls (31182). A single petroglyph on a loose cobble was recorded as Isolated Find 1 (IF-1).

A total of 21 sites, 17 previously documented and four newly documented, were identified on the project area and are documented in this report. Two of the sites (Site 10020 and Site 10034) were determined to be natural geological features. Six of the sites were determined to be pre-Contact era, three associated with habitation, one with agriculture, a single petroglyph site, and one single feature site (Site 10012) formerly contained two burials. Twelve of the sites were determined to be Historic era sites, the majority associated with coffee agriculture and cattle ranching. Two Historic era habitation sites were also documented in the AIS study. One site (Site 10015) was determined to be a short segment of modern bulldozer road.

The burials at Site 10012 were removed and reinterred off-project prior to 1983. The site was further excavated to ensure that all *iwi* had been removed. The site was then back-filled and leveled by bulldozer.

Table 5: Inventory of Escott & Escott (2020) Archaeological Sites.

SIHP#	TYPE	FUNCTION	AGE
10011	Platform	Ag. Clearing	Pre-Contact
10012	Platform & Wall	Burial	Prehistoric
10013	Enclosure & Lava Tube	Habitation	Pre-Contact
10015	Bulldozer Road	Transportation	Modern
10017	Platform	Cattle Ramp	Historic
10018	Enclosure	Agricultural	Historic
10019	6 Rock Mounds	Ag. Clearing	Historic
10020	Bedrock Outcrop	Geological Feature	Natural
10031	Enclosure Wall	Agriculture	Historic
10033	Planting Complex	Coffee Ag	Historic
10034	Bedrock Outcrop	Geological Feature	Natural
10049	Terraces	Agriculture	Historic
10067	Terraces	Habitation	Prehistoric
10068	Enclosure	Habitation	Prehistoric
10069	Modified Bluff/Platform	Habitation	Historic
10070	U-Shape Enclosure	Agriculture	Historic
10071	Platform	Habitation	Prehistoric
10072	Modified Bluff	Ag. Clearing	Pre-Contact
10073	Platforms	Ranching/Ag.	Historic
10074	Enclosure	Coffee Work Shed	Historic
10075	Enclosure	Pig Pen	Historic
30592	Railroad Berm	Transportation	Historic
IF-1	Petroglyph	Marker	Prehistoric
31181	Enclosure	Coffee Work Shed	Historic
31182	Rock Walls	Ranching & Agri	Historic

* Site numbers are preceded by the prefix 50-10-37-.

CULTURAL INFORMANT INTERVIEWS

Consultation was sought from Jordan Kea Calpito, SHPD Burial Sites Specialist; Kamakana Ferreira, OHA Compliance Officer; Nicole Lui, cultural descendant, Sean Naleimaile, State Historic Preservation Division (SHPD) Hawai‘i Island Archaeologist; Kekoa Nezara, Kona Hawaiian Civic Club President; Shane Nelson, OHA West Hawai‘i Representative; and J, Curtis Tyler III, cultural descendant (Table 4). Consultation was also conducted via telephone with Gregg Kashiwa who served as project property manager for parcels 016 and 017 in the early 1980s.

Table 4: Individuals Responses to CIA Consultation Request.

Name	Affiliation	Responded	Has Knowledge	Cultural Practices
Jordan Kea Calpito	SHPD Burial Sites Specialist	No	-	-
Kamakana Ferreira	OHA Compliance Officer	No	-	-
Gregg Kashiwa	Former Property Manager	Yes	Yes	No
Nicloe Lui	Cultural Descendant	Yes	Yes	No
Sean Naleimaile	SHPD Archaeologist	No	-	-
Kekoa Nazara	Kona Hawaiian Civic Club	Yes	Some	No
Shane Nelson	OHA West Hawai‘i Rep.	No	-	-
J. Curtis Tyler III	Cultural Descend	Yes	Yes	No

GREGG KASHIWA CONSULTATION

Gregg Kashiwa was interviewed by phone on April 19, 2016. Mr. Kashiwa was the project property manager for parcels 016 and 017 in the early 1980s and was present during AIS work documented in the Hammatt et al. (1992). He is originally from O‘ahu but lived in Kona for several decades. Mr. Kashiwa remembered that the 5-acre portion of Parcel 017 in the southeast portion of the project area was excluded from the original AIS because the property owners were planning to give the five acres to a group to use as an agricultural preserve. The five acres and the property below (to the west) had already been bulldozed for agricultural use. Mr. Kashiwa knew that there were ranch walls and Historic era agricultural features on the project area, but did not know how they were used, as they were no longer in use during his time in Kona. He also remembered the old railroad bed and berm and that there was a small railroad stop along the track just south of the project area.

SUMMARY

The "level of effort undertaken" to identify potential effect by a project to cultural resources, places or beliefs (OEQC 1997) has not been officially defined and is left up to the investigator. A good faith effort can mean contacting agencies by letter, interviewing people who may be affected by the project or who know its history, research identifying sensitive areas and previous land use, holding meetings in which the public is invited to testify, notifying the community through the media, and other appropriate strategies based on the type of project being proposed and its impact potential.

In the case of the present parcel, consultation was sought from Jordan Kea Calpito, SHPD Burial Sites Specialist; Kamakana Ferreira, OHA Compliance Officer; Nicole Lui, cultural descendant, Sean Naleimaile, State Historic Preservation Division (SHPD) Hawai‘i Island Archaeologist; Kekoa Nezara, Kona Hawaiian Civic Club President; Shane Nelson, OHA West Hawai‘i Representative; and J, Curtis Tyler III, cultural descendant. Consultation was also conducted via telephone with Gregg Kashiwa who served as project property manager for parcels 016 and 017 in the early 1980s.

Public notices (see Appendix A) were placed in the December 2019 issue of the Office of Hawaiian Affairs (OHA) Ka Wai Ola Newspaper. Public notices were also published in the Honolulu Star-Advertiser, and the West Hawai‘i Today on November 17th, 20th and 21st.

Historical and cultural source materials were extensively used and can be found listed in the References Cited portion of the report. Such scholars as I‘i, Kamakau, Chinen, Kame‘eleihiwa, Fornander, Kuykendall, Kelly, Handy and Handy, Puku‘i and Elbert, Thrum, and Cordy have contributed, and continue to contribute to our knowledge and understanding of Hawai‘i, past and present. The works of these and other authors were consulted and incorporated in the report where appropriate. Land use document research was supplied by the Waihona ‘Aina 2007 Data Base.

CIA INQUIRY RESPONSE

As suggested in the "Guidelines for Accessing Cultural Impacts" (OEQC 1997), CIAs incorporating personal interviews should include ethnographic and oral history interview procedures, circumstances attending the interviews, as well as the results of this consultation. It is also permissible to include organizations with individuals familiar with cultural practices and features associated with the project area.

As stated above, consultation was sought from the Office of Hawaiian Affairs, the SHPD Burial Sites Branch, the SHPD Archaeology Branch, families associated with Kaloa 5th Ahupuaʻa, and long-time Kona residents.

There were no responses to the public notices published in the OHA Ka Wai Ola, West Hawaiʻi Today or the Honolulu Star-Advertiser newspapers. J. Curtis Tyler III, Nicole Lui and Greg Kashiwa did provide information concerning lands of Hōlualoa 1st Ahupuaʻa. There were no past or ongoing cultural practices identified with lands of the current project area.

An analysis of the potential effect of the proposed construction of residences on cultural resources, practices or beliefs, its potential to isolate cultural resources, practices or beliefs from their setting, and the potential of the project to introduce elements which may alter the setting in which cultural practices take place is a requirement of the OEQC (No. 10, 1997). Based on historical research and responses from the above listed contacts, it is reasonable to conclude that, there will be no traditional cultural practices affected and there will be no direct adverse effect upon cultural practices or beliefs in the broader project area region.

CULTURAL ASSESSMEMNT

Based on the results of an Archaeological Assessment of the project area, the results of previous archaeological studies, as well as organizational response, individual cultural informant responses, and archival research, it is reasonable to conclude that, pursuant to Act 50, the exercise of native Hawaiian rights, or any ethnic group, related to gathering, access or other customary activities will not be affected by development activities on this parcel. The proposed project is not a location for past or ongoing cultural practices. The proposed undertaking will not produce adverse effects to any native Hawaiian cultural practices within the project area or in the broader region.

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APPENDIX A: PUBLIC NOTICES AND AFFIDAVITS

HOLUALOA

Information requested by Scientific Consultant Services, Inc. of past and ongoing cultural practices on 76.122 acres of land in Hōlualoa 1st Ahupua'a, North Kona District, Island of Hawai'i, TMK: (3) 7-6-021:016, 017, 018 and 019. Please respond within 30 days to Glenn Escott at (808) 938-0968 or at ggescott@yahoo.com.

December 2019 Ka Wai Ola Public Notice.

AFFIDAVIT OF PUBLICATION

IN THE MATTER OF
CULTURAL IMPACT ASSESSMENT NOTICE - WHEELOCK, KAILUA KONA III

STATE OF HAWAII }
} SS.
City and County of Honolulu }

Doc. Date: NOV 21 2019 **# Pages:** 1
Notary Name: COLLEEN E. SORANAKA First Judicial **Circuit**
Doc. Description: Affidavit of Publication

NOV 21 2019
Notary Signature Date

COLLEEN E. SORANAKA NOTARY PUBLIC No. 90-263 STATE OF HAWAII

CULTURAL IMPACT ASSESSMENT NOTICE

Information requested by Scientific Consultant Services, Inc. of past and ongoing cultural practices on 76.122 acres of land in Holualoa 1st Ahupua'a, North Kona District, Island of Hawai'i, TMK: (3) 7-6-021: 016, 017, 018 and 019. Please respond within 30 days to Glenn Escott at (808) 938-0968 or at gglescott@yahoo.com.
(SA1245900 11/17, 11/20, 11/21/19)

Lisa Sakakida being duly sworn, deposes and says that she is a clerk, duly authorized to execute this affidavit of Oahu Publications, Inc. publisher of The Honolulu Star-Advertiser, MidWeek, The Garden Island, West Hawaii Today, and Hawaii Tribune-Herald, that said newspapers are newspapers of general circulation in the State of Hawaii, and that the attached notice is true notice as was published in the

Honolulu Star-Advertiser 3 times on:
11/17, 11/20, 11/21/2019
MidWeek 0 times on:

The Garden Island 0 times on:

Hawaii Tribune-Herald 0 times on:

West Hawaii Today 0 times on:

Other Publications: 0 times on:

And that affiant is not a party to or in any way interested in the above entitled matter.

Lisa Sakakida

Subscribed to and sworn before me this 21 day of November A.D. 20 19

Colleen E. Soranaka, Notary Public of the First Judicial Circuit, State of Hawaii
My commission expires: Jan 06 2020

Ad # 0001245900

COLLEEN E. SORANAKA NOTARY PUBLIC No. 90-263 STATE OF HAWAII

ICSP NO.: _____

November 2019 Honolulu Star-Advertiser Public Notice.

AFFIDAVIT OF PUBLICATION

IN THE MATTER OF
CULTURAL IMPACT ASSESSMENT NOTICE - WHEELOCK, KAILUA KONA III

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Honolulu Star-Advertiser 0 times on:

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Hawaii Tribune-Herald 0 times on:

West Hawaii Today 3 times on:

11/17, 11/20, 11/21/2019

Other Publications: 0 times on:

And that affiant is not a party to or in any way interested in the above entitled matter.

Lisa Sakakida

Subscribed to and sworn before me this 21 day of November A.D. 20 19

Colleen E. Soranaka, Notary Public of the First Judicial Circuit, State of Hawaii
My commission expires: Jan 06 2020

COLLEEN E. SORANAKA NOTARY PUBLIC No. 90-263 STATE OF HAWAII

Ad # 0001245902

ICSP NO.:

November 2019 West Hawai'i Today Public Notice.

APPENDIX 5: Archaeological Inventory Survey Reports

SCS Project Number 1871-2

ARCHAEOLOGICAL INVENTORY SURVEY REPORT FOR 5.0 ACRES LOCATED IN HŌLUALOA 1ST AHUPUA‘A, NORTH KONA DISTRICT, HAWAI‘I ISLAND, HAWAI‘I [TMK: (3) 7-6-021:017 POR.]

Prepared By:

Glenn G. Escott, M.A.
&
Suzan Escott, B.A.

MAY 2018
FINAL

Prepared for:
East West Realty
700 Bishop St. Suite 1000
Honolulu, HI 96813-4112

SCIENTIFIC CONSULTANT SERVICES Inc.

1347 Kapi‘olani Boulevard, Suite 408 Honolulu, HI 96814
Hawai‘i Island Office: PO Box 155 Kea‘au, HI 96749

ABSTRACT

At the request of property owner Kona Three, LLC, Scientific Consultant Services, Inc. (SCS) conducted an archaeological inventory survey (AIS) of a 5.0-acre portion of land TMK: (3)-7-6-021:017 located in Hōlualoa 1st Ahupuaʻa, North Kona District, Island of Hawaiʻi, Hawaiʻi. The owner is proposing to develop the property and contracted the archaeological study in anticipation of County of Hawaiʻi Planning Department application requirements. The owner's contact mailing address is 181 Kalanianaole Street Hilo, HI 96720-4703.

Prior to fieldwork, a search of geological maps, aerial photos, historical maps, historical documents, and archaeological reports was conducted. A pedestrian survey and site recording were conducted in March and April 2016 by Joe Farrugia, B.A., Suzan Escott, B.A, Tomasi Patolo, B.A., and Glenn Escott, M.A. A series of north/south transects spaced 2.0 to 4.0 meters apart were walked across the entire project area. Ground cover consisted of tall California and Guinea grass, *koa haole*, *kiawe*, and several *kukui* nut trees. Ground visibility was fair to poor.

The project area lands were used for cattle ranching and commercial agriculture from the early 1900s until the present. The majority of the project area has been bulldozed. Evidence of bulldozing is visible in aerial photographs as alternating bands of cleared bulldozer tracks and bands of push pile. Pedestrian survey confirmed the linear bands in the aerial photographs are bulldozer- cleared paths and linear piles of bulldozed rock along the cleared bulldozer paths.

Twenty two newly identified archaeological sites were recorded during the course of the archaeological inventory survey study. The sites are primarily agricultural terraces associated with pre-Contact era to Historic era agriculture. Several rock walls and enclosures are associated with Historic era agriculture and ranching. A pre-Contact era to later post-Contact era lava tube burial and a portion of the old railroad berm were also recorded.

All 22 sites identified during the current AIS study were assessed significant under criterion "d" as they are likely to yield information important to history. The railroad berm is also significant under criteria "a" and "c" as it is associated with events that have made a significant contribution to the broad patterns of our history and it embodies distinctive characteristics of the type, period, and method of railroad bed construction. The burial is also significant criterion "e" as it has important value to Hawaiian people and people of other ethnic backgrounds in the state. The burial is recommended for preservation in place with preservation treatments to be outlined in a Burial Site Component of a Preservation Plan (BSCPP). The railroad berm is recommended for preservation with preservation measures to be outlined in an archaeological preservation.

Archaeological monitoring is recommended for initial grubbing within the five-acre project area and for any proposed ground disturbance in the vicinity of Site 30592 and Site 30593 to ensure interim construction preservation measures are in place and to prevent disturbance of the two archaeological sites.

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INTRODUCTION

At the request of East West Realty, Scientific Consultant Services, Inc. (SCS) conducted an archaeological inventory survey (AIS) of a 5.0-acre portion of TMK: (3)-7-6-021:017 located in Hōlualoa 1st Ahupuaʻa, North Kona District, Island of Hawaiʻi, Hawaiʻi (Figure 1 and Figure 2). The owner is proposing to develop the property and contracted the archaeological study as in anticipation of County of Hawaiʻi Planning Department application requirements. The project area is bounded on the north and west by undeveloped cattle pasture, on the south by a seasonal gulch, and on the west by developed residential and farm land (Figure 3). The project area lands were used for cattle pasture and agriculture from the early 1900s to the present. The property is owned by Kona Three, LLC. The owner's mailing address is 181 Kalanianaole Street Hilo, HI 96720-4703.

METHODS

The archaeological inventory survey was undertaken in accordance with Hawaiʻi Administrative Rules 13§13-284 and was performed in compliance with the Rules Governing Minimal Standards for Archaeological Inventory Surveys and Reports contained in Hawaiʻi Administrative Rules 13§13-276.

ARCHIVAL METHODS

In addition to referencing available resources at SCS, archival research was conducted in the State Historic Preservation Division (SHPD) report database and library facility (Hilo, HI), the Hawaiʻi County land records office, the *Waihona ʻAina Mahele* database website, Ulukau database website, the Papakilo database website, the Hawaiian collections holdings at the University of Hawaiʻi-Hilo Library, and the Hawaii State Library system. Archival work consisted of research on the history and archaeology of the project area, as well as specific searches of previous archaeological studies in and around the current project area. Historic land use data, land ownership, maps, and narrative information were obtained from the Hawaiʻi County land records office, Hawaiian internet sites, and the University of Hawaiʻi, Hilo.

FIELD METHODS

Inventory survey field work was conducted March and April 2012 (140 Man-hours total) by Joe Farrugia, B.A.; Tomasi Patolo, B.A.; Suzan Escott, B.A.; and Glenn

Escott, M.A. Glenn Escott provided overall project direction and is the principal investigator for this study.

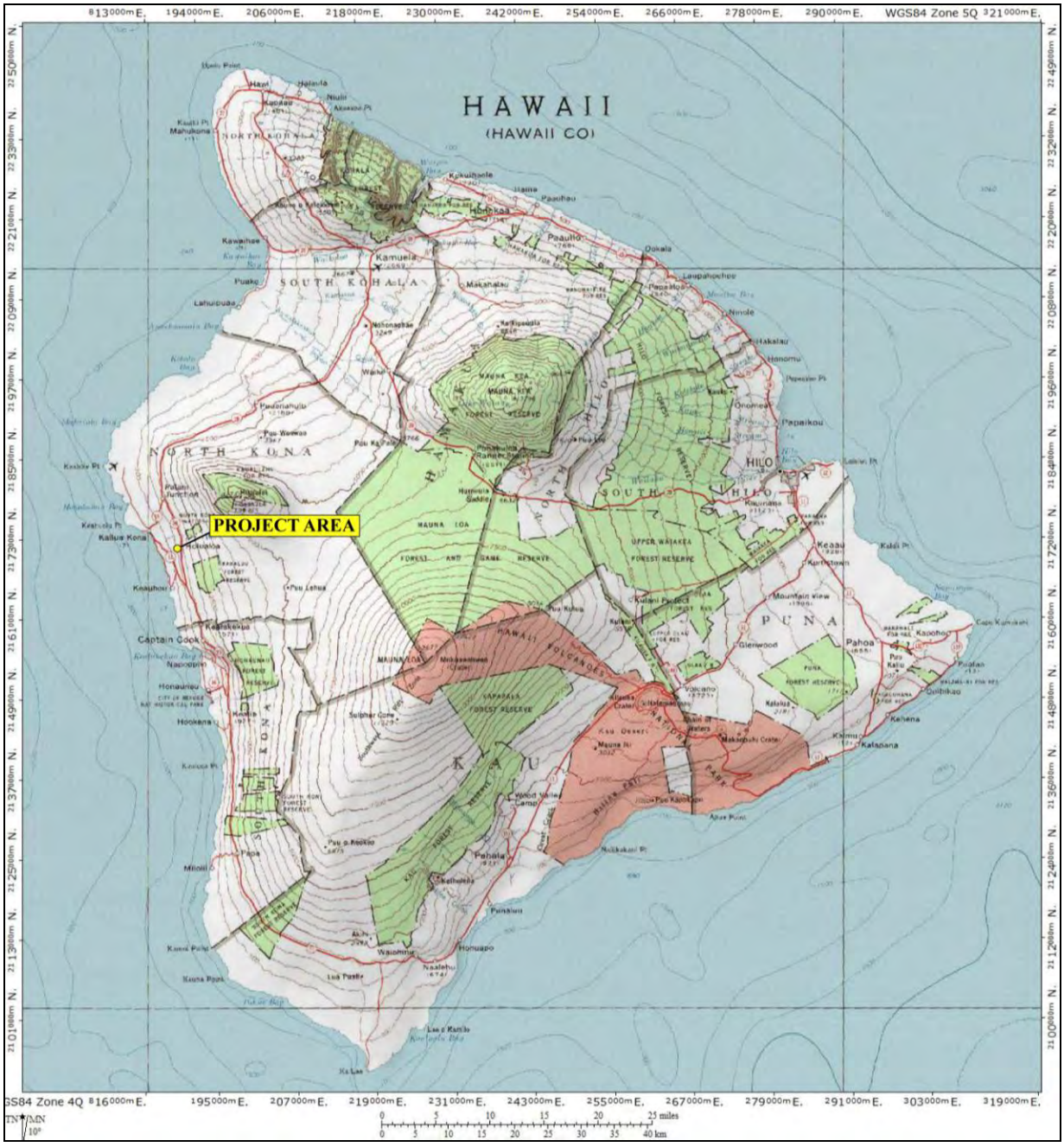

Figure 1: 5,500 K-Series Map of Hawai‘i Island Showing Location of Project Area (National Geographic Topo!, 2003. Data Sources: National Geographic Society, USGS).

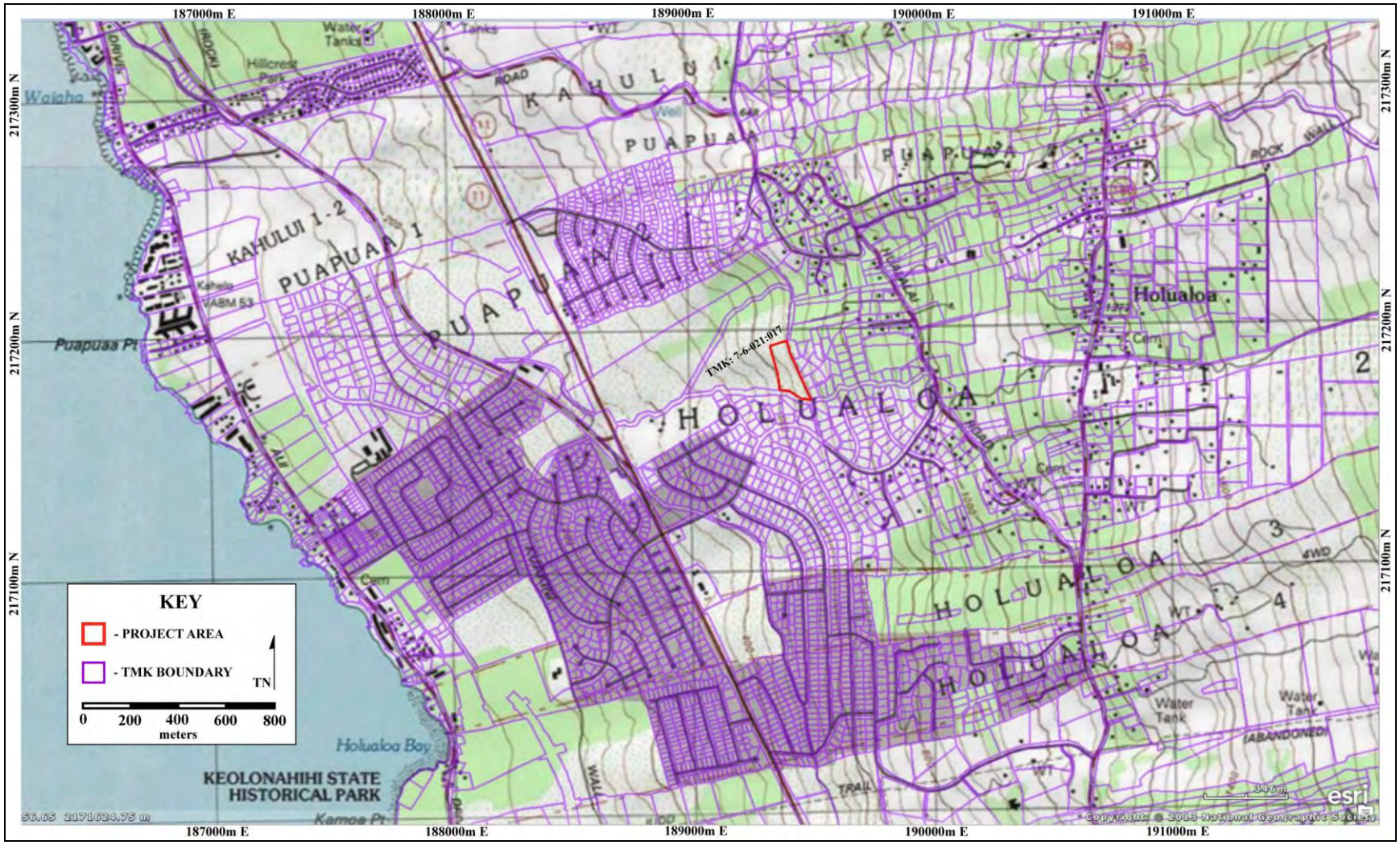

Figure 2: 7.5-Minute Series USGS Topographic Map Showing Location of Project Area (Kealakekua Quad, ESRI, 2013. Data Sources: National Geographic Society, USGS).

Figure 3: Aerial Photograph Showing Project Area (within Red Boundary), Hōlualoa, HI, Zone 5 North, 189445 m E, 2171790 m N. (Google Earth, 2013 Image. Data Sources: Digital Globe, GeoEye, Earthstar, USDA, and USGS).

There were three main field components to the Inventory Survey process: pedestrian survey of the entire project area; plotting located sites on a project area map with Global Position System (GPS) Universal Transverse Mercator (UTM) units (Zone 5 North) using WSGS84 datum; and individual site mapping and recording. A series of north/south transects spaced 2.0 to 4.0 meters apart were walked across the entire project area. Ground cover consisted of tall California and Guinea grass, koa haole, kiawe, and a few kukui trees. Ground visibility was fair to poor.

Site boundaries were determined by the aerial extent of features and by feature function and temporal association. Features that were in close proximity to each other and that appeared to have functional and temporal associations suggesting they were constructed and used as a functional set of features--those features were included together as a single site. Features that were beyond twenty to thirty meters away from each other, or that were constructed at very different times, or for different very purposes, were separated into individual sites. Age determinations were expressed in terms of recognized formal eras including pre-Contact era (before 1778), early post-Contact era (1778-1850), Historic era (1851-1965), and Modern era (post-1965). Age was interpreted on the bases of feature construction and artifacts recovered from excavations.

Features at eleven of the twenty two sites were selected for test excavation to determine site function, construction method, and age. Two types of hand excavations, shovel probes (SP) and test units (TU), were used depending on the size of features, percentage to be excavated, percentage of screening, and overall goals of excavation. A total of 29 shovel probes and two test-units were excavated at eleven sites (Table 1).

Table 1: Inventory of Subsurface Testing.

Site #	Site Type	Features	Site Function	Testing
30591	Agricultural Complex	6	Agriculture	SP-1, 2, 3
30594	Agricultural Complex	6	Agriculture	SP-1 & 2
30596	Hearth	1	Food Preparation	TU-1
30599	Platform & Enclosure	2	Ranching/Agriculture	SP-1 & 2, TU-1
30600	Terrace	1	Agriculture	SP-1
30602	Enclosure	1	Ranching/Agriculture	SP-1, 2, 3 & 4
30603	Enclosure	4	Ranching/Agriculture	SP-1 & 2
30604	Agricultural Complex	4	Agriculture	SP-1
30607	Agricultural Complex	7	Agriculture	SP-1 to SP-10
30610	Terrace	1	Agriculture	SP-1
30611	Agricultural Complex	3	Agriculture	SP-1, 2, 3

Test-units were excavated as 0.5 x 1.0 meter or 1.0 x 1.0 meter units, dug in natural stratigraphic layers. These were excavated at features that were thought to have a high potential to yield functional and temporal diagnostic artifacts, and used where vertical control would contribute to this data. Shovel probes (SP) were units that were roughly 0.4 x 0.4 meters square, and were used to examine stratigraphy, and assess the presence or absence of cultural deposits. Test-unit and shovel probe excavations were screened for cultural material through 1/8th inch mesh. Stratigraphic profiles were drawn for test-units.

Disarticulated human skeletal remains were identified within a lava tube during the field survey. The skeletal elements were partially covered in shallow sediment. Sediment was cleared in small increments from a partially covered pelvis to aid in identification. SHPD was notified and approved of the clearing of sediment from the pelvis.

Cultural material was recorded by type on standard SCS excavation forms and collected. Soil colors were recorded using Munsell color charts, soil composition was recorded with the aid of the U.S. Department of Agriculture Soil Survey Manual on standard soil stratigraphy forms, and profiles were drawn. Overview photographs were taken of individual site features, sites, excavations, and the project area using a 1.0 meter measuring tape.

LABORATORY METHODS

Inventory of midden and artifacts collected from the test excavations were weighed and analyzed by layer of provenience within each excavation unit. Appendix A contains a tabular inventory of all artifacts collected during archaeological excavation. Volcanic-glass and basalt debitage was counted and described in terms of core, primary, secondary, interior, exterior, or non-diagnostic flakes.

For all other artifacts, dimensions, weight, count, and diagnostic characteristics were recorded. All artifact data were tabulated. Field notes, maps, cultural material, and photographs pertaining to this project are currently being curated at the SCS facilities on the Island of Hawai‘i.

ORAL INTERVIEW

Gregg Kashiwa was interviewed by phone on April 19, 2016. Mr. Kashiwa was the project property manager for parcels 016 and 017 in the early 1980s and was present during AIS work documented in the Hammatt et al. (1992). He is originally from O‘ahu but lived in Kona for several decades. Mr. Kishawa remembered that the current 5-acre project area was excluded from the original AIS because the property owners were planning to give the five acres to a group to use as an agricultural preserve. The five acres and the property below (to the west) had already been bulldozed for agricultural use. Mr. Kishawa knew that there were ranch walls and Historic era agricultural features on the project area, but did not know how they were used, as they were no longer in use during his time in Kona. He also remembered the old railroad bed and berm and that there was a small railroad stop along the track just south of the project area.

ENVIRONMENTAL SETTING

The current project area consists of an undeveloped 5.0-acre portion of TMK: (3) 7-6-021:017. The project area is situated on fairly steeply sloping land with level areas in between elevation breaks. The project area is between 600 to 680 feet (183 to 207 meters) above mean sea level (amsl). The project area lands are part of a large former cattle ranch and agricultural area that was started in the early 1900s. The lower portion of the project area is still used to pasture cattle. The project area and surrounding lands were bulldozed sometime between the 1940s and 1970s. Evidence of bulldozing is visible in aerial photographs as alternating bands of cleared bulldozer tracks and bands of push pile (see Figure 3). Pedestrian survey confirmed the linear bands in the aerial photographs are bulldozer-cleared paths and linear piles of bulldozed rock along the cleared bulldozer paths. The former Kona Sugar Company railroad bed is present along the western edge of the project area.

The project area ground surface is a Hualālai lava flow dating between 5,000 and 10,000 years before present (ybp) (Wolfe and Morris 1996). Soil in the project area is Punalu‘u Series (rPYD series) extremely rocky peat with six to twenty percent slopes (Sato 1973:48). The majority of the project area has been bulldozed in the past and the present ground surface is rocky soil.

Rainfall in the project area is very low, less than thirty inches per year. There is a seasonal gulch along the southern edge of the project area. This region is extremely dry,

hot, and somewhat barren except for thick California grass (*Urochloa mutica*), Guinea grass (*Megathyrsus maximus*), and some *koa haole* (*Leucaena leucocephala*), *kiawe* (*Prosopis pallida*), and *kukui* nut (*Aleurites moluccana*) trees (Starr Environmental 2016).

HISTORICAL AND CULTURAL CONTEXTS

Kona is divided into two sections: North Kona or *Kona ʻakau*, and; South Kona, or *Kona hema* (Maly 1996). *Kona ʻakau* was further subdivided into north (called *Kekaha*) and south (called *Konakaiʻōpua*) areas, with the division between the two at the *ahupuaʻa* of Keahuolu. The project area is in Hōlualoa 1st Ahupuaʻa (Figure 4) within the area of *Konakaiʻōpua* in *Kona ʻakau*. Hōlualoa means (literally) "long sled course" (Pukui *et al*. 1974:48). Hōlualoa 1st is a traditional *ahupuaʻa* stretching from the ocean to the foot of Hualālai in the uplands. The coastline of Hōlualoa 1st Ahupuaʻa is primarily low rock cliffs.

Very little is recorded of Hōlualoa Ahupuaʻa in traditional oral accounts. *The Heart Stirring Legend of Ka-Miki*, published in the Hawaiian language newspaper *Ka Hoku o Hawaii* and translated by Maly (1993) contains the only description of Hōlualoa. The legend is set in the 13th century but also reflects more recent influences (Maly and Maly 2002: 17). According to the narrative,

> The lands of Hōlualoa were named for the chief of that name; both Hōlualoa and Puapuaʻa were high chiefs, who controlled the lands from mountain to sea, which bear their names… Kaluaokalani served as a priest of Hōlualoa at the temple of Pākiha. This *heiau* was near the contest field of Hōlualoa… The lands of this region are named for various *aliʻi*, all of whom were related. When the chief Hōlualoa took up the challenge against Kepakaʻiliʻula on behalf of the Kona chiefs, Hōlualoa called upon his god *Kālaipāhoa* to assist him in his battle… Hōlualoa was the first chief to call upon the god *Kālaipāhoa*, and this was the beginning of this gods' use by the chiefs of Hawaiʻi [Maly 1993:208-209].

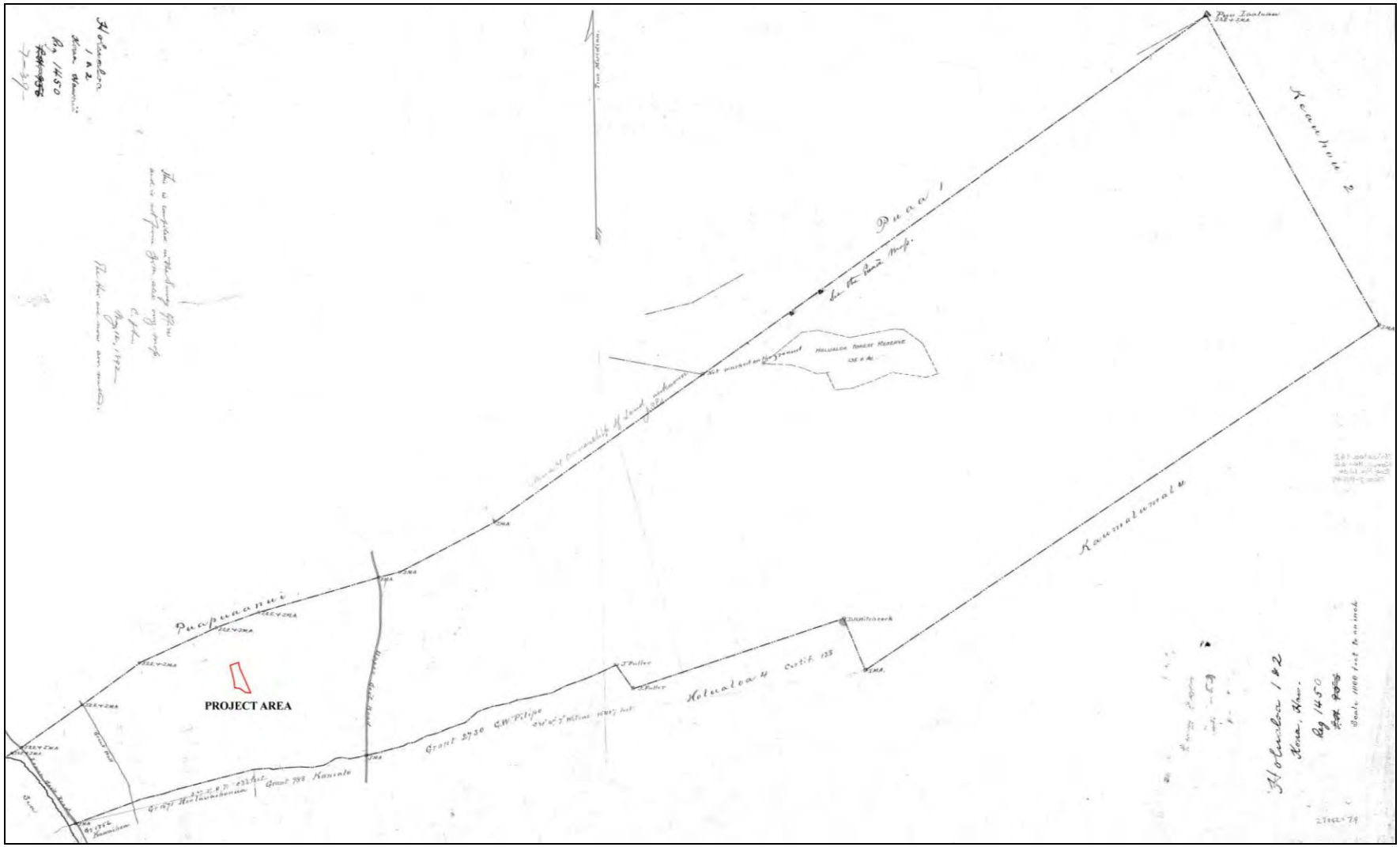

Figure 4: Map of Hōlualoa 1st and 2nd Ahupua‘a Showing Location of Project Area in Red Border (Alexander 1855).

PRE-CONTACT ERA

Hōlualoa, Kona, and much of the leeward side of Hawai‘i Island, while well populated at the time of European Contact, were settled later than the windward side. Many archaeologists believe that Hawai‘i Island was first settled around A.D. 1,000 by people sailing from the Marquesas (Athens et al. 2014; Dye 2011; Kahn et al. 2014; Kirch 2011; Kirch and McCoy 2007; McCoy 2005 and 2007; Mulrooney et al. 2011; Reith et al. 2011; Wilmhurst et al. 2011a and 2011b).

An article published in the Journal of Archaeological Science reviewing radiocarbon dates recovered at archaeological sites on the Island of Hawai‘i suggests that, by relying on only carbon samples from short-lived plant remains, the most reliable dates point to initial Polynesian colonization of Hawai‘i Island occurring between A.D. 1220 and 1261 (Rieth et al. 2011:2747).

Early settlers founded settlements on the windward shores in likely places such as Waipi‘o, Waimanu, and Hilo Bay. The windward, or *ko‘olau* shores receive abundant rainfall and have numerous streams such as the Wailuku, Waiolama, ‘Alenaio, and Wailoa that facilitated agricultural and fishpond production (Maly 1996:3). The windward shores also provide rich benthic and pelagic marine resources.

The dry leeward shores of Hawai‘i Island presented a very different environment requiring a modified set of subsistence strategies. Archaeologists and historians are uncertain about the exact motives that lead to the establishment and spread of settlements on the leeward side of Hawai‘i, but some suggest population pressure, dwindling fertile land, growing socio-political stratification, or simply the opportunity for a new start might have lead to new communities developing on the dryer west side of the island (Cordy 2000:130). The process was likely underway soon after initial settlement of Hawai‘i Island (Cordy 2000).

During this period, areas of permanent habitation were established in Kona (Cordy 1981, 1995; Schilt 1984). Habitation was concentrated along the shoreline and lowland slopes, and informal fields were cleared at higher elevations where rainfall was higher. Agricultural fields and habitation areas expanded across the slopes and coastal area of Hualālai during the period between AD 1200 and 1400 (Burtchard 1995; Cordy 1995).

The development of extensive formal walled fields likely began sometime around AD 1400 to 1600. This period marks the initial construction of the Kona Field System (KFS) (Schilt 1984). The development of the KFS may be, in part, a by-product of the need to extract more subsistence resources from an increasingly limited agricultural base. The population in Kona increased dramatically during this period, as reflected in the abundant radiocarbon dates from habitation structures, shelter caves, and agricultural soils of this period (Burtchard 1995; Haun *et al*. 1998; Schilt 1984). During this period, the stratified chiefdom structure becomes clearly developed in the archaeological record.

Large residential complexes and *heiau* reflect the segregation of places and power for the growing hierarchy of high and lower chiefs, and ceremonial stewards (Cordy 1981; Haun *et al*. 1998; Hommon 1986). The produce from the formal walled fields were distributed to higher chiefs through a hierarchy of lower chiefs responsible for management and collection of the cultivated and wild resources.

By the time of the Competition Period (AD 1600 to 1800), the royal centers and larger *heiau* were in place, reflecting the growth in power of the rulers and chiefs in the region (Barrera 1971; Hammatt and Folk 1980). Resources may have reached their maximum carrying capacity, resulting in social stress between neighboring groups. Hostility between groups is reflected archaeologically with the development of refuge caves during this period (Schilt 1984). This volatile period was probably accompanied by internal rebellion and territorial annexation (Hommon 1986; Kirch 1985). Royal centers are located at Kailua, Hōlualoa, Kahalu‘u, Kealakekua, and Honaunau (Cordy 1995).

The region of Hōlualoa developed into a royal center in the late 1600s to early 1700s under the reigns of Keakamahana (reigned 1680-1700) and Keakealaniwahine (reigned 1700-1720) (Cordy 2000:244). Many *‘ali‘i* and *konohiki* residences and numerous religious sites are known to have existed here. The majority of the *heiau* and royal residences were constructed along or near the coast, most notably at Kamoa Point south of the project area. The royal center at Hōlualoa was eclipsed in the second half of the 1700s by the royal center in the Kahalu‘u and Keauhou region.

The Kona Field System

During his travels in the region in 1823 William Ellis noted that the area above and south of Kailua was:

> quite a garden compared with that through which they had passed on first leaving the town. It was generally divided into small fields, about fifteen rods square, fenced with low stone walls, made of fragments of lava which had been gathered from the surface of the enclosures. These fields were planted with bananas, sweet potatoes, mountain taro, tapa trees, melons and sugar cane, flourishing luxuriantly in every direction [Handy 1940:114 and 162].

> Rocky lands in the olden days were walled up all around with big and small stones of the patch until there was a wall about 2 feet high and in the enclosure were but weeds of every kind, amaʻu tree ferns and so on, and then topped well with soil taken from the patch itself to enrich it [Handy 1940:147].

These gardens have been studied in some detail, and are often referred to as the "Kona Field System". Many of the archaeological projects conducted within Kona deal with components of the Kona Field System (Cordy 1995; Newman 1970; Schilt 1984). This area extends north at least to Kaʻu Ahupuaʻa and south to Honaunau, west from the coastline and east to the forested slopes of Hualālai (Cordy 1995). A large portion of this area is designated in the Hawaiʻi SIHP (State Inventory of Historic Places) as Site 50-10-37-6601. The basic characteristics and general locations of the zones within the system as presented in Newman (1970) have been confirmed and elaborated on by more intensive and extensive ethnohistorical investigations (Kelly 1983).

The *kula* zone of the Kona Field System is the area from sea level to 150 m amsl. This lower elevation zone is traditionally associated with habitation and the cultivation of sweet potatoes (*uala*), paper mulberry (*wauke*), and gourds (*ipu*). Agricultural features, such as clearing mounds, planting mounds, planting depressions, modified outcrops, and planting terraces, are common throughout much of this zone (Hammatt and Clark 1980; Hammatt and Folk 1980; Haun *et al*. 1998; Schilt 1984).

Dwellings are often scattered throughout the agricultural portion of the *kula*, but they are commonly concentrated along the shoreline subdivision of the *kula* zone (Cordy 1981). The shoreline zone, extending inland approximately 200 m, was used primarily

for permanent habitation and other non-agricultural activities, such as canoe storage, ceremonial and burial practices, recreation, and fishing-related activity.

Royal centers and high chiefly centers were also situated within the shoreline of the *kula*. These complexes include dwellings for rulers, chiefs, and the supporting populace, places of refuge, and other structures. Single, or clustered, burials are also situated in the shoreline, and near-shore *kula* (Han *et al*. 1986; Hammatt and Clark 1980; Hammatt and Meeker 1979). Burials occur in caves, within finely built platforms, cruder rock mounds, and houses in the shoreline, and are more often in the near-shore *kula* (Cordy 1995; Han *et al*. 1986; Schilt 1984; Tainter 1973; Tomonari-Tuggle 1993).

The large, and densely populated, royal centers were situated at several locations along the shoreline between Kailua and Honaunau (Cordy 1995; Tomonari-Tuggle 1993). The residential areas, large and small *heiau*, sporting areas, and burial clusters, are present continuously farther inland than the usual 200 meters for the shoreline habitation portion of the *kula*. Consequently, a variety of non-agricultural features are present in the *kula* near royal centers.

The *kalu'ulu* zone above 150 m amsl is a wetter region above the *kula* where bread fruit and other arboreal crops were cultivated (Kelly 1983). Sweet potatoes (*Ipomoea batatas*), *ti*, (*Cordyline fruticosa*) *wauke* (*Broussonetia papyrifera*), *taro* (*Colocasia esculenta*), and sugar cane (*Saccharum* sp.), planted among the arboreal crops, were mulched with grass (Menzies1920:75-76). The current project area is in the *kalu'ulu* zone.

Above the *kalu'ulu* zone, in the *'apa'a* zone, fields with low stone walls were cultivated with bananas, sweet potatoes, *taro*, *wauke*, melons, *ti* and sugar cane. The *'apa'a* zone was notable for fresh water springs. Above the *'apa'a* zone was the *'ama'u* zone where walled fields were created to grow plantains and bananas. Timber from various tree species was collected from the *'apa'a* zone and the *'ama'u* zone. Bird catching and other forest resources extraction activities were conducted in these upper two zones. Temporary habitations were constructed to be used seasonally when working in the uplands.

In the region, people initially moved into coastal settings *and* more upland settings (*e.g.,* the '*āpa'a* agronomic zone) at the same time, essentially ignoring the drier intermediate zone (except, of course, as a throughway between their gardens and the sea). In this way, the first settlers could immediately plant seedlings in the wetter uplands,

knowing the crops would succeed. Permanent settlement would have first been restricted to the coast, but the same people would have also been occupying the uplands (at least temporarily) as well. It is only later that the 'intermediate zone'(and the *kalu'ulu* agronomic zone), would have been utilized for planting.

POST-CONTACT ERA

The extensive features of the Kona Field System were exploited and altered during the post-contact era. Walls, *kua'iwi*, springs, and pathways created generations earlier were used and planted with alien cultigens (coffee, cotton, sugar, citrus, and sisal) and ultimately used as pastures for cattle.

Ranching has its roots in the first cattle and sheep brought to the island in 1793 and 1794 by Vancouver. Two cows, three bulls, five ewes, and five rams were released to prosper in the region of Kealakekua in 1794 (Vancouver 1967:(3)11). Kamehameha placed a ten-year *kapu* on the killing of cattle so that they would have the opportunity to multiply. A 486-acre stone corral was built in the uplands of Lehu'ula-Honua'ino, above Kāināliu where they were raised (Bowser 1880, cited in Maly and Maly 2001:285).

Two American captains, William Shaler and Richard Cleveland presented two horses to John Young in 1803. Cleveland later returned with more than 200 horses brought from California. Donkeys, mules and oxen were also imported for transportation and hauling. Goats were also brought to the island and left to multiply in the wild.

By 1813 to 1815 cows began overrunning agricultural fields and became a danger to travelers and residents (Ellis 1963: 291; Wilkes 1970: 204). A number of walls were commissioned to keep feral sheep, goats, and cattle out of agricultural areas and away from homes. By 1848, in Kona District a Great Wall (the Kuakini Wall) was constructed from Lanihau to 'Ōnouli (Maly and Maly 2001:286).

In 1830 Governor Kuakini moved to oversee and improve government cattle by constructing corrals. Liholiho visited the same year to witness strides made in the nascent cattle ranching industry. It was hoped that the exportation of tallow, hides, and salted beef would supplant the defunct Sandalwood trade as a major source of income. Several ventures related to ranching, including tallow making, tanning, saddle making, and blacksmithing were initiated (Bergin 2004: 156). Cowhide was tanned using the astringent bark of local trees (Wilkes 1970: 218). The lion's share of commercial

enterprises on the island involved supplying whaling ships and the local market with beef.

The changing subsistence and trade regimes developed by incoming European and American settlers, as well as other historical factors, caused a depopulation of the coastal areas of Kona. Ranches were established at middle and upper elevations, and farms were established in the uplands where rainfall was higher and the temperatures were cooler. Cattle ranching and clearing for sugar cane and coffee removed many of the endemic species of plants. The suite of vegetation that existed prior to the pre-Contact era were replaced by *koa haole* (*Leucaen*a *leucocephala*), kiawe (*Prosopis pallida*), and other newly introduced invasive plant species.

Schools, churches, stores, and other businesses were also established in the uplands. During the late 1800s and early 1900s, coastal Kona was no longer the densely populated sociopolitical center it once was. It became a small cluster of houses along the trail from Kailua Bay to Keauhou (Tomonari-Tuggle 1993:15). Homesteads, ranches, and plantations developed in the uplands during this period as reflected in the pattern of Land Commission Awards (LCA) and Land Grants (LG) recorded during the Māhele.

THE MĀHELE

With the coming of the Great Māhele (1848), the Alien Land Ownership Act (1850) and the Kuleana Act (1850), the traditional Hawaiian archetype of land-use was essentially deconstructed and replaced with the European concept of fee-simple land ownership. Article IV of the Board of Commissioners to Quiet Land Titles was passed in December 1845 and began the legal process of private land ownership. Through the Māhele of 1847-48 the Alien Land Ownership Act of 1850 and the Kuleana Act of 1850, land was made available for private ownership.

The Māhele established a board of five commissioners to oversee land claims and to issue patents and leases for valid claims. Kauikeaouli (Kamehameha III) established and ratified laws to protect Hawaiian crown lands as foreigners began claiming ownership of land they were granted permission to use for homes and business interests (Daws 1968:111; Kameʻeleihiwa 1992: 169-70, 176; Kelly 1983: 45; Kuykendall 1938(1): 145 footnote 47, 152, 165-6, 170;). Among other things, foreigners were demanding private ownership of land to secure their island investments (Kameʻeleihiwa 1992: 178; Kuykendall 1938(1): 138, 145, 178, 184, 202, 206, 271).

Under the Māhele and subsequent acts (the Kuleana Act of 1850 and the Alien Land Ownership Act of 1850), the lands of the kingdom of Hawai‘i were divided among the king (crown lands), the *ali‘i* and *konohiki*, and the government. Once lands were thus divided and private ownership was instituted, the *maka‘āinana* (commoners), if they had been made aware of the procedures, were able to claim the plots on which they had been cultivating and living as stipulated in the Kuleana Act (1850). These claims, however, could not include any previously cultivated or presently fallow land, *okipu‘u*, stream fisheries, or many other resources traditionally necessary for survival (Kame‘eleihiwa 1992:295; Kelly 1983:45-76; Kirch and Sahlins 1992 vol.1:3, 135-137, and vol.2:2).

The right of claimants to land was based on the written testimony of at least two witnesses who could corroborate the claimant's long-standing occupation and use of the parcel(s) in question. The claimant might have been awarded a patent for the property, subsequently called Land Commission Awards (LCAs) (Chinen 1961:16).

The Land Commission awarded the majority of Hōlualoa 1st and 2nd Ahupua‘a to Victoria Kamāmalu Ka‘ahumanu IV, *Kahina Nui* of Hawai‘i Island and Crown Princess of Hawai‘i as Land Commission Award (LCA) Number 7713, ‘Apana 43 (Figure 5). Several smaller LCA and Land Grant (LG) properties were also recorded in the upland region of Hōlualoa 1st and 2nd Ahupua‘a (Figure 6). Twenty four Land Commission awards were recorded in Hōlualoa 1st Ahupua‘a, the ahupua‘a where the project area is located (see Figure 6 and Table 2).

All but two of the LC awards (LCA #3660to Munn and LCA #7713 to Kamāmalu) were *mauka* (east) of the current project area. With the exception of these LC awards, the average award was 2.8 acres, most (n=16) were for less than 3.0 acres. Three Land Grants (LG #1592, 1602, and 3630) were also recorded in Hōlualoa 1st and 2nd Ahupua‘a. LG #1592 was a 25.0-acre parcel sold to Kealalio and LG #3630 was a 38.2-acre parcel sold to W.H. Cromwell. Almost all of the awards and grants were used as subsistence and commercial farm land, and some were used to pasture cattle.

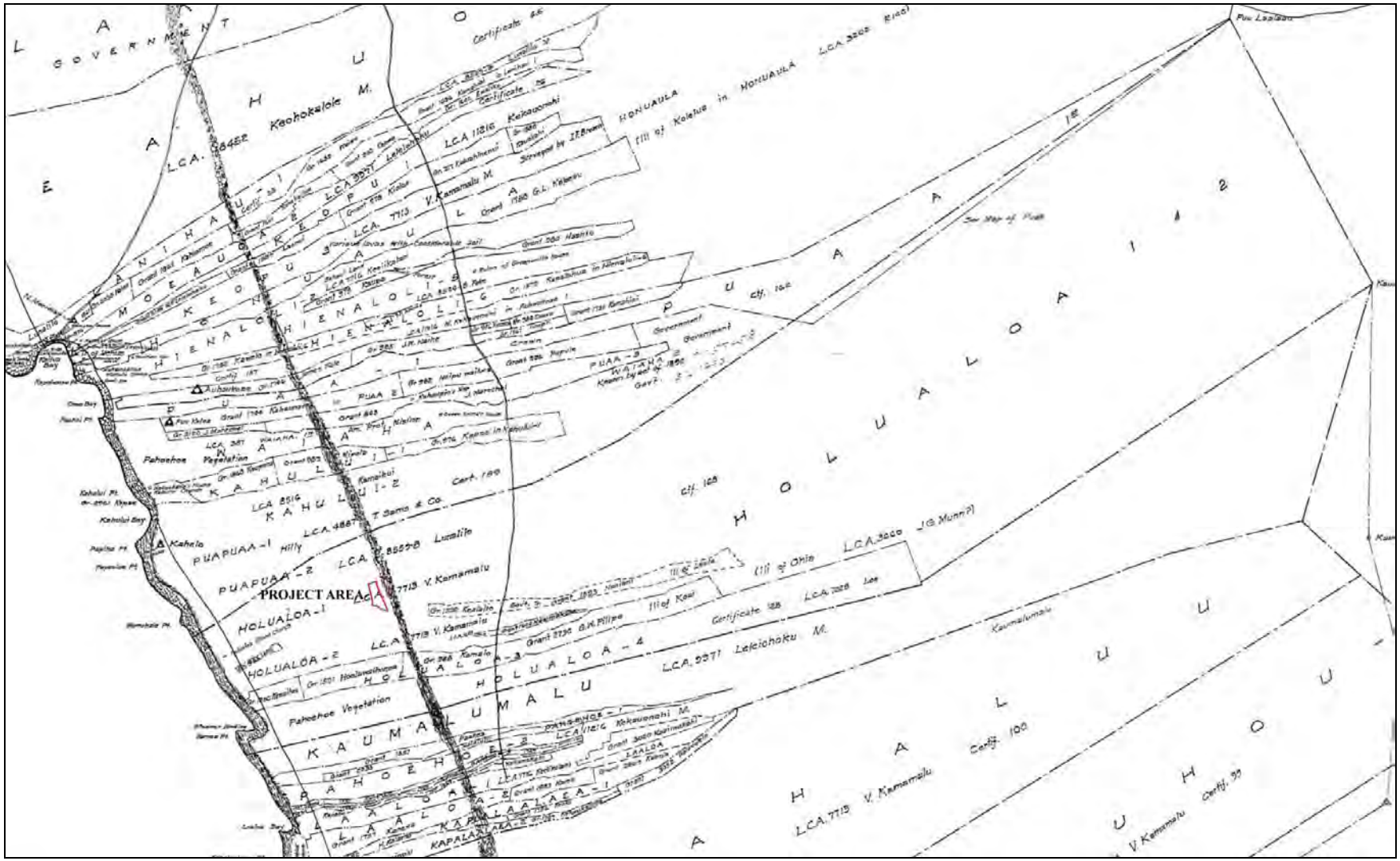

Figure 5: Portion of Kailua Section, North Kona Map Showing Location of LCA 7713 and Project Area in Red Border (Aki 1952).

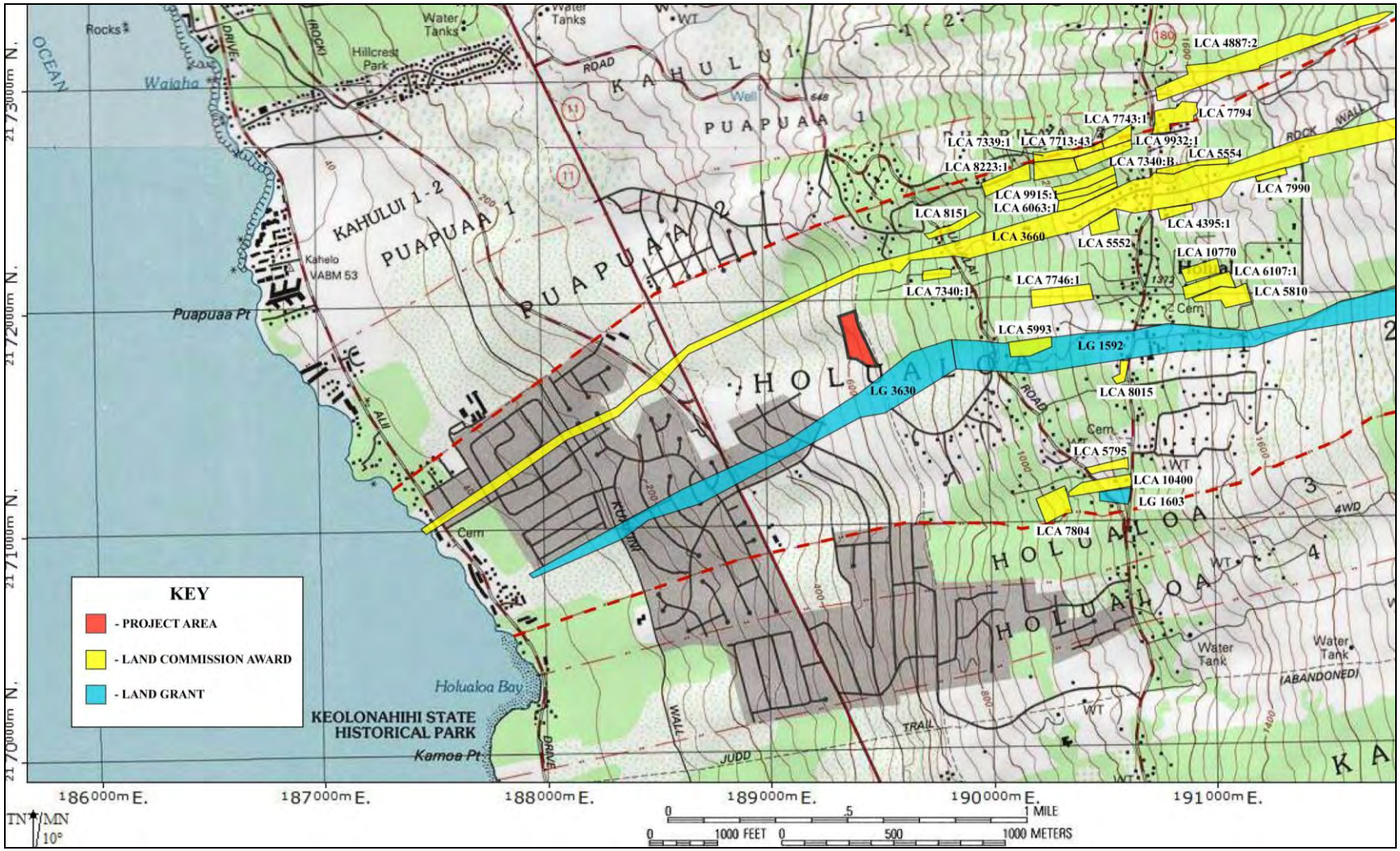

Figure 6: 7.5-Minute Series USGS Topographic Map Showing Location of Land Commission Awards, Land Grants, and the Project Area (National Geographic Topo!, 2003, Kealakekua Quad. Data Sources: National Geographic Society, USGS).

Table 2: Land Commission Awards Recorded in Hōlualoa 1st and 2nd Ahupuaʻa.

LCA#	AWARDED TO	AHUPUAʻA	ACRES
3660	John G. Munn	Hōlualoa 1st	111.5
4395	Kekoi	Hōlualoa 1st	1.7
5552	Kauila	Hōlualoa 1st	1.9
5554	Keawekolohe	Hōlualoa 1st	11.27
5795	Keliikanakaole	Hōlualoa 2nd	2.2
5810	Kaopukauila	Hōlualoa 1st	1.74
5993	Leipalapala	Hōlualoa 2nd	2.0
6063	Hāna	Hōlualoa 1st	2.9
6107	Naai	Hōlualoa 1st	3.94
7339	Kuaana	Hōlualoa 1st	4.15
7340	Kama 2	Hōlualoa 1st	2.5
7340:B	Kama 1	Hōlualoa 1st	1.3
7443	Kalimapaa	Hōlualoa 1st	1.94
7713	Kamamalu	Hōlualoa 1st & Hōlualoa 2nd	Large
7746	Kamahalo	Hōlualoa 1st	5.0
7794	Kauakini	Hōlualoa 1st	1.8
7990	Pupuka	Hōlualoa 1st	1.1
8015	Aipo	Hōlualoa 2nd	1.4
8151	Hehena	Hōlualoa 1st	2.3
8223	Ikaiaka	Hōlualoa 1st	3.5
9915	Limahana	Hōlualoa 1st	2.42
9932	Lumaawe	Hōlualoa 1st	2.98
10770	Puuone	Hōlualoa 1st	3.06
10400	Naaimakaohi	Hōlualoa 1st & Hōlualoa 2nd	3.5

EARLY POST-CONTACT ERA AND HISTORIC ERA

Formal cattle ranching began in the Kona region in the mid-1800s, but wild cattle may have been in the area as early as the late 1700s. The *pā ʻāina* (ʻwalls of the landʼ), native tenantsʼ wall enclosures, were prevalent in the area, as indicated by their inclusion in many local Māhele testimonies. These were used to mark the boundary of properties and to keep livestock out of crop areas (Kuykendall 1957:318 note 76). Later, cattle ranchers built walls to control their cattle.

> In the early 1840s, cattle were said to be "maintained on the *kula*," a mile from the coast where the ground was "covered with herbage" (Wilkes 1845:4, 95). Cattle, introduced to Kona by Vancouver in 1794, became a nuisance later, when their numbers increased. They fed on the grass of the kula and from time to time on the thatch of Hawaiians' homes and on vegetables in their gardens. The open upland fields, bounded only by low earth and stone walls, were in full cultivation in the 1850s [Kelly 1983:76].

Ranchers leased land below the railroad to graze cattle that they owned (Kelly 1983:111). Higher walls were built in the 1920s and 1930s to control animals. According to Joe Gomes, a longtime rancher in the area,

> Walls about 3 ft high can keep donkeys penned. The usual wall is about 4 ½ ft high and keeps cattle in. For goats you need a wall 6 to 8 ft high. For wild pigs you need a 6 to 8 ft-high wall. They climb over lower walls easily. They come down from the mountains for macadamia nuts and also in mango season for mangoes [Kelly 1983:112].

Sugar was a major crop in Hawaiʻi as early as signing of the Reciprocity Treaty in 1876 (Kelly 1983:90). The sugar industry grew rapidly, and by 1899 the only sugar mill in the Kona area was built by the Kona Sugar Company. Many Chinese worked on the sugar plantations (Kelly 1983:111). They built a railroad in 1901 to haul cane from the fields to their mill site along the Waiʻaha stream, north of the current project area. The stream did not provide enough water to mill cane year round and company failed in 1903. The Kona Sugar Company was bought by James Castel in 1906 and was later purchased by Japanese investors. The Kona Sugar Company continued to operate until 1926.

The railroad was bought by Kona Development Company, and was used for freight, sugarcane and by the Hawaiian Lumber Company. Sugar was grown above the railroad line. The cut sugar was delivered to the tracks with the assistance of gravity, by wire cables and flumes. The rail line was seven miles long and extended from Hōlualoa to Keōpuka (Figure 7).

Cotton was grown on lands below the railroad tracks (Kelly 1983:111). Cotton gins were located south of the project area. Cotton was being picked as late as the 1930s. Other plants grown below the tracks in the dryer lands were sisal and tobacco (Kelly 1983:112).

Traditional Hawaiian subsistence practices, including the rights to collect resources from all ecological zones of one's *ahupua'a*, were challenged, restricted, or prevented. As private land owners considered their property off limits to others, cultivation and collection of resources on private land diminished. Individual Hawaiian cultural beliefs, specialized knowledge, and practices associated with the use of the different ecological resource zones also diminished. The development of cattle ranching and commercial crops, such as sugar cane and coffee, removed traditional cultigens and resources from large swaths of the lands of Kona.

The changing subsistence and trade regimes developed by incoming European and American settlers, as well as other historical factors, caused a depopulation of the coastal areas of Kona. Ranches were established at lower elevations and farms were established in the uplands where rainfall was higher and the temperatures were cooler. Schools, churches, stores, and other businesses were also established in the uplands. During the late 1800s and early 1900s, Hōlualoa was no longer the densely populated sociopolitical center it once was. The coastal area of Hōlualoa had become a small cluster of houses along the trail from Kailua Bay to Keauhou.

The project area is just *makai* (west) of the majority of land commission awards and is at the same elevation as portions of the land grants in the region. Based on historic documents, the project area and surrounding lands were likely being used for subsistence and commercial agriculture, as well as for cattle pasture from the mid to late 1800s. The project area might have been used later than surrounding lands because of its steep slopes and very rocky soil, but based on aerial photographs, the project area was bulldozed sometime around the 1950s in preparation for commercial agriculture.

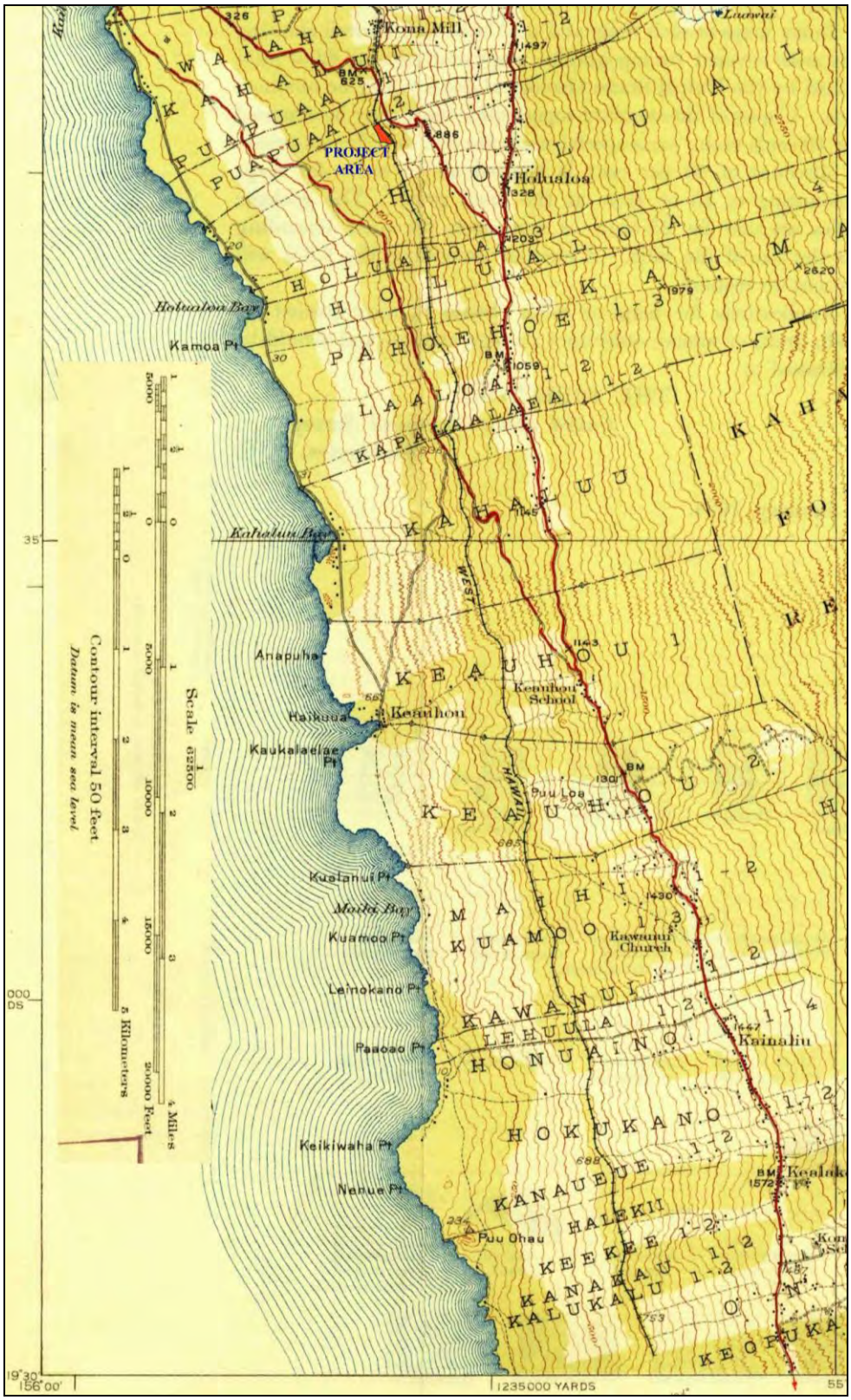

Figure 7: Portion of 15-Minute Series USGS Topographic Map Showing Location of Railroad and Project Area (USGS 1928).

PREVIOUS ARCHAEOLOGICAL STUDIES

There are at least 33 previous archaeological reports for lands near the current project area, including studies in Puapuaʻa 2nd and Hōlualoa 1st, 2nd, and 3rd Ahupuaʻa (Table 4 and Figure 8). The studies were conducted from the coast to roughly 1,460 ft amsl and encompass the *kula* region (0-500 ft), the *kaluʻulu* region (500-1,000 ft), and the lower portions of the *ʻāpaʻa* region (1,000-2,500 ft). Results of the previous archaeological studies are summarized below by elevation: studies numbered 1through 15 in Table 2 and Figure 8 are situated from the coast to Queen Kaʻahumanu Highway (0-360 ft amsl), studies 16 through 21 are located from above the Queen Kaʻahumanu Highway to just below Hualālai Road (306-760 ft amsl), and studies 22 through 24 are above Hualālai Road to just above Māmalahoa Highway (1,100-1,460 ft amsl).

Table 3: Inventory of Previous Archaeological Investigations.

Project Number (Figure 8)	Reference	Type of Study	Area in Acres	Results
1	Landrum et al. 1990	Archaeological Inventory Survey	N/A	46 Sites
1	Calis et al. 2004	Archaeological Data Recovery	N/A	10 Sites
2	Carlson & Rosendahl 1990	Archaeological Inventory Survey	65	64 Sites
3	Haun et al. 1998	Archaeological Inventory Survey	15	31 Sites
4	Hammatt & Folk 1981	Archaeological Survey	20	20 Sites
4	Hammatt et al. 1986	Archaeological Survey & Excavations	20	21 Sites
5	Haun & Henry 2001	Archaeological Data Recovery	1.59	1 Site
6	Escott 2013	Archaeological Inventory Survey	1.962	2 Sites
7	Sinoto 1979	Archaeological Reconnaissance Survey	6	Rock Walls
8	Hammatt 1979b	Archaeological Survey	22	3 Sites
9	Hammatt 1979c	Archaeological Survey	23	39 Sites
10	Conolly & Gunness 1979	Archaeological Reconnaissance Survey	46.8	80 Sites
10	Hammatt 1979a	Archaeological Inventory Survey	46.8	11 Sites
10	Hammatt 1980	Archaeological Survey & Excavation	103	88 Sites
11	Nelson et al. 205	Archaeological Inventory Survey	28	22 Sites
12	Rosendhal 1978	Archaeological Reconnaissance Survey	2.5	1 Site
12	Soehren 1980a	Archaeological	n/a	7 Sites

Project Number (Figure 8)	Reference	Type of Study	Area in Acres	Results
		Reconnaissance Survey		
12	Wolforth et al. 2000	Archaeological Inventory Survey	8	7 Sites
13	Barrera 1995	Archaeological Reconnaissance Survey	17	3 + several ag. mounds
13	Haun & Henry 2000	Archaeological Inventory Survey	17	12 (104 Features, 82 of Which Were Agricultural)
14	Rosendahl 1989	Archaeological Field Inspection	6	Modified Outcrops
15	Schilt 1984	Archaeological Study	17	134 Sites
16	Walker & Rosendahl 1988	Archaeological Reconnaissance Survey	104	67 Sites
16	Graves & Goodfellow 1993	Archaeological Data Recovery	104	58 Sites
16	Maly & Rosendahl 2006	Archaeological Preservation Plan	104	67 Sites
17	Hammatt et al. 1992	Archaeological Survey	174	71 Sites
18	Soehren 1980b	Archaeological Reconnaissance Survey	16	1 Site
19	Rechtman 2006	Archaeological Inventory Survey	1.008	2 Sites
20	Rosendahl 1988	Archaeological Reconnaissance Survey	17	17 Sites
20	Fager & Graves 1993	Archaeological Inventory Survey	17	17 Sites
21	Dircks et al. 2013	Archaeological Inventory Survey	10.266	1 Site (149 Historic to Modern Farming Features)
22	Desilets et al. 2004	Archaeological Inventory Survey	11.7	1 Homestead Features
23	Rechtman 2013		29	24 Sites
24	Clark & Rechtman 2006	Archaeological Inventory Survey	2.7	6 Historic Era Sites

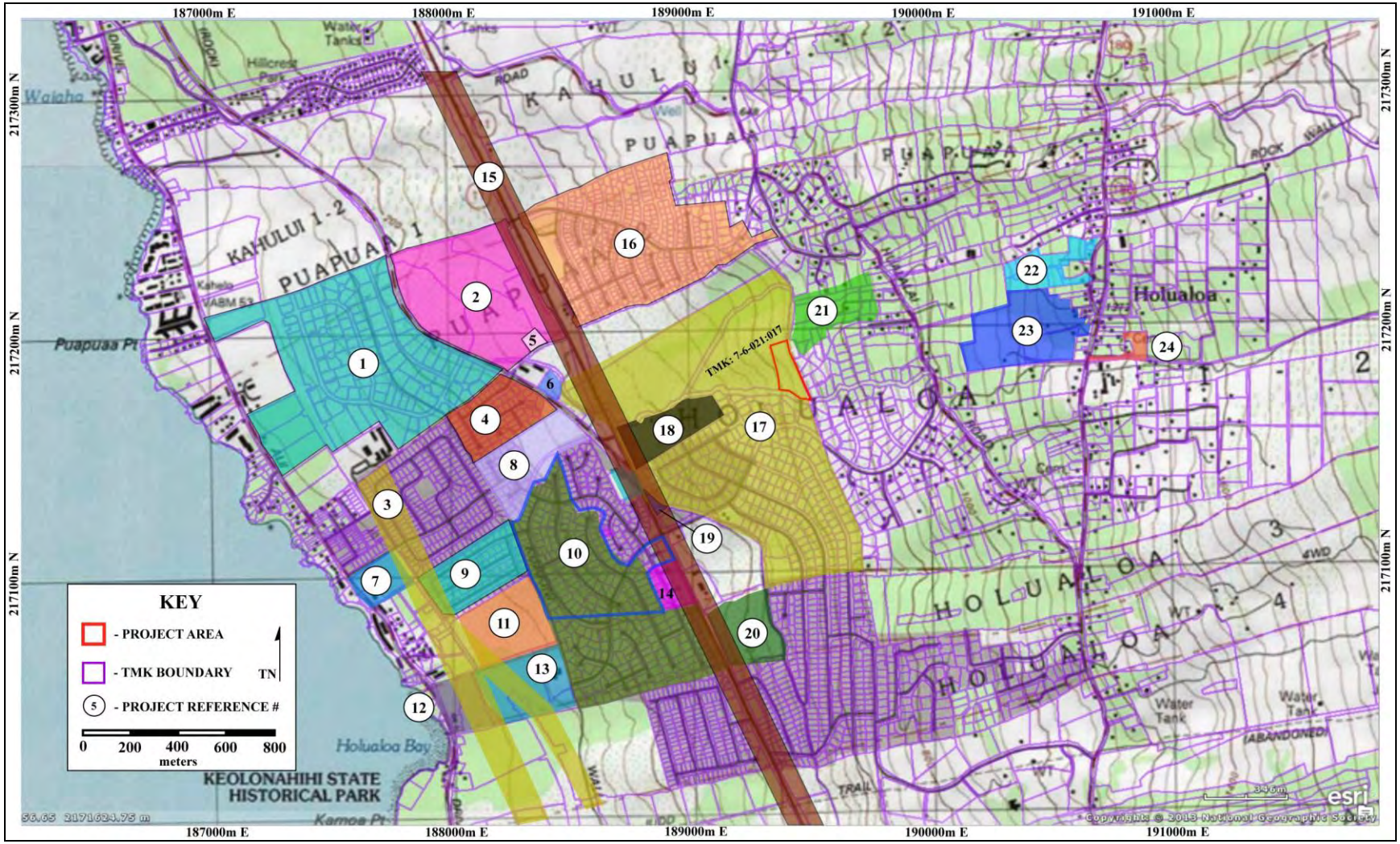

Figure 8: 7.5-Minute Series USGS Topographic Map Showing Location of Previous Archaeological Studies and Project Area (Kealakekua Quad, ESRI, 2013. Data Sources: National Geographic Society, USGS).

REGIONAL PREVIOUS ARCHAEOLOGICAL STUDIES

1. Landrum et al. 1990, and Calis et al. 2004. PHRI, Inc. conducted an archaeological inventory survey (Landrum et al. 1990) and SCS, Inc. conducted data recovery investigations (Calis et al. 2004) at the Kahakai development project. The project area is located within the lower elevations of Puapuaʻa 2nd Ahupuaʻa. Pre-Contact era to early post-Contact era cave shelters, agricultural rock clearing mounds, burials, shrines, and a possible heiau were identified during the AIS study. A heiau complex, several burials, and five permanent habitation sites were recommended for preservation. All of the preservation sites are near the coast.

2. Carleson and Rosendahl 1990. PHRI, Inc. conducted an archaeological inventory survey of 65 acres between Kuakini and Queen Kaʻahumanu highways in Puapuaʻa 2nd Ahupuaʻa. Their study recorded 64 archaeological sites including pre-Contact era habitation, agricultural, and burial sites. Seven sites were assessed as significant and recommended for preservation (Carleson and Rosendahl 1990: 34).

3. Haun et al. 1998. PHRI, Inc. conducted an archaeological inventory survey of the proposed Aliʻi Drive corridor through several ahupuaʻa. Numerous pre-Contact era site complexes were recorded in Puapuaʻa 2nd and Hōlualoa 1st through 4th Ahupuaʻa. The site complexes included a large number of agricultural features, as well as habitation, burial, and ceremonial features.

4. Hammatt and Folk 1981, and Hammat et al. 1986. Two archaeological surveys were conducted on a 20-acre parcel of below Kuakini Highway. The first study recorded 20 sites, and the second recorded 21 sites. None of the sites were recommended for preservation (Hammatt and Folk 1981: ii, and Hammatt et al. 1986: 87). The report also recommended that the single documented burial be relocated.

5. Haun & Henry 2001. Haun and Associates conducted an archaeological data recovery study at a c-shaped enclosure located on 1.59 acres of land below Queen Kaʻahumanu Highway

6. Escott 2013. SCS conducted an archaeological study on1.962 acres of land near the intersection of Kuakini and Queen Kaʻahumanu highways. Two historic era ranch walls were recorded during the study.

7. Sinoto 1979. Aki Sinoto recorded several Historic era ranch rock walls on a six acre parcel of land just mauka of Ali‘i Drive.

8. Hammatt 1979b. The Archaeological Research Center, Inc. conducted an archaeological survey of 22 acres just south of Kuakini Highway. Three archaeological sites were recorded during the study. None of the sites were recommended for preservation (Hammatt 1979b: ii, and 10).

9. Hammatt 1979c. The Archaeological Research Center, Inc. conducted an archaeological survey of 23 acres located in the near coastal portion of Hōualoa 1st and 2nd Ahupua‘a. Thirty nine archaeological sites were recorded during the study. The report recommended that all burials, including a known cemetery site be relocated (Hammatt 1979a: 5). None of the remaining sites (pre-Contact era habitation and agriculture sites) were recommended for preservation in place.

10. Conolly and Gunness 1979, and Hammatt 1979a and 1980. The Archaeological Research Center, Inc. conducted an archaeological survey of 103 acres within the near coastal portions of Hōlualoa 1st through 4th Ahupua‘a (Hammatt 1980). One hundred and thirty six archaeological sites were recorded on the project area. They included pre-Contact era habitation, agriculture, burial, and a ceremonial sites. The Hammatt report recommended that a heiau (Site 6661) was significant and should be preserved in place (Hammatt 1980: 4). The report also recommended that the single documented burial be relocated to the perimeter of heiau (Site 6661) and preserved. No other sites were recommended for preservation.

11. Nelson et al. 2005. An archaeological inventory survey was conducted by Rechtman Consulting on 28.0 acres located in the near coastal portion of Hōlualoa 2nd Ahupua‘a. A total of 22 sites containing 150 features were recorded. The sites were primarily pre-Contact era agricultural and habitation sites, though five burial sites, a possible heiau, and a trail were also documented within the project area.

12. Rosendahl 1978, Soehren 1980a, Wolforth et al. 2000. PHRI conducted an archaeological inventory survey of eight acres of coastal Hōlualoa 3rd Ahupua‘a and recorded seven archaeological sites including three Historic era rock walls, three residential sites, and Hikapaia Heiau.

13. Barrera 1995, Haun & Henry 2000. Barrera (1995) recorded a possible burial platform, two habitation site, agricultural rock clearing mounds and modified outcrops during a reconnaissance survey of 17 acres in near coastal Hōlualoa 2nd Ahupuaʻa. Haun and Associates conducted an archaeological inventory survey of the property and recorded 12 sites with 104 features (Haun and Henry 2000:14). The majority of features (n=82) were pre-Contact era agricultural rock clearing mounds. Eleven permanent habitation and one temporary habitation feature were also recorded during the study.

14. Rosendahl 1989. PHRI conducted an archaeological field inspection of 6.0 acres of land just below Queen Kaʻahumanu Highway in Hōlualoa 2nd Ahupuaʻa. Several modified outcrops were recorded in the letter report. There were no other archaeological features identified on the project area.

15. Schilt 1984. The Bishop Museum conducted an archaeological study of the Kuakini Highway Realignment Project located roughly along present day Queen Kaʻahumanu Highway and recorded 39 sites Puapuaʻa 2nd and Hōlualoa 1st and 2nd Ahupuaʻa. Twenty two of the sites were pre-Contact to early post-Contact era agricultural gardens and modified outcrops (rock clearing). There were also traditional habitation platforms and trails, as well as Historic era roads and walls recorded during the study.

16. Walker and Rosendahl 1988, Graves and Goodfellow 1993, and Maly and Rosendahl 2006. An archaeological reconnaissance survey (Walker and Rosendahl 1988), an archaeological data recovery study (Graves and Goodfellow 1993), and an archaeological preservation plan (Maly and Rosendahl 2006) were conducted by PHRI, Inc. for 104 acres in the upland region of Puapuaʻa 2nd Ahupuaʻa. A total of 67 sites were documented within the project area, including traditional (KFS) sites, temporary habitation sites, three burials, and a *heiau*. The archaeological preservation plan recommended that the three burials be relocated to the *heiau* site, and that the *heiau* be preserved as a formal historic preservation area (Maly and Rosendahl 2006).

17. Hammatt et al. 1992. An archaeological survey was conducted by Cultural Surveys Hawaiʻi on 174 acres of land in the upland region of Hōlualoa 1st, 2nd, and 3rd Ahupuaʻa. The project area lands had been heavily bulldozed during the modern era for ranching and agricultural purposes. Despite the bulldozing, seventy one sites were recorded during the study, including temporary habitation features, rock walls, agricultural features, and

three burial sites. Many of the sites were determined to be associated with Historic era ranching and agriculture.

18. Soehren 1980b. Soehren conducted an archaeological reconnaissance survey of 16.0 acres above Queen Ka‘ahumanu Highway in the inland region of Hōlualoa 1st Ahupua‘a (Soehren 1980b). A single enclosure was identified during the survey.

19. Rechtman 2006. An archaeological inventory survey was conducted by Rechtman Consulting, LLC on a roughly one-acre parcel located *makai* of Queen Ka‘ahumanu Highway in Hōlualoa 2nd Ahupua‘a. Two rock walls were recorded on the project area. The report recommended no further work at the wall sites.

20. M. Rosendahl 1988, Fager & Graves 1993. Fager and Graves (1993) conducted an archaeological inventory survey of 17.0 acres just mauka of Queen Ka‘ahumanu Highway in Hōlualoa 3rd Ahupua‘a. Seventeen sites containing 27 pre-Contact to early post-Contact era agricultural features, including rock mounds, modified outcrops, C-shaped enclosures, terraces, walls, and rock enclosures, were recorded.

21. Dircks et al. 2013. Rechtman Consulting conducted an archaeological inventory survey of 10.266 acres of land located between 840 and 920 ft amsl in Hōlualoa 1st and 2nd Ahupua‘a. One Historic era to modern era homestead/agriculture site (Miyose Farm) containing 149 features was recorded during the survey.

22. Desilets et al. 2004. Desilets et al. (2004) conducted an archaeological inventory survey of 11.7 acres of land in the *‘āpa‘a* region of Hōlualoa 1st Ahupua‘a. A single site associated with Historic era and modern era homesteads, commercial agriculture (coffee), and ranching was recorded. Features included rock walls, roads, coffee terraces, and buildings.

23. Rechtman 2013. Rechtman Consulting conducted and archaeological inventory survey of 29 acres of land located in the *‘āpa‘a* region of Hōlualoa 1st Ahupua‘a. Twenty four sites were recorded. The majority of the sites were associated with Historic era and modern era homesteads, commercial agriculture. Features included rock walls, roads, and remnants of structures. A single pre-Contact era to early post-Contact era residential and agricultural site was also recorded.

24. Clark & Rechtman 2006. Rechtman Consulting conducted an archaeological inventory survey of 2.7 acres of land located in the *ʻāpaʻa* region of Hōlualoa 1st Ahupuaʻa. Six sites were recorded, including five ranch walls and an area of coffee terraces.

A number of conclusions can be made from the previous archaeological studies. A primary conclusion is that the majority of habitation features, especially permanent habitation features, are located from the coast to about 360 ft amsl, below the present day Queen Kaʻahumanu Highway. The same is true of ceremonial features, burials, and, to a lesser extent, agricultural features. The density of agricultural features and habitation features, mostly temporary habitation features, in the upland regions between 360 ft amsl and 700 ft amsl is much lower than the site density in the coastal *kula* and lower *kaluʻulu* regions of the KFS. The pre-Contact traditional Hawaiian settlement and agricultural patterns are strongly oriented to the *kula* and lower *kaluʻulu* regions.

Even though cattle ranching and commercial agriculture may have removed some archaeological sites from the ground surface in the *kaluʻulu* region, there appear to be fewer sites than at lower elevations. The majority of sites in the *kaluʻulu* region are KFS agricultural sites including rock clearing mounds, modified outcrops, garden enclosures, and low garden walls. Within the lands of the current project, it is clear that ranching and commercial agricultural practices have removed and damaged many of the pre-Contact era sites from the ground surface (see the Hammatt et al. 1992 summary below). Moreover, many of the sites identified near the current project area are associated with Historic era ranching and commercial agriculture.

A second conclusion is that the establishment of Historic era homesteads, ranches, and commercial agriculture seems to have removed, or obscured, the majority of pre-Contact era sites in the upper *kaluʻulu* and lower *ʻāpaʻa* regions. It might be that pre-Contact uses in these regions did not involve the construction of large or permanent features, as in the lower regions of Kona. It is also likely that Historic era ranching and commercial agriculture in the lower *ʻāpaʻa* region have caused large scale land alterations through the use of bulldozers for pasture and garden. It is possible that traditional features were disassembled to build rock walls and coffee terraces.

CURRENT PROJECT AREA SPECIFIC PREVIOUS ARCHAEOLOGY

Lands of the current AIS study are most closely related to sites identified in the northern portion of the archaeological study conducted by Hammatt et al. (1992). The northern portion of that study encompassed 66.039 acres of land located between 320 to 690 feet (98 to 210 meters) amsl [TMK: (3) 7-6-021:016 and 017] (Figure 9). The current project area is located at the southeastern corner of the northern portion of the Hammatt et al. (1992) project area. In August of 2016, SCS conducted an archaeological sites inspection (Escott 2016) of the 20 previously recorded archaeological sites and the remains of two modern agricultural areas (Table 4) identified in the northern portion of the Hammatt et al. (1992) project area.

The project area and surrounding lands were bulldozed sometime between the 1940s and 1970s. Evidence of bulldozing is visible in aerial photographs as alternating bands of cleared bulldozer tracks and bands of push pile. Pedestrian survey confirmed that the linear bands in the aerial photographs are bulldozer-cleared paths and linear piles of bulldozed rock along the cleared bulldozer paths.

Seven of the 20 archaeological sites (SIHP #50-10-37-10015, #50-10-37-10017, #50-10-37-10018, #50-10-37-10020, #50-10-37-10033, #50-10-37-10034, and #50-10-37-10049, hereafter abbreviated to the last five digits) were recorded by CSH in tabular format only (Table 2). These are sites identified during the pedestrian survey that were determined to be associated with modern clearing and agricultural activities, or were natural geological features, and no written description or plan maps were generated. Written descriptions of the remaining 13 sites are in the CSH AIS report. Excavations were conducted at ten of the 13 sites. There are plan view figures for four of the 13 sites.

<u>SIHP #10011 (CSH Site 9)</u>

Site 10011 is a rectangular platform on slightly sloping bulldozed pasture land. As described by CSH, the feature has formal construction elements suggesting possible use other than agricultural rock clearing, including larger rocks (small boulders) forming an outer perimeter with smaller rocs (cobbles) forming the interior top surface. The outer perimeter is stacked one to two courses high and is roughly faced along the south side. The top surface of the platform is a slightly uneven and level rock paving.

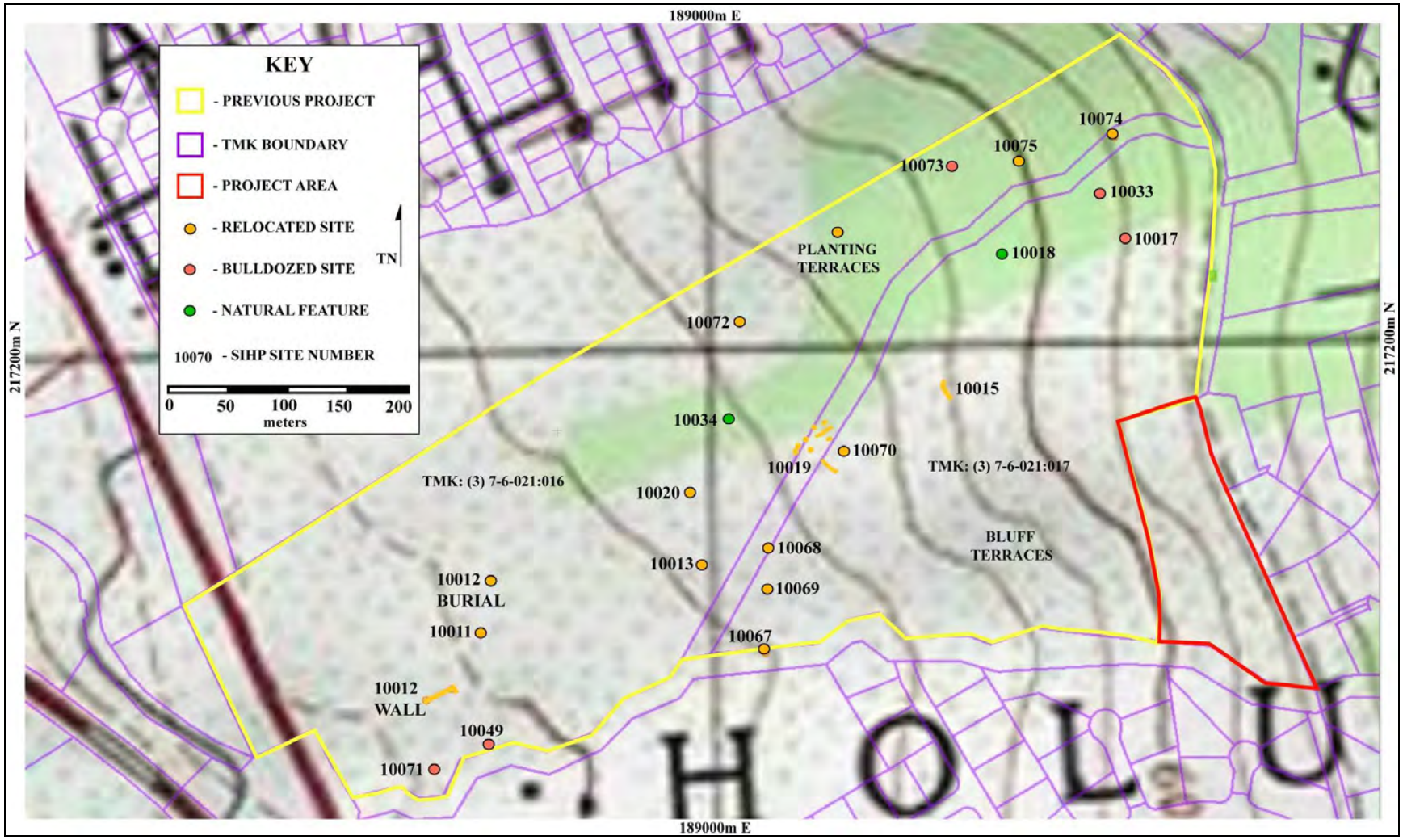

Figure 9: 7.5-Minute Series USGS Topographic Map Showing Location of Northern Portion of Hammatt et al. (1992) Sites and Current Project Area (ESRI, 2011. Sources: National Geographic Society, USGS. Kealakekua Quadrangle).

Table 4: Inventory of Hammatt et al. (1992) Archaeological Sites Inspection and Assessment Results.

SIHP#	CSH Site#	Type	Function	Age	Excavation	Level of AIS Recording	Site Assessment
10011	9	Platform	Ag. Clearing	Prehistoric	Tested	Description	AIS Site Description Correct
10012	10	Platform & Wall	Burial	Prehistoric	Excavated	Description, Planview, & Profiles	AIS Site Description Correct
10013	11	Enclosure & Lava Tube	Habitation	Prehistoric	Excavated	Description & Planview	AIS Site Description Correct
10015	13	Terrace	Road Bed	Historic	No	Tabular	AIS Site Description Correct
10017	15	Platform	Cattle Ramp	Historic	No	Tabular	Bulldozed – No Longer Present
10018	16	Enclosure	Agricultural	Historic	No	Tabular	Natural Bedrock Outcrop
10019	17	6 Rock Mounds	Ag. Clearing	Historic	Tested	Description	AIS Site Description Correct
10020	18	Platform	Ag. Clearing	Historic	No	Tabular	Natural Bedrock Outcrop
10033	112	Planting Complex	Coffee Ag	Historic	No	Tabular	Bulldozed – No Longer Present
10034	113	Platform	Ag. Clearing	Historic	No	Tabular	AIS Site Description Correct
10049	216	Terraces	Agriculture	Historic	No	Tabular	Bulldozed – No Longer Present
10067	232	Terraces	Habitation	Prehistoric	Tested	Description	AIS Site Description Correct
10068	233	Enclosure	Habitation	Prehistoric	Tested	Description & Planview	AIS Site Description Correct
10069	234	Modified Bluff/Platform	Habitation	Historic	Tested	Description	AIS Site Description Correct
10070	235	U-Shape Enclosure	Agriculture	Historic	Tested	Description	AIS Site Description Correct
10071	237	Platform	Habitation	Prehistoric	No	Description	Relocated - Bulldozed
10072	238	Modified Bluff	Ag. Clearing	Historic	Tested	Description	AIS Site Description Likely Correct
10073	239	Platforms	Ranching/Ag.	Historic	No	Description	Relocated - Bulldozed
10074	240	Enclosure	Coffee Work Shed	Historic	Tested	Description	AIS Site Description Likely Correct
10075	241	Enclosure	Pig Pen	Historic	No	Description, Planview, & Profile	AIS Site Description Likely Correct
		Historic Planting Terraces	Agriculture	Modern	No	On Project Map	AIS Site Description Likely Correct
		Bluff Terraces	Agriculture	Modern	No	On Project Map	AIS Description Correct

CSH excavated a 1.5 m wide trench through the platform and recovered three cowrie shells, suggesting the platform is a rock clearing mound. The location of the trench within the feature, the length of the trench, and the methods used to recover cultural material are not described in the CSH AIS. While the form, construction method, location of the feature suggest it is a temporary habitation feature or a feature used for activities associated with agriculture, the small amount of cultural material recovered from subsurface excavation suggest it is a rock clearing mound. The platform appears to be unaltered and is in good condition.

SIHP #10012 (CSH Site 10)

Site 10012 is a rectangular burial platform (mound) and rock wall segment on slightly sloping bulldozed pasture land. The platform was excavated by CSH and the *iwi* were reinterred at Pu‘uhonua o Hōnaunau National Historic Park (NHP). The platform has been bulldozed and only the base of the feature remains. SCS excavated a 1.0 m by 1.0 m test-unit in the center of the feature during the sites inspection and assessment work (Escott 2016) to determine the presence or absence of *iwi*. The test-unit was excavated to bedrock and all material was screened through 1/8th inch mesh screen. There were no *iwi* fragments and no other cultural material recovered from the excavation. The platform has been bulldozed and is in poor condition.

The L-shape rock wall segment was located approximately 95.0 meters southwest of the burial platform. It is roughly 23.0 m long (NE/SW) by 1.0 m wide and between 0.5 and 0.9 m in height. The wall is constructed of angular and subangular cobbles and small boulders. It is cobble core filled and bi-faced. The wall is partially collapsed in places and is in good condition.

SIHP #10013 (CSH Site 11)

Site 10013 is a roughly square habitation enclosure and a small modified lava tube. The enclosure appears to have been partially bulldozed after the CSH AIS fieldwork was completed, as the wall heights are much lower than those described in the AIS report. Rocks from the bulldozed walls are piled along the edges of the enclosure. The base of the enclosure walls is still evident on the ground surface. The CSH AIS lava tube description was assessed to be correct. The interior of the short lava tube is not modified. Site 10013 has been altered by bulldozing and is in fair to poor condition.

SIHP #10015 (CSH Site 13)

Site 10015 is a modern dirt road bed.

SIHP #10017 (CSH Site 15)

Site 10017 is described in the CSH pedestrian survey summary table as a cattle loading ramp. The area where Site 10017 was plotted on the project map is an area of bulldozed pasture with numerous large bulldozer push piles. CSH determined through consultation with SHPD and Hawai‘i County Planning that the feature did not warrant a written description in the CSH AIS report. It is possible that the feature was determined to be a bulldozer pile after CSH first identified it, or it might have been bulldozed later. The possible cattle loading ramp (Site 10017) appears to have been bulldozed or was originally a bulldozer push pile.

SIHP #10018 (CSH Site 16)

Site 10018 is described in the CSH pedestrian survey summary table as an enclosure. The area where Site 10018 was plotted on the project map is an area of natural bedrock outcrop surrounding a large tamarind tree. The bare bedrock outcrop encloses a roughly level area of soil. There are no modifications to the outcrop. CSH did not include a site description or map of the enclosure in the AIS report, likely because it was determined to be natural. There are no other archaeological features in the area around the bedrock outcrop. A final possibility is that the Site 10018 feature was bulldozed after the CSH AIS work was completed.

SIHP #10019 (CSH Site 17)

Site 10019 is six rock clearing mounds located along the southeast edge of a seasonal gulch. The presence of a metal file recovered during excavation of one of the mounds suggests the mounds are modern. The rock mounds, appear to have been impacted by flood events, they are partially collapsed, and are in fair to poor condition.

SIHP #10020 (CSH Site 18)

Site 10020 is described in the CSH pedestrian survey summary table as a platform. The area where Site 10020 was plotted on the project map is an area of bulldozed pasture with natural bedrock outcrops and loose rocks. A roughly rectangular pile of natural bedrock boulders was identified at the location of Site 10020. The boulders are naturally occurring bedrock small boulders and cobbles. There is a portion along the west side of the pile that appears to contain bulldozer push from a nearby wall

breach. The top of the rock pile is uneven but somewhat level. There is no stacking or facing apparent on the rock pile. The pile is natural, but its roughly rectangular shape and somewhat level top surface make it appear to be a possible archaeological feature. It is likely that CSH added the feature to their pedestrian survey summary table for these reasons. CSH did not include a site description or map of the feature in the AIS report, likely because it was determined to be natural.

SIHP #10033 (CSH Site 112)

Site 10033 is described in the CSH pedestrian survey summary table as a planting complex associated with modern coffee agriculture. There were coffee trees in the area when CSH conducted their AIS fieldwork. The area where Site 10033 was plotted on the project map is an area of bulldozed pasture along the southeast edge of a seasonal gulch. During the current sites inspection, it was apparent that the ground surface in this area has been impacted by flood events and bulldozing. There are no longer coffee trees and there is only a single short wall segment in the area where Site 10033 was previously identified. The planting features are no longer present.

The L-shape wall segment is roughly 5.0 m long (N/S) by 1.0 m wide and is 1.0 m in maximum height. The wall is constructed of angular and subangular cobbles and small boulders. It is cobble core filled and bi-faced. The wall has been bulldozed on both ends and is in fair condition.

SIHP #10034 (CSH Site 113)

Site 10034 was described in the CSH pedestrian survey summary table as a platform (rock mound). It was determined through consultation with SHPD and Hawai‘i County Planning that the features did not warrant a written description in the CSH AIS report. During the current site inspection, the feature was identified along the north edge of a seasonal gulch. The platform appears to have been bulldozed. Currently, the feature is a roughly 2.5 m long (E/W) by 1.8 m wide by 0.35 m high concentration of rock. The base of the platform appears to be intact in the ground surface. It is possible that the feature was in this state when CSH first identified it, or it might have been bulldozed later. The feature is most likely a rock clearing mound. It has been impacted by bulldozing and is in poor condition.

SIHP #10049 (CSH Site 216)

Site 10049 is described in the CSH pedestrian survey summary table as two linear agricultural terraces. The area where Site 10049 was plotted on the project map is along the bulldozed north bank of a seasonal gulch. During the current sites inspection, it was apparent that the ground surface in this area has been impacted by flood events and bulldozing. Site 10049 has been bulldozed and is no longer present.

SIHP #10067 (CSH Site 232)

Site 10067 is a rock wall and several soil retaining terraces constructed on the sloping north bank of a seasonal gulch. Cultural material recovered from excavations suggests the site is Prehistoric and is likely associated with temporary habitation and agriculture. The site appears to be unaltered and is in good condition.

SIHP #10068 (CSH Site 233)

Site 10068 is a small rectangular enclosure. Cultural material recovered from excavations suggests the site is Prehistoric and is likely associated with temporary habitation. The site has been bulldozed and only the base of the enclosure walls remain, with the exception of the southeast corner which is still intact.

SIHP #10069 (CSH Site 234)

Site 10069 is a modified bluff/platform. Cultural material recovered from excavations suggests that the site is a Prehistoric volcanic-glass tool working site associated with nearby agriculture. The site had been bulldozed prior to the CSH AIS. It is in poor condition.

SIHP #10070 (CSH Site 235)

Site 10070 is U-shaped enclosure. The feature construction, the lack of cultural material recovered from test excavation, and the enclosure's proximity to Historic era agricultural rock clearing mounds all suggest the enclosure is related to Historic era agriculture, most likely coffee growing. The site had been partially bulldozed prior to the CSH AIS. It is in poor condition.

SIHP #10071 (CSH Site 237)

Site 10071 was described in the CSH pedestrian survey summary table as a rectangular platform. The feature was relocated along the north edge of a seasonal gulch during the current site inspection and appears to have been bulldozed after the CSH AIS

fieldwork. The feature is now a roughly 5.8 m long (E/W) by 5.0 m wide concentration of loose rocks on the bulldozed level ground surface. There are bulldozer track marks on the loose rocks and on surrounding exposed bedrock. The feature is in poor condition.

SIHP #10072 (CSH Site 238)

Site 10072 includes two large modified outcrops, terraces, rock clearing mounds, and level soil areas. Test excavation of the largest modified outcrop did not contain cultural material. A small amount of sea urchin shell was recovered from additional testing of one of the rock mounds. The CSH AIS interpreted the site as associated with Historic era agriculture. It is possible that based on the feature types and construction method that the site is associated with pre-Contact era agriculture, though the limited subsurface test excavations to date do not support this interpretation. The site appears to be unaltered and is in good condition.

SIHP #10073 (CSH Site 239)

Site 10073 was described in the CSH AIS report as two platforms or cattle loading chutes or ramps. During the current site inspection, the features were identified along the edge of a *mauka-makai* ranch road and appear to be bulldozer push piles. It is possible that the features were in this state when CSH first identified them, or they might have been bulldozed later. The two features at Site 10073 appear to be bulldozer push piles.

SIHP #10074 (CSH Site 240)

Site 10074 is a roughly square rock enclosure likely used as a foundation for an Historic era structure associated with commercial agriculture. Cultural material recorded at the site included both Prehistoric and Historic era artifacts. The site was bulldozed at some point subsequent to the CSH AIS study. All that remains is the partially collapsed portion of what appears to be the southeast corner of the enclosure wall. The site is in poor condition.

SIHP #10075 (CSH Site 241)

Site 10075 is a roughly square rock enclosure interpreted as an Historic era pig pen. The site appears to have been partially bulldozed at some point subsequent to the CSH AIS study. Portions of the wall corners remain although the walls are no longer as high as they were described in the CSH AIS report. The site is in poor condition.

Historic Planting Terraces

The CSH AIS identified an area containing Historic era planting terraces within the northeast portion of Parcel 016. The features were relocated exactly where they were plotted on the CSH AIS project map. The features included rock mounds, linear rock alignments, terraces, modified outcrops, and level soil areas. The features were not subjected to subsurface testing during the CSH AIS. It was likely determined through consultation with SHPD and Hawai‘i County Planning that the features did not warrant testing or written descriptions. The features might be Historic in age.

Bluff Terraces

The CSH AIS identified an area containing bluff terraces within the southeast portion of Parcel 017. The features were relocated exactly where they were plotted on the CSH AIS project map. The features were not described in the CSH study because it was determined that the features were modern bulldozer push piles. Pedestrian survey of the area during the current sites inspection confirmed that they are bulldozer push piles.

All but three (Site 10017, 10033, and 10049) of the 20 archaeological sites recorded in the CSH AIS are still present on the project area. Two sites (Site 10071 and 10073) were present but bulldozed to the point that a precise assessment was not possible. Although the CSH AIS site descriptions for Site 10071 and 10073 appear likely correct. Two sites (Site 10018 and 10020) were determined to be natural geological features.

Of the 13 sites that were not impacted beyond recognition by bulldozing, ten were determined to be correctly recorded in the CSH AIS report, and three were determined to be likely correctly recorded in the CSH AIS report.

The Historic planting terraces recorded in the northeast portion of Parcel 016 were determined to be likely correctly recorded, and the bluff terraces recorded in the south east portion of Parcel 017 was determined to be correctly recorded in the CSH AIS report.

Based on the CSH AIS report and a February 8, 1993 Gamrex, Inc. letter to SHPD, CSH recorded 20 archaeological sites and two Historic/Modern era agricultural areas during their initial pedestrian survey. These sites were described in tabular format and a pedestrian survey summary was given to SHPD and Hawai‘i County Planning for

review. SHPD and County Planning then made a site visit to consult with CSH on the preliminary site interpretations and the appropriate level of documentation for each site. CSH then returned to selected sites and recorded written descriptions and created site and feature plan maps for sites at which they were required to do so. The remaining sites were either determined to be natural or associated with Historic/Modern era commercial agriculture and no further documentation was required in the AIS report.

Overall, based on the SCS sites inspection and assessment (Escott 2016), the CSH AIS report correctly identified project area archaeological sites and tested, recorded, and interpreted them correctly. All of the Parcel 016 and Parcel 017 archaeological sites documented in the CSH AIS report were recommended for no further work (Hammatt et al. 1984:38). The recommendation was made as "the significant material from the study area has been recovered and further investigation would be of minimum productivity" (Hammatt et al. 1984:38).

The majority of sites (n=14) documented in the northern portion of the Hammatt et al. (1992) project area were interpreted as Historic era ranching and commercial agriculture features. Only six sites were interpreted as pre-Contact era to early post-Contact era, four of them were associated with temporary habitation, one with agricultural rock clearing, and one with burial practices.

EXPECTED ARCHAEOLOGICAL PATTERNS

Based on previous archaeological studies, geological studies, historical research, interviews, and County Planning Department records it is expected that any archaeological sites remaining on the current project area will be related to traditional pre-Contact era agriculture, temporary habitation, burial practices, and to early post-Contact era and Historic era ranching and agricultural activities.

It is likely that many of the pre-Contact to early post-Contact era sites have been removed or disturbed by Historic era and modern ranching and commercial agriculture. This is especially true because the area around the current project era was used as cattle pasture from the Historic era to the present. Additionally, the project area is in a location that was bulldozed sometime between the 1940s and the 1970s in preparation for a commercial agricultural project, most likely coffee growing. Aerial photos clearly show that bulldozer transects were cut north/south across the entire five-acre project area.

Archaeological sites and features that are likely to remain on the project area will likely include pre-Contact era to early post-Contact era rock clearing mounds, terraces, small enclosures, and burials. It is also likely that Historic era and modern features related to ranching and agriculture will also be identified on the project area. These include primarily rock walls constructed to confine cattle.

RESULTS OF FIELDWORK

Twenty two newly identified archaeological sites were recorded during the course of the archaeological inventory survey study (Table 5 and Figure 10). The sites are primarily agricultural complexes and terraces associated with pre-Contact era, through early post-Contact era to Historic era agriculture. Several rock walls and enclosures are associated with Historic era agriculture and ranching. A pre-Contact era to later post-Contact era single lava tube burial was also recorded. A portion of the old railroad berm was also recorded along the eastern edge of the project area. All site numbers are preceded by the prefix #50-10-37-.

SITE 30591	**Agricultural Complex**
FUNCTION:	Agriculture
AGE:	Pre-Contact to Early Post-Contact Era
DIMENSIONS:	20.0 m (N/S) by 9.0 m by 0.95 m in max. height
CONDITION:	Good
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	None
EXCAVATION:	Shovel Probe Testing (SP-1, SP-2, SP-3)

DESCRIPTION: Site 30591 is an agricultural complex located within the northern portion of the project area, immediately south of the north project area boundary (see Figure 10). The site is situated at 650 ft amsl on a west facing slope, among *koa haole* trees and Guinea grass ground cover.

The complex is six terraces and planting features (Features 1 through 6) constructed on a level area along a west facing slope (Figure 11). The site is approximately 20.0 m in length (N/S) and 9.0 m wide, with a maximum height of 0.95 m. There is a *mauka*/*makai* rock alignment at the center of the site and level terraces extending north and south from the rock alignment. Feature 1 through Feature 4 are south of the alignment and Feature 5 and Feature 6 are north. There are three *pāhoehoe*

Table 5: Inventory of Archaeological Sites Identified on the AIS Project Area.

Site #	Site Type	Features	Site Function	Age	Testing
30591	Agricultural Complex	6	Agriculture	Pre-Contact to Historic Era	SP-1, 2, 3
30592	Railroad Bed and Berm	1	Transportation	Historic Era	
30593	Lava Tube	1	Burial	Pre-Contact to Early Post-Contact Era	
30594	Agricultural Complex	6	Agriculture	Pre-Contact to Historic Era	SP-1 & 2
30595	Rock Wall	1	Ranching	Historic Era	
30596	Hearth	1	Food Preparation	Historic Era	TU-1
30597	Rock Wall	1	Ranching	Historic Era	
30598	Rock Wall	1	Agriculture/Ranching	Pre-Contact to Historic Era	
30599	Platform & Enclosure	2	Ranching/Agriculture	Historic Era	SP-1 & 2, TU-1
30600	Terrace	1	Agriculture	Historic Era	SP-1
30601	Rock Wall	1	Ranching	Historic Era	
30602	Enclosure	1	Ranching/Agriculture	Historic Era	SP-1, 2, 3 & 4
30603	Enclosure	4	Ranching/Agriculture	Historic Era	SP-1 & 2
30604	Agricultural Complex	4	Agriculture	Pre-Contact to Historic Era	SP-1
30605	Rock Wall	1	Ranching/Agriculture	Historic Era	
30606	Rock Wall	1	Ranching/Agriculture	Pre-Contact to Historic Era	
30607	Agricultural Complex	7	Agriculture	Pre-Contact to Historic Era	SP-1 to SP-10
30608	Enclosure	1	Structure	Historic Era	
30609	Enclosure	1	Structure	Historic Era	
30610	Terrace	1	Agriculture	Pre-Contact to Historic Era	SP-1
30611	Agricultural Complex	3	Agriculture	Pre-Contact to Historic Era	SP-1, 2, 3
30612	Lava Blister	1	Refuse Dump	Historic Era	

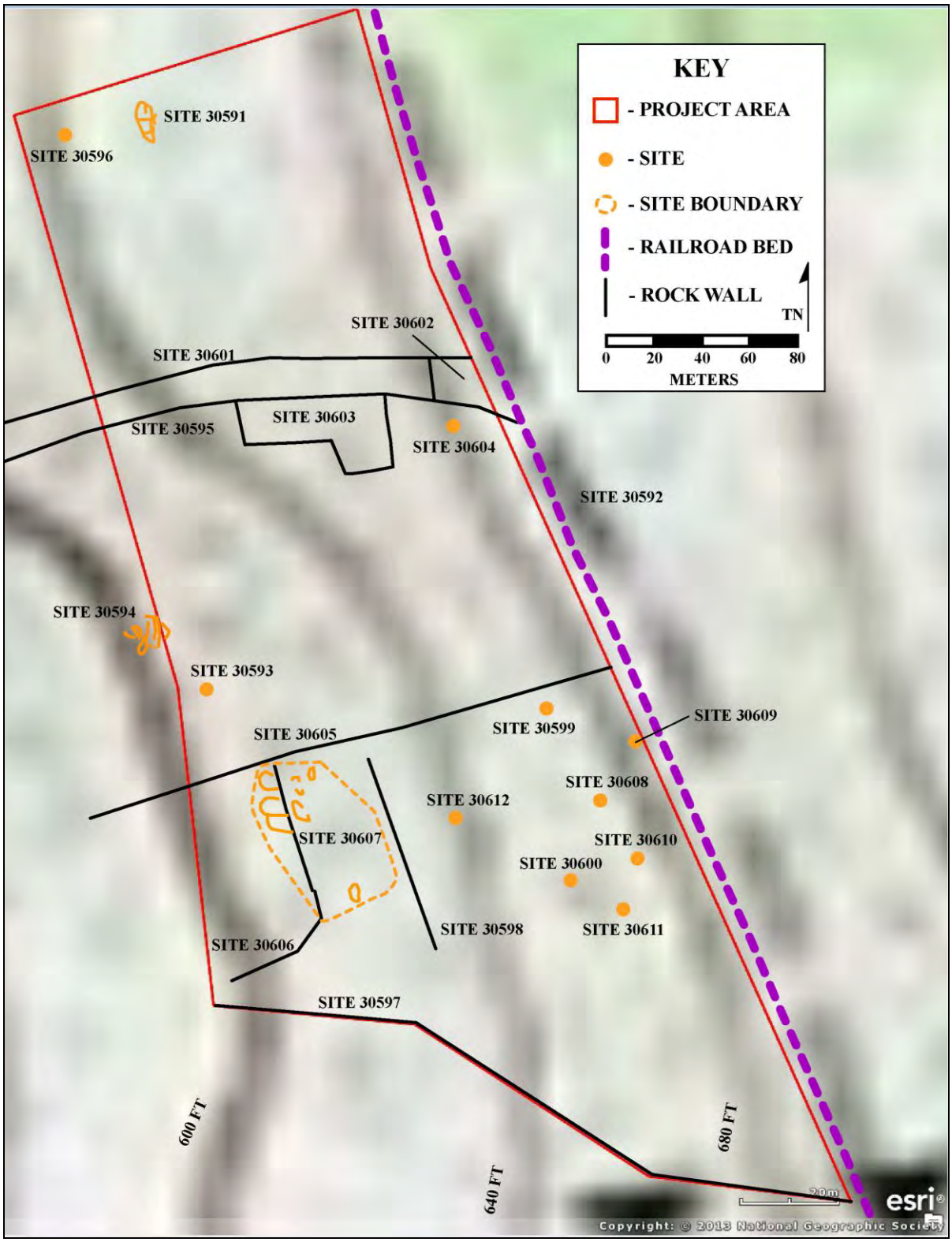

Figure 10: 7.5-Minute Series USGS Topographic Map Showing Locations of Project Area Archaeological Sites (ESRI, 2011. Sources: National Geographic Society, USGS. Kealakekua Quadrangle).

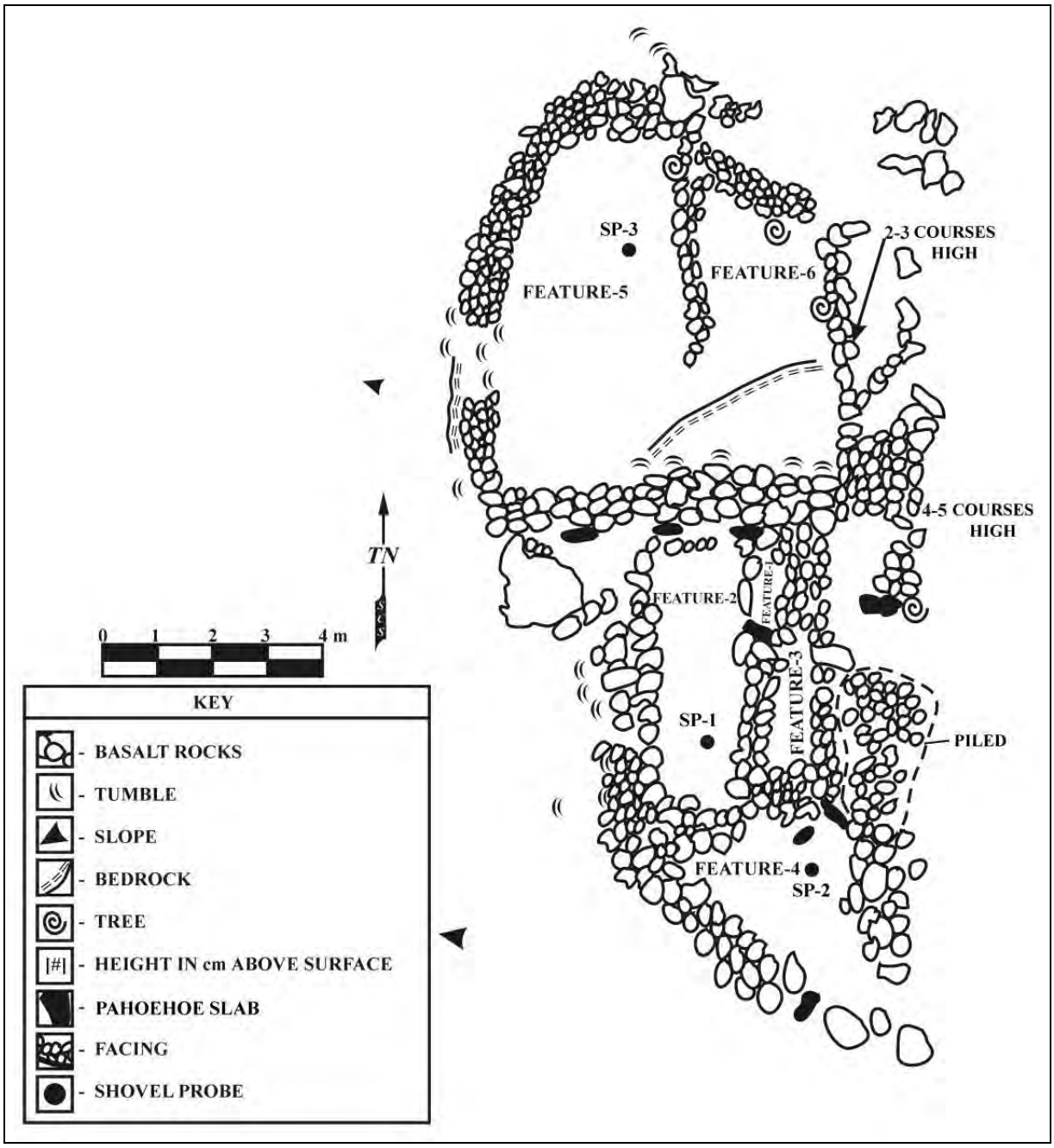

Figure 11: Site 30591 Plan View Map.

slabs along the south side of the central rock alignment that were placed with their longest axis oriented vertically.

Feature 1 is an oval planting feature constructed along the central rock alignment and along the east side of the site (Figure 12). It is constructed of a single course of small basalt boulders and cobbles and is approximately 2.0 m in length (N/S) by 0.70 m wide, with a maximum height of 0.59 m. The feature is collapsed in some areas and is in fair condition.

Feature 2 is a rectangular soil filled terrace located immediately west of Feature 1 (Figure 13). It is constructed along the south side of the central rock alignment. The terrace is approximately 5.5 m in length (N/S) by 2.50 m wide, with a maximum height of 0.68 m. It is constructed of angular and sub angular basalt cobbles and small boulders ranging in size from 0.20 to 0.50 m. The feature is collapsed in some areas and is in fair condition.

Feature 3 is a small rectangular soil filled terrace located immediately south of Feature 1 (Figure 14). The terrace is approximately 3.50 m in length (N/S) and 1.40 m wide, with a maximum height of 0.70 m. It is constructed of angular and sub angular basalt cobbles and small boulders ranging in size from 0.20 to 0.70 m. The feature is collapsed in some areas and is in fair condition.

Feature 4 is a roughly rectangular terrace located immediately south of Feature 2 and Feature 4 (Figure 15). The terrace is approximately 5.0 m in length (NW/SE) by 3.40 m wide, narrowing slightly at the southern terminus, with a maximum height of 0.50 m. It is constructed of angular and sub angular basalt cobbles and small boulders ranging in size from 0.25 to 0.50 m. The feature is collapsed in some areas and is in fair condition.

Feature 5 is a roughly rectangular terrace located in the northwest corner of the site (Figure 16). The terrace is constructed along the northwest side of the central rock alignment. The terrace is approximately 8.0 m in length (N/S) by 4.0 m wide, with a maximum height of 0.70 m. It is constructed of angular and sub angular basalt cobbles and small boulders ranging in size from 0.25 to 0.70 m. The feature is collapsed in some areas, generally where smaller rocks have been utilized, and is in fair condition.

Figure 12: Photograph of Site 30591 Feature 1 Looking Northeast.

Figure 13: Photograph of Site 30591 Feature 2 Looking North.

Figure 14: Photograph of Site 30591 Feature 3 Looking Northeast.

Figure 15: Photograph of Site 30591 Feature 4 Looking Southeast.

Figure 16: Photograph of Site 30591 Feature 5 Looking South.

Feature 6 is a roughly rectangular terrace located in the northeast corner of the site (Figure 17). The terrace is constructed along the northeast side of the central rock alignment. The terrace is approximately 6.1 m in length (N/S) by 3.2 m wide, with a maximum height of 0.55 m. It is constructed of angular and sub angular basalt cobbles and small boulders, some as large as 0.50 m. The feature is collapsed in some areas and is in fair condition.

All of the terrace and planting features at Site 30591 are constructed of roughly piled rock. There is no formal stacking or facing evident in the feature construction. There were no cultural remains identified on the ground surface at the site. There is a fair amount of bulldozer pushed rock piled along the *mauka* (east) side of the site.

Shovel Probe Testing

Three shovel probes (SP) were excavated at Site 30591. The shovel probes were excavated within the soil area of Feature 2, Feature 4 and Feature 5 terraces. The shovel probes were dug to depths ranging from 6.0 to 32.0 cmbs, and terminated on bedrock or large basalt rocks (Table 5). Shovel probe stratigraphy consisted of Layer I (0-13 cmbs) loose (10YR3/2) dark brown fine sandy silt loam overlying Layer II (13-32 cmbs) soft (10YR4/4) dark yellowish brown fine sandy silt. A single fragment of sea urchin spine was identified in SP-1 and was not collected. SP-2 and SP-3 did not contain cultural material.

Table 6: Site 30591 Shovel Probe Results.

Feature	SP#	Depth (cm)	Layers	BOE	Artifacts
2	1	0 - 32 cm	I & II	Basalt Rock	Urchin Spine Fragment
4	2	0 - 6 cm	I	Basalt Rock	-
5	3	0 - 15 cm	I & II	Basalt Rock	-

The piled rock construction of the site and the form of the terrace features suggest the site was constructed to retain soil for agricultural purposes. The lack of cultural material on the ground surface and the small amount of cultural material recovered from the shovel probes at Site 30591 supports the interpretation that the site consists of agricultural planting terraces and a small planting feature. Site 30591 has been slightly impacted by modern bulldozing, is partially collapsed in places, and is in fair to good condition. No further work is recommended at the site.

Figure 17: Photograph of Site 30591 Feature 6 Looking North.

SITE 30592 **Railroad Berm**
FUNCTION: Transportation
AGE: Historic Era
DIMENSIONS: 265.0 m (SE/NW) by 2.50 m by 1.5 m max. height
CONDITION: Good
INTEGRITY: Possesses Integrity of Location and Materials
SURFACE ARTIFACTS: Modern Trash Debris
EXCAVATION: None
DESCRIPTION: Site 30592 is an Historic era railroad berm located along the eastern boundary of the project area (see Figure 10). The railroad berm is approximately 265.0 m in length (SEN/W) and 2.5 m wide within the project area, continuing north and south beyond the project area limits. The railroad bed is a level dirt and rock surface, and the berm is located along the west side of the railroad bed. The berm is a retaining wall constructed of small boulders and large cobbles stacked up to nine courses high (Figure 18). The berm is well faced with fairly tightly fitted natural rock. The rock has not been worked prior to stacking. The berm face slopes slightly toward the east as it approaches the top to prevent collapse.

The surface of the railroad bed has been bulldozed in the fairly recent past, likely during construction of the homes along the east edge of the project area property. Portions of the berm are partially collapsed. There is a fair amount of modern construction debris and refuse along the course of the railroad bed. The railroad berm is in good condition.

SITE 30593 **Lava Tube**
FUNCTION: Burial
AGE: Pre-Contact to Early Post-Contact Era
DIMENSIONS: 60.0 m (E/W) by 9.0 m by 0.95 m in max. height
CONDITION: Good
INTEGRITY: Possesses Integrity of Location and Materials
SURFACE ARTIFACTS: None
EXCAVATION: None
DESCRIPTION: Site 30593 is a Lava tube located at 610 ft amsl along the central western portion of the project area, immediately east of the project area boundary (see Figure 10). The site is situated on a western facing slope, among *koa haole* and trees with Guinea grass ground cover.

Figure 18: Photograph of Site 30592 Looking East.

The skeletal remains of a single individual were identified in a lava tube near the *makai* (west) boundary of the project area. The lava tube can be accessed through two openings, one at the *makai* end of the lava tube and a second, larger opening approximately 20.0 meters *mauka* (east) of the *makai* opening (Figure 19). The lava tube continues east 15.0 meters and east-southeast 25.0 to 30.0 meters from the *mauka* opening. A second tube, connecting to the east-southeast tube, continues west-southwest 30.0 meters.

The *makai* entrance is an approximately 0.9 m long (E/W) by 0.7 m wide hole in the exposed *pāhoehoe* ground surface. The floor of the lava tube is 0.5 to 0.9 cm below the opening and is primarily bare lava with deposits of natural pebbles, small cobbles, and fine sediment washed into the tube from the opening and a second point in the tube approximately 6.0 m east of the opening. The tube slopes gently upward in an easterly direction. Sediment from a collapsed point 6.0 meters into the tube covers the lava tube floor in thicker deposits nearer to the point of collapse.

The distal end of a human femur, talus, metatarsal, and phalange were identified on the surface of the lava tube floor below the *makai* opening. The skeletal elements were small in size and were deteriorated, making positive identification difficult. The ilium of a small human pelvis was identified protruding from the sediment along the south wall of the lava tube, approximately 5.0 m *mauka* of the *makai* opening. Sediment was cleared in small increments to expose one half of a pelvis. Half of the ilium had deteriorated and was no longer present on the pelvis.

More sediment (4.0 to 8.0 cm in thickness) was removed to expose additional human skeletal elements located within close proximity to the pelvis. These included lumbar, thoracic, and cervical vertebrae; ribs; both clavicles and shoulder blades; the left ulna and radius; several phalanges; and two incisors and a molar.

The other half of the pelvis; cranium, mandible, other long bones, and remaining skeletal elements were not located in the limited removal of sediment. If these skeletal elements are buried beneath the sediment on the floor of the lava tube, they may no longer be articulated with the identified skeletal elements. It is possible that they have moved down slope of the *in situ* burial. This is likely, as a calcaneus, tarsals, and metatarsals were identified during a second, more thorough inspection of the lava tube floor under the *makai* opening—a distance of 5.0 m down slope of the burial location. At

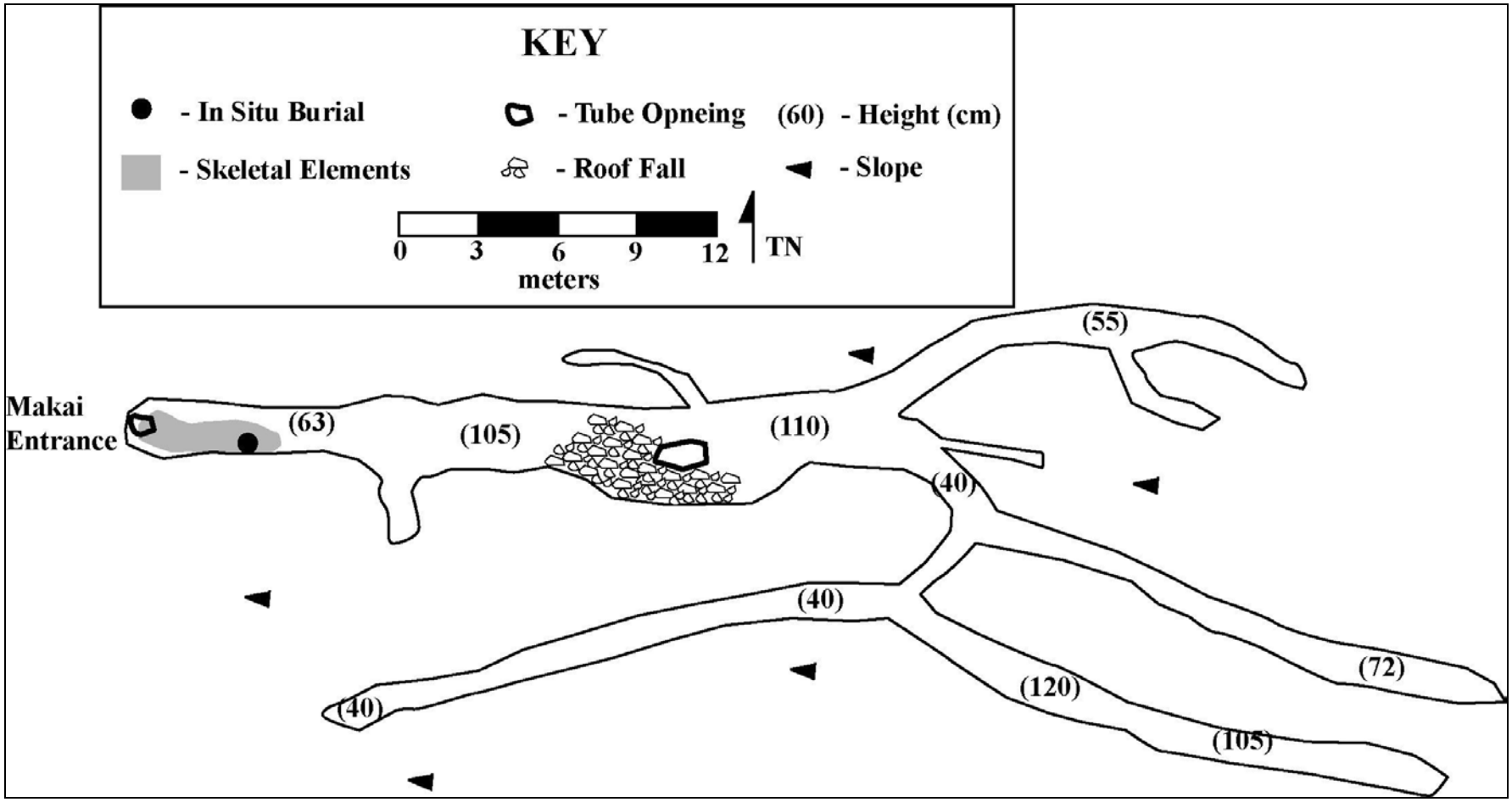

Figure 19: Site 30593 Plan View Sketch Map.

least a portion of the femur and several foot bones have moved down slope of the original burial location.

Based on the limited removal of sediment from the skeletal elements, the burial is of a single individual in a supine position, arms at sides, with head located *mauka* (east) and feet *makai*. The size of the skeletal elements indicates a young adult of small stature or a subadult. The skeletal elements were fairly deteriorated so that sex and age could not be definitively ascertained. The burial appears to be only slightly altered by rainwater runoff flowing through the lava tube and is in good condition. Site 30593 is recommended for preservation.

SITE 30594	**Agricultural Complex**
FUNCTION:	Agriculture
AGE:	Historic Era
DIMENSIONS:	20.0 m (E/W) by 17.0 m by 0.70 m in max. height
CONDITION:	Good
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	Heavy gauge wire, golf balls
EXCAVATION:	Shovel Probe Testing (SP-1, SP-2)

DESCRIPTION: Site 30594 is an agricultural complex located at 600 ft amsl approximately 16.0 meters northwest of Site 30593, along the western project area boundary (see Figure 10). The site is situated on a west facing slope, among *koa haole* and trees with Guinea grass ground cover. The site is in an area of broken bedrock suggestive of an large outcrop or collapsed lava tube. The rock is mostly angular and slabby, though there are also subangular rocks at the site.

The complex is six narrow terraces (Features 1through 6) constructed on a moderately steep west facing slope (Figure 20). The site is approximately 20.0 m in length (E/W) by 17.0 m wide, with a maximum height of 0.70 m. Features 1 through 4 are roughly parallel and are situated with their long axis oriented north/south. Feature 1 is the uppermost terrace along the east side of the site. Feature 5 and Feature 6 are smaller terraces oriented northwest/southeast and are down slope of Features 1 through 4, along the west side of the site.

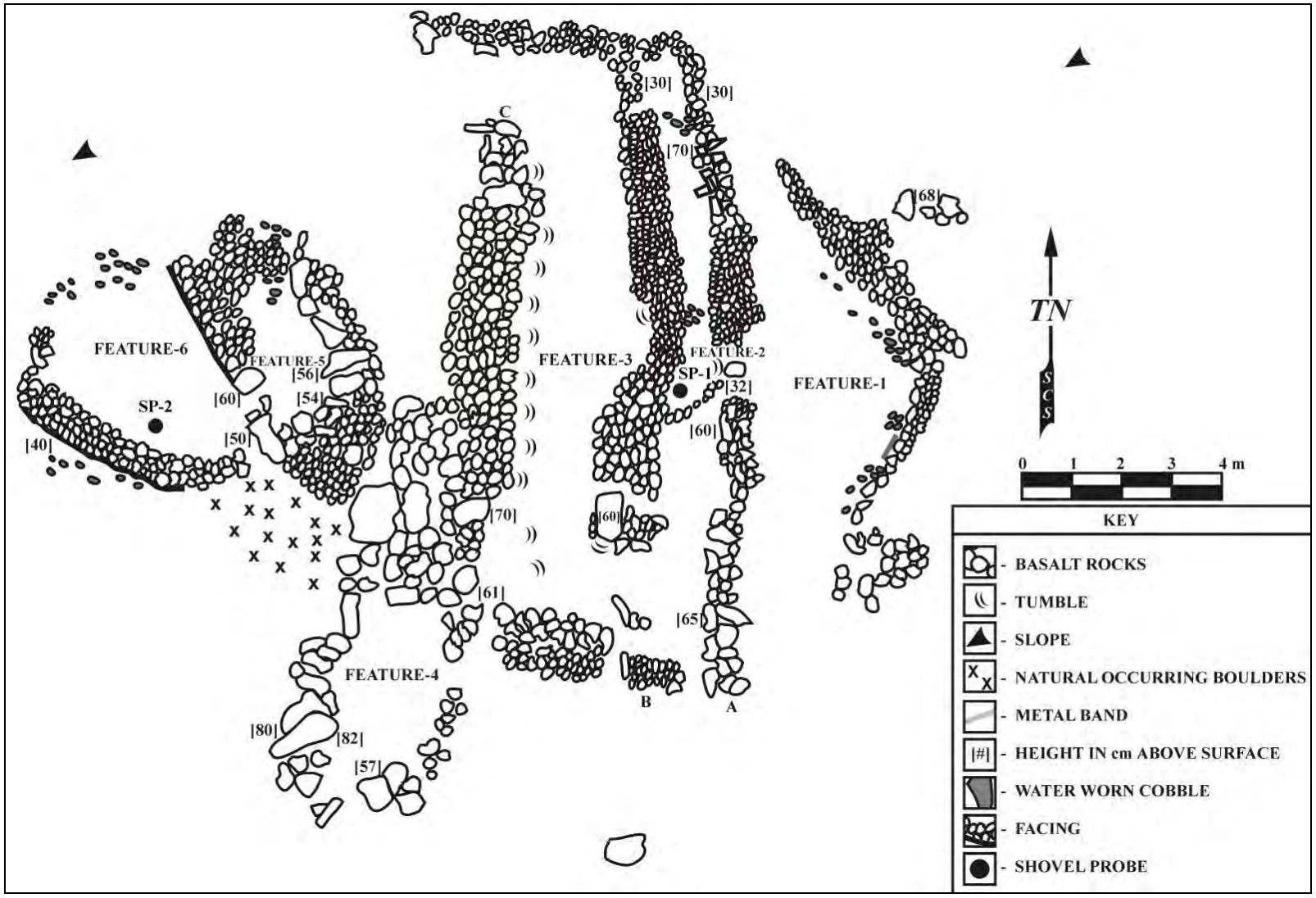

Figure 20: Site 30594 Plan View Map.

Feature 1 is a roughly rectangular soil filled terrace on the east side of the site (Figure 21). It is approximately 10.0 m long by 1.8 m wide, with a maximum height of 0.81 m. There is a retaining wall constructed of piled and stacked angular and subangular small boulders and cobbles along the west side of the level soil terrace. There is no formal facing evident in the retaining wall construction.

There is another pile of rock *mauka* (east) of the soil filled terrace of Feature 1, constructed of piled angular and sub angular basalt cobbles and boulders. There is no formal facing evident in the rock pile. The retaining wall to the west and the rock pile to the east are partially collapsed in some areas. It looks as though Feature 1 has been impacted by bulldozing, especially along the north side of the feature. Feature 1 is in fair condition.

Feature 2 is a linear soil filled terrace located west of Feature 1 (Figure 22). The terrace retaining wall trends N/S, curving down slope at its northern terminus. It is approximately 14.0 m in length by 1.20 m wide, with a maximum height of 0.70 m. The retaining wall of the terrace is constructed of piled angular and subangular basalt cobbles and small boulders ranging in size from 0.40 to 0.75 m. There is no formal facing evident in the terrace construction. It looks as though Feature 1 has been impacted by bulldozing, especially along the north side of the feature. The retaining wall is collapsed in some areas and is in fair condition.

Feature 3 is a linear soil filled terrace situated down slope, to the west, of Feature 2 (Figure 23). The terrace retaining wall trends N/S. It is approximately 14.0 m in length and 1.40 m wide, with a maximum height of 0.70 m. It is constructed of piled angular and sub angular basalt cobbles and small boulders, which range in size from 0.40 to 0.75 m. There is no formal facing evident in the terrace construction. The retaining wall is collapsed in some areas and is in fair condition.

Feature 4 is a rectangular rock and soil filled terrace located on the south end of Feature 3. The terrace retaining wall trends N/S and is approximately 7.0 m in length by 2.90 m wide, with a maximum height of 0.70 m. It is constructed of piled angular and sub angular basalt cobbles and small boulders, which range in size from 0.40 to 0.75 m throughout the southern portion of the feature. The northern portion is composed of larger rock, incorporating what are likely *in situ* boulders that continue south to form portions of the soil filled terrace. The level soil filled terrace at the south

Figure 21: Photograph of Site 30594 Feature 1 on Left and Feature 2 on Right Looking South.

Figure 22: Photograph of Site 30594 Feature 1 in Top Left, Feature 2 at Center, Feature 3 at Far Right, Looking South.

Figure 23: Photograph of Site 30594 Feature 2 on Left and Feature 3 on Right Looking South.

end of the feature is approximately 5.0 m in length and 4.0 m wide, with a maximum height of 0.82 m, and contains rock. There is no formal facing evident in the terrace construction. The feature is collapsed in some areas and is in fair condition.

Feature 5 is a soil filled terrace/enclosure situated down slope, to the west, of Feature 4 (Figure 24). It trends NW/SE, and is roughly oval. It is approximately 5.5 m in length by 3.40 m wide, with a maximum height of 0.60 m. It is constructed of piled and stacked angular and sub angular basalt cobbles and small boulders. The rock is stacked up to four courses high on bedrock along the westernmost perimeter of the feature. The eastern and southeastern portions of the feature incorporate naturally occurring small boulders into the construction. There is no formal facing evident in the terrace construction. Feature 5 is collapsed in some areas and is in fair condition.

Feature 6 is a level soil filled terrace situated down slope, to the west, of Feature 5 (Figure 25). The terrace retaining wall trends NW/SE curving up slope at either end. It is approximately 4.5 m in length by 1.0 m wide, with a maximum height of 0.80 m. It is constructed of angular and sub angular basalt cobbles and small boulders, which are stacked up to three courses high along the westernmost perimeter. There is some very rough facing evident in the terrace construction. The retaining wall is collapsed in some areas and is in fair condition.

A strand of heavy gauge wire and two golf balls were encountered on the ground surface at the site.

Shovel Probe Testing

A total of two shovel probes were excavated within Site 30594 to determine site function and age. The shovel probes were excavated approximately 11.0 m from one another within the soil area of Feature 2 terrace (SP-1) and Feature 6 terrace (SP-2). The shovel probes were dug to depths ranging from 26.0 to 55.0 cmbs and terminated on bedrock or large basalt rocks (Table 6). Shovel probe stratigraphy consisted of three natural stratigraphic layers: Layer I (0-12 cmbs) loose dark brown (10YR3/2) fine sandy silt loam, Layer II (12-38 cmbs) soft brown (10YR4/3) sandy silt, and Layer III (38-55 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. There were no cultural materials recovered from the shovel probes.

Figure 24: Photograph of Site 30594 Feature 5 Looking Northeast.

Figure 25: Photograph of Site 30594 Feature 6 in Foreground and Feature 5 in Background, Looking Northeast.

Table 7: Site 30594 Shovel Probe Results.

SP#	Depth (cm)	Layers	BOE	Artifacts
1	0 - 55 cm	I, II, III	Basalt Rock	-
2	0 - 26 cm	I & II	Basalt Rock	-

The terraces at Site 30594 are fairly crudely constructed and were not constructed with much formal stacking or facing. The Feature 1 through Feature 4 retaining walls resemble linear piles of rock left along the outside edges of a bulldozer transect. The rock appears to be from a large concentration of naturally occurring bedrock on the ground surface, possibly the remains of a collapsed lava tube. However, the features also appear as though they could have been constructed as agricultural terraces, especially Feature 5 and Feature 6. Subsurface testing did not recover any cultural material. Site 30594 is interpreted as a pre-Contact era to Historic era agricultural site. The site has been slightly altered by cattle ranching and agricultural activities, is in fair condition and no further work is recommended.

SITE 30595 **Rock Wall**
FUNCTION: Cattle Ranching
AGE: Historic Era
DIMENSIONS: 90.0 m (E/W) by 1.10 m by 1.31m in max. height
CONDITION: Good
INTEGRITY: Possesses Integrity of Location and Materials
SURFACE ARTIFACTS: None
EXCAVATION: None
DESCRIPTION: Site 30595 is the remains of an Historic era wall located between 630 and 690 ft amsl within the northern portion of the project area (see Figure 10). The wall trends *mauka*/*makai* and is located on west sloping land with *kukui* nut and *koa haole* trees and Guinea grass ground cover. The wall has been breach by bulldozing in several places and portions of the wall continue to the east, beyond the project area.

The wall is constructed of angular and subangular basalt cobbles and small boulders, incorporating boulders as large as 0.60 m at the base (Figure 26). It is bifaced and cobble core filled (Figure 27). The wall is approximately 90.0 m in length (E/W) within the project area, by 1.10 m wide, with a maximum height of 1.31 m. The wall bisects the property east to west, terminating to the east at the Site 30592 railroad berm, where it is attached to the south face of the berm, continuing to the west beyond the

Figure 26: Photograph of Site 30595 Wall Looking North.

Figure 27: Photograph of Site 30595 Wall Collapse Showing Cobble Core Fill, Looking North.

property boundary. A portion of the eastern wall segment, approximately 18.0 m, constitutes the southern boundary of Site 30602 enclosure. There is a 1.0 m breach in the wall for access to the enclosure.

There was no cultural material on the ground surface at the site. Site 30595 is a Historic era wall that has been altered by bulldozing, is partially collapsed in places, and is in fair condition. No further work is recommended at Site 30595.

SITE 30596	**Hearth**
FUNCTION:	Possible Cooking
AGE:	Historic Era
DIMENSIONS:	2.50 m (E/W) by 2.10 m by 0.85 m in max. height
CONDITION:	Good
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	None
EXCAVATION:	Test Unit (TU-1)

DESCRIPTION: Site 30596 is a hearth located within the northwestern corner of the project area (see Figure 10). The hearth is situated on an exposed bedrock outcrop in a level area, approximately 10.0 m east of the top of a shallow west facing slope. There are *koa haole* and *kukui* nut trees with Guinea grass ground cover throughout the area.

The hearth is constructed on a narrow finger of hollow *pāhoehoe*. The top of the small *pāhoehoe* "tube" is broken open in places. The hearth is constructed within an opening in the top of the small "tube." It is constructed of cobble and small boulder size *pāhoehoe* slabs positioned in a roughly rectangular configuration around the opening (Figure 28 and Figure 29). The hearth is approximately 2.50 m in length (E/W) and 2.10 m wide, with a maximum height of 0.85 m. There was no cultural material identified on the ground surface at the site.

A 1.0 m by 0.5 m test-unit (TU-1) was excavated in the hearth to determine feature function and age. TU-1 was excavated as two stratigraphic layers (Layer I and Layer II) and terminated on bedrock at 28 cmbs (Figure 30).

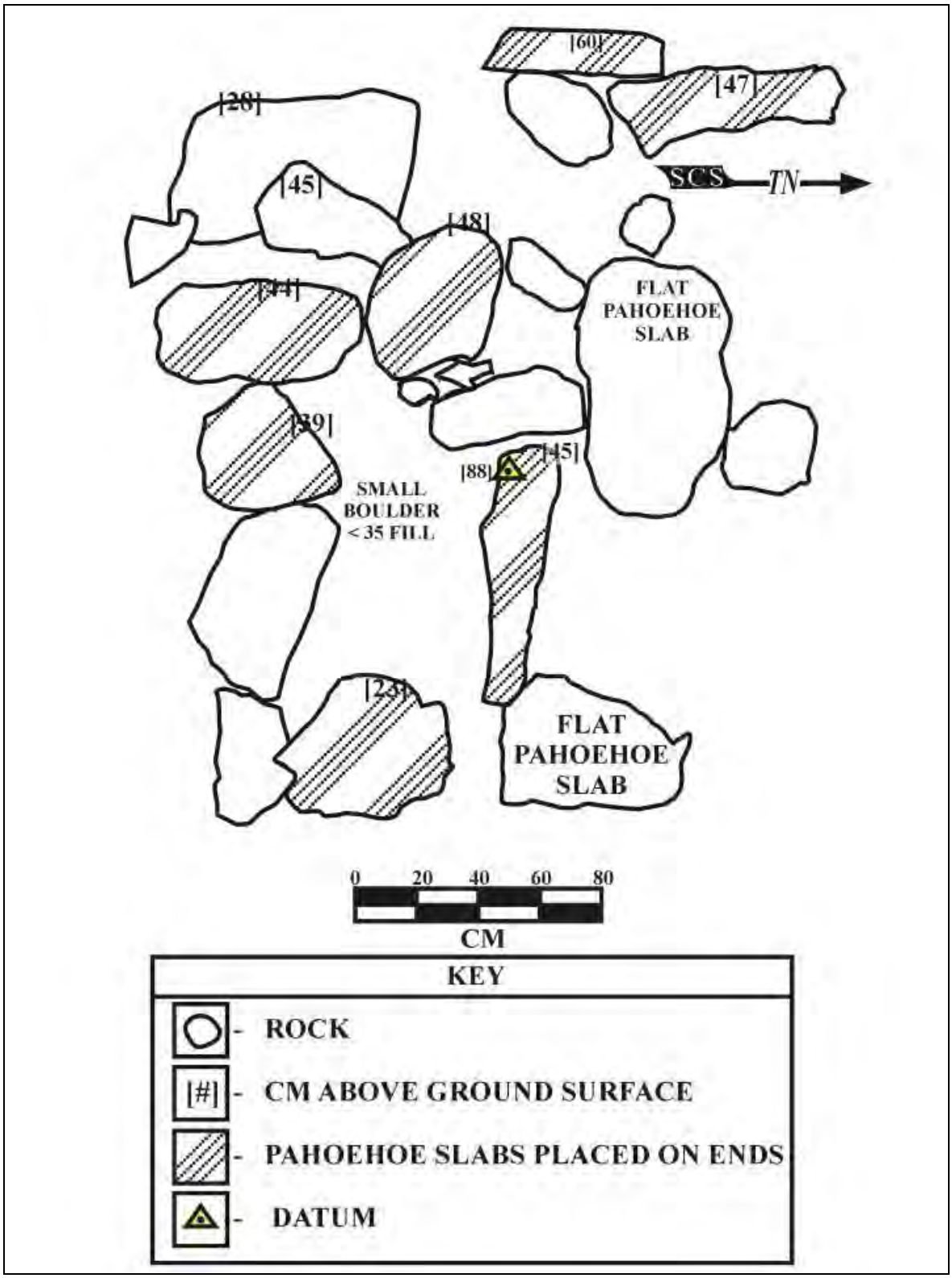

Figure 28: Site 30596 Plan View Map.

Figure 29: Photograph of Site 30596 Hearth Looking West.

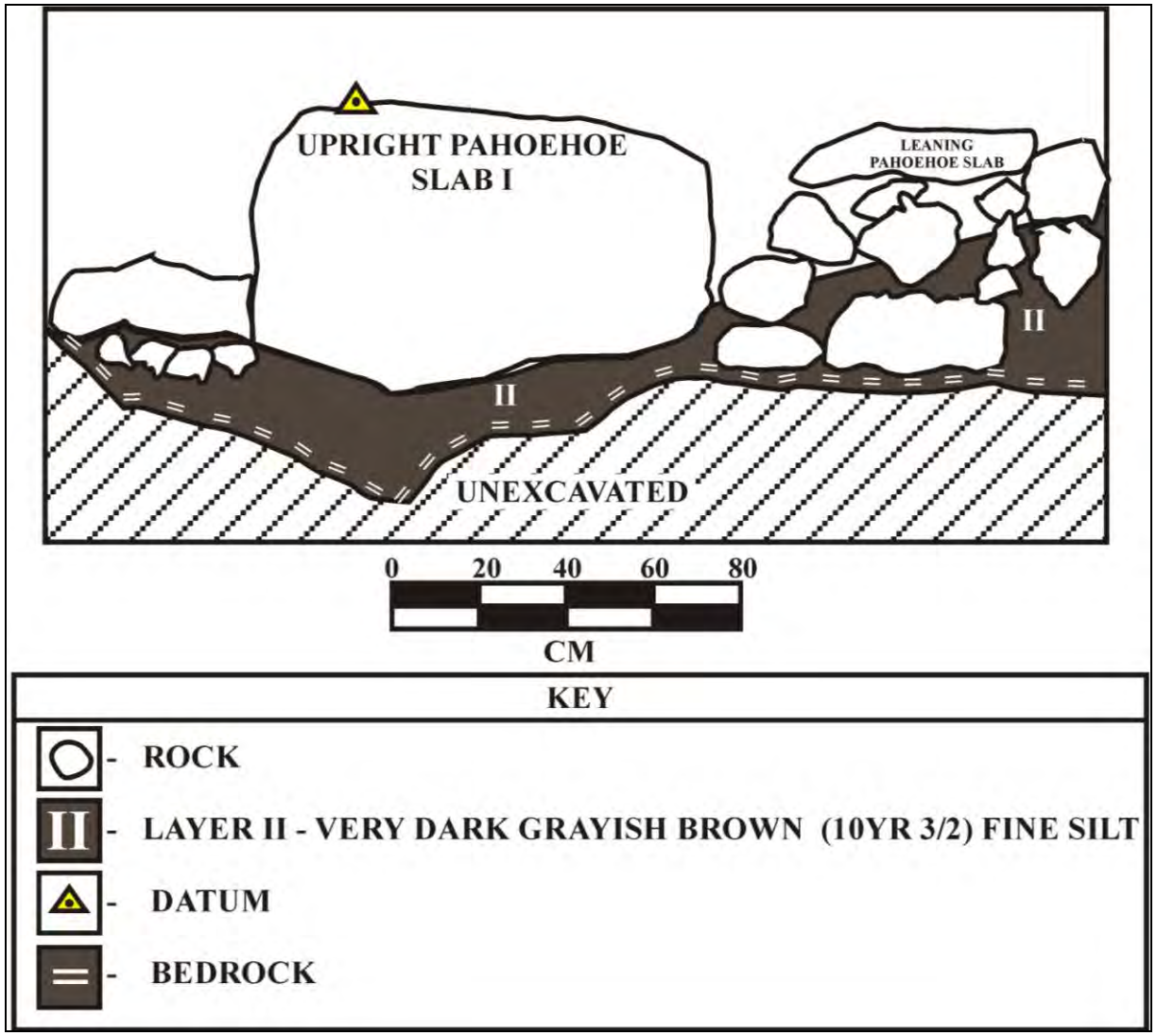

Figure 30: Site 30596 TU-1 North Profile.

Layer I (0-20 cmbs) was loose angular and subangular cobbles and small boulders removed from the center of the hearth. The base of Layer I was roughly even with the top of Layer II (Figure 31).

Layer II (20-40 cmbs) was loose (10YR3/2) very dark grayish brown fine sandy silt with less than 5% gravels and cobbles, and roughly 1% fine rootlets. Layer II terminated on bedrock (Figure 32). A small amount of midden (marine shell, bird bone, rodent bone, and burnt *kukui* nut shell) and charred material was recovered from TU-1, Layer I (see Appendix A). Based on the formal construction of the hearth, it is interpreted as a Historic era fire feature. The hearth appears to be unaltered, is in good condition and no further work is recommended at Site 30596.

SITE 30597	**Rock Wall**
FUNCTION:	Cattle Ranching
AGE:	Historic Era
DIMENSIONS:	145.0 m (E/W) by 0.90 m by 1.30 m in max. height
CONDITION:	Fair
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	None
EXCAVATION:	None

DESCRIPTION: Site 30597 is an historic era rock wall located between 590 and 690 amsl along the southern boundary of the project area (see Figure 10). The *mauka*/*makai* wall is constructed along the north side of a seasonal gulch and marks the property boundary. There are *koa haole* and *kukui* nut trees with Guinea grass ground cover throughout the area.

The wall is constructed of stacked angular and subangular basalt cobbles and small boulders, incorporating small boulders as large as 0.50 m at the base (Figure 33). It is bifaced and cobble core filled. The rock wall is approximately 145.0 m long (E/W) where it crosses the project area, by 0.90 m wide, with a maximum height of 1.30 m. The east terminus of the wall is at the east end of the project area. The wall continues downhill beyond the west property boundary. Portions of the wall are no longer present, and may have been removed by flood events. Site 30597 is an Historic era ranch wall, and although it has collapsed in some areas, it is generally in fair condition. There were no cultural remains encountered on the ground surface at the site. Site 30597 appears to be slightly altered, is in fair condition and no further work is recommended.

Figure 31: Photograph of Site 30596 TU-1 Top of Layer II, Looking West.

Figure 32: Photograph of Site 30596 TU-1 Base of Excavation, Looking West.

Figure 33: Photograph of Site 30597 Wall with Gulch in Background, Looking South.

SITE 30598 **Wall**

FUNCTION: Agriculture/Ranching

AGE: Pre-Contact Era to Historic Era

DIMENSIONS: 110.0 m (N/S) by 1.30 m by 0.80 m in max. height

CONDITION: Fair

INTEGRITY: Possesses Integrity of Location and Materials

SURFACE ARTIFACTS: None

EXCAVATION: None

DESCRIPTION: Site 30598 is a segment of a rock wall located between 600 and 690 ft amsl in the southern portion of the project area (see Figure 10). There are *koa haole* and *kukui* nut trees with Guinea grass ground cover throughout the area.

The wall is constructed of piled and stacked angular and subangular basalt small boulders, incorporating small boulders as large as 0.50 m throughout (Figure 34). The wall is roughly faced and is not cobble core filled. The rock wall is approximately 110.0 m long (E/W) where it crosses the project area, by 0.90 m wide, with a maximum height of 1.30 m. The east terminus of the wall is along the east property boundary. The wall continues west beyond the west property boundary. The wall has been impacted by bulldozing and portions of the wall are no longer present. Site 30598 is a pre-Contact era agricultural wall or an Historic era ranch wall, and although it is collapsed in some areas, it is generally in fair condition. There were no cultural remains encountered on the ground surface at the site. No further work is recommended at Site 30598.

SITE 30599 **Platform with Enclosure**

FUNCTION: Agricultural

AGE: Historic Era

DIMENSIONS: 8.0 m (NW/SE) by 6.50 m by 1.40 m in max. height

CONDITION: Fair, Slightly Altered

INTEGRITY: Possesses Integrity of Location and Materials

SURFACE ARTIFACTS: Historic glass and metal

EXCAVATION: Shovel Probe Testing (SP-1, SP-2); Test Unit (TU-1)

DESCRIPTION: Site 30599 is an enclosed platform located at 670 ft amsl within the central eastern portion of the project area (see Figure 10). It is situated on a gentle west facing slope 20 meters west of Site 30592 railroad berm. There are *koa haole* trees and Guinea grass ground cover throughout the area.

Figure 34: Photograph of Site 30598 Wall Overview Looking West.

Site 30599 is a platform (Feature 1) and a roughly rectangular enclosure (Feature 2) measuring 8.0 m long (NW/SE) by 6.50 m wide (Figure 35). The Feature 1 platform is located at the north end of the site and the Feature 2 enclosure extends south from the platform.

The Feature 1 platform is approximately 2.0 m long (N/S) and 1.8 m wide, with a maximum height of 1.40 m. It is constructed of angular and subangular basalt cobbles and small boulders stacked three to four courses high (Figure 36). The outer perimeter of the platform is constructed with larger rocks (small boulder slabs) stacked on their flat sides with their longest edge facing the outer edge of the platform. The interior of the platform is constructed of smaller subangular rocks placed inside the larger perimeter rocks. The north and east sides of the platform are well faced. The west side of the platform is collapsed (Figure 37). The feature construction is similar to Historic era rock clearing mounds and platforms documented in Kona and other places on Hawai‘i Island. A large water worn cobble, corrugated metal roofing, and bottle glass fragments were identified on the Feature 1 platform.

The Feature 2 enclosure is rectangular and measured 5.10 m long (NW/SE) by 4.80 m wide, with a maximum height of 0.35 m. The enclosure walls are constructed of piled small boulders and cobbles, with some roughly stacked, one to two courses wide and one to three course high (Figure 38). The enclosure opens to the south. The interior of the enclosure is level soil. A screw top jar, a Bakelite pot, bottle glass fragments, and two pieces of sheet metal were encountered on the surface at the site (Figure 39).

Two shovel probes and a test-unit (TU-1) were excavated at Site 30599 to determine the function and the age of the two features.

Shovel Probe Testing

Two shovel probes were excavated in the level soil interior of Feature 2. The shovel probes were excavated approximately 4.2 m from one another within the enclosure. They were excavated to depths ranging from 34.0 to 37.0 cmbs and terminating on bedrock or large basalt rocks (Table 7).

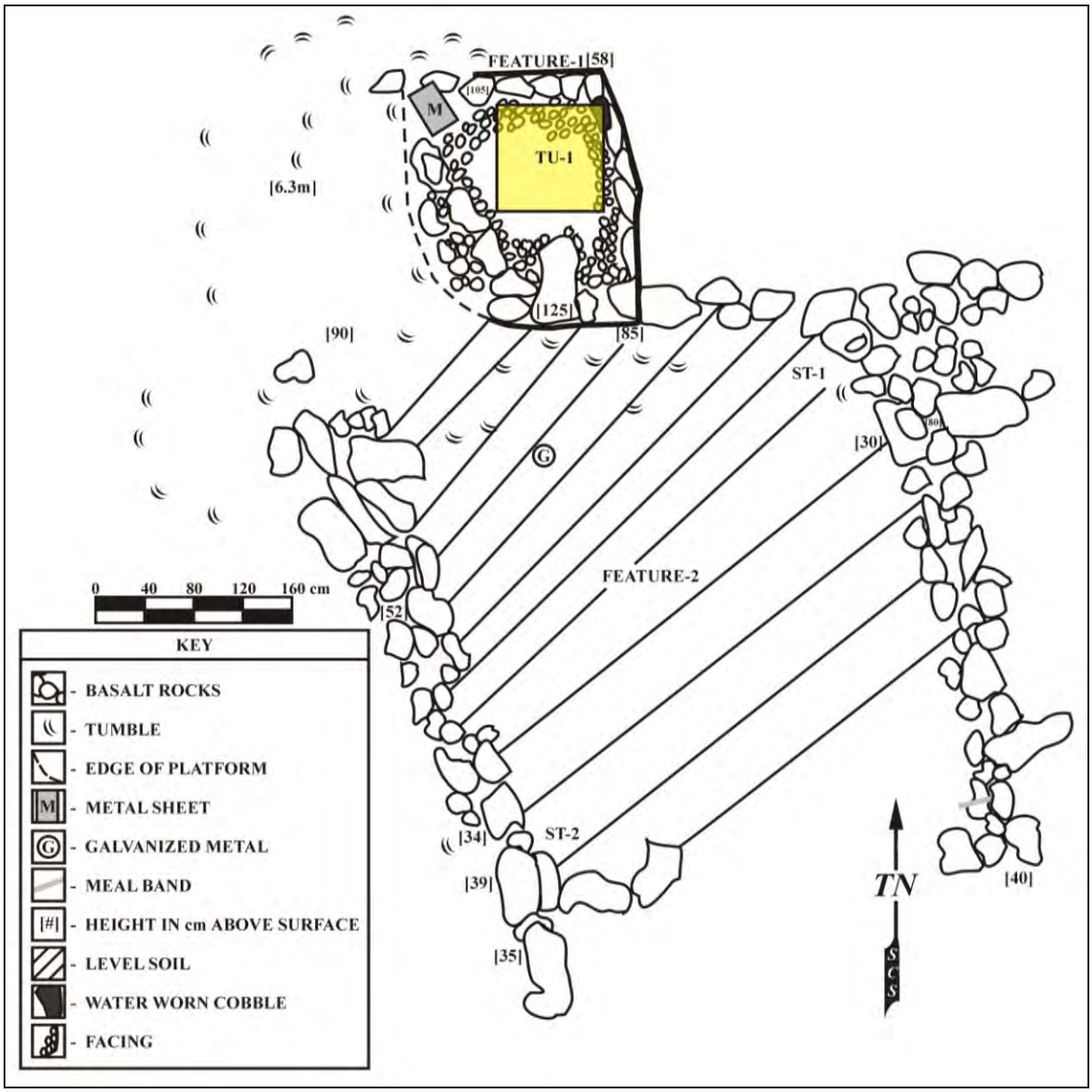

Figure 35: Site 30599 Plan View Map.

Figure 36: Photograph of Site 30599 Feature 1 Platform with Top Cleared of Debris Showing Stacked Stone Construction, Looking West.

Figure 37: Photograph of Site 30599 Feature 1 Platform Showing West Side Collapse, Looking East.

Figure 38: Photograph of Site 30599 Feature 2 Enclosure Looking East.

Figure 39: Photograph of Surface Artifacts Collected at Site 30599.

Table 8: Site 30599 Shovel Probe Results.

SP#	Depth (cm)	Layers	BOE	Artifacts
1	0 - 34 cm	I & II	Basalt Rock	Glass and metal fragments
2	0 - 37 cm	I & II	Basalt Rock	Donkey shoe, glass, metal and plastic fragments

Shovel probe stratigraphy consisted of Layer I (0-14 cmbs) loose dark brown (10YR3/2) fine sandy silt loam overlying Layer II (14-37 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. SP-1 contained a single bottle glass fragment, three pane glass fragments, and four rusted metal fragments. SP-2 contained a donkey shoe, a single piece amethyst bottle glass, a piece of plastic, and ten rusted metal fragments, three of which are nail fragments. Artifacts recovered from SP-1 and SP-2 were not collected.

TU-1

TU-1 was a 1.0 m by 1.0 m test-unit excavated in the center of the platform (see Figure 35). TU-1 was excavated as two natural stratigraphic layers to a maximum depth of 1.45 cm below the top surface of the platform and terminated on bedrock (Figure 40).

Layer I (0-90 cmbs) was loose cobbles and small boulders mixed with "O" Horizon organic detritus. A small amount of rusted metal fragments and modern bottle glass were recovered from Layer I.

Layer II (90-145 cmbs) was loose 10YR3/4 dark yellowish brown sandy silt, cobbles and small boulders, and loose bedrock slabs. A small amount of rusted metal fragments, a metal twist top bottle cap, a wire nail, and modern brown and clear bottle glass were recovered from Layer II (see Appendix A). Slabs of bedrock were also removed from the base of TU-1. TU-1 terminated on bedrock (Figure 41).

Site 30599 is interpreted as an Historic era to Modern era commercial agriculture and ranching work area. Base on the platform construction, surface artifacts at the site, and the metal and glass recovered from TU-1, the site was likely constructed in the mid 1900s and was likely used for ranching and/or commercial agricultural activities through the 1960s. Site 30599 is slightly altered (Feature 1 partial collapse) and is in fair condition. No further work is recommended at Site 30599.

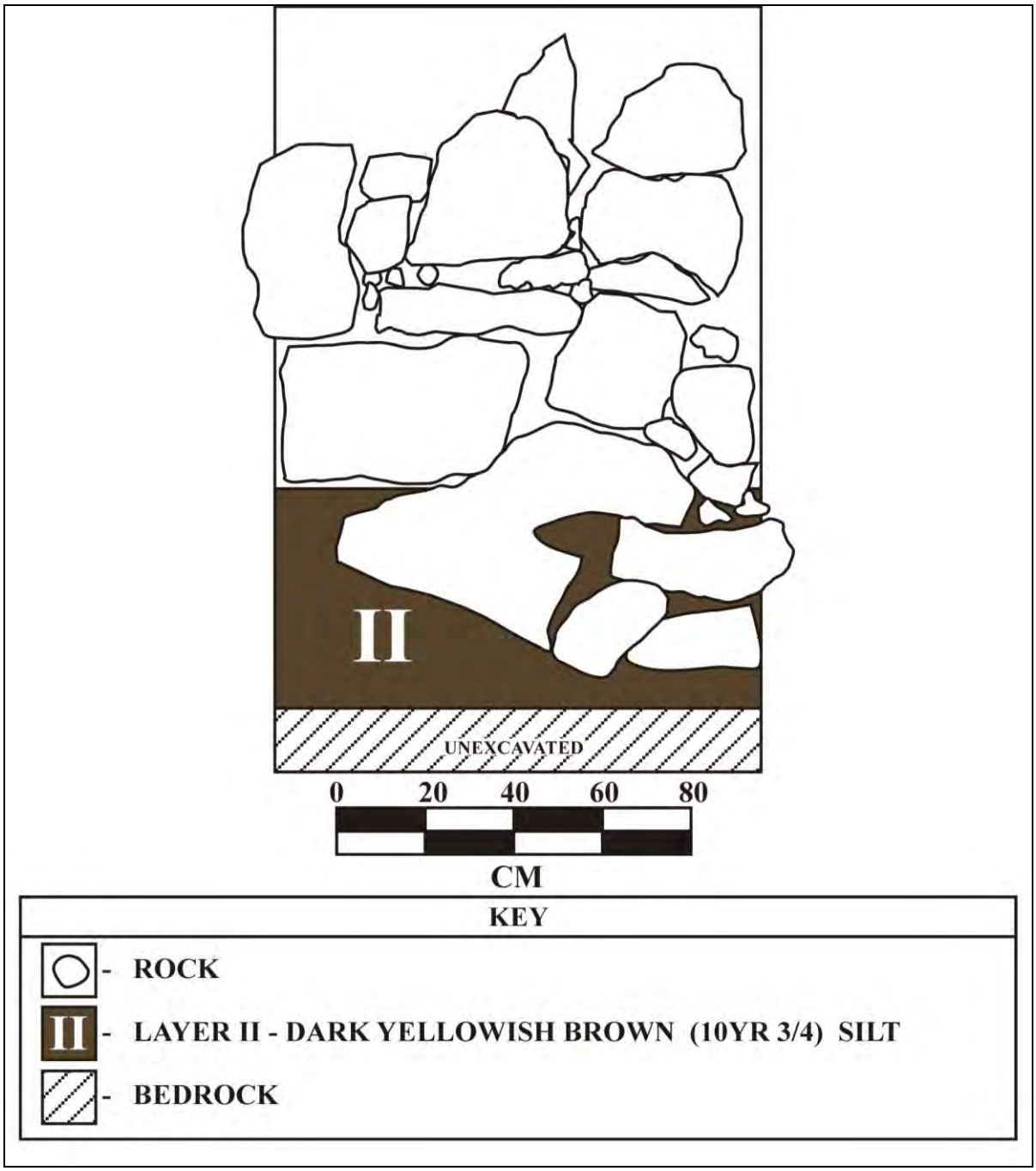

Figure 40: Site 30599 TU-1 South Profile.

Figure 41: Photograph of Site 30599 TU-1 Base of Excavation Looking East.

SITE 30600	**Terrace**
FUNCTION:	Agricultural
AGE:	Historic Era
DIMENSIONS:	4.0 m (E/W) by 4.30 m by 0.35m in max. height
CONDITION:	Good
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	None
EXCAVATION:	Shovel Probe Testing (SP-1)

DESCRIPTION: Site 30600 is a three-sided terrace located at 660 ft amsl approximately 35.0 meters south of Site 30599 (see Figure 10). It is situated on a gentle west facing slope with *koa haole* trees and Guinea grass ground cover. The enclosure is constructed of angular and subangular basalt small boulders piled one to two courses high and wide on the ground surface (Figure 42). It is approximately 4.0 m in length (E/W) and 3.30 m wide, with a maximum height of 0.35 m. There were no artifacts identified on the ground surface at the site.

Shovel Probe Testing

A single shovel probe (SP-1) was excavated within the level soil interior of Site 30600 to determine the function and age of the terrace. The shovel probe was excavated to a depth of 30.0 cmbs and terminated on bedrock or a large basalt rock. The shovel probe matrix did not contain cultural material.

Based on the simple construction of the terrace, its size, and the proportionally large number of Historic era sites recorded on the project area, it is likely that Site 30600 is also an Historic era agricultural terrace, possibly associated with coffee growing. Site 30600 appears to be unaltered and is in good condition. No further work is recommended at Site 30600.

Figure 42: Photograph of Site 30600 Looking Southeast.

SITE 30601 **Rock Wall**
FUNCTION: Ranching
AGE: Historic Era
DIMENSIONS: 80.0 m (NW/SE) by 1.20 m by 1.50 m in max. height
CONDITION: Good
INTEGRITY: Possesses Integrity of Location and Materials
SURFACE ARTIFACTS: None
EXCAVATION: None
DESCRIPTION: Site 30601 is an Historic era wall located between 635 and 685 ft amsl within the northern portion of the project area (see Figure 10). The wall is oriented *mauka*/*makai* and is situated 10 meters north of and parallel to the Site 30595 wall (Figure 43). There are *kukui* nut and *koa haole* trees, and Guinea grass ground cover throughout the area.

The wall bisects the property east to west, and is attached to the Site F2 railroad berm to the east. The wall continues west beyond the west project area boundary (see Figure 10). The wall is approximately 80.0 m in long (E/W) where it crosses the project area by 1.20 m wide, with a maximum height of 1.50 m. It is constructed of stacked angular and subangular basalt cobbles and small boulders (Figure 44). The wall is bifaced and cobble core filled and is stacked up to seven courses high in some areas. A portion of the wall to the east, approximately 12.0 m, constitutes the northern boundary of the Site 30602 enclosure. There are sections of the wall which are reinforced with pig and barbed wire fencing attached to T posts. Site 30601 is an Historic era ranch wall, appears to be unaltered, and is in good condition. No further work is recommended at Site 30601.

SITE 30602 **Enclosure**
FUNCTION: Ranching/Agricultural
AGE: Historic Era
DIMENSIONS: 23.0 m (E/W) by 16.0 m by 2.10 m in max. height
CONDITION: Fair
INTEGRITY: Possesses Integrity of Location and Materials
SURFACE ARTIFACTS: Historic era bottle
EXCAVATION: Shovel Probe Testing (SP-1, SP-2, SP-3, SP-4)
DESCRIPTION: Site 30602 is an enclosure located between 680 and 685 ft amsl within the northeastern portion of the project area (see Figure 10). It is situated on a

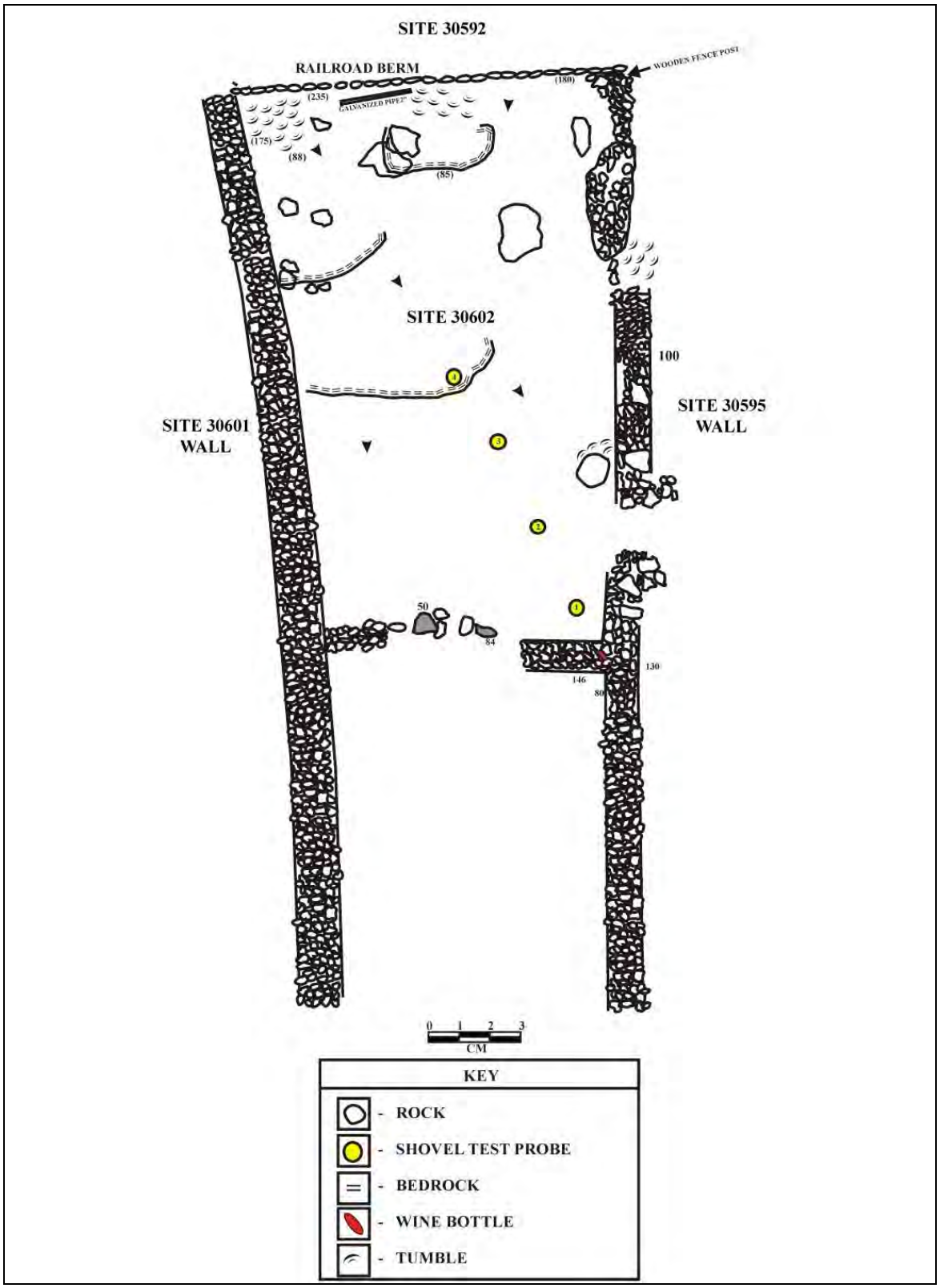

Figure 43: Site 30602 Plan View Map Showing Portions of Site 30592, Site 30595, and Site 30601.

Figure 44: Photograph of Site 30601 Rock Wall Looking North.

gentle *mauka*/*makai* slope, within close proximity to the eastern project area boundary. There are *koa haole* trees with Guinea grass ground cover throughout the area.

The enclosure is formed by utilizing and modifying several existing walls (see Figure 43). It is bounded to the east by a 16.0 m section of Site 30592 railroad berm, to the north by a 21.0 m section of Site 30601 wall, to the south by a 23.0 m section of Site 30595 wall (Figure 45) and to the west by a wall which spans the distance between Site 30601 and Site 30595, approximately 10.0 m. The Site 30602 wall is constructed of stacked angular and subangular basalt cobbles and small boulders. The western boundary wall of the enclosure varies in condition from good to almost nonexistent, with only the southernmost portion of the wall remaining. The intact wall segment is approximately 3.30 m in length and 0.90 m wide, with a maximum height of 1.30 m. There is a aqua colored bottle at the top of the wall segment (Figure 46). All other portions of the Site 30602 west wall have been altered to varying degrees. The mid section is completely gone with the exception of a few rocks, two of which remain in place.

A section of Site 30595 wall has been removed to create an entrance to Site 30602 enclosure interior. Exposed bedrock is visible within in the northeastern portion of the enclosure interior, encompassing approximately one third of the total area. There is a section of galvanized pipe near the base of Site 30592 railroad berm. There is loose rock from collapsed portions of wall, which lie within the interior. The Site 30592 railroad berm portion of the enclosure to the east predates the other walls that form the enclosure and the western enclosure boundary wall is the most recently constructed.

Shovel Probe Testing

A line of four shovel probes spaced roughly 3.0 meters apart were excavated within the level soil interior of the enclosure. The shovel probe line extended from the southwest corner, toward the northeast corner, terminating midway at a bedrock outcrop. The shovel probes were excavated to depths ranging from 27.0 to 60.0 cmbs and terminated on bedrock or large basalt rocks (Table 9).

Figure 45: Photograph of Site 30602 West Wall (Left)and Site 30595 Wall (Right) Looking East.

Figure 46: Photograph of Site 30602 Enclosure Wall and Bottle.

Table 9: Site 30602 Shovel Probe Results.

SP#	Depth (cm)	Layers	BOE	Artifacts
1	0 - 60 cm	I, II, III	Basalt Rock	*Kukui* Nut Shell
2	0 - 60 cm	I, II, III	Basalt Rock	*Kukui* Nut Shell
3	0 - 47 cm	I, II, III	Basalt Rock	-
4	0 - 27 cm	I & II	Basalt Bedrock	-

Two of the four shovel probes contained unburned *kukui* nut shell. No other cultural material was recovered from the shovel probes. There were no cultural remains encountered on the ground surface at the site, with the exception of the bottle and the section of galvanized pipe.

Based on the construction style and the fact that the feature is constructed onto the Site 30592 railroad berm, Site 30602 is interpreted as an Historic era enclosure associated with ranching and commercial agriculture. The feature wall is partially collapsed and is in fair condition. No further work is recommended at Site 30602.

SITE 30603 **Enclosure**
FUNCTION: Ranching/Agricultural
AGE: Historic Era
DIMENSIONS: 35.0 m (NE/SW) by 24.0 m by 1.45 m in max. height
CONDITION: Fair
INTEGRITY: Possesses Integrity of Location and Materials
SURFACE ARTIFACTS: None
EXCAVATION: Shovel Probe Testing (SP-1, SP-2)
DESCRIPTION: Site 30603 is an L-shape enclosure (Feature 1) and three linear terraces (Feature 2, 3, and 4) located between 680 and 685 ft amsl immediately west of Site 30602 (see Figure 10). It is situated on a gentle west facing slope among *koa haole* trees with Guinea grass ground cover.

The L-shape enclosure is constructed onto the south side of the Site 30595 rock wall and is approximately 35.0 m long (NE/SW) by 24.0 m wide (Figure 47). The enclosure walls are roughly 66.0 m long by 1.0 m wide with a maximum height of 1.45 m. The walls are constructed of stacked angular and subangular basalt cobbles and small boulders and is bifaced and cobble core filled (Figures 48, 49, and 50).

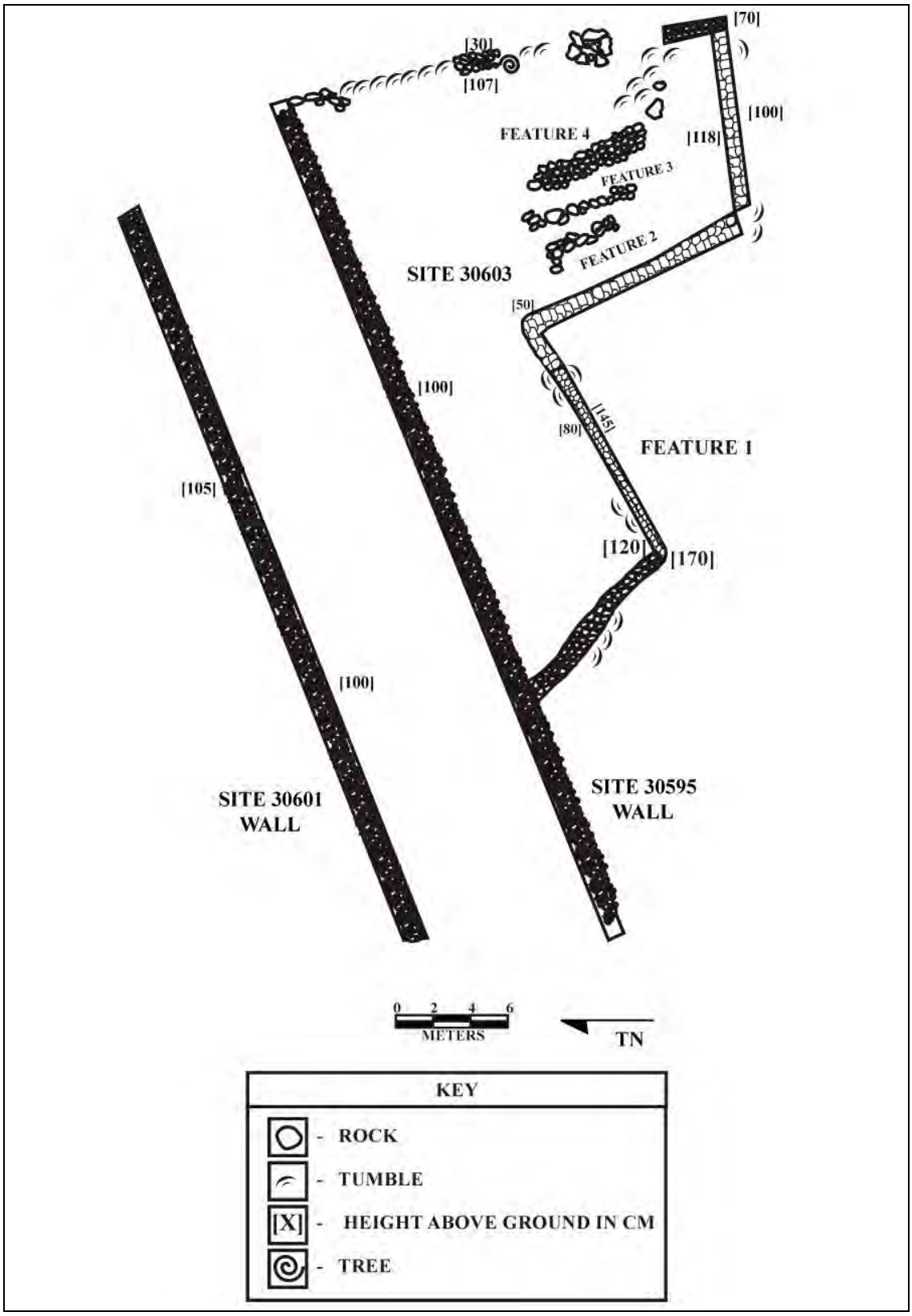

Figure 47: Site 30603 Plan View Map.

Figure 48: Photograph of Site 30603 Southwest Corner of Enclosure Feature 1, Looking Northwest.

Figure 49: Photograph of Site 30603 Western South Wall of Enclosure Feature 1, Looking Southwest.

Figure 50: Photograph of Site 30603 Middle Corner of Enclosure Feature 1, Looking South.

A roughly 35.0 m segment of the Site 30595 rock wall forms the north boundary of the enclosure (Figure 51). The eastern enclosure wall segment is approximately 24.0 m long (NW/SW) and is mostly collapsed. Portions of the southern and western wall segments have also collapsed, although the easternmost segment of the southern wall is still intact.

There are three linear agricultural terraces (Features 2, 3, and 4) within the southeast corner of the enclosure (Figure 52 and Figure 53). The terraces are oriented NW/SE within the rocky soil interior of the enclosure. Feature 2 is furthest *makai* (west) and Feature 4 is furthest *mauka* (east).

The Feature 2 retaining wall is approximately 4.0 m in length and 1.0 m wide, with a maximum height of 0.60 m. The Feature 3 retaining wall is approximately 6.0 m in length and 0.50 m wide, with a maximum height of 0.60 m. The Feature 4 retaining wall is a more substantial construct than the others. It is approximately 7.0 m in length and 1.0 m wide, with a maximum height of 0.90 m. No cultural material was identified on the ground surface at the site.

Shovel Probe Testing

Two shovel probes were excavated within the level soil surfaces of terraces Feature 2 (SP-1) and Feature 3 (SP-2) to determine function and age. The shovel probes were excavated approximately 4.0 m apart, were dug to depths ranging from 30.0 to 36.0 cmbs, and terminated on bedrock or large basalt rocks (Table 9). Shovel probe stratigraphy consisted of Layer I (0-13 cmbs) loose dark brown (10YR3/2) fine sandy silt loam overlying Layer II (13-36 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. A small amount of unburned *kukui* nut shell was recovered from SP-2.

Table 10: Site 30603 Shovel Probe Results.

SP#	Depth (cm)	Layers	BOE	Artifacts
1	0 - 30 cm	I & II	Basalt Rock	-
2	0 - 36 cm	I & II	Basalt Rock	*Kukui* Nut Shell

Figure 51: Photograph of Site 30595 Wall Portion of Site 30603 Enclosure Feature 1, Looking North.

Figure 52: Photograph of Site 30603 Feature 2 Terrace Looking Southeast.

Figure 53: Photograph of Site 30603 Feature 2 Terrace (Center) and Feature Retaining Wall (Left), Looking Southeast.

Based on the construction style of the enclosure and the fact that the enclosure walls are constructed onto the Site 30595 wall, and the Site 30595 wall is constructed onto the Site 30592 railroad berm, Site 30603 is interpreted as an Historic era enclosure associated with agriculture and ranching. Site 30603 has been impacted by modern land clearing activities and is in fair condition. No further work is recommended at Site 30603.

SITE 30604 **Agricultural Complex**
FUNCTION: Agricultural
AGE: Pre-Contact Era to Historic Era
DIMENSIONS: 12.0 m (NW/SE) by 5.0 m
CONDITION: Fair
INTEGRITY: Possesses Integrity of Location and Materials SURFACE ARTIFACTS: None
EXCAVATION: Shovel Probe Testing (SP-1)
DESCRIPTION: Site 30604 is an agricultural complex located at 675 ft amsl 2.0 meters south of Site 30602 (see Figure 10). It is situated on a gentle west facing slope with *koa haole* trees and Guinea grass ground cover throughout the area.

Site 30604 is a planting feature (Feature 1) and three terraces (Features 2, 3, and Feature 4) (Figure 54). Feature 1 is a possible oval planting feature located in the southeast corner of the site. It is constructed of angular basalt cobbles and small boulders piled one to two courses high and two to three courses wide on the ground surface (Figure 55). The feature is approximately 2.50 m in length (E/W) and 2.10 m wide, with a maximum height of 0.60 m. There were no cultural remains on the ground surface at Feature 1.

Feature 2 is a small two-sided terrace located along the northwest edge of Feature 1. The terrace is 2.70 long (NW/SE) by 1.5 m wide. The terrace retaining wall is 2.70 m long by 0.60 m wide and is 0.62 m in maximum height above the ground surface to the southwest. It is constructed of basalt cobbles and small boulders piled up to three courses high on the ground surface (Figure 56). There were no cultural remains on the ground surface at Feature 2.

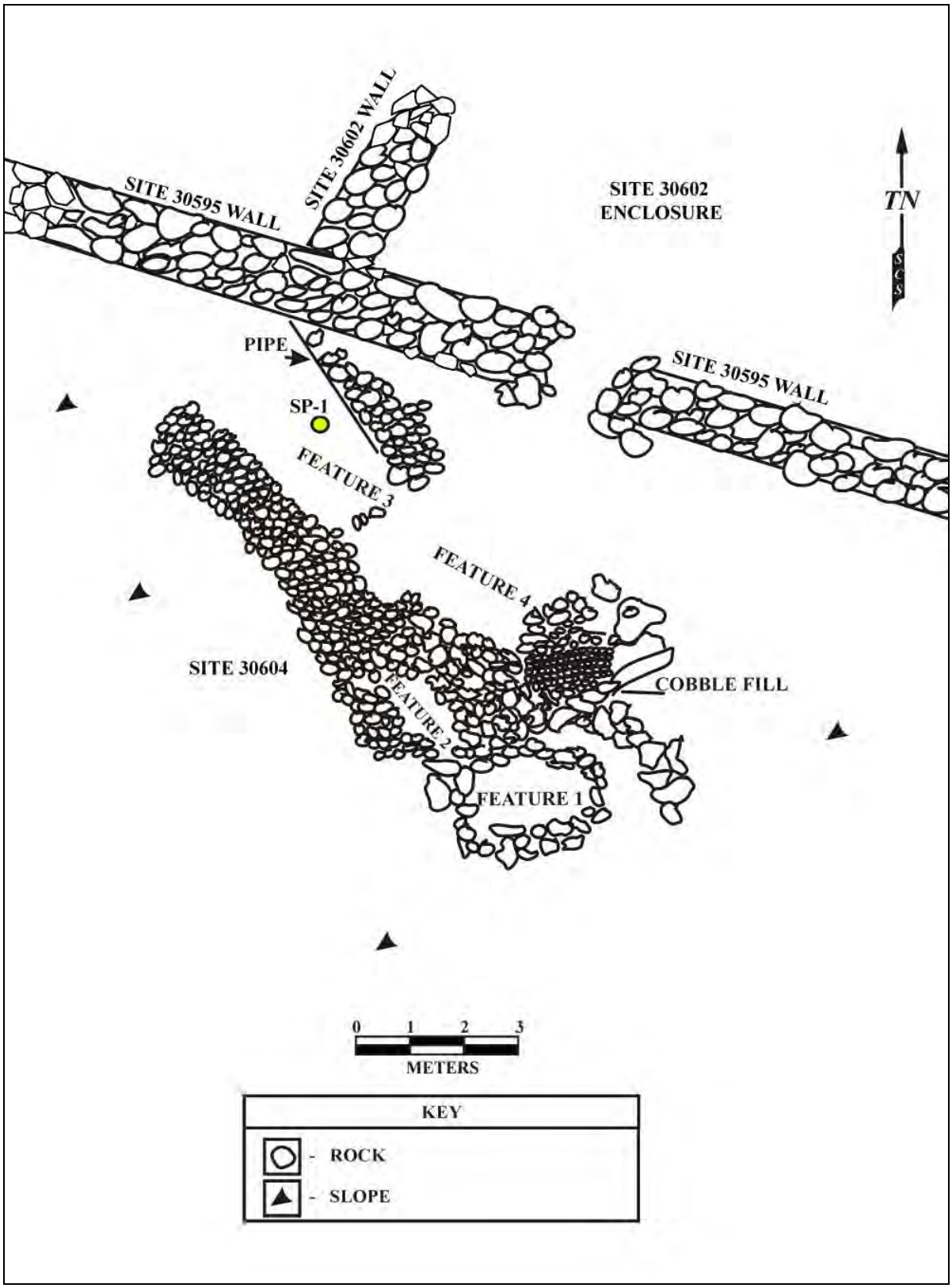

Figure 54: Site 30604 Plan View Map.

Figure 55: Photograph of Site 30604 Feature 1 Looking Southwest.

Figure 56: Photograph of Site 30604 Feature 2 Looking Southeast.

Feature 3 is a linear terrace located along the northwest side of Feature 2. The terrace is 4.80 long (NW/SE) by 3.0 m wide. The terrace retaining wall is 2.70 m long by 1.0 m wide and is 0.85 m in maximum height above the ground surface to the southwest. It is constructed of basalt cobbles and small boulders piled up to three courses high on the ground surface (Figure 57). A section of galvanized pipe is situated along the easternmost portion of the terrace. There were no cultural remains identified at Feature 3.

Shovel Probe Testing

A shovel probe (SP-1) was excavated within the level soil of the Feature 3 terrace to determine function and age. SP-1 was excavated to a depth of 50.0 cmbs and terminated on bedrock or a large basalt rock. Shovel probe stratigraphy consisted of three natural stratigraphic layers: Layer I (0-14 cmbs) loose dark brown (10YR3/2) fine sandy silt loam, Layer II (14-41 cmbs) soft brown (10YR4/3) sandy silt, and Layer III (41-50 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. A railroad spike, a wire nail, and a volcanic-glass flake were recovered from SP-1 (Figure 58). The volcanic-glass flake was collected and the other artifacts were left at the site.

Feature 4 is a two-sided terrace located along the north edge of Feature 1. The terrace is approximately 2.25 m long (NE/SW) by 2.0 m wide, and is 0.80 m in maximum height. It is constructed of angular and subangular basalt cobbles and small boulders piled on the ground surface (Figure 59). There is single strand wire within the western portion of the site.

It is possible that Site 30604 is a pre-Contact to early post-Contact era agricultural site. The single volcanic-glass flake suggests that area might have been used for agricultural and resource gathering. However, the proximity of Site 30604 to Site 30602 and the presence of the railroad spike and wire nail suggest that Site 30604 was definitely used during the Historic era. It is very likely that Site 30604 was an Historic era agricultural site associated with sugarcane or coffee growing.

Figure 57: Photograph of Site 30604 Feature 3 Looking Southeast.

Figure 58: Photograph of Artifacts Recovered from Site 30604, Feature 3, SP-1.

Figure 59: Photograph of Site 30604 Feature 4 Looking South.

SITE 30605	**Rock Wall**
FUNCTION:	Ranching
AGE:	Historic Era
DIMENSIONS:	90. m (E/W) by 0.75 m by 1.0 m in max. height
CONDITION:	Good
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	None
EXCAVATION:	None

DESCRIPTION: Site 30605 is an Historic era wall located between 600 and 685 ft amsl through the center of the project area (see Figure 10). The wall trends *mauka*/*makai* across the west facing slope. There are *kukui* nut and *koa haole* trees with Guinea grass ground cover throughout the area.

The wall bisects the property east to west, terminating to the east near the Site 30592 railroad berm and continuing to the west beyond the project area boundary. The wall is constructed of angular and subangular basalt cobbles and small boulders, incorporating some as large as 0.50 m (Figure 60). The wall is approximately 90.0 m long (E/W) where it crosses the project area by 0.75 m wide, with a maximum height of 1.0 m. It is a bifaced, cobble core filled wall and is stacked up to five courses in height. The condition of the wall diminishes near its western terminus where it has collapsed. There were no cultural remains encountered within the area of the site. Site 30605 has been impacted by modern land clearing activities, is partially collapsed in places, and is in good condition. No further work is recommended for Site 30605.

Figure 60: Photograph of Site 30605 Wall Looking Northeast.

SITE 30606	**Rock Wall**
FUNCTION:	Ranching/Agricultural
AGE:	Pre-Contact to Historic Era
DIMENSIONS:	37.0 m (NW/SE) by 1.90 m by 1.30 m in max. height
CONDITION:	Poor
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	None
EXCAVATION:	None

DESCRIPTION: Site 30606 is an Historic era wall segment located at 620 ft amsl within the southwestern portion of the project area (see Figure 10). The wall trends northwest/southeast and is situated in an area with *koa haole* trees and Guinea grass ground cover.

The Site 30606 rock wall segment is located between the Site 30605 wall and the Site 30597 wall, and is less formally constructed than either of the two (Figure 61). The wall is approximately 37.0 m in length (NW/SE) and 1.90 m wide, with a maximum height of 1.30 m. Site 30606 is presently a rubble wall consisting of angular and sub angular basalt cobbles piled three to six courses high and three to four courses wide on the ground surface. There is no formal stacking or facing evident in the wall construction, though it might have been a stacked and faced wall that has been disturbed by modern land clearing activities. The majority of the western (downhill) portions of the wall have collapsed, with an increase in collapse in low lying areas. There were no cultural remains identified on the ground surface at the site. Site 30606 is an Historic era rock wall associated with ranching. It has been altered by modern land clearing, is mostly collapsed, and is in poor condition.

Figure 61: Photograph of Site 30606 Rock Wall Looking North.

SITE 30607	**Agricultural Complex**
FUNCTION:	Agriculture
AGE:	Pre-Contact Era to Historic Era
DIMENSIONS:	55.0 m (NW/SE) by 27.5
CONDITION:	Fair
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	None
EXCAVATION:	Shovel Probe Testing (SP-1 through SP-10)

DESCRIPTION: Site 30607 is an agricultural complex located between 620 and 630 ft amsl within the southwestern portion of the project area, on a steep west facing slope (see Figure 10). There are *koa haole* trees with Guinea grass ground cover throughout the area.

The Site 30607 agricultural complex includes seven terraces (Feature 1 through Feature 7) located north of wall Site 30597, south of wall Site 30605, west of wall Site 30598 and on both sides of wall Site 30606 (Figure 62). Feature 1 is a three-sided terrace located in the northeast corner of the site. The terrace retaining wall is constructed primarily of angular and subangular basalt cobbles and small boulders piled up to four courses in high (Figure 63). It is approximately 3.70 m in length (N/S) by 1.40 m wide, with a maximum height of 1.05 m. There is no formal stacking or facing in the feature construction. There were no cultural remains on the ground surface at Feature 1.

Shovel Probe Testing

A shovel probe (SP-1) was excavated within the sloping soil interior of Feature 1 to determine function and age. The shovel probe was excavated to a depth of 37.0 cmbs and terminated on bedrock or a large basalt rock. SP-1 stratigraphy was Layer I (0-16 cmbs) loose dark brown (10YR3/2) fine sandy silt loam overlying Layer II (16-37 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. SP-1 contained a total of five volcanic-glass fragments and several charcoal fragments.

Feature 2 is a three-sided terrace located within the central western portion of Site 30607. The terrace is situated on a west facing slope and is constructed along the west side of wall Site 30606. The northwest and southwest corners of the terrace are curved and the terrace retaining walls are constructed of angular and subangular basalt cobbles and small boulders piled on the ground surface (Figure 64). There is no formal stacking

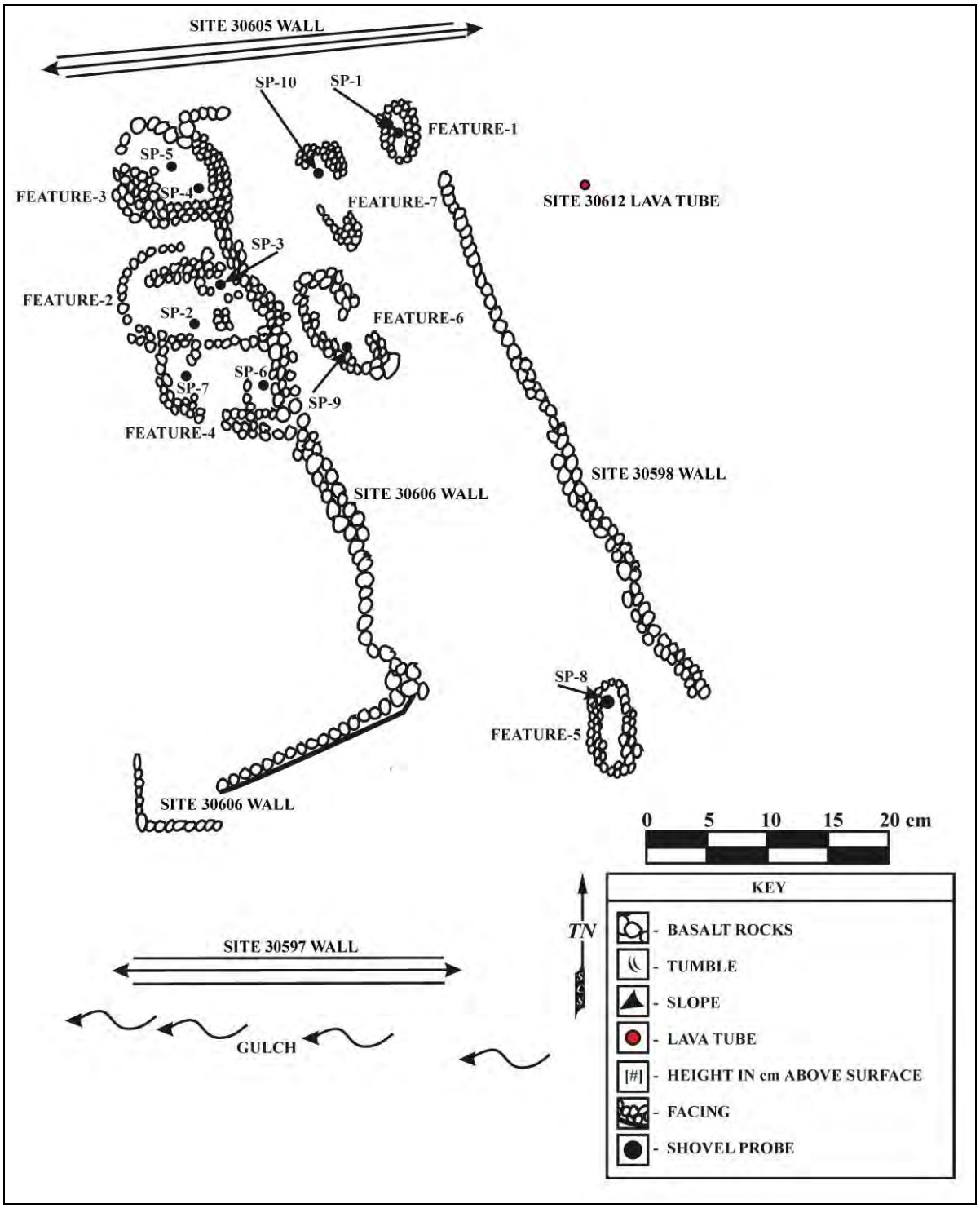

Figure 62: Site 30607 Plan View Map.

Figure 63: Photograph of Site 30607 Feature 1 Terrace Looking Southeast.

Figure 64: Photograph of Site 30607 Feature 2 Terrace (Background) and Site 305956 Wall (Foreground), Looking West.

or facing evident in the feature construction. The terrace is approximately 10.0 m in length (E/W) and 6.0 m wide, with a maximum height of 1.10 m.

There are large quantities of rock within the soil area of the terrace. Piled rock combined with rock which has collapsed from surrounding areas (Site 30606 rubble wall and elsewhere) is approximately 1.10 m in height and 2.10 m wide, dividing the surface of the terrace to form two areas. The westernmost area is approximately 7.5 m in length (E/W) and 5.5 m wide (Figure 65). The easternmost area is an enclosed area formed by rock piled on the surface of the terrace where it abuts Site 30606 (Figure 66). The enclosed area is approximately 5.0 m in length (N/S) and 2.5 m wide. There were no cultural remains at Feature 2.

Shovel Probe Testing

Two shovel probes (SP-2 and SP-3) were excavated within the level soil interior of Feature 2 to determine feature function and age. The shovel probes were excavated approximately 4.5 m from one another, within the western area (SP-2) and the eastern area (SP-3). The shovel probes were excavated to depths ranging from 34.0 to 43.0 cmbs and terminated on bedrock or large basalt rocks (Table 10). Shovel probe stratigraphy consisted of three natural stratigraphic layers: Layer I (0-16 cmbs) loose dark brown (10YR3/2) fine sandy silt loam, Layer II (16-37 cmbs) soft brown (10YR4/3) sandy silt, and Layer III (37-43 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. The shovel probes did not contain cultural material.

Table 11: Site 30607 Feature 2 Shovel Probe Results.

SP#	Depth (cm)	Layers	BOE	Artifacts
2	0 - 43 cm	I, II, III	Basalt Rock	-
3	0 - 34 cm	I & II	Basalt Rock	-

Feature 3 is three-sided terrace located north of Feature 2. The terrace is situated on a west facing slope and is constructed along the west side of wall Site 30606. The northwest and southwest corners of the terrace are curved and the terrace retaining walls are constructed of angular and subangular basalt cobbles and small boulders piled on the ground surface (Figure 67). There is no formal stacking or facing evident in the feature construction. Feature 3 is approximately 7.5 m in length (N/S) and 7.0 m wide, with a maximum height of 0.60 m. The western portion of the terrace retaining wall is mostly collapsed. There were no cultural remains at Feature 3.

Figure 65: Photograph of Site 30607, Feature 2, Western Area Looking East.

Figure 66: Photograph of Site 30607, Feature 2, Eastern Area Looking East.

Figure 67: Photograph of Site 30607, Feature 3 Looking South.

Shovel Probe Testing

Two shovel probes (SP-4 and SP-5) were excavated within the level soil interior of Feature 3. The shovel probes were excavated approximately 2.5 m from one another. The shovel probes were excavated to depths ranging from 48.0 to 54.0 cmbs and terminated on bedrock or large basalt rocks (Table 11). Shovel probe stratigraphy consisted of three natural stratigraphic layers: Layer I (0-14 cmbs) loose dark brown (10YR3/2) fine sandy silt loam, Layer II (14-38 cmbs) soft brown (10YR4/3) sandy silt, and Layer III (38-54 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. SP-4 contained two volcanic glass flakes recovered between 0-15 cmbs, and small charcoal fragments recovered between 15-30 cmbs. SP-5 contained several very small charcoal fragments that were not collected.

Table 12: Site 30607 Feature 3 Shovel Probe Results.

SP#	Depth (cm)	Layers	BOE	Artifacts
4	0 - 54 cm	I, II, III	Basalt Rock	Volcanic glass, Charcoal Fragments
5	0 - 48 cm	I, II, III	Basalt Rock	Charcoal Fragments

Feature 4 is a two-sided terrace located along the south edge of Feature 2. The terrace abuts the west edge of wall Site 30606. It is approximately 10.0 m in length (E/W) and 6.5 m wide, with a maximum height of 0.94 m. The terrace retaining wall is constructed of angular and subangular basalt cobbles and small boulders piled on the ground surface (see Figure 62). There is no formal stacking or facing evident in the feature construction. There is piled rock near the center of the terrace that divides the surface of the terrace into two areas. The easternmost area is enclosed by rock piled near the center of the terrace and by wall Site 30606 (Figure 68). The enclosed area is approximately 5.5 m in length (N/S) and 2.5 m wide. The westernmost portion is approximately 7.5 m in length (E/W) and 5.0 m wide (Figure 69). The south edge of the terrace is partially collapsed. There were no cultural remains at Feature 4.

Shovel Probe Testing

Two shovel probes (SP-6 and SP-7) were excavated within Site 30607 Feature 4 to determine feature function and age. The shovel probes were excavated approximately 4.5 m from one another within the eastern area (SP-6) and the western area (SP-7). The shovel probes were excavated to depths ranging from 32.0 to 55.0 cmbs and terminated on bedrock or large basalt rocks (Table 12).

Figure 68: Photograph of Site 30607 Feature 4 Eastern Area Looking North.

Figure 69: Photograph of Site 30607 Feature 4 Western Area Looking Northwest.

Shovel probe stratigraphy consisted of three natural stratigraphic layers: Layer I (0-12 cmbs) loose dark brown (10YR3/2) fine sandy silt loam, Layer II (12-38 cmbs) soft brown (10YR4/3) sandy silt, and Layer III (38-55 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. SP-7 contained a single fragment of dense crystalline basalt, possibly an unpolished exterior flake.

Table 13: Site 30607 Feature 4 Shovel Probe Results.

SP#	Depth (cm)	Layers	BOE	Artifacts
6	0 - 55 cm	I, II, III	Basalt Rock	-
7	0 - 32 cm	I & II	Basalt Rock	Basalt Debitage

Feature 5 is a three-sided terrace located in the southeast corner of Site 30607 (see Figure 62). The terrace is approximately 7.5 m in length (N/S) and 3.0 m wide, with a maximum height of 1.20 m. The terrace retaining wall is constructed of angular and subangular basalt cobbles and small boulders piled on the ground surface (Figure 70). There is no formal stacking or facing evident in the feature construction. The west terrace retaining wall is collapsed, potentially brought about by *koa haole* tree growth, as well as the steepness of the slope. There were no cultural remains on the ground surface at Feature 5.

Shovel Probe Testing

A shovel probe (SP-8) was excavated within the level soil interior of Feature 5. The shovel probe was excavated to a depth of 30.0 cmbs and terminated on bedrock or a large basalt rock. SP-8 contained several very small charcoal fragments which were not collected.

Feature 6 is a three-sided terrace located east of Feature 2 and Feature 4 (see Figure 62). The terrace retaining wall is angled, situated cross-slope and constructed of angular and subangular basalt boulders piled on the ground surface (Figure 71). The terrace is approximately 7.6 m in length (NW/SE) by 3.5 m wide, with a maximum height of 1.20 m. Portions of the retaining wall to the east ere collapsed. There were no cultural remains identified on the ground surface at Feature 6.

Figure 70: Photograph of Site 30607 Feature 5 Looking South.

Figure 71: Photograph of Site 30607 Feature 6 Looking South.

Shovel Probe Testing

A single shovel probe (SP-9) was excavated within the level soil interior of Feature 6. The shovel probe was excavated to a depth of 33.0 cmbs and terminated on bedrock or a large basalt rock. Shovel probe stratigraphy consisted of Layer I (0-13 cmbs) loose dark brown (10YR3/2) fine sandy silt loam overlying Layer II (13-33 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. SP-9 did not contain cultural material.

Site 30607 Feature 7 is a three-sided terrace located west of Feature 1 (see Figure 62). The terrace is situated cross-slope and is constructed of piled angular and subangular basalt boulders piled on the ground surface (Figure 72). There is no formal stacking or facing evident in feature construction. The terrace is 8.60 m in length (NW/SE) by 2.90 m wide, with a maximum height of 0.60 m. There were no cultural remains on the ground surface within the area of Feature 7.

Shovel Probe Testing

A single shovel probe (SP-10) was excavated within the level soil interior of Feature 10. The shovel probe was excavated to a depth of 37.0 cmbs and terminated on bedrock or a large basalt rock. Shovel probe stratigraphy consisted of Layer I (0-14 cmbs) loose dark brown (10YR3/2) fine sandy silt loam overlying Layer II (14-37 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. SP-10 contained a single volcanic glass flake and five marine shell fragments which were recovered from 0-15 cmbs.

Site 30607 Summary

Sites 30598 (low piled wall), 30606, (low piled wall), and 30607 (agricultural complex) are all likely components of a single agricultural complex. This interpretation is based on their proximity to each other, their feature construction technique, and the fact that three of the Site 30607 terraces are constructed along the west side of the Site 30606 wall. In addition, it is very likely that the Site 306012 lava blister is also associated with these three sites. The small amount of traditional cultural material recovered from subsurface testing at Site 30607 is typical of traditional pre-Contact to early post-Contact era agricultural features. However, it might be that the artifacts are not directly associated with these features, and that they are related to resource collection prior to the construction of the features.

Figure 72: Photograph of Site 30607 Feature 7 Looking North.

The terrace features themselves are somewhat similar to Kona field System features recorded at projects in the general area of the current project. They differ in that they are more roughly constructed. This might be a function of the available rock in this location—the rock is much larger than that found in other places. However, it seems just as likely, or more likely, that the features were constructed in the Historic era for commercial agriculture. Their somewhat rough and hasty construction is similar to other Historic era agricultural features, most notably coffee terraces, documented at nearby project area. In addition, the presence of the Historic era refuse dump at nearby Site 30612 further suggests the agricultural complex is an Historic era site.

Site 30607 has been altered by ground clearing activities, the features are partially collapsed in places, and the site is in fair condition. No further work is recommended at Site 30607.

SITE 30608	**Enclosure**
FUNCTION:	Temporary Dwelling and Storage
AGE:	Historic Era
DIMENSIONS:	7.5 m (N/S) by 3.3 m by 1.20 m in max. height
CONDITION:	Fair
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	None
EXCAVATION:	None

DESCRIPTION: Site 30608 is a rectangular enclosure located at 670 ft amsl within the southeastern portion of the project area, roughly 15.0 m west of the Site 30592 railroad berm (see Figure 10). It is situated on a moderate west facing slope in an area of *koa haole* trees and Guinea grass ground cover.

The enclosure is rectangular and is constructed of angular and subangular basalt cobbles and small boulders, some of which are as large as 0.80 m (Figure 73). The wall is bifaced and cobble core filled. It is approximately 7.50 m in length (N/S) and 3.30 m wide, with a maximum height of 1.20 m. Portions of the walls to the north and southwest have collapsed, suggesting that the enclosure might have been impacted by heavy equipment.

Figure 73: Photograph of Site 30608 Enclosure Looking Southeast.

It is possible that the enclosure was constructed by modifying a wall segment just west of the Site 30592 railroad berm wall. Rocks might have been removed from the ends of the wall to construct two walls (north and south walls) between the wall segment and the railroad berm to the east. The east wall of the enclosure is the railroad berm wall. There is single strand heavy gauge fencing wire within the interior of the feature. Based on construction method and proximity to the railroad berm, it is most likely that Site 30608is the remains of an Historic era structure. The enclosure has been altered by modern land clearing activities and is in fair condition.

SITE 30609	**Enclosure**
FUNCTION:	Temporary Dwelling and Storage
AGE:	Historic Era
DIMENSIONS:	6.6m (N/S) by 4.5 m by 1.20 m in max. height
CONDITION:	Good
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	None
EXCAVATION:	None

DESCRIPTION: Site 30609 is a rectangular enclosure located at 680 ft amsl approximately 14.0 meters northeast of Site 30609 (see Figure 10). It is situated on a moderate west facing slope close to the eastern project area boundary and just west of the Site 30592 railroad berm. There are *koa haole* trees and Guinea grass ground cover throughout the area.

The enclosure is rectangular and is constructed of angular and subangular basalt boulders, some of which are as large as 1.05 m (Figure 74 and Figure 75). The wall is bifaced and cobble core filled. It is approximately 6.60 m in length (N/S) and 4.5 m wide, with a maximum height of 1.20 m.

It is possible that the enclosure was constructed by modifying a wall segment just west of the Site 30592 railroad berm wall. Rocks might have been removed from the ends of the wall to construct two walls (north and south walls) between the wall segment and the railroad berm to the east. The east wall of the enclosure is the railroad berm wall.

Portions of the walls to the east have collapsed, indicating that this structure may have been impacted by heavy equipment. Site 30609 is approximately 14.0 m northeast of Site 30608, and is similar in construction. A single strand of heavy gauge fencing wire

was found in the interior of this feature also. Based on construction method and proximity to the railroad berm, it is most likely that Site 30609is the remains of an Historic era structure. The enclosure has been altered by modern land clearing activities and is in fair condition.

SITE 30610	**Terrace**
FUNCTION:	Agricultural
AGE:	Pre-Contact Era Historic Era
DIMENSIONS:	6.75 m (NW/SE) by 3.0 m by 0.40 m in max. height
CONDITION:	Fair
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	None
EXCAVATION:	Shovel Probe Testing (SP-1)

DESCRIPTION: Site 30610 is a three-sided terrace located at 675 ft amsl within the southeastern portion of the project area (see Figure 10). The site is situated on a west facing slope, to the southwest and down slope of Site 30608, within close proximity to the eastern project area boundary. There are *koa haole* trees and Guinea grass ground cover throughout the area.

The terrace is approximately 6.75 m long (NW/SE) by 3.4 m wide, with a maximum height of 0.40 m (Figure 76). The interior soil surface of the terrace slopes slightly to the west. The terrace retaining wall is constructed of piled angular and subangular basalt cobbles and small boulders, some as large as 0.45 m (Figure 77). Portions of the retaining wall to the southwest may have been removed by modern land clearing activities. There were no cultural remains encountered on the surface in the area of the terrace.

Shovel Probe Testing

A single shovel probe (SP-1) was excavated within the soil filled interior of Site 30610. The shovel probe was excavated to a depth of 22.0 cmbs and terminated on bedrock or a large basalt rock. Shovel probe stratigraphy consisted of Layer I (0-13 cmbs) loose dark brown (10YR3/2) fine sandy silt loam overlying Layer II (13-22 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. SP-1 contained several very small fragments of charcoal which were not collected.

Figure 74: Photograph of Site 30609 Enclosure Looking East.

Figure 75: Photograph of Site 30609 Enclosure Looking Northeast.

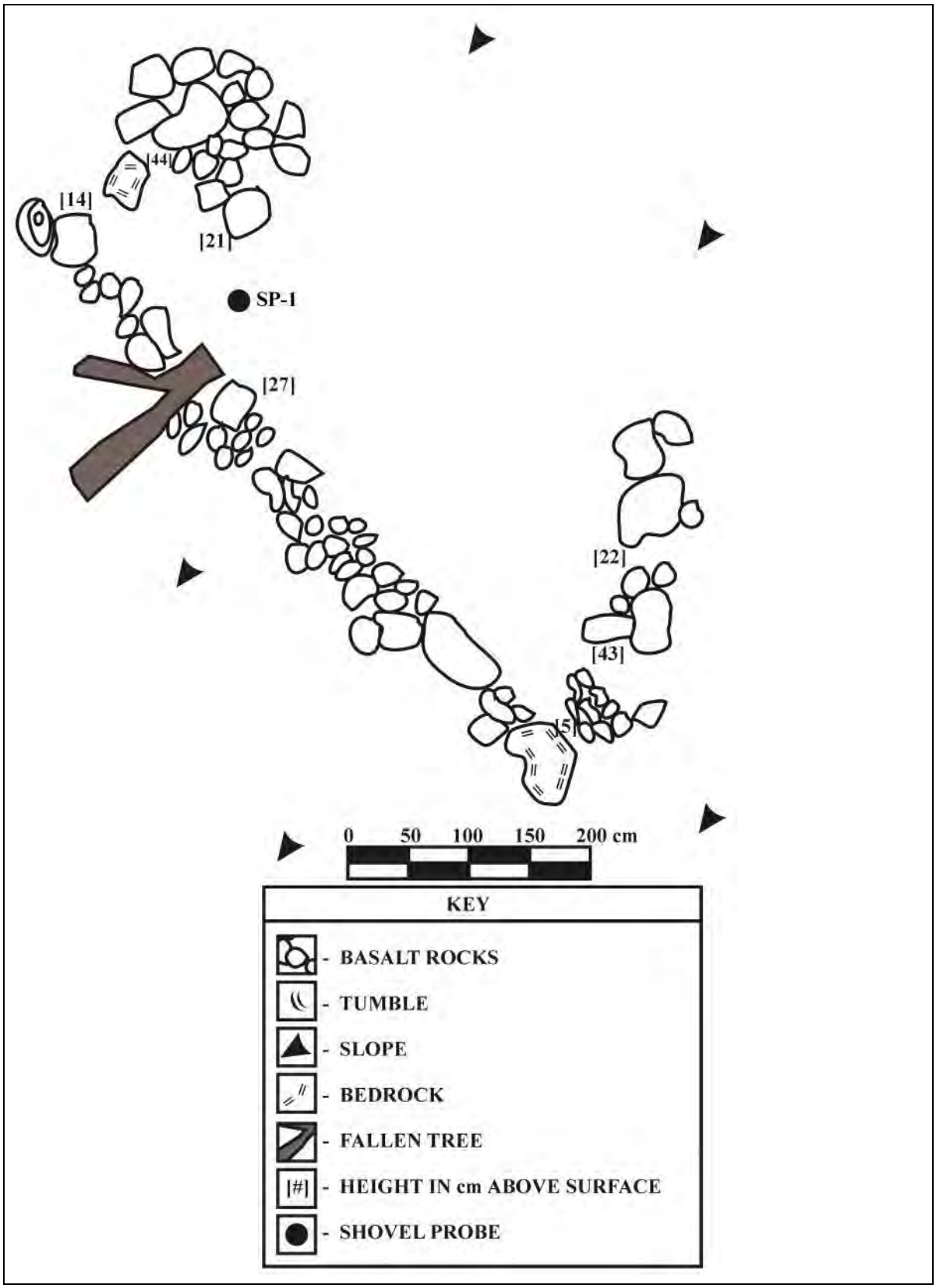

Figure 76: Site 30610 Plan View Map.

Figure 77: Photograph of Site 30610 Terrace Looking Southwest.

SITE 30611	**Agricultural Complex**
FUNCTION:	Agriculture
AGE:	Historic Era
DIMENSIONS:	10.0 m (N/S) by 7.0 m
CONDITION:	Good
INTEGRITY:	Possesses Integrity of Location and Materials
SURFACE ARTIFACTS:	None
EXCAVATION:	Shovel Probe Testing (SP-1, SP-2, and SP-3)

DESCRIPTION: Site 30611 is an agricultural complex located at 670 ft amsl in the southeast portion of the project area (see Figure 10). The site is three terraces (Features, 1, 2, and 3) situated on a west facing slope in an area of *koa haole* and *kukui* nut trees with Guinea grass ground cover.

Feature 1 is located at the northeast end of the site and is a roughly rectangular soil filled terrace approximately 6.5 m long (NW/SE) by 2.0 m wide, with a maximum height of 1.0 m along southwest edge (Figure 78). The terrace retaining wall is constructed of piled angular and subangular basalt cobbles and small boulders, some as large as 0.90 m (Figure 79). There is no formal stacking or facing evident in the feature construction. The northern portion of the terrace has collapsed in several areas. The southern portion is better preserved, where several large somewhat tabular boulders have been incorporated into the construction. There were no cultural remains identified at Feature 1.

Shovel Probe Testing

A shovel probe (SP-1) was excavated within the level soil interior of Feature 1. The shovel probe was excavated to a depth of 29.0 cmbs and terminated on bedrock or a large basalt rock. Shovel probe stratigraphy consisted of Layer I (0-13 cmbs) loose dark brown (10YR3/2) fine sandy silt loam overlying Layer II (13-29 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. SP-1 contained a single fragment of rusted metal.

Feature 2 is a two-sided terrace located at the south end of the site. The terrace retaining wall is constructed of piled angular and subangular basalt boulders, some as large as 0.75 m (Figure 80). There is no formal stacking or facing evident in the feature construction. The terrace is approximately 3.5 m in length (NW/SE) and 2.5 m wide,

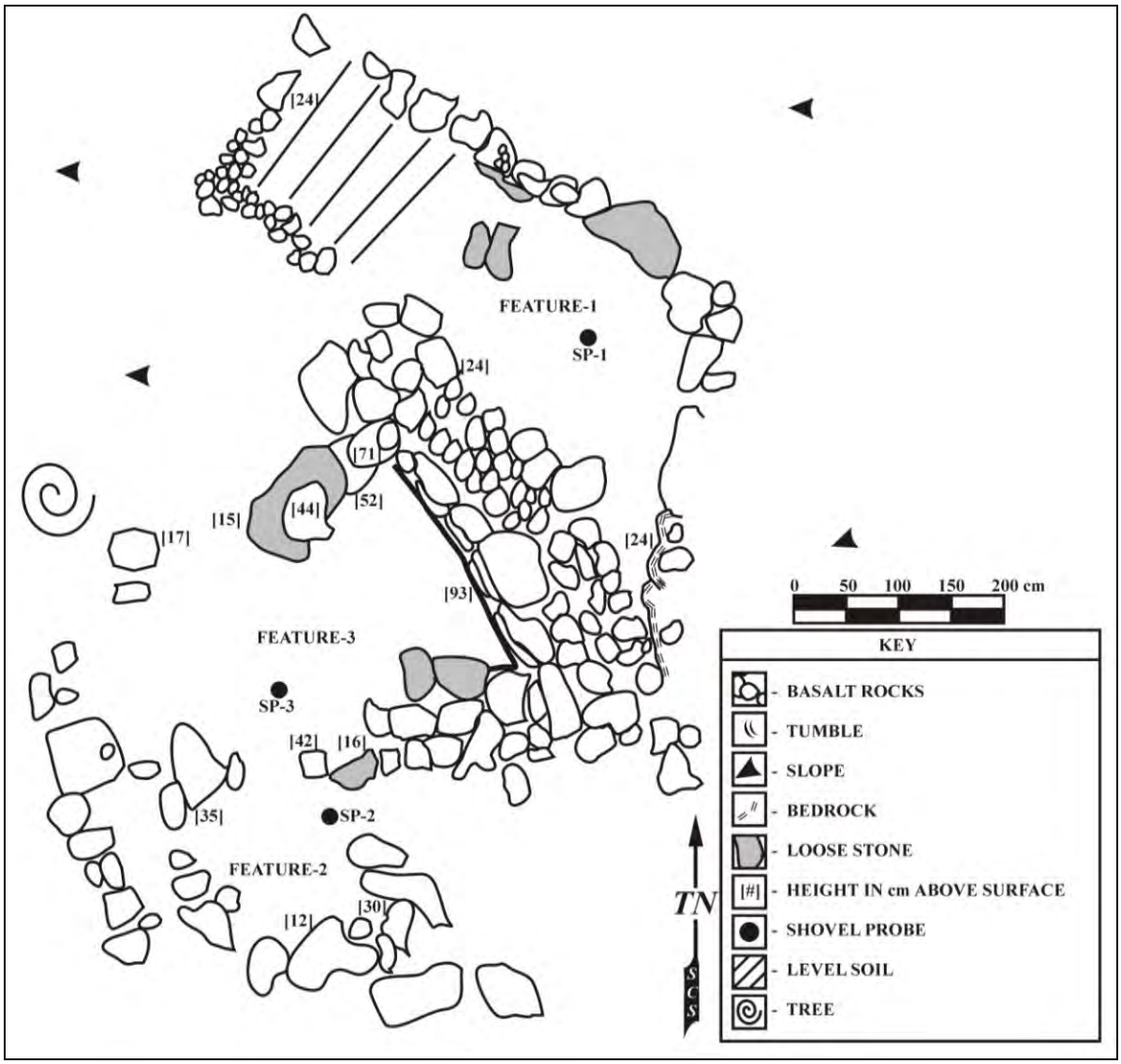

Figure 78: Site 30611 Plan View Map.

Figure 79: Photograph of Site 30611 Feature 1 Looking Southeast.

Figure 80: Photograph of Site 30611 Feature 2 Looking South.

with a maximum height of 0.35 m, the surface of which slopes to the west. There were no cultural remains on the ground surface at Feature 2.

Shovel Probe Testing

A single shovel probe (SP-2) was excavated within the level soil interior of Feature 2. The shovel probe was excavated to a depth of 20.0 cmbs and terminated on bedrock or a large basalt rock. Shovel probe stratigraphy consisted of Layer I (0-12 cmbs) loose dark brown (10YR3/2) fine sandy silt loam overlying Layer II (12-20 cmbs) soft dark yellowish brown (10YR4/4) fine sandy silt. SP-2 did not contain cultural material.

Feature 3 is a roughly rectangular terrace located between Feature 1 and Feature 2 (see Figure 78). The terrace is approximately 3.40 m in length (NW/SE) by 2.25 m wide, with a maximum height of 0.52 m. The terrace retaining wall is constructed of piled angular and subangular basalt cobbles and small boulders, some as large as 0.75 m (Figure 81). A partial wall along the southeastern boundary of the Feature 3 terrace separates it from the Feature 2 terrace, which is situated to the immediate south. The intact portion of wall is 1.50 m, although it likely formerly continued southwest the entire length of the terrace, forming two separate terraces. There were no cultural remains on the ground surface at Feature 3.

Shovel Probe Testing

A single shovel probe (SP-3) was excavated in the level soil interior of Feature 3. The shovel probe was excavated to a depth of 11.0 cmbs and terminated on bedrock or a large basalt rock. Shovel probe stratigraphy consisted of Layer I (0-11 cmbs) loose dark brown (10YR3/2) fine sandy silt loam. SP-3 did not contain cultural material.

Site 30611 Summary

The terrace features at Site 30611 are somewhat similar to Kona field System features recorded at projects in the general area of the current project. They differ in that they are more roughly constructed. This might be a function of the available rock in this location—the rock is much larger than that found in other places. However, it seems just as likely, or more likely, that the features were constructed in the Historic era for commercial agriculture. Their somewhat rough and hasty construction is similar to other Historic era agricultural features, most notably coffee terraces, documented at nearby project area. Site 30611 has been slightly altered by ground clearing activities, the

Figure 81: Photograph of Site 30611 Feature 1 Looking Northeast.

features are partially collapsed in places, and the site is in fair condition. No further work is recommended at Site 30611.

SITE 30612	**Lava Blister**
FUNCTION:	Refuse Disposal Area
AGE:	Historic Era
DIMENSIONS:	3.40 m (NE/SW) by 3.40 m by 1.15 m in max. height
INTEGRITY:	Possesses Integrity of Location and Materials
CONDITION:	Good
SURFACE ARTIFACTS:	None
EXCAVATION:	None

DESCRIPTION: Site 30612 is a small open lava blister located within the central southern portion of the project area (see Figure 10). The site is situated on a west facing slope approximately 10.0 meters east of wall Site 30598 (see Figure 37). There are *koa haole* trees with Guinea grass ground cover throughout the area.

The lava blister is opening is directly above the blister and measures 1.0 m long (N/S) by 0.65 m wide (Figure 82). The blister is approximately 3.40 m in length (NE/SW) and 3.40 m wide, with a maximum ceiling height of 1.15 m. A fair amount of Historic era refuse is scattered on the floor of the blister. Some of the items collected and photographed included glass bottles, fragments of ceramic and stoneware bowls and plates, rusted solder top cans, a section of corrugated roofing material, cow bones, and various glass and metal fragments (Figures 83, 84, and 85).

Site 30612 is an Historic era refuse disposal area. It is unaltered and in good condition. No further work is recommended for Site 30612.

Figure 82: Photograph of Site 30612 Blister Opening Looking North.

Figure 83: Photograph of Site 30612 Historic Era Bottles and Plateware.

Figure 84: Photograph of Site 30612 Soldered Cans.

Figure 85: Photograph of Site 30612 Historic Era Bottles.

CONCLUSION

DISCUSSION

Twenty two newly identified archaeological sites were recorded during the course of the archaeological inventory survey study. The sites are primarily agricultural terraces associated with pre-Contact era to Historic era agriculture and rock walls and enclosures associated with Historic era agriculture and ranching. A pre-Contact era to later post-Contact era lava tube burial and a portion of the old railroad berm were documented along the western and eastern edge of the project area, respectively.

The five acre project area has three primary divisions created by ranch walls (Site 30595, 30601, and 3065). All three of the walls are Historic era ranch walls and have typical formal characteristics of ranch walls; they are bi-faced, cobble core filled, and their sides slope inward towards the tops of the walls. They are all approximately 1.0 meter in height. Site 30597, located along the south boundary of the property and along the north side of a seasonal gulch, is similarly constructed.

Site 30602 and Site 30603 are enclosures constructed along wall Site 30595 and wall Site 30601. The latter two wall sites are constructed onto the west edge of the Site 30592 railroad berm and post-date the railroad berm. Sites 30602 and 30603 enclosures, as well as the wall sites, appear to be associated with both Historic era ranching and agriculture.

The northern portion of the project area, north of wall Site 30601 is north of the bulldozed "terraces" (see Figure3). It is mostly open grassland that appears to have been bulldozed during the Historic era to early Modern era. There were only two sites (Site 30591 and 30956) recorded in this northern third of the project area. Site 30591 is an agricultural complex with six terraces. Site 30956 is a hearth.

It is possible that the two sites are pre-Contact era to early post-Contact era in age. The terrace features are somewhat similar to Kona field System features recorded at projects in the general area of the current project. They differ in that they are more roughly constructed. This might be a function of the available rock in this location—the rock is much larger than that found in other places. However, it seems just as likely, or more likely, that the features were constructed in the Historic era for commercial agriculture. Their somewhat rough and hasty construction is similar to other Historic era agricultural features, most notably coffee terraces,

documented at nearby project area. The hearth at Site 30596 is similar to other Historic era rectangular hearths recoded at sites on Hawai‘i Island.

The middle one third of the project area between wall Site 30595 and 30605 is entirely within the bulldozed “terraces” portion of the project area (see Figure 3). There are three small sites (Site 30593, 30594, and 30604) within the middle third of the project area. Site 30593 is a pre-Contact era to early post-Contact era lava tube burial. Site 30594 is an agricultural terrace complex. The agricultural terraces at Site 30594 are somewhat similar to Kona field System features, but are much more roughly constructed than the formal cross-slope terraces and *mauka/makai kua‘iwi* walls documented in the KFS. Site 30604, based on artifacts recovered from subsurface testing and the site’s proximity to Site 30602 and 30603, is an Historic era agricultural terrace site.

It is interesting to note that there is a lower site density in the northern two divisions of the project area compared to the site density in the southern one third of the project. The northern two thirds likely were used primarily for cattle pasture. It is also likely that the two wall sites 30595 and 30601 formed a cattle chute or road leading to and from the two enclosures (Site 30602 and Site 30603) and the railroad bed.

The southern third of the project area, south of wall Site 30605, contained six primarily agricultural sites (Site 30598, 30600, 30606, 30607, 30610, and 30611) and four Historic era sites (Site 30599, 30608, 30609, and 30612) with functions other than primarily agricultural growing (see Figure 10). The nonagricultural sites are located closer to the railroad bed. The cluster of all of these sites together in this area seems to suggest that they are part of a Historic era commercial agricultural field. The proximity of this area to the seasonal gulch to the south might have influenced the decision to construct the agricultural features in this area.

All of the agricultural complexes documented in the project area are located between 600 and 700 feet (182 to 213 meters) amsl, within the lower *kalu‘ulu* zone. The region was traditionally used by Hawaiians for growing bread fruit and other arboreal crops, sweet potatoes, *ti*, *wauke* dryland *taro*, and sugarcane.

Volcanic-glass flakes, a basalt flake, and marine shell fragments were recovered in small amounts from subsurface testing, indicating that Hawaiians did pass through and use the project area lands. The lack of temporary habitation features and the fact that there aren’t more formally constructed agricultural terraces and rock clearing mounds suggests that they might not have

used the area for extensive cultivation. If so, the agricultural terraces documented during the current study are most likely the remains of Historic era commercial agriculture.

SIGNIFICANCE ASSESSMENTS

Sites identified during this project were assessed for their significance as outlined in Hawai‘i Administrative Rules §13-284-6. To be assessed as significant a site shall possess integrity of location, design, setting, materials, workmanship, feeling, and association and shall meet one or more of the following five criteria:

(a) It must be associated with events that have made a significant contribution to the broad patterns of our history, or be considered a traditional cultural property.

(b) It must be associated with the lives of persons significant in the past.

(c) It must embody distinctive characteristics of a type, period, or method of construction, or represent a significant and distinguishable entity whose components may lack individual distinction.

(d) It must have yielded or may be likely to yield, information important in prehistory or history.

(e) Have important value to native Hawaiian people or other ethnicities in the state, due to associations with cultural practices and traditional beliefs that were, or still are, carried out.

All of the archaeological sites documented in this report were evaluated for their significance (Table 14). All 22 sites identified during the current AIS study possess integrity of location and materials and were assessed significant under criterion “d” as they are likely to yield information important to prehistory and/or history. All of the sites, with the exception of the railroad berm Site 30592 and the burial Site 30593 provide information important to agricultural pursuits and cattle ranching. They provide data on pre-Contact era through post-Contact era and the Historic era features constructed to grow subsistence crops. They also provide data important to changing land-use as some farmers began to use land for cattle pasture in response to exposure to external trade routes and expanding markets on Hawai‘i Island and O‘ahu.

Table 14: Inventory of Project Area Archaeological Sites, Significance Assessments and Site Recommendations.

Site #	Site Type	Site Function	Age	Significance Criteria	Recommendation
30591	Agricultural Complex	Agriculture	Pre-Contact to Historic Era	d	No Further Work
30592	Railroad Bed and Berm	Transportation	Historic Era	a, c, d	Preservation
30593	Lava Tube	Burial	Pre-Contact to Early Post-Contact Era	d, e	Preservation
30594	Agricultural Complex	Agriculture	Pre-Contact to Historic Era	d	No Further Work
30595	Rock Wall	Ranching	Historic Era	d	No Further Work
30596	Possible Hearth	Food Preparation	Historic Era	d	No Further Work
30597	Rock Wall	Ranching	Historic Era	d	No Further Work
30598	Rock Wall	Agriculture/Ranching	Pre-Contact to Historic Era	d	No Further Work
30599	Platform & Enclosure	Ranching/Agriculture	Historic Era	d	No Further Work
30600	Terrace	Agriculture	Historic Era	d	No Further Work
30601	Rock Wall	Ranching	Historic Era	d	No Further Work
30602	Enclosure	Ranching/Agriculture	Historic Era	d	No Further Work
30603	Enclosure	Ranching/Agriculture	Historic Era	d	No Further Work
30604	Agricultural Complex	Agriculture	Pre-Contact to Historic Era	d	No Further Work
30605	Rock Wall	Ranching/Agriculture	Historic Era	d	No Further Work
30606	Rock Wall	Ranching/Agriculture	Pre-Contact to Historic Era	d	No Further Work
30607	Agricultural Complex	Agriculture	Pre-Contact to Historic Era	d	No Further Work
30608	Enclosure	Dwelling and Storage	Historic Era	d	No Further Work
30609	Enclosure	Dwelling and Storage	Historic Era	d	No Further Work
30610	Terrace	Agriculture	Pre-Contact to Historic Era	d	No Further Work
30611	Agricultural Complex	Agriculture	Pre-Contact to Historic Era	d	No Further Work
30612	Lava Blister	Refuse Dump	Historic Era	d	No Further Work

Ranch wall sites (30592, 30595, 30597, 30598, 30601, 30605 and 30606) and Historic era enclosure sites (30608 and 30609) provide information on how the land was altered and the types of features that were necessary to farming and ranching. Even the Historic era refuse dump (Site 30612) provides data on the types of items were available, useful and necessary to farmers and ranchers.

The railroad berm Site 30592 is also significant under criteria "a" and "c" as it is associated with events that have made a significant contribution to the broad patterns of our history and it embodies distinctive characteristics of the type, period, and method of railroad bed construction. The burial Site 30593 is also significant criterion "e" as it has important value to Hawaiian people and people of other ethnic backgrounds in the state.

SCS consulted with the Office of Hawaiian Affairs (OHA) Kona representative Shane Nelson to ask for any input regarding Site 30592.

RECOMMENDATIONS

The burial Site 30593 is recommended for preservation in place with preservation treatments to be outlined in a Burial Site Component of a Preservation Plan (BSCPP). The railroad berm Site 30592 is recommended for preservation with preservation measures to be outlined in an archaeological preservation plan.

No further work is recommended for the remaining 20 archaeological sites (Sites 30591and 30594 through 30612). Information recorded for all 22 archaeological sites during the current study has adequately ascertained their function and age. Archaeological monitoring is recommended for initial grubbing within the five-acre project area and for any proposed ground disturbance in the vicinity of Site 30592 and Site 30593 to ensure interim construction preservation measures are in place and to prevent disturbance of the two archaeological sites.

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APPENDIX A: ARTIFACT INVENTORY

Site	FE #	Unit	Layer/ Level	Depth	Identification	Weight	Count	Remarks
30596	1	TU-1	II	0-28 cmbs	Marine Invertabrate	2.56 g	11	Gastropoda: Cypraea sp.
30596	1	TU-1	II	0-28 cmbs	Marine Invertabrate	1.17 g	4	Gastropoda: Nerita sp.
30596	1	TU-1	II	0-28cmbs	Marine Invertabrate	4.05 g	81	Echnoidea: Non-Diagnostic
30596	1	TU-1	II	0-28 cmbs	Bone	3.89 g	1	Bird
30596	1	TU-1	II	0-28 cmbs	Bone	0.08 g	4	Rodent
30596	1	TU-1	II	0-28 cmbs	Kukui	1.18 g	9	Charred
30596	1	TU-1	II	0-28 cmbs	Carbon	4.92 g	123	
30599	1	TU-1	II	90-145 cmbs	Bottle Glass Fragment	9.01 g	1	Clear
30599	1	TU-1	II	90-145 cmbs	Jar Glass Fragment	2.35 g	1	Brown
30599	1	TU-1	II	90-145 cmbs	Nail Fragments	1.88 g	2	Wire Cut
30599	1	TU-1	II	90-145 cmbs	Bottle Cap	3.77 g	1	Rusted Metal
30599	1	TU-1	II	90-145 cmbs	Jar Lid	7.36 g	3	Rusted Metal
30599	1	TU-1	II	90-145 cmbs	Metal Fragments	48.69	21	Rusted
30599	1	TU-1	II	90-145 cmbs	Carbon	0.38 g	3	
30604	3	SP-1	I & II	0-50 cmbs	Volcanic Glass Flake	0.04 g	1	

Site	FE #	Unit	Layer/ Level	Depth	Identification	Weight	Count	Remarks
30607	1	SP-1	I & II	0-37 cmbs	Volcanic Glass Debitage	3.03 g	5	
30607	1	SP-1	I & II	0-37 cmbs	Carbon	.83 g	30	
30607	3	SP-1	I	0-15 cmbs	Coral Fragments	0.08 g	2	
30607	3	SP-1	I	0-15 cmbs	Volcanic Glass Flake	0.17 g	2	
30607	3	SP-1	II	15-30 cmbs	Carbon	0.06g	7	
30607	4	SP-7	I & II	0-32 cmbs	Basalt Flake	2.14 g	1	

SCS Project Number 2330-1

ARCHAEOLOGICAL INVENTORY SURVEY REPORT FOR 76.121 ACRES LOCATED IN HŌLUALOA 1ST AHUPUA‘A, NORTH KONA DISTRICT, HAWAI‘I ISLAND, HAWAI‘I [TMK: (3) 7-6-021:016-019]

Prepared By:

Glenn G. Escott, M.A.
&
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MAY 2020
DRAFT

Prepared for:
Kona Three, LLC
101 Hualālai Street
Hilo, HI 96720

SCIENTIFIC CONSULTANT SERVICES Inc.

1347 Kapi‘olani Boulevard, Suite 408 Honolulu, HI 96814
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ABSTRACT

At the request of property owner Kona Three, LLC, Scientific Consultant Services, Inc. (SCS) conducted an archaeological inventory survey (AIS) of a 76.121 acres of land TMK: (3) 7-6-021:016, 017 (por.), 018, and 019 located in Hōlualoa 1st Ahupuaʻa, North Kona District, Island of Hawaiʻi, Hawaiʻi. The owner is proposing to develop the property and contracted the archaeological study required for an Environmental Assessment (EA) as required for County of Hawaiʻi Planning Department permit applications. The point of contact (owner) for the project is Mr. Richard Wheelock. The owner's mailing address is 101 Hualālai Street Hilo, HI 96720. Mr. Wheelock can also be contacted by email at richard@eastwestrealty.org or by phone at 808-753-3167.

Prior to fieldwork, a search of geological maps, aerial photos, historical maps, historical documents, and archaeological reports was conducted. Pedestrian survey and site recording were conducted throughout 2020 by Joe Farrugia, B.A., Suzan Escott, B.A, Tomasi Patolo, B.A., Nicole Mello, B.A., and Glenn Escott, M.A.

The project area lands were used for cattle ranching and commercial agriculture from the early 1900s until the present. The majority of the project area has been bulldozed. Evidence of bulldozing is visible in aerial photographs as alternating bands of cleared bulldozer tracks and bands of push pile. Pedestrian survey confirmed the linear bands in the aerial photographs are bulldozer- cleared paths and linear piles of bulldozed rock along the cleared bulldozer paths.

Sixteen archaeological sites were identified and recorded in the project. Fifteen of the sites were previously documented and two sites were previously undocumented (a small coffee shed enclosure Site #50-10-37-31181; ranch walls Site #50-10-37-31182).

Five of the sites were determined to be pre-Contact era habitation and agriculture sites. A single petroglyph (Isolate Find 1) was also recorded. Eleven of the sites were determined to be Historic era sites, the majority associated with cattle ranching and coffee and sugarcane agriculture.

All of the archaeological sites were assessed significant under criterion "d" as they are likely to yield information important to prehistory and/or history. The railroad berm Site 30592 is also significant under criteria "a" and "c" as it is associated with events that have made a significant contribution to the broad patterns of our history and it embodies distinctive characteristics of the type, period, and method of railroad bed construction. A petroglyph (Isolated Find-1) is also significant criterion "e" as it has important value to Hawaiian people and people of other ethnic backgrounds in the state.

The railroad berm Site 30592 and the petroglyph are recommended for preservation with preservation measures to be outlined in an archaeological preservation. No further work is recommended at the remaining fifteen sites.

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INTRODUCTION

At the request of property owner Kona Three, LLC, Scientific Consultant Services, Inc. (SCS) conducted an archaeological inventory survey (AIS) of a 76.121 acres of land TMK: (3) 7-6-021:016, 017 (por.), 018, and 019 located in Hōlualoa 1st Ahupuaʻa, North Kona District, Island of Hawaiʻi, Hawaiʻi (Figure 1 through Figure 4). The owner is proposing to develop the property and contracted the archaeological study required for an Environmental Assessment (EA) as required for County of Hawaiʻi Planning Department permit applications. The point of contact (owner) for the project is Mr. Richard Wheelock. The owner's mailing address is 101 Hualālai Street Hilo, HI 96720. Mr. Wheelock can also be contacted by email at richard@eastwestrealty.org or by phone at 808-753-3167.

METHODS

The archaeological inventory survey was undertaken in accordance with Hawaiʻi Administrative Rules 13§13-284 and was performed in compliance with the Rules Governing Minimal Standards for Archaeological Inventory Surveys and Reports contained in Hawaiʻi Administrative Rules 13§13-276.

ARCHIVAL METHODS

In addition to referencing available resources at SCS, archival research was conducted in the State Historic Preservation Division (SHPD) report database and library facility (Hilo, HI), the Hawaiʻi County land records office, the *Waihona ʻAina Māhele* database website, Ulukau database website, the Papakilo database website, the Hawaiian collections holdings at the University of Hawaiʻi-Hilo Library, and the Hawaii State Library system. Archival work consisted of research on the history and archaeology of the project area, as well as specific searches of previous archaeological studies in and around the current project area. Historic land use data, land ownership, maps, and narrative information were obtained from the Hawaiʻi County land records office, Hawaiian internet sites, and the University of Hawaiʻi, Hilo.

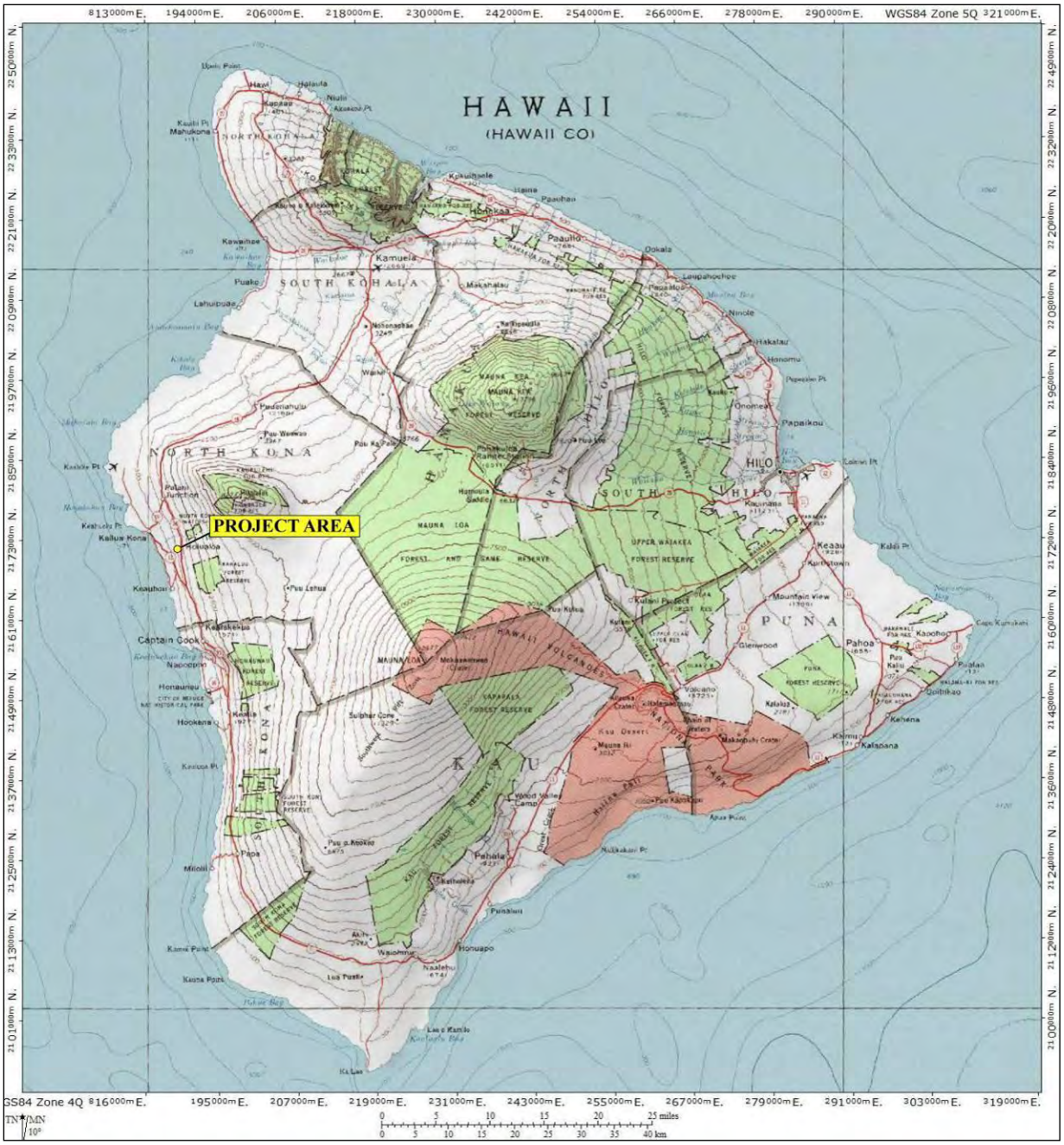

Figure 1: 5,500 K-Series Map of Hawai‘i Island Showing Location of Project Area (National Geographic Topo!, 2003. Data Sources: National Geographic Society, USGS).

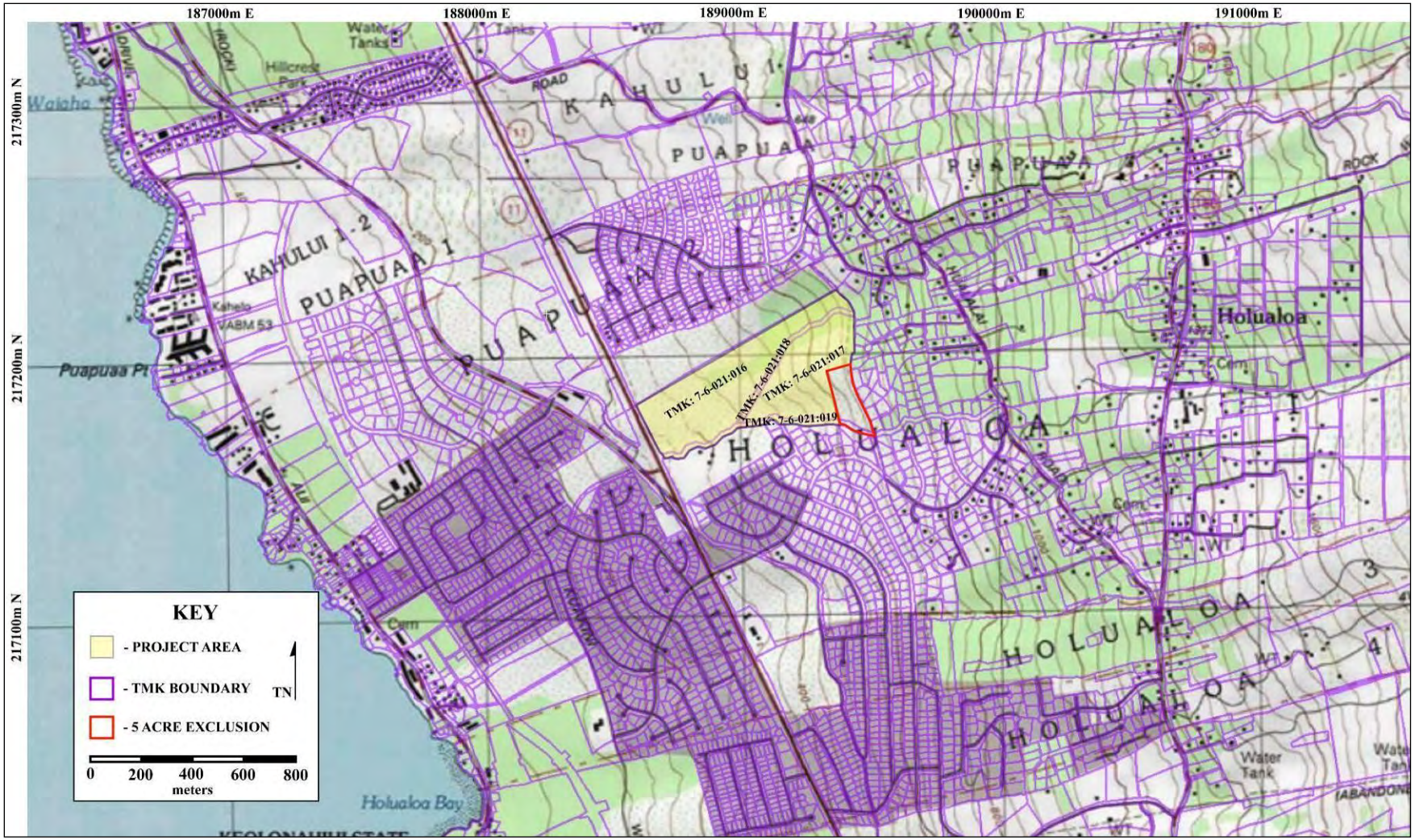

Figure 2: 7.5-Minute Series USGS Topographic Map Showing Location of Project Area (Kealakekua Quad, ESRI, 2013. Data Sources: National Geographic Society, USGS).

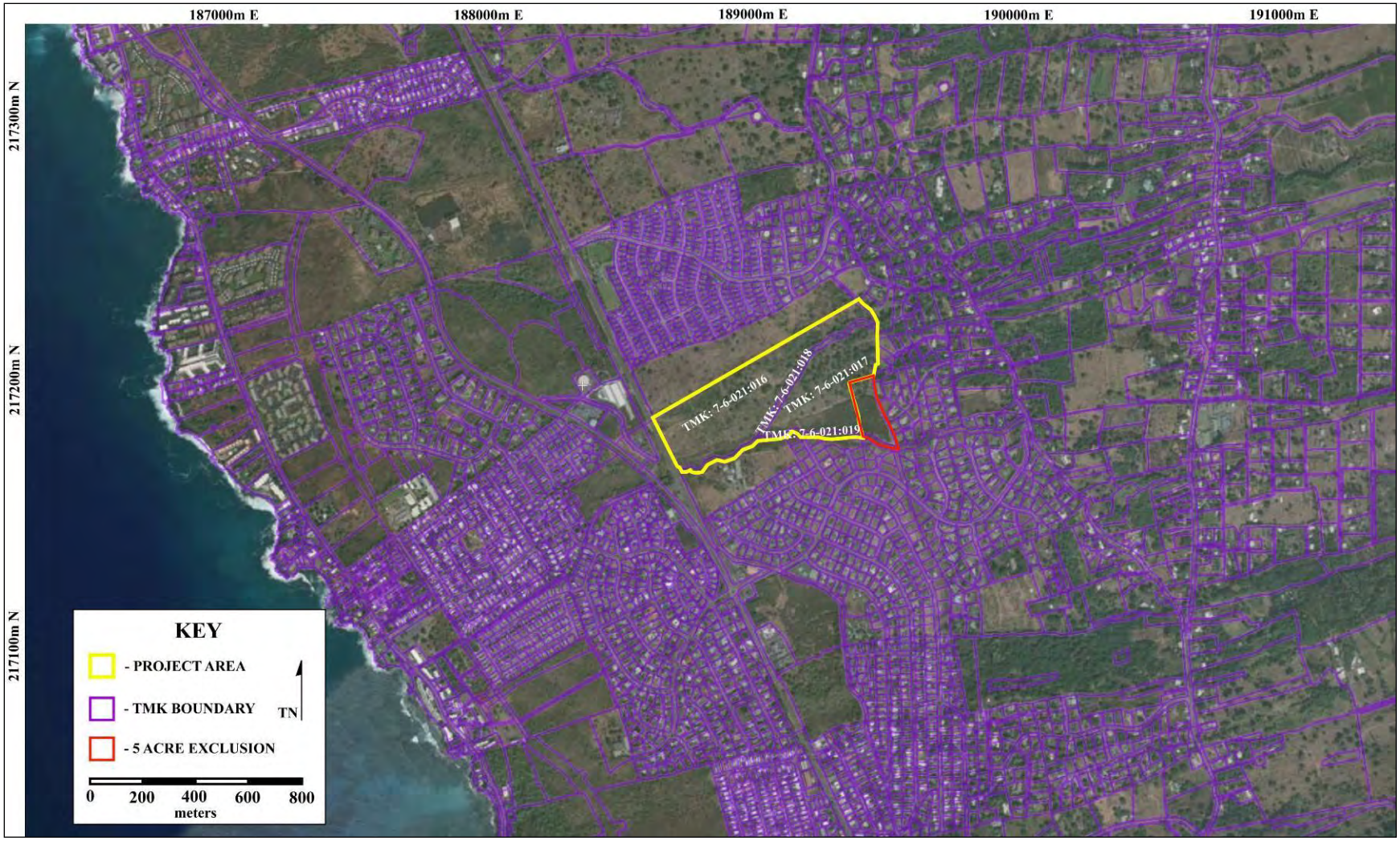

Figure 3: Aerial Photograph Showing Project Area, Hōlualoa, HI, Zone 5 North, 189445 m E, 2171790 m N. (ESRI, 2013 Image. Data Sources: Digital Globe, GeoEye, Earthstar, USDA, and USGS).

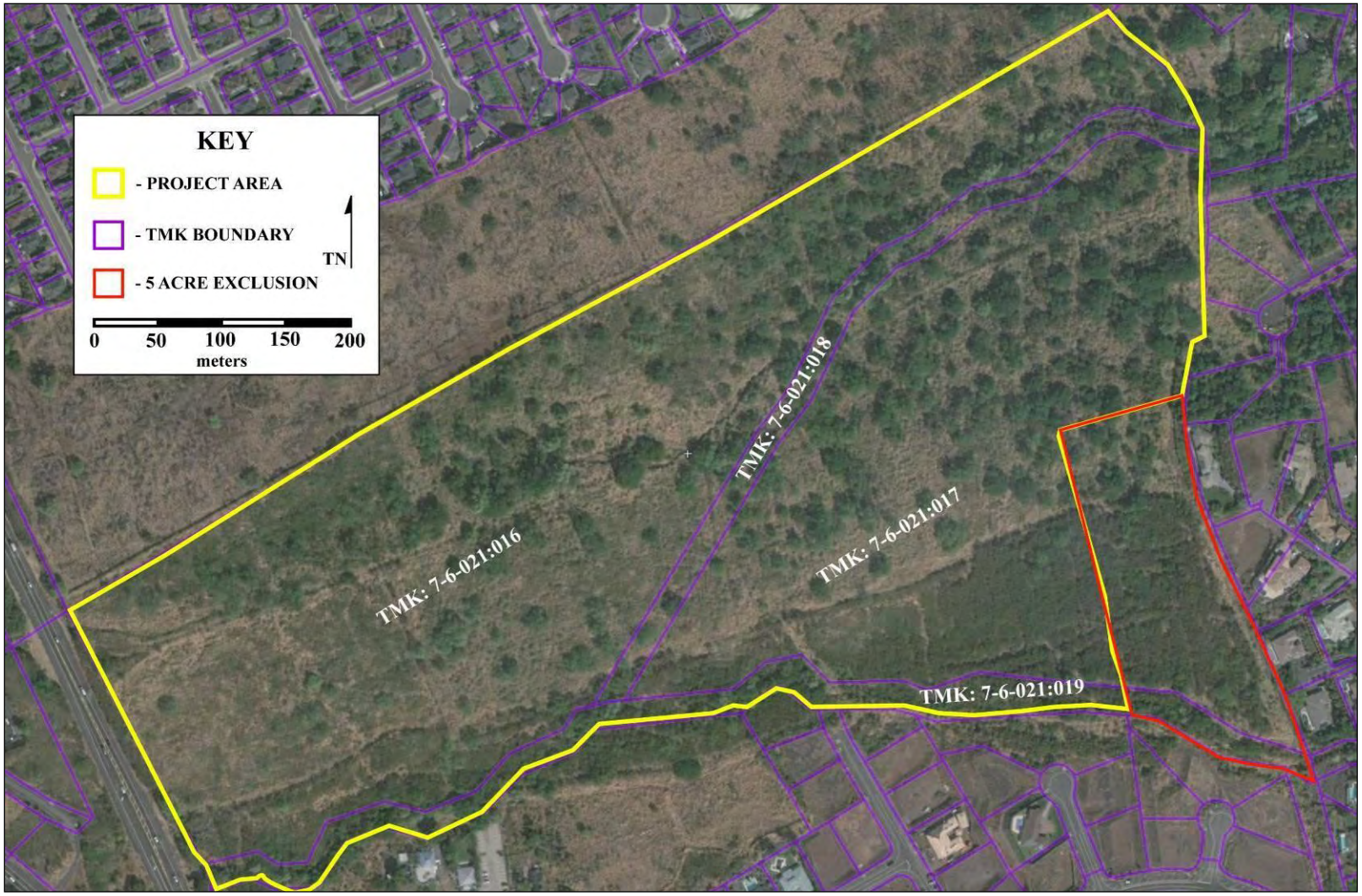

Figure 4: Aerial Photograph Close-Up Showing Project Area, Hōlualoa, HI, Zone 5 North, 189445 m E, 2171790 m N. (ESRI, 2013 Image. Data Sources: Digital Globe, GeoEye, Earthstar, USDA, and USGS).

FIELD METHODS

The archaeological pedestrian survey included: 100% pedestrian survey of the project area, Global Position System (GPS) plotting archaeological sites on USGS and TMK maps; individual site mapping, photographing and recording; and subsurface excavation and recording.

Pedestrian survey and site recording were conducted in throughout 2020 by Joe Farrugia, B.A., Suzan Escott, B.A, Tomasi Patolo, B.A., Nicole Mello, B.A., and Glenn Escott, M.A. A series of north/south transects spaced 2.0 to 4.0 meters apart were walked across the entire project area. Ground cover consisted of tall California and Guinea grass, *koa haole*, *kiawe*, and several *kukui* nut trees. Ground visibility was good. The fieldwork totaled 208 person-hours. Glenn Escott was the Principal Investigator and Project Director.

GPS points for sites were plotted in the field using a Garmin GPSmap 62 hand-held GPS unit. Site points were plotted in ArcGIS using Universal Transverse Mercator (UTM) units (Zone 5 North) and NAD83/WSGS84 datum.

Site boundaries were determined by the aerial extent of features and by feature function and temporal association. Features that were in close proximity to each other and that appeared to have functional and temporal associations suggesting they were constructed and used as a functional set of features--those features were included together as a single site. Features that were beyond twenty to thirty meters away from each other, or that were constructed at very different times, or for different very purposes, were separated into individual sites.

Photographs were taken of sites and features using a 25 cm north arrow scale with 5 cm black and white increments. Representative plan view maps showing the location and morphology of identified sites and features were drafted using tape-and compass mapping techniques. Site documentation included site and feature type, function, construction method, and age. Feature type, function, and age were determined by observing environmental context and topographic location, feature size and shape, construction material, construction methods, and associated artifacts if present.

Table 1: Inventory of Subsurface Test Excavations.

SIHP# *	TYPE	FUNCTION	AGE	CSH EXCAVATIONS	SCS EXCAVATIONS
10011	Platform	Ag./Temp Habitation	Pre-Contact	1.5 m long trench	TU-1 (2.4 X 1.2 m)
10012•	Platform & Wall	Burial	Pre-Contact	Entire Feature	Site No Longer Present
10013	Enclosure & Lava Tube	Habitation	Pre-Contact	4.5 m sq. total	Site Mostly Bulldozed
10017	Platform	Cattle Ramp	Historic	-	Site No Longer Present
10018	Enclosure	Agricultural	Historic	-	Site Mostly Bulldozed
10019	6 Rock Mounds	Ag. Clearing	Historic	3 1.0 m x 1.0 m long trenches	Site Mostly Bulldozed
10031	Enclosure Wall	Agriculture	Historic	-	Site Mostly Bulldozed
10033	Planting Complex	Coffee Ag	Historic	-	Site No Longer Present
10049	Terraces	Agriculture	Historic	-	Site No Longer Present
10067	Terraces	Habitation	Pre-Contact	1.0 X 1.0 m	-
10068	Enclosure	Habitation	Pre-Contact	0.5 X 0.25 m	Site Mostly Bulldozed
10069	Modified Bluff/Platform	Habitation	Historic	0.5 X 0.5 m	Site Mostly Bulldozed
10070	U-Shape Enclosure	Agriculture	Historic	1.0 X 0.5 m	Site Mostly Bulldozed
10071	Platform	Habitation	Pre-Contact	-	Site No Longer Present
10072	Modified Bluff	Ag. Clearing	Pre-Contact	7.0 m square total	Site Mostly Bulldozed
10073	Complex	Ranching/Ag.	Historic	-	TU-1 (2.3 X 1.2 m), TU-2 (1 X1 m)
10074	Enclosure	Coffee Work Shed	Historic	1.25 m sq. total	Site Mostly Bulldozed
10075	Enclosure	Pig Pen	Historic	-	Site Mostly Bulldozed
30592	Railroad Berm	Transportation	Historic	-	-
31181	Enclosure	Coffee Work Shed	Historic	-	Site On Bedrock
31182	Rock Walls	Ranching & Ag.	Historic	-	-

* Site numbers are preceded by the prefix 50-10-37-.
Orange Shading - Site no longer present.
• Burial Site 10012 reinterred off project prior to 1983.

Feature types and functions were selected from a set of recognized formal archaeological types and functions developed within Hawaiian archaeology over many decades of research. Age determinations are expressed in terms of recognized formal eras including pre-Contact era (before 1778), early post-Contact era (1778-1850), Historic era (1851-1965), and Modern era (post-1965). Age was interpreted on the basis of feature dimensions, type, construction, and artifacts recovered from excavations.

Many of the sites identified during the current AIS survey were bulldozed in the past (Table 1). In addition, many sites were previously excavated during the previous Cultural surveys Hawai‘i (CSH) AIS study (Hammatt et al. 1992). Sites that were mostly bulldozed or that did not have sediment deposits, or at which CSH had conducted adequate subsurface excavations to accurately interpret site function and age were not excavated during the current AIS study.

SCS conducted test excavations at two sites (Site #50-10-37-10011 and #50-10-37- 10073, hereafter site numbers are abbreviated to their last five digits) to better determine site function, construction method, and age. Test units (TU) were excavated in features at both sites. A total of 2.88 square meters were excavated in Site 10011 Feature 1. A total of 3.76 square meters

Test-units were excavated at features that had a high potential to yield functional and temporal diagnostic artifacts, and where vertical control would contribute to this data. Test units were placed to expose the base of feature architecture. Test-units were excavated in natural stratigraphic layers and arbitrary 10 cm levels when natural stratigraphic layers were thicker than 10 cm. Sediment excavated from all units was screened for cultural material through 1/8th inch mesh. Stratigraphic profiles were drawn for test units and post-excavation photographs were taken.

Cultural material was recorded by type on standard SCS excavation forms and collected. Soil colors were recorded using Munsell color charts, soil composition was recorded with the aid of the U.S. Department of Agriculture Soil Survey Manual on standard soil stratigraphy forms, and profiles were drawn.

LABORATORY METHODS

Inventory of midden and artifacts collected from the test excavations were weighed and analyzed by layer of provenience within each excavation unit. Weight, count and diagnostic characteristics were recorded for all artifacts. Field notes, maps, cultural material, and photographs pertaining to this project are currently being curated at the SCS facilities on the Island of Hawai‘i.

ORAL INTERVIEW ANDCONSULTATION

Gregg Kashiwa was interviewed by phone on April 19, 2016. Mr. Kashiwa was the project property manager for parcels 016 and 017 in the early 1980s and was present during AIS work documented in the Hammatt et al. (1992). He is originally from O‘ahu but lived in Kona for several decades. Mr. Kashiwa remembered that five acres in the northeast corner of the project area were excluded from the original AIS because the property owners were planning to give the five acres to a group to use as an agricultural preserve. The five acres and much of the current project area had already been bulldozed for agricultural use and for cattle ranching. Mr. Kashiwa knew that there were ranch walls and Historic era agricultural features on the project area, but did not know how they were used, as they were no longer in use during his time in Kona. He also remembered the old railroad bed and berm and that there was a small railroad stop along the track just south of the project area.

Mr. Shane Nelson, the Office of Hawaiian Affairs (OHA) West Hawaii Representative was contacted to consult on the disposition and preservation of Railroad Berm Site 30592.

ENVIRONMENTAL SETTING

The current project area consists of undeveloped land used as cattle pasture for several decades. Prior to that, coffee was grown in the northeast quadrant of the project area. The project area is situated on fairly steeply sloping land with level areas in between elevation breaks. The project area is between 360 and 7000 feet (110 to 213 meters) above mean sea level (amsl). The project area lands are part of a large former cattle ranch and agricultural area that was started in the early 1900s. The project area is still used to pasture cattle. The project area lands were bulldozed sometime between the 1940s and 1970s. Evidence of bulldozing is visible in aerial photographs as alternating bands of cleared bulldozer tracks and bands of push pile (see Figure 4). Pedestrian

survey confirmed the linear bands in the aerial photographs are bulldozer-cleared paths and linear piles of bulldozed rock along the cleared bulldozer paths. The former Kona Sugar Company railroad bed is present along the eastern edge of the project area.

The project area ground surface is a Hualālai lava flow dating between 5,000 and 10,000 years before present (ybp) (Wolfe and Morris 1996). Soil in the project area is Punalu‘u Series (rPYD series) extremely rocky peat with six to twenty percent slopes (Sato 1973:48). The majority of the project area has been bulldozed in the past and the present ground surface is rocky soil.

Rainfall in the project area is very low, less than thirty inches per year. Parcel 018 and Parcel 019 are seasonal gulches that drain rainfall down slope to the west. This project area region is dry, hot, and somewhat barren except for thick California grass (*Urochloa mutica*), Guinea grass (*Megathyrsus maximus*), *koa haole* (*Leucaena leucocephala*), and scattered *kukui* (*Aleurites moluccana*) trees (Starr Environmental 2016). A fairly large number of introduced tree species associated with Historic era ranching and farming are present in the project area, including *kiawe* (*Prosopis pallida*), monkey pod (*Samanea saman*), opiuma (*Pithecellobium dulce*), tamarind (*Tamarindus indica*), coffee (*Coffea arabica*), and bamboo (*Bambusa sp.*).

HISTORICAL AND CULTURAL CONTEXTS

Kona is divided into two sections: North Kona or *Kona ‘akau*, and; South Kona, or *Kona hema* (Maly 1996). *Kona ‘akau* was further subdivided into north (called *Kekaha*) and south (called *Konakai‘ōpua*) areas, with the division between the two at the *ahupua‘a* of Keahuolu. The project area is in Hōlualoa 1st Ahupua‘a (see Figure 1 and Figure 2) within the area of *Konakai‘ōpua* in *Kona ‘akau*. Hōlualoa means (literally) “long sled course” (Pukui *et al*. 1974:48). Hōlualoa 1st is a traditional *ahupua‘a* stretching from the ocean to the foot of Hualālai in the uplands. The coastline of Hōlualoa 1st Ahupua‘a is primarily low rock cliffs.

Very little is recorded of Hōlualoa Ahupua‘a in traditional oral accounts. *The Heart Stirring Legend of Ka-Miki*, published in the Hawaiian language newspaper *Ka Hoku o Hawaii* and translated by Maly (1993) contains the only description of Hōlualoa. The legend is set in the 13th century but also reflects more recent influences (Maly and Maly 2002: 17). According to the narrative,

> The lands of Hōlualoa were named for the chief of that name; both Hōlualoa and Puapuaʻa were high chiefs, who controlled the lands from mountain to sea, which bear their names… Kaluaokalani served as a priest of Hōlualoa at the temple of Pākiha. This *heiau* was near the contest field of Hōlualoa… The lands of this region are named for various *aliʻi*, all of whom were related. When the chief Hōlualoa took up the challenge against Kepakaʻiliʻula on behalf of the Kona chiefs, Hōlualoa called upon his god *Kālaipāhoa* to assist him in his battle… Hōlualoa was the first chief to call upon the god *Kālaipāhoa*, and this was the beginning of this gods' use by the chiefs of Hawaiʻi [Maly 1993:208-209].

PRE-CONTACT ERA

Hōlualoa, Kona, and much of the leeward side of Hawaiʻi Island, while well populated at the time of European Contact, were settled later than the windward side. Many archaeologists believe that Hawaiʻi Island was first settled around A.D. 1,000 by people sailing from the Marquesas (Athens et al. 2014; Dye 2011; Kahn et al. 2014; Kirch 2011; Kirch and McCoy 2007; McCoy 2005 and 2007; Mulrooney et al. 2011; Reith et al. 2011; Wilmhurst et al. 2011a and 2011b).

An article published in the Journal of Archaeological Science reviewing radiocarbon dates recovered at archaeological sites on the Island of Hawaiʻi suggests that, by relying on only carbon samples from short-lived plant remains, the most reliable dates point to initial Polynesian colonization of Hawaiʻi Island occurring between A.D. 1220 and 1261 (Rieth et al. 2011:2747).

Early settlers founded settlements on the windward shores in likely places such as Waipiʻo, Waimanu, and Hilo Bay. The windward, or *koʻolau* shores receive abundant rainfall and have numerous streams such as the Wailuku, Waiolama, ʻAlenaio, and Wailoa that facilitated agricultural and fishpond production (Maly 1996:3). The windward shores also provide rich benthic and pelagic marine resources.

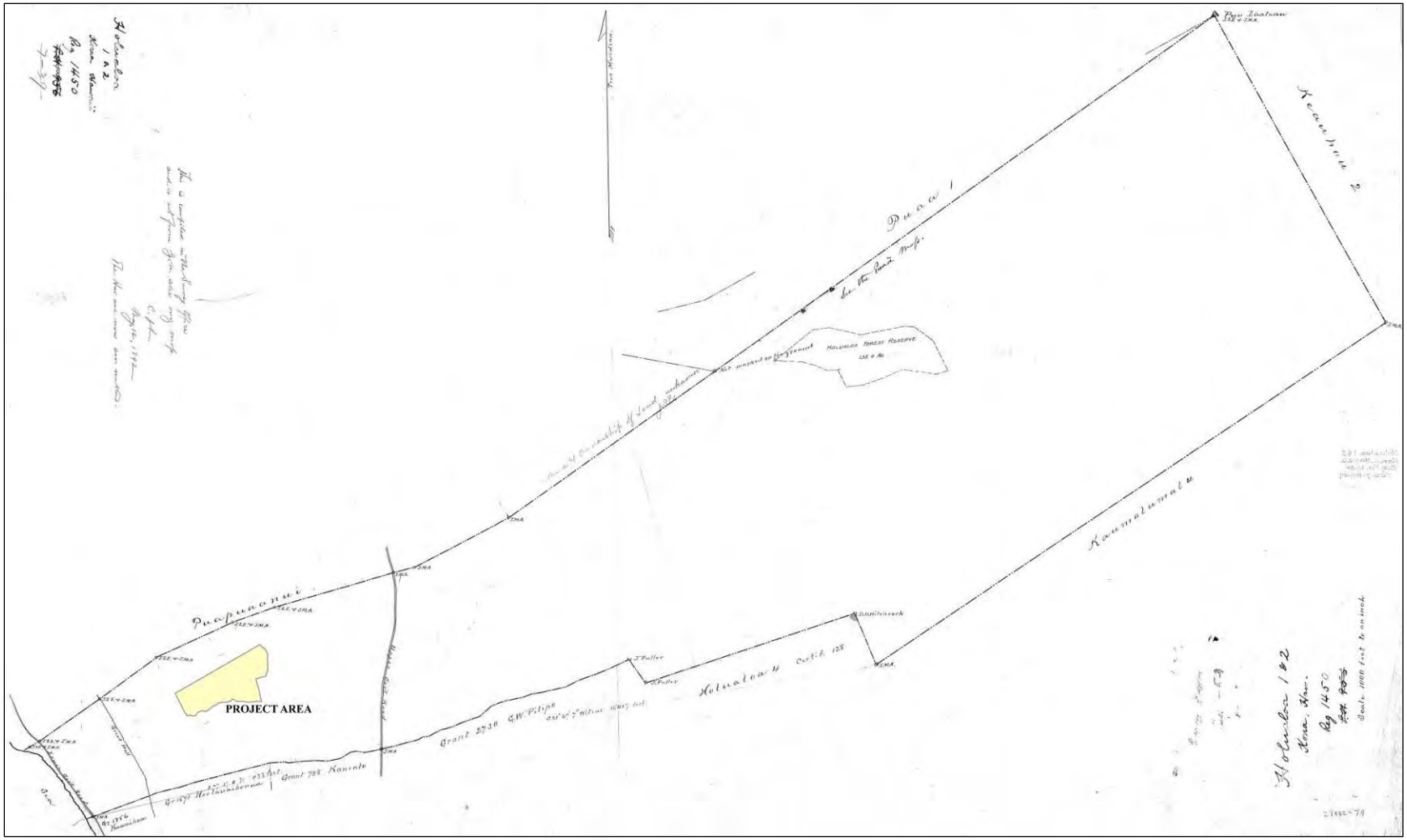

Figure 5: Map of Hōlualoa 1st and 2nd Ahupua‘a Showing Location of Project Area in Yellow (Alexander 1855).

The dry leeward shores of Hawai‘i Island presented a very different environment requiring a modified set of subsistence strategies. Archaeologists and historians are uncertain about the exact motives that lead to the establishment and spread of settlements on the leeward side of Hawai‘i, but some suggest population pressure, dwindling fertile land, growing socio-political stratification, or simply the opportunity for a new start might have lead to new communities developing on the dryer west side of the island (Cordy 2000:130). The process was likely underway soon after initial settlement of Hawai‘i Island (Cordy 2000).

During this period, areas of permanent habitation were established in Kona (Cordy 1981, 1995; Schilt 1984). Habitation was concentrated along the shoreline and lowland slopes, and informal fields were cleared at higher elevations where rainfall was higher. Agricultural fields and habitation areas expanded across the slopes and coastal area of Hualālai during the period between AD 1200 and 1400 (Burtchard 1995; Cordy 1995).

The development of extensive formal walled fields likely began sometime around AD 1400 to 1600. This period marks the initial construction of the Kona Field System (KFS) (Schilt 1984). The development of the KFS may be, in part, a by-product of the need to extract more subsistence resources from an increasingly limited agricultural base. The population in Kona increased dramatically during this period, as reflected in the abundant radiocarbon dates from habitation structures, shelter caves, and agricultural soils of this period (Burtchard 1995; Haun *et al*. 1998; Schilt 1984). During this period, the stratified chiefdom structure becomes clearly developed in the archaeological record.

Large residential complexes and *heiau* reflect the segregation of places and power for the growing hierarchy of high and lower chiefs, and ceremonial stewards (Cordy 1981; Haun *et al*. 1998; Hommon 1986). The produce from the formal walled fields were distributed to higher chiefs through a hierarchy of lower chiefs responsible for management and collection of the cultivated and wild resources.

By the time of the Competition Period (AD 1600 to 1800), the royal centers and larger *heiau* were in place, reflecting the growth in power of the rulers and chiefs in the region (Barrera 1971; Hammatt and Folk 1980). Resources may have reached their maximum carrying capacity, resulting in social stress between neighboring groups. Hostility between groups is reflected archaeologically with the development of refuge

caves during this period (Schilt 1984). This volatile period was probably accompanied by internal rebellion and territorial annexation (Hommon 1986; Kirch 1985). Royal centers are located at Kailua, Hōlualoa, Kahaluʻu, Kealakekua, and Honaunau (Cordy 1995).

The region of Hōlualoa developed into a royal center in the late 1600s to early 1700s under the reigns of Keakamahana (reigned 1680-1700) and Keakealaniwahine (reigned 1700-1720) (Cordy 2000:244). Many *ʻaliʻi* and *konohiki* residences and numerous religious sites are known to have existed here. The majority of the *heiau* and royal residences were constructed along or near the coast, most notably at Kamoa Point south of the project area. The royal center at Hōlualoa was eclipsed in the second half of the 1700s by the royal center in the Kahaluʻu and Keauhou region.

The Kona Field System

During his travels in the region in 1823 William Ellis noted that the area above and south of Kailua was:

> quite a garden compared with that through which they had passed on first leaving the town. It was generally divided into small fields, about fifteen rods square, fenced with low stone walls, made of fragments of lava which had been gathered from the surface of the enclosures. These fields were planted with bananas, sweet potatoes, mountain taro, tapa trees, melons and sugar cane, flourishing luxuriantly in every direction [Handy 1940:114 and 162].

> Rocky lands in the olden days were walled up all around with big and small stones of the patch until there was a wall about 2 feet high and in the enclosure were but weeds of every kind, amaʻu tree ferns and so on, and then topped well with soil taken from the patch itself to enrich it [Handy 1940:147].

These gardens have been studied in some detail, and are often referred to as the "Kona Field System". Many of the archaeological projects conducted within Kona deal with components of the Kona Field System (Cordy 1995; Newman 1970; Schilt 1984). This area extends north at least to Kaʻu Ahupuaʻa and south to Honaunau, west from the coastline and east to the forested slopes of Hualālai (Cordy 1995). A large portion of this

area is designated in the Hawai‘i SIHP (State Inventory of Historic Places) as Site 50-10-37-6601. The basic characteristics and general locations of the zones within the system as presented in Newman (1970) have been confirmed and elaborated on by more intensive and extensive ethnohistorical investigations (Kelly 1983).

The *kula* zone of the Kona Field System is the area from sea level to 150 m amsl. This lower elevation zone is traditionally associated with habitation and the cultivation of sweet potatoes (*uala*), paper mulberry (*wauke*), and gourds (*ipu*). Agricultural features, such as clearing mounds, planting mounds, planting depressions, modified outcrops, and planting terraces, are common throughout much of this zone (Hammatt and Clark 1980; Hammatt and Folk 1980; Haun *et al*. 1998; Schilt 1984).

Dwellings are often scattered throughout the agricultural portion of the *kula*, but they are commonly concentrated along the shoreline subdivision of the *kula* zone (Cordy 1981). The shoreline zone, extending inland approximately 200 m, was used primarily for permanent habitation and other non-agricultural activities, such as canoe storage, ceremonial and burial practices, recreation, and fishing-related activity.

Royal centers and high chiefly centers were also situated within the shoreline of the *kula*. These complexes include dwellings for rulers, chiefs, and the supporting populace, places of refuge, and other structures. Single, or clustered, burials are also situated in the shoreline, and near-shore *kula* (Han *et al*. 1986; Hammatt and Clark 1980; Hammatt and Meeker 1979). Burials occur in caves, within finely built platforms, cruder rock mounds, and houses in the shoreline, and are more often in the near-shore *kula* (Cordy 1995; Han *et al*. 1986; Schilt 1984; Tainter 1973; Tomonari-Tuggle 1993).

The large, and densely populated, royal centers were situated at several locations along the shoreline between Kailua and Honaunau (Cordy 1995; Tomonari-Tuggle 1993). The residential areas, large and small *heiau*, sporting areas, and burial clusters, are present continuously farther inland than the usual 200 meters for the shoreline habitation portion of the *kula*. Consequently, a variety of non-agricultural features are present in the *kula* near royal centers.

The *kalu‘ulu* zone above 150 m amsl is a wetter region above the *kula* where bread fruit and other arboreal crops were cultivated (Kelly 1983). Sweet potatoes (*Ipomoea batatas*), *ti*, (*Cordyline fruticosa*) *wauke* (*Broussonetia papyrifera*), *taro* (*Colocasia esculenta*), and sugar cane (*Saccharum* sp.), planted among the arboreal

crops, were mulched with grass (Menzies1920:75-76). The current project area is in the *kalu'ulu* zone.

Above the *kalu'ulu* zone, in the *'apa'a* zone, fields with low stone walls were cultivated with bananas, sweet potatoes, *taro*, *wauke*, melons, *ti* and sugar cane. The *'apa'a* zone was notable for fresh water springs. Above the *'apa'a* zone was the *'ama'u* zone where walled fields were created to grow plantains and bananas. Timber from various tree species was collected from the *'apa'a* zone and the *'ama'u* zone. Bird catching and other forest resources extraction activities were conducted in these upper two zones. Temporary habitations were constructed to be used seasonally when working in the uplands.

In the region, people initially moved into coastal settings *and* more upland settings (*e.g.,* the '*āpa'a* agronomic zone) at the same time, essentially ignoring the drier intermediate zone (except, of course, as a throughway between their gardens and the sea). In this way, the first settlers could immediately plant seedlings in the wetter uplands, knowing the crops would succeed. Permanent settlement would have first been restricted to the coast, but the same people would have also been occupying the uplands (at least temporarily) as well. It is only later that the 'intermediate zone'(and the *kalu'ulu* agronomic zone), would have been utilized for planting.

POST-CONTACT ERA

The extensive features of the Kona Field System were exploited and altered during the post-contact era. Walls, *kua'iwi*, springs, and pathways created generations earlier were used and planted with alien cultigens (coffee, cotton, sugar, citrus, and sisal) and ultimately used as pastures for cattle.

Ranching has its roots in the first cattle and sheep brought to the island in 1793 and 1794 by Vancouver. Two cows, three bulls, five ewes, and five rams were released to prosper in the region of Kealakekua in 1794 (Vancouver 1967:(3)11). Kamehameha placed a ten-year *kapu* on the killing of cattle so that they would have the opportunity to multiply. A 486-acre stone corral was built in the uplands of Lehu'ula-Honua'ino, above Kāināliu where they were raised (Bowser 1880, cited in Maly and Maly 2001:285).

Two American captains, William Shaler and Richard Cleveland presented two horses to John Young in 1803. Cleveland later returned with more than 200 horses

brought from California. Donkeys, mules and oxen were also imported for transportation and hauling. Goats were also brought to the island and left to multiply in the wild.

By 1813 to 1815 cows began overrunning agricultural fields and became a danger to travelers and residents (Ellis 1963: 291; Wilkes 1970: 204). A number of walls were commissioned to keep feral sheep, goats, and cattle out of agricultural areas and away from homes. By 1848, in Kona District a Great Wall (the Kuakini Wall) was constructed from Lanihau to ʻŌnouli (Maly and Maly 2001:286).

In 1830 Governor Kuakini moved to oversee and improve government cattle by constructing corrals. Liholiho visited the same year to witness strides made in the nascent cattle ranching industry. It was hoped that the exportation of tallow, hides, and salted beef would supplant the defunct Sandalwood trade as a major source of income. Several ventures related to ranching, including tallow making, tanning, saddle making, and blacksmithing were initiated (Bergin 2004: 156). Cowhide was tanned using the astringent bark of local trees (Wilkes 1970: 218). The lion's share of commercial enterprises on the island involved supplying whaling ships and the local market with beef.

The changing subsistence and trade regimes developed by incoming European and American settlers, as well as other historical factors, caused a depopulation of the coastal areas of Kona. Ranches were established at middle and upper elevations, and farms were established in the uplands where rainfall was higher and the temperatures were cooler. Cattle ranching and clearing for sugar cane and coffee removed many of the endemic species of plants. The suite of vegetation that existed prior to the pre-Contact era were replaced by *koa haole* (*Leucaen*a *leucocephala*), kiawe (*Prosopis pallida*), and other newly introduced invasive plant species.

Schools, churches, stores, and other businesses were also established in the uplands. During the late 1800s and early 1900s, coastal Kona was no longer the densely populated sociopolitical center it once was. It became a small cluster of houses along the trail from Kailua Bay to Keauhou (Tomonari-Tuggle 1993:15). Homesteads, ranches, and plantations developed in the uplands during this period as reflected in the pattern of Land Commission Awards (LCA) and Land Grants (LG) recorded during the Māhele.

THE MĀHELE

With the coming of the Great Māhele (1848), the Alien Land Ownership Act (1850) and the Kuleana Act (1850), the traditional Hawaiian archetype of land-use was essentially deconstructed and replaced with the European concept of fee-simple land ownership. Article IV of the Board of Commissioners to Quiet Land Titles was passed in December 1845 and began the legal process of private land ownership. Through the Māhele of 1847-48 the Alien Land Ownership Act of 1850 and the Kuleana Act of 1850, land was made available for private ownership.

The Māhele established a board of five commissioners to oversee land claims and to issue patents and leases for valid claims. Kauikeaouli (Kamehameha III) established and ratified laws to protect Hawaiian crown lands as foreigners began claiming ownership of land they were granted permission to use for homes and business interests (Daws 1968:111; Kameʻeleihiwa 1992: 169-70, 176; Kelly 1983: 45; Kuykendall 1938(1): 145 footnote 47, 152, 165-6, 170;). Among other things, foreigners were demanding private ownership of land to secure their island investments (Kameʻeleihiwa 1992: 178; Kuykendall 1938(1): 138, 145, 178, 184, 202, 206, 271).

Under the Māhele and subsequent acts (the Kuleana Act of 1850 and the Alien Land Ownership Act of 1850), the lands of the kingdom of Hawaiʻi were divided among the king (crown lands), the *aliʻi* and *konohiki*, and the government. Once lands were thus divided and private ownership was instituted, the *makaʻāinana* (commoners), if they had been made aware of the procedures, were able to claim the plots on which they had been cultivating and living as stipulated in the Kuleana Act (1850). These claims, however, could not include any previously cultivated or presently fallow land, *okipuʻu*, stream fisheries, or many other resources traditionally necessary for survival (Kameʻeleihiwa 1992:295; Kelly 1983:45-76; Kirch and Sahlins 1992 vol.1:3, 135-137, and vol.2:2).

The right of claimants to land was based on the written testimony of at least two witnesses who could corroborate the claimant's long-standing occupation and use of the parcel(s) in question. The claimant might have been awarded a patent for the property, subsequently called Land Commission Awards (LCAs) (Chinen 1961:16).

The Land Commission awarded the majority of Hōlualoa 1st and 2nd Ahupuaʻa to Victoria Kamāmalu Kaʻahumanu IV, *Kahina Nui* of Hawaiʻi Island and Crown Princess of Hawaiʻi as Land Commission Award (LCA) Number 7713, ʻApana 43 (Figure 6).

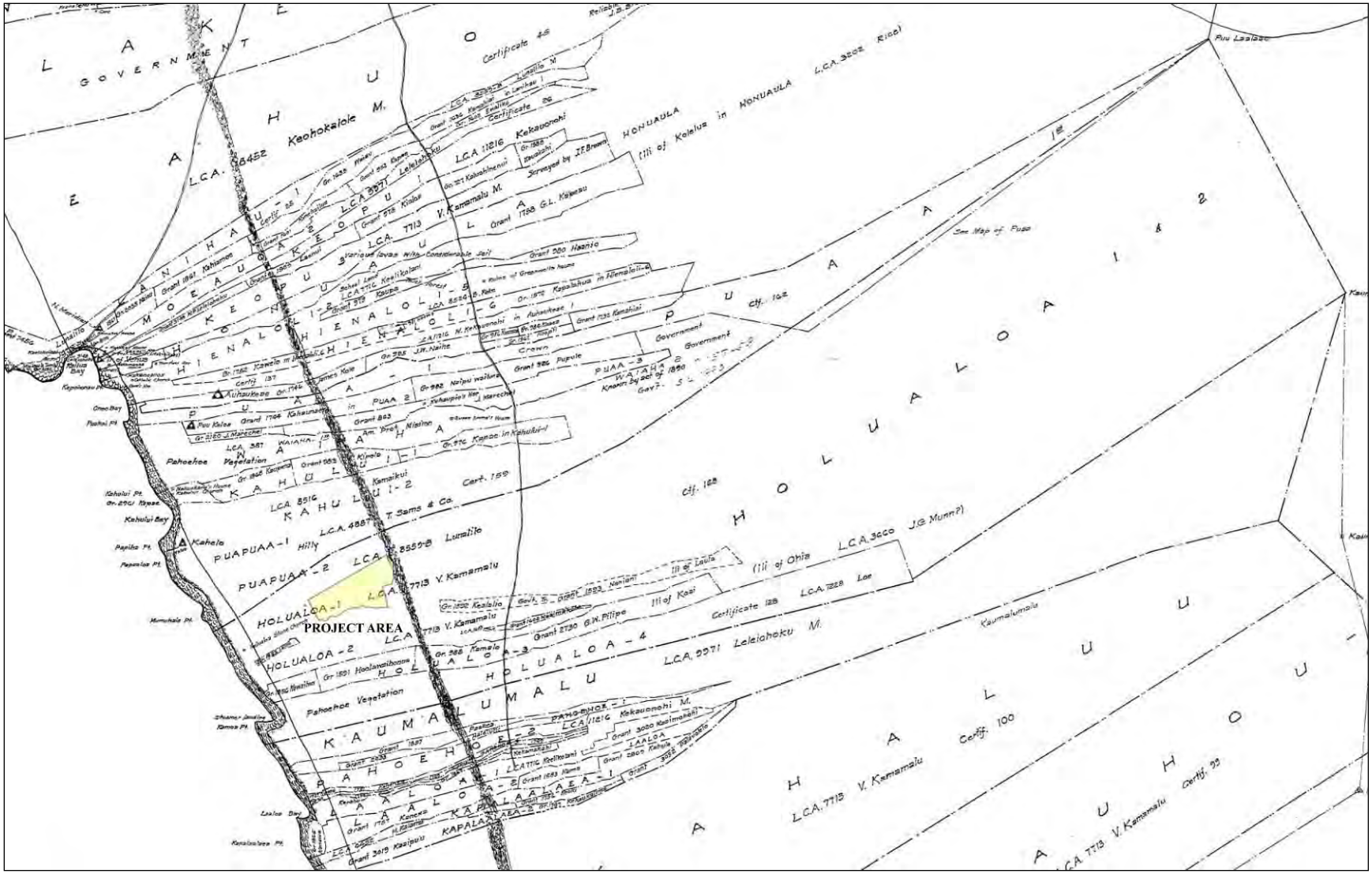

Figure 6: Portion of Kailua Section, North Kona Map Showing Location of LCA 7713 and Project Area in Red Border (Aki 1952).

Several smaller LCA and Land Grant (LG) properties were also recorded in the upland region of Hōlualoa 1st and 2nd Ahupuaʻa (Figure 7). Twenty four Land Commission awards were recorded in Hōlualoa 1st Ahupuaʻa, the ahupuaʻa where the project area is located (see Figure 7 and Table 2).

Table 2: Land Commission Awards Recorded in Hōlualoa 1st and 2nd Ahupuaʻa.

LCA#	AWARDED TO	AHUPUAʻA	ACRES
3660	John G. Munn	Hōlualoa 1st	111.5
4395	Kekoi	Hōlualoa 1st	1.7
5552	Kauila	Hōlualoa 1st	1.9
5554	Keawekolohe	Hōlualoa 1st	11.27
5795	Keliikanakaole	Hōlualoa 2nd	2.2
5810	Kaopukauila	Hōlualoa 1st	1.74
5993	Leipalapala	Hōlualoa 2nd	2.0
6063	Hāna	Hōlualoa 1st	2.9
6107	Naai	Hōlualoa 1st	3.94
7339	Kuaana	Hōlualoa 1st	4.15
7340	Kama 2	Hōlualoa 1st	2.5
7340:B	Kama 1	Hōlualoa 1st	1.3
7443	Kalimapaa	Hōlualoa 1st	1.94
7713	Kamamalu	Hōlualoa 1st & Hōlualoa 2nd	Large
7746	Kamahalo	Hōlualoa 1st	5.0
7794	Kauakini	Hōlualoa 1st	1.8
7990	Pupuka	Hōlualoa 1st	1.1
8015	Aipo	Hōlualoa 2nd	1.4
8151	Hehena	Hōlualoa 1st	2.3
8223	Ikaiaka	Hōlualoa 1st	3.5
9915	Limahana	Hōlualoa 1st	2.42
9932	Lumaawe	Hōlualoa 1st	2.98
10770	Puuone	Hōlualoa 1st	3.06
10400	Naaimakaohi	Hōlualoa 1st & Hōlualoa 2nd	3.5

A portion of LCA #3660 to John G. Munn makes up a thin strip of land located through the center of the current project area. With the notable exception of LCA #3660 and a few other large LCAs, the average award was 2.8 acres, most (n=16) were for less than 3.0 acres. Three Land Grants (LG #1592, 1602, and 3630) were also recorded in Hōlualoa 1st and 2nd Ahupuaʻa. LG #1592 was a 25.0-acre parcel sold to Kealalio and LG #3630 was a 38.2-acre parcel sold to W.H. Cromwell. Almost all of the awards and grants were used as subsistence and commercial farm land, and some were used to pasture cattle (Escott and Escott 2018).

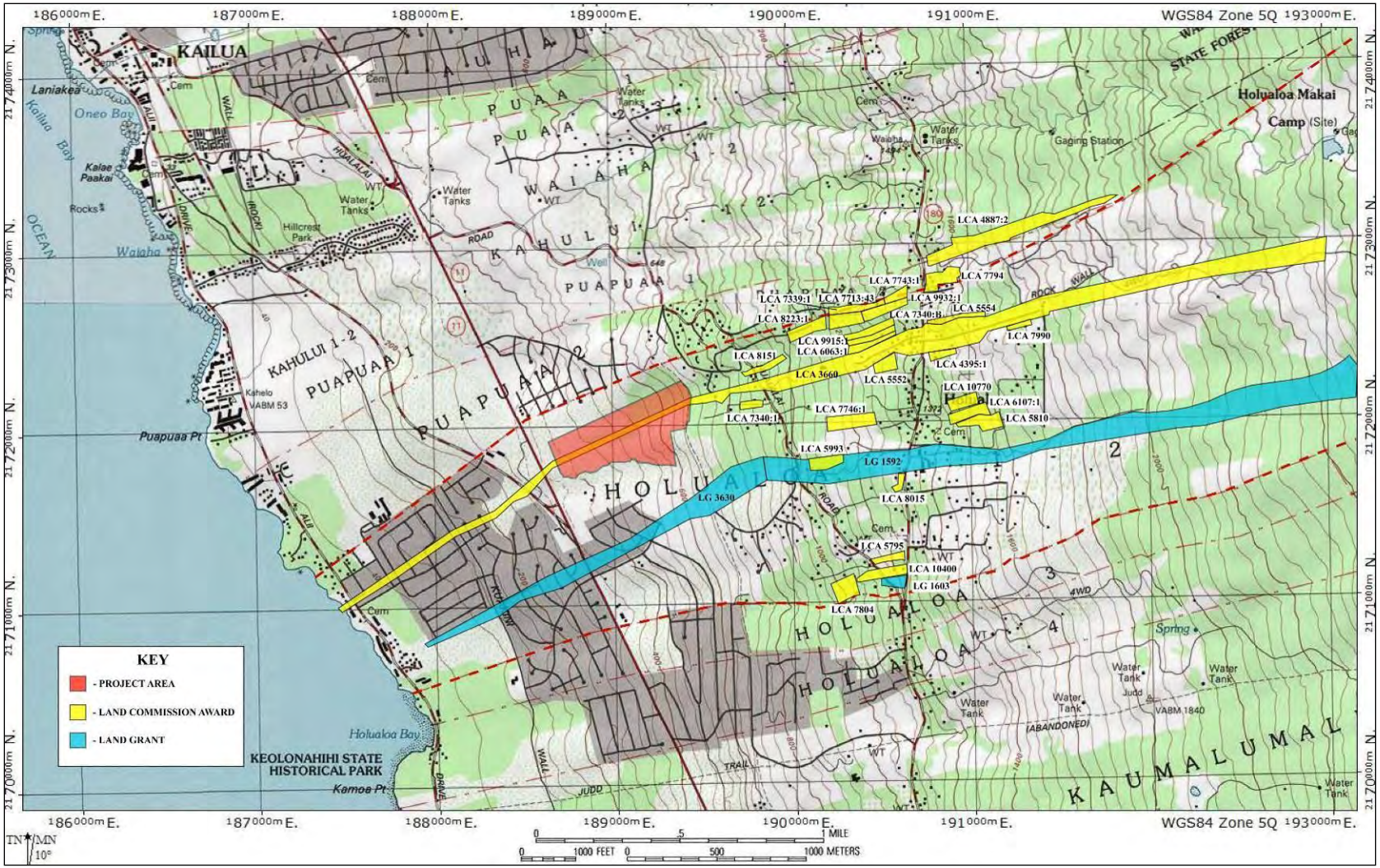

Figure 7: 7.5-Minute Series USGS Topographic Map Showing Location of Land Commission Awards, Land Grants, and the Project Area (National Geographic Topo!, 2003, Kealakekua Quad. Data Sources: National Geographic Society, USGS).

EARLY POST-CONTACT ERA AND HISTORIC ERA

Formal cattle ranching began in the Kona region in the mid-1800s, but wild cattle may have been in the area as early as the late 1700s. The *pā ʻāina* (ʻwalls of the landʼ), native tenantsʼ wall enclosures, were prevalent in the area, as indicated by their inclusion in many local Māhele testimonies. These were used to mark the boundary of properties and to keep livestock out of crop areas (Kuykendall 1957:318 note 76). Later, cattle ranchers built walls to control their cattle.

> In the early 1840s, cattle were said to be "maintained on the *kula*," a mile from the coast where the ground was "covered with herbage" (Wilkes 1845:4, 95). Cattle, introduced to Kona by Vancouver in 1794, became a nuisance later, when their numbers increased. They fed on the grass of the kula and from time to time on the thatch of Hawaiians' homes and on vegetables in their gardens. The open upland fields, bounded only by low earth and stone walls, were in full cultivation in the 1850s [Kelly 1983:76].

Ranchers leased land below the railroad to graze cattle that they owned (Kelly 1983:111). Higher walls were built in the 1920s and 1930s to control animals. According to Joe Gomes, a longtime rancher in the area,

> Walls about 3 ft high can keep donkeys penned. The usual wall is about 4 ½ ft high and keeps cattle in. For goats you need a wall 6 to 8 ft high. For wild pigs you need a 6 to 8 ft-high wall. They climb over lower walls easily. They come down from the mountains for macadamia nuts and also in mango season for mangoes [Kelly 1983:112].

Sugar was a major crop in Hawaiʻi as early as signing of the Reciprocity Treaty in 1876 (Kelly 1983:90). The sugar industry grew rapidly, and by 1899 the only sugar mill in the Kona area was built by the Kona Sugar Company. Many Chinese worked on the sugar plantations (Kelly 1983:111). They built a railroad in 1901 to haul cane from the fields to their mill site along the Waiʻaha stream, north of the current project area. The stream did not provide enough water to mill cane year round and company failed in 1903. The Kona Sugar Company was bought by James Castel in 1906 and was later purchased by Japanese investors. The Kona Sugar Company continued to operate until 1926.

The railroad was bought by Kona Development Company, and was used for freight, sugarcane and by the Hawaiian Lumber Company. Sugar was grown above the railroad line. The cut sugar was delivered to the tracks with the assistance of gravity, by wire cables and flumes. The rail line was seven miles long and extended from Hōlualoa to Keōpuka (Figure 8).

Cotton was grown on lands below the railroad tracks (Kelly 1983:111). Cotton gins were located south of the project area. Cotton was being picked as late as the 1930s. Other plants grown below the tracks in the dryer lands were sisal and tobacco (Kelly 1983:112).

Traditional Hawaiian subsistence practices, including the rights to collect resources from all ecological zones of one's *ahupua'a*, were challenged, restricted, or prevented. As private land owners considered their property off limits to others, cultivation and collection of resources on private land diminished. Individual Hawaiian cultural beliefs, specialized knowledge, and practices associated with the use of the different ecological resource zones also diminished. The development of cattle ranching and commercial crops, such as sugar cane and coffee, removed traditional cultigens and resources from large swaths of the lands of Kona.

The changing subsistence and trade regimes developed by incoming European and American settlers, as well as other historical factors, caused a depopulation of the coastal areas of Kona. Ranches were established at lower elevations and farms were established in the uplands where rainfall was higher and the temperatures were cooler. Schools, churches, stores, and other businesses were also established in the uplands. During the late 1800s and early 1900s, Hōlualoa was no longer the densely populated sociopolitical center it once was. The coastal area of Hōlualoa had become a small cluster of houses along the trail from Kailua Bay to Keauhou.

The project area is just *makai* (west) of the majority of land commission awards and is at the same elevation as portions of the land grants in the region. Based on historic documents, the project area and surrounding lands were likely being used for subsistence and commercial agriculture, as well as for cattle pasture from the mid to late 1800s. The project area might have been used later than surrounding lands because of its steep slopes and very rocky soil, but based on aerial photographs, the project area was bulldozed sometime around the 1950s in preparation for commercial agriculture.

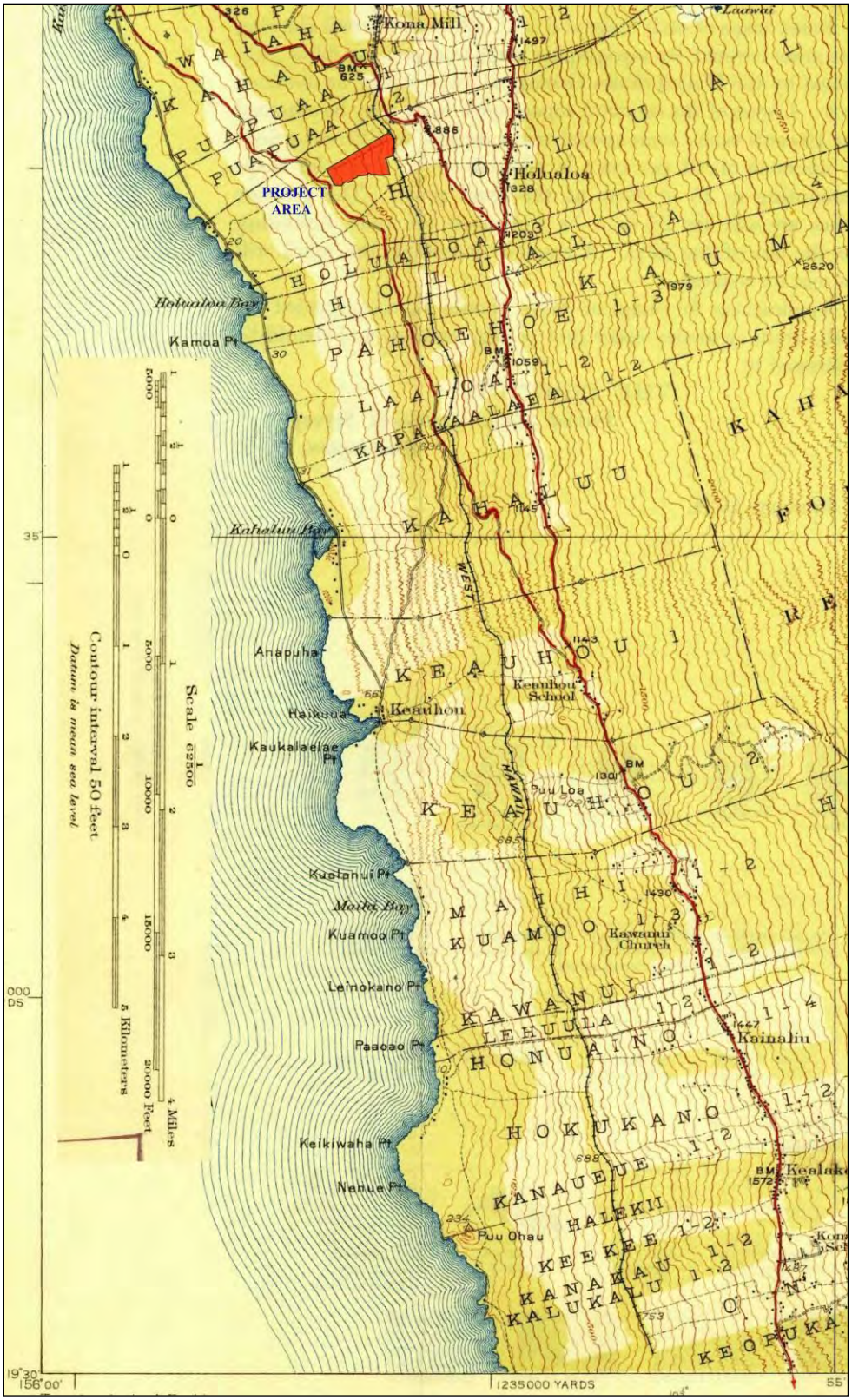

Figure 8: Portion of 15-Minute Series USGS Topographic Map Showing Location of Railroad and Project Area (USGS 1928).

PREVIOUS ARCHAEOLOGICAL STUDIES

There are at least 33 previous archaeological reports for lands near the current project area, including studies in Puapuaʻa 2nd and Hōlualoa 1st, 2nd, and 3rd Ahupuaʻa (Table 4 and Figure 9). The studies were conducted from the coast to roughly 1,460 ft amsl and encompass the *kula* region (0-500 ft), the *kaluʻulu* region (500-1,000 ft), and the lower portions of the *ʻāpaʻa* region (1,000-2,500 ft). Results of the previous archaeological studies are summarized below by elevation: studies numbered 1through 15 in Table 3 and Figure 9 are situated from the coast to Queen Kaʻahumanu Highway (0-360 ft amsl), studies 16 through 21 are located from above the Queen Kaʻahumanu Highway to just below Hualālai Road (306-760 ft amsl), and studies 22 through 24 are above Hualālai Road to just above Māmalahoa Highway (1,100-1,460 ft amsl).

Table 3: Inventory of Previous Archaeological Investigations.

Project Number (Figure 8)	Reference	Type of Study	Area in Acres	Results
1	Landrum et al. 1990	Archaeological Inventory Survey	N/A	46 Sites
1	Calis et al. 2004	Archaeological Data Recovery	N/A	10 Sites
2	Carlson & Rosendahl 1990	Archaeological Inventory Survey	65	64 Sites
3	Haun et al. 1998	Archaeological Inventory Survey	15	31 Sites
4	Hammatt & Folk 1981	Archaeological Survey	20	20 Sites
4	Hammatt et al. 1986	Archaeological Survey & Excavations	20	21 Sites
5	Haun & Henry 2001	Archaeological Data Recovery	1.59	1 Site
6	Escott 2013	Archaeological Inventory Survey	1.962	2 Sites
7	Sinoto 1979	Archaeological Reconnaissance Survey	6	Rock Walls
8	Hammatt 1979b	Archaeological Survey	22	3 Sites
9	Hammatt 1979c	Archaeological Survey	23	39 Sites
10	Conolly & Gunness 1979	Archaeological Reconnaissance Survey	46.8	80 Sites
10	Hammatt 1979a	Archaeological Inventory Survey	46.8	11 Sites
10	Hammatt 1980	Archaeological Survey & Excavation	103	88 Sites
11	Nelson et al. 205	Archaeological Inventory Survey	28	22 Sites
12	Rosendhal 1978	Archaeological Reconnaissance Survey	2.5	1 Site
12	Soehren 1980a	Archaeological	n/a	7 Sites

Project Number (Figure 8)	Reference	Type of Study	Area in Acres	Results
		Reconnaissance Survey		
12	Wolforth et al. 2000	Archaeological Inventory Survey	8	7 Sites
13	Barrera 1995	Archaeological Reconnaissance Survey	17	3 + several ag. mounds
13	Haun & Henry 2000	Archaeological Inventory Survey	17	12 (104 Features, 82 of Which Were Agricultural)
14	Rosendahl 1989	Archaeological Field Inspection	6	Modified Outcrops
15	Schilt 1984	Archaeological Study	17	134 Sites
16	Walker & Rosendahl 1988	Archaeological Reconnaissance Survey	104	67 Sites
16	Graves & Goodfellow 1993	Archaeological Data Recovery	104	58 Sites
16	Maly & Rosendahl 2006	Archaeological Preservation Plan	104	67 Sites
17	Hammatt et al. 1992	Archaeological Survey	174	71 Sites
18	Soehren 1980b	Archaeological Reconnaissance Survey	16	1 Site
19	Rechtman 2006	Archaeological Inventory Survey	1.008	2 Sites
20	Rosendahl 1988	Archaeological Reconnaissance Survey	17	17 Sites
20	Fager & Graves 1993	Archaeological Inventory Survey	17	17 Sites
21	Dircks et al. 2013	Archaeological Inventory Survey	10.266	1 Site (149 Historic to Modern Farming Features)
22	Desilets et al. 2004	Archaeological Inventory Survey	11.7	1 Homestead Features
23	Rechtman 2013		29	24 Sites
24	Clark & Rechtman 2006	Archaeological Inventory Survey	2.7	6 Historic Era Sites
25	Escott & Escott 2018	Archaeological Inventory Surve	5.0	22 Pre-Contact and Historic Era Sites

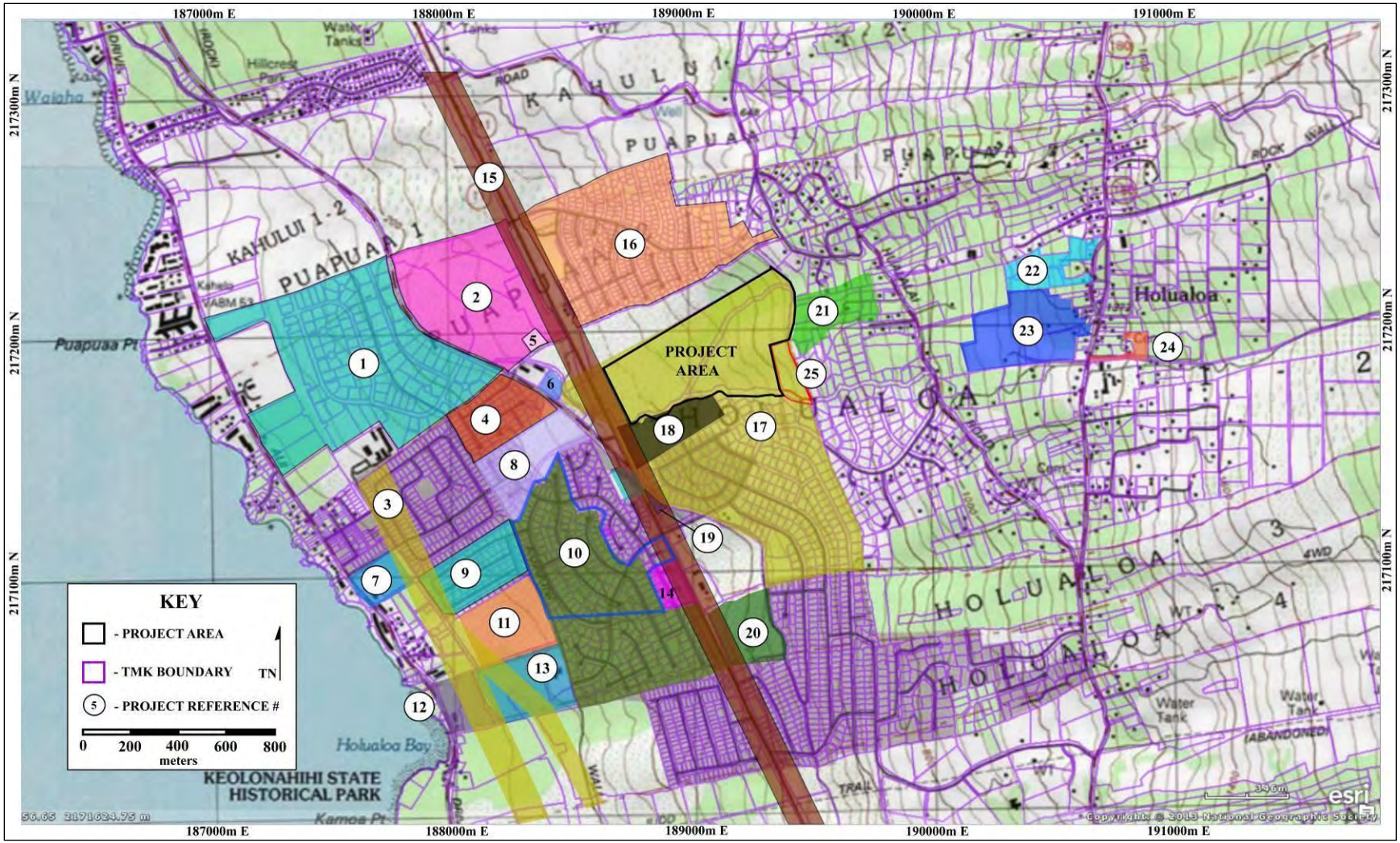

Figure 9: 7.5-Minute Series USGS Topographic Map Showing Location of Previous Archaeological Studies and Project Area (Kealakekua Quad, ESRI, 2013. Data Sources: National Geographic Society, USGS).

REGIONAL PREVIOUS ARCHAEOLOGICAL STUDIES

1. Landrum et al. 1990, and Calis et al. 2004. PHRI, Inc. conducted an archaeological inventory survey (Landrum et al. 1990) and SCS, Inc. conducted data recovery investigations (Calis et al. 2004) at the Kahakai development project. The project area is located within the lower elevations of Puapuaʻa 2nd Ahupuaʻa. Pre-Contact era to early post-Contact era cave shelters, agricultural rock clearing mounds, burials, shrines, and a possible heiau were identified during the AIS study. A heiau complex, several burials, and five permanent habitation sites were recommended for preservation. All of the preservation sites are near the coast.

2. Carleson and Rosendahl 1990. PHRI, Inc. conducted an archaeological inventory survey of 65 acres between Kuakini and Queen Kaʻahumanu highways in Puapuaʻa 2nd Ahupuaʻa. Their study recorded 64 archaeological sites including pre-Contact era habitation, agricultural, and burial sites. Seven sites were assessed as significant and recommended for preservation (Carleson and Rosendahl 1990: 34).

3. Haun et al. 1998. PHRI, Inc. conducted an archaeological inventory survey of the proposed Aliʻi Drive corridor through several ahupuaʻa. Numerous pre-Contact era site complexes were recorded in Puapuaʻa 2nd and Hōlualoa 1st through 4th Ahupuaʻa. The site complexes included a large number of agricultural features, as well as habitation, burial, and ceremonial features.

4. Hammatt and Folk 1981, and Hammatt et al. 1986. Two archaeological surveys were conducted on a 20-acre parcel of below Kuakini Highway. The first study recorded 20 sites, and the second recorded 21 sites. None of the sites were recommended for preservation (Hammatt and Folk 1981: ii, and Hammatt et al. 1986: 87). The report also recommended that the single documented burial be relocated.

5. Haun & Henry 2001. Haun and Associates conducted an archaeological data recovery study at a c-shaped enclosure located on 1.59 acres of land below Queen Kaʻahumanu Highway

6. Escott 2013. SCS conducted an archaeological study on1.962 acres of land near the intersection of Kuakini and Queen Kaʻahumanu highways. Two historic era ranch walls were recorded during the study.

7. Sinoto 1979. Aki Sinoto recorded several Historic era ranch rock walls on a six acre parcel of land just mauka of Ali‘i Drive.

8. Hammatt 1979b. The Archaeological Research Center, Inc. conducted an archaeological survey of 22 acres just south of Kuakini Highway. Three archaeological sites were recorded during the study. None of the sites were recommended for preservation (Hammatt 1979b: ii, and 10).

9. Hammatt 1979c. The Archaeological Research Center, Inc. conducted an archaeological survey of 23 acres located in the near coastal portion of Hōlualoa 1st and 2nd Ahupua‘a. Thirty nine archaeological sites were recorded during the study. The report recommended that all burials, including a known cemetery site be relocated (Hammatt 1979a: 5). None of the remaining sites (pre-Contact era habitation and agriculture sites) were recommended for preservation in place.

10. Conolly and Gunness 1979, and Hammatt 1979a and 1980. The Archaeological Research Center, Inc. conducted an archaeological survey of 103 acres within the near coastal portions of Hōlualoa 1st through 4th Ahupua‘a (Hammatt 1980). One hundred and thirty six archaeological sites were recorded on the project area, including pre-Contact era habitation, agriculture, burial, and ceremonial sites. The Hammatt report recommended that a heiau (Site 6661) was significant and should be preserved in place (Hammatt 1980: 4). The report also recommended that the single documented burial be relocated to the perimeter of heiau (Site 6661) and preserved. No other sites were recommended for preservation.

11. Nelson et al. 2005. An archaeological inventory survey was conducted by Rechtman Consulting on 28.0 acres located in the near coastal portion of Hōlualoa 2nd Ahupua‘a. A total of 22 sites containing 150 features were recorded. The sites were primarily pre-Contact era agricultural and habitation sites, though five burial sites, a possible heiau, and a trail were also documented within the project area.

12. Rosendahl 1978, Soehren 1980a, Wolforth et al. 2000. PHRI conducted an archaeological inventory survey of eight acres of coastal Hōlualoa 3rd Ahupua‘a and recorded seven archaeological sites including three Historic era rock walls, three residential sites, and Hikapaia Heiau.

13. Barrera 1995, Haun & Henry 2000. Barrera (1995) recorded a possible burial platform, two habitation site, agricultural rock clearing mounds and modified outcrops during a reconnaissance survey of 17 acres in near coastal Hōlualoa 2nd Ahupuaʻa. Haun and Associates conducted an archaeological inventory survey of the property and recorded 12 sites with 104 features (Haun and Henry 2000:14). The majority of features (n=82) were pre-Contact era agricultural rock clearing mounds. Eleven permanent habitation and one temporary habitation feature were also recorded during the study.

14. Rosendahl 1989. PHRI conducted an archaeological field inspection of 6.0 acres of land just below Queen Kaʻahumanu Highway in Hōlualoa 2nd Ahupuaʻa. Several modified outcrops were recorded in the letter report. There were no other archaeological features identified on the project area.

15. Schilt 1984. The Bishop Museum conducted an archaeological study of the Kuakini Highway Realignment Project located roughly along present day Queen Kaʻahumanu Highway and recorded 39 sites Puapuaʻa 2nd and Hōlualoa 1st and 2nd Ahupuaʻa. Twenty two of the sites were pre-Contact to early post-Contact era agricultural gardens and modified outcrops (rock clearing). There were also traditional habitation platforms and trails, as well as Historic era roads and walls recorded during the study.

16. Walker and Rosendahl 1988, Graves and Goodfellow 1993, and Maly and Rosendahl 2006. An archaeological reconnaissance survey (Walker and Rosendahl 1988), an archaeological data recovery study (Graves and Goodfellow 1993), and an archaeological preservation plan (Maly and Rosendahl 2006) were conducted by PHRI, Inc. for 104 acres in the upland region of Puapuaʻa 2nd Ahupuaʻa. A total of 67 sites were documented within the project area, including traditional (KFS) sites, temporary habitation sites, three burials, and a *heiau*. The archaeological preservation plan recommended that the three burials be relocated to the *heiau* site, and that the *heiau* be preserved as a formal historic preservation area (Maly and Rosendahl 2006).

17. Hammatt et al. 1992. An archaeological survey was conducted by Cultural Surveys Hawaiʻi on 174 acres of land in the upland region of Hōlualoa 1st, 2nd, and 3rd Ahupuaʻa. The project area lands had been heavily bulldozed during the modern era for ranching and agricultural purposes. Despite the bulldozing, seventy one sites were recorded during the study, including temporary habitation features, rock walls, agricultural features, and

three burial sites. Many of the sites were determined to be associated with Historic era ranching and agriculture.

18. Soehren 1980b. Soehren conducted an archaeological reconnaissance survey of 16.0 acres above Queen Ka‘ahumanu Highway in the inland region of Hōlualoa 1st Ahupua‘a (Soehren 1980b). A single enclosure was identified during the survey.

19. Rechtman 2006. An archaeological inventory survey was conducted by Rechtman Consulting, LLC on a roughly one-acre parcel located *makai* of Queen Ka‘ahumanu Highway in Hōlualoa 2nd Ahupua‘a. Two rock walls were recorded on the project area. The report recommended no further work at the wall sites.

20. M. Rosendahl 1988, Fager & Graves 1993. Fager and Graves (1993) conducted an archaeological inventory survey of 17.0 acres just mauka of Queen Ka‘ahumanu Highway in Hōlualoa 3rd Ahupua‘a. Seventeen sites containing 27 pre-Contact to early post-Contact era agricultural features, including rock mounds, modified outcrops, C-shaped enclosures, terraces, walls, and rock enclosures, were recorded.

21. Dircks et al. 2013. Rechtman Consulting conducted an archaeological inventory survey of 10.266 acres of land located between 840 and 920 ft amsl in Hōlualoa 1st and 2nd Ahupua‘a. One Historic era to modern era homestead/agriculture site (Miyose Farm) containing 149 features was recorded during the survey.

22. Desilets et al. 2004. Desilets et al. (2004) conducted an archaeological inventory survey of 11.7 acres of land in the *‘āpa‘a* region of Hōlualoa 1st Ahupua‘a. A single site associated with Historic era and modern era homesteads, commercial agriculture (coffee), and ranching was recorded. Features included rock walls, roads, coffee terraces, and buildings.

23. Rechtman 2013. Rechtman Consulting conducted and archaeological inventory survey of 29 acres of land located in the *‘āpa‘a* region of Hōlualoa 1st Ahupua‘a. Twenty four sites were recorded. The majority of the sites were associated with Historic era and modern era homesteads, commercial agriculture. Features included rock walls, roads, and remnants of structures. A single pre-Contact era to early post-Contact era residential and agricultural site was also recorded.

24. Clark & Rechtman 2006. Rechtman Consulting conducted an archaeological inventory survey of 2.7 acres of land located in the *ʻāpaʻa* region of Hōlualoa 1st Ahupuaʻa. Six sites were recorded, including five ranch walls and an area of coffee terraces.

A number of conclusions can be made from the previous archaeological studies. A primary conclusion is that the majority of habitation features, especially permanent habitation features, are located from the coast to about 360 ft amsl, below the present day Queen Kaʻahumanu Highway. The same is true of ceremonial features, burials, and, to a lesser extent, agricultural features. The density of agricultural features and habitation features, mostly temporary habitation features, in the upland regions between 360 ft amsl and 700 ft amsl is much lower than the site density in the coastal *kula* and lower *kaluʻulu* regions of the KFS. The pre-Contact traditional Hawaiian settlement and agricultural patterns are strongly oriented to the *kula* and lower *kaluʻulu* regions.

Even though cattle ranching and commercial agriculture may have removed some archaeological sites from the ground surface in the *kaluʻulu* region, there appear to be fewer sites than at lower elevations. The majority of sites in the *kaluʻulu* region are KFS agricultural sites including rock clearing mounds, modified outcrops, garden enclosures, and low garden walls. Within the lands of the current project, it is clear that ranching and commercial agricultural practices have removed and damaged many of the pre-Contact era sites from the ground surface (see the Hammatt et al. 1992 summary below). Moreover, many of the sites identified near the current project area are associated with Historic era ranching and commercial agriculture.

A second conclusion is that the establishment of Historic era homesteads, ranches, and commercial agriculture seems to have removed, or obscured, the majority of pre-Contact era sites in the upper *kaluʻulu* and lower *ʻāpaʻa* regions. It might be that pre-Contact uses in these regions did not involve the construction of large or permanent features, as in the lower regions of Kona. It is also likely that Historic era ranching and commercial agriculture in the lower *ʻāpaʻa* region have caused large scale land alterations through the use of bulldozers for pasture and garden. It is possible that traditional features were disassembled to build rock walls and coffee terraces.

25. Escott & Escott 2018. SCS conducted an archaeological inventory survey on a 5.0-acre portion of Parcel 017 (Escott and Escott 2018) and recorded twenty-two new archaeological sites within the project area (Table 4 and Figure 10). Fifteen of the sites are single-feature sites. The remaining seven agricultural sites contained two to seven features. A majority of the sites are agricultural terraces and complexes dating to the pre-Contact era to the Historic era. The agricultural complexes are located in the lower *kalu'ulu* zone, between 600 and 700 feet (182 to 213 meters) amsl.

Three of the ranch walls (Site #50-10-37-30595, #50-10-37-30601, and #50-10-37-3065) are the primary dividers of the five-acre project area. All site numbers in this report are preceded by the numerical prefix #50-10-37, and hereafter only the last five digits of the site number is used.

The Historic era walls have typical characteristics of ranch walls including cobble core fill and bi-faced inward sloping walls toward the top. They are approximately 1.0 meter tall. Site 30602 and 30603 are Historic era ranching and agricultural enclosures constructed along wall Site 30595 and wall Site 30601. These two wall sites are constructed onto the west edge of the Site 30592 railroad berm and post-date the railroad berm.

The northern third of the project area only has two sites (Site 30591 and 30956). Site 30591 is an agricultural complex with six terraces. Portions of the sites were bulldozed in the early Modern era. Both sites date to pre-Contact to early Historic era. The terraces reflect Kona Field System features but are roughly constructed that more closely resemble Historic era commercial agriculture. Site 30956 is a rectangular Historic style hearth.

The middle one third of the project area between wall sites 30595 and is within the bulldozed "terraces" portion of the project area. Site is a pre-Contact era to early post-Contact era lava tube burial. The burial will be preserved in place in accordance with a Burial Site Component of a Preservation Plan. Site 30594 is an agricultural terrace complex that resembles the Kona Field System but is more roughly constructed. Artifacts recovered from subsurface testing at Site 30604 suggest it is a Historic era agricultural terrace.

Table 4: Inventory of Archaeological Sites Identified on the AIS Project Area (Escott and Escott 2018).

Site # *	Site Type	Features	Site Function	Age	Testing
30591	Agricultural Complex	6	Agriculture	Pre-Contact to Historic Era	SP-1, 2, 3
30592	Railroad Bed and Berm	1	Transportation	Historic Era	
30593	Lava Tube Burial	1	Burial	Pre-Contact to Early Post-Contact Era	
30594	Agricultural Complex	6	Agriculture	Pre-Contact to Historic Era	SP-1 & 2
30595	Rock Wall	1	Ranching	Historic Era	
30596	Hearth	1	Food Preparation	Historic Era	TU-1
30597	Rock Wall	1	Ranching	Historic Era	
30598	Rock Wall	1	Agriculture/Ranching	Pre-Contact to Historic Era	
30599	Platform & Enclosure	2	Ranching/Agriculture	Historic Era	SP-1 & 2, TU-1
30600	Terrace	1	Agriculture	Historic Era	SP-1
30601	Rock Wall	1	Ranching	Historic Era	
30602	Enclosure	1	Ranching/Agriculture	Historic Era	SP-1, 2, 3 & 4
30603	Enclosure	4	Ranching/Agriculture	Historic Era	SP-1 & 2
30604	Agricultural Complex	4	Agriculture	Pre-Contact to Historic Era	SP-1
30605	Rock Wall	1	Ranching/Agriculture	Historic Era	
30606	Rock Wall	1	Ranching/Agriculture	Pre-Contact to Historic Era	
30607	Agricultural Complex	7	Agriculture	Pre-Contact to Historic Era	SP-1 to SP-10
30608	Enclosure	1	Structure	Historic Era	
30609	Enclosure	1	Structure	Historic Era	
30610	Terrace	1	Agriculture	Pre-Contact to Historic Era	SP-1
30611	Agricultural Complex	3	Agriculture	Pre-Contact to Historic Era	SP-1, 2, 3
30612	Lava Blister	1	Refuse Dump	Historic Era	

* Site numbers are preceded by the prefix 50-10-37-.

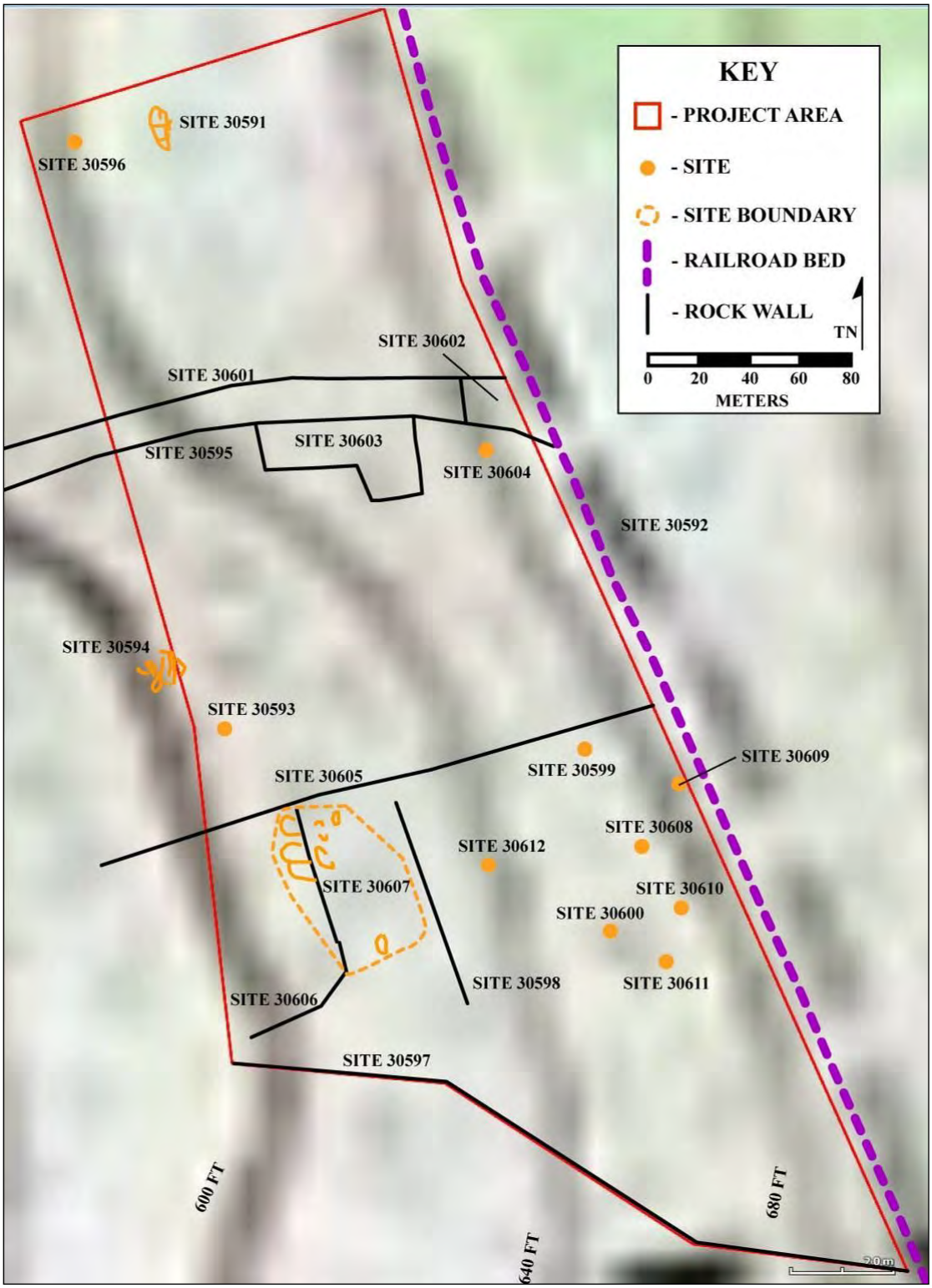

Figure 10: 7.5-Minute Series USGS Topographic Map Showing Locations of Escott and Escott (2018) AIS Project Area Archaeological Sites (ESRI, 2011. Sources: National Geographic Society, USGS. Kealakekua Quadrangle).

The southern third of the project area, south of wall Site 30605, contained six primarily agricultural sites (Site 30598, 30600, 30606, 30607, 30610, and 30611) and four Historic era sites (Site 30599, 30608, 30609, and 30612) with functions other than agriculture. The agricultural features included rock walls (Site 30598 and30606), terraces (Site 30600 and 30610), and agricultural complexes with terraces (Site 30607 and 30610). The non-agricultural features included three enclosures (Site 30599, 30608, and 30609), and a refuse disposal area lava blister (Site 30612). The cluster of these sites indicates their use for Historic era commercial agriculture.

Twenty-nine shovel probes and two excavation units tested the sites. Marine shell fragments, a basalt flake and volcanic-glass flakes recovered during testing indicate that Hawaiians likely used the area for limited agricultural purposes. However, the agricultural terraces more closely resemble the remains of Historic era commercial agriculture.

All 22 sites identified during the current AIS study were assessed significant under criterion "d" as they are likely to yield information important to history. The railroad berm is also significant under criteria "a" and "c" as it is associated with events that have made a significant contribution to the broad patterns of our history and it embodies distinctive characteristics of the type, period, and method of railroad bed construction. The railroad berm was recommended for preservation with preservation measures outlined in an archaeological preservation plan (Escott and Mello 2019b). The rest of the sites require no further work.

The burial is also significant under criterion "e" as it has important value to Hawaiian people and people of other ethnic backgrounds in the state. The burial was recommended for preservation in place with preservation treatments outlined in a Burial Site Component of a Preservation Plan (Escott and Mello 2019a).

CURRENT PROJECT AREA SPECIFIC PREVIOUS ARCHAEOLOGY

Lands of the current AIS study were subject to an AIS study conducted by Hammatt et al. (1992). That study encompassed 66.039 acres of land within the current project area located between 320 to 690 feet (98 to 210 meters) amsl [TMK: (3) 7-6-021:016 and 017] (see Figure 9, Project #17). The current project area is located within the northern portion of the Hammatt et al. (1992) project area.

Twenty one archaeological sites and two areas of bulldozed modern planting "terraces" were recorded in the AIS report (Figure 11 and Table 5). Eight of the 21 archaeological sites (SIHP #50-10-37-10015, #50-10-37-10017, #50-10-37-10018, #50-10-37-10020, #50-10-37-10031, #50-10-37-10033, #50-10-37-10034, and #50-10-37-10049, hereafter abbreviated to the last five digits) were recorded by CSH in tabular format only. Written descriptions of the remaining 13 sites are in the CSH AIS report. Excavations were conducted at ten of the 13 sites. The AIS report included plan view figures for four of the 13 sites. At the request of SHPD, additional site documentation for Sites 10011, 10012, 10031, 10049, and 10071 was submitted to SHPD in a letter report (Hammatt and Shideler 2007).

Six of the sites were determined to be pre-Contact era, four associated with habitation, one with agriculture, and one single feature site (Site 10012) contained two burials. Fifteen of the sites were determined to be Historic era sites, the majority associated with coffee agriculture and cattle ranching. Two Historic era habitation sites were also documented in the AIS study.

The burials at Site 10012 were removed and reinterred off-project prior to 1983 (see Appendix A Reinterment Documentation). The site was further excavated to ensure that all *iwi* had been removed. The site was then back-filled and leveled by bulldozer.

The AIS recommended no further work at all 21 sites documented in the current project area. The Hammatt and Shideler (2007) letter report repeated the AIS recommendation that "all surface sites in the area were documented" in the AIS report and that "significant material from the study area has been recovered and that further investigation would be of minimum productivity" (Hammatt and Shideler 2007:11). However, the authors recommended that the sites should be relocated to document their current conditions and to document the sites to prevailing SHPD AIS standards.

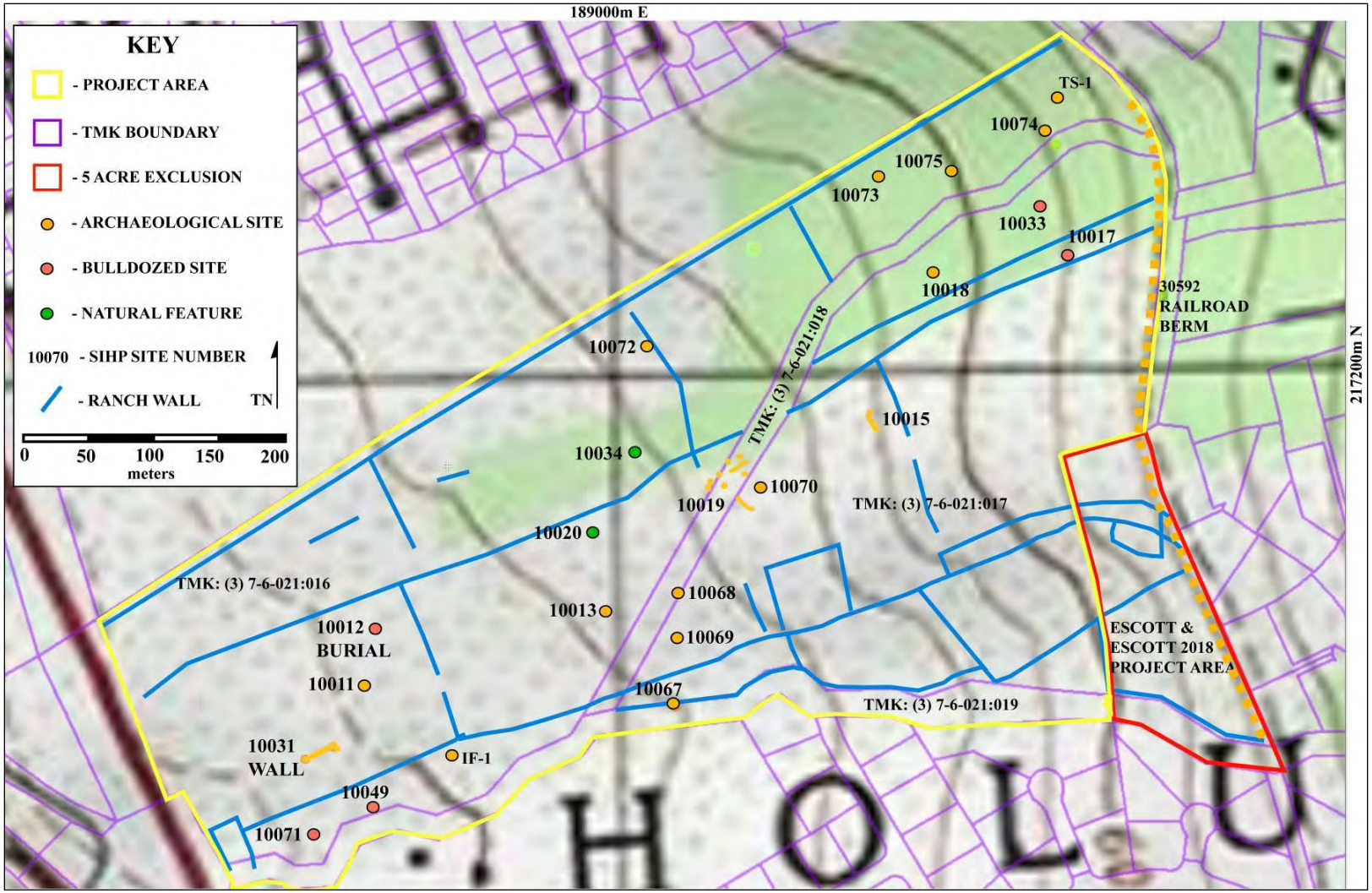

Figure 11: 7.5-Minute Series USGS Topographic Map Showing Location of Northern Portion of Hammatt et al. (1992) Sites and Current Project Area (ESRI, 2011. Sources: National Geographic Society, USGS. Kealakekua Quadrangle).

Table 5: Inventory of Previously Recorded Archaeological Sites (Hammatt et al. 1992; Hammatt and Shideler 2007).

SIHP# *	CSH SITE#	TYPE	FUNCTION	AGE	DOCUMENTATION	EXCAVATION	CULTURAL MATERIAL
10011	9	Platform	Ag. Clearing	Prehistoric	Description & Planview	1.5 m long trench	3 cowrie shells
10012	10	Platform & Wall	Burial	Prehistoric	Description, Planview, & Profiles	Entire Feature	Burial reinterred off-project
10013	11	Enclosure & Lava Tube	Habitation	Prehistoric	Description & Planview	4.5 m square total	Fire features & Prehistoric artifacts
10015	13	Terrace	Road Bed	Historic	Description		
10017	15	Platform	Cattle Ramp	Historic	Tabular		
10018	16	Enclosure	Habitation	Historic	Description		
10019	17	6 Rock Mounds	Ag. Clearing	Historic	Description	3 1.0 m wide trenches	Metal File
10020	18	Platform	Ag. Clearing	Historic	Description		
10031	110	Enclosure Wall	Agriculture	Historic	Description		
10033	112	Planting Complex	Coffee Ag	Historic	Description		
10034	113	Platform	Ag. Clearing	Historic	Description		
10049	216	Terraces	Agriculture	Historic	Description		
10067	232	Terraces	Habitation	Prehistoric	Description	1.0 X 1.0 m	VG & a small amount of midden & fire feature
10068	233	Enclosure	Habitation	Prehistoric	Description & Planview	0.5 X 0.25 m	small amount of midden
10069	234	Modified Bluff/Platform	Habitation	Historic	Description	0.5 X 0.5 m	VG & a small amount of midden
10070	235	U-Shape Enclosure	Agriculture	Historic	Description	1.0 X 0.5 m	No artifacts
10071	237	Platform	Habitation	Prehistoric	Description		
10072	238	Modified Bluff	Ag. Clearing	Historic	Description	7.0 m square total	No arts Small amount of MS in TU-2
10073	239	Platforms & Enclosure	Ranching/Ag.	Historic	Description	1.0 X 1.0	
10074	240	Enclosure	Coffee Work Shed	Historic	Description	1.25 m square total	1 VG, little MS, historic artifacts
10075	241	Enclosure	Pig Pen	Historic	Description, Planview, & Profile		

* Site numbers are preceded by the prefix 50-10-37-.

In a letter to the County of Hawai‘i Department of Planning dated July 30, 2018, (Log. No. 2018.00878 Doc. No. 2018.00878), SHPD requested a new pedestrian survey to identify all archaeological historic properties present on the project area, and to update previous archaeological documentation to include site plans for each site with site boundaries and areas impacted by bulldozing, photographs of all sites and features, an assessment of their integrity, and site significance.

EXPECTED ARCHAEOLOGICAL PATTERNS

Based on previous archaeological studies, geological studies, historical research, interviews, and County Planning Department records it is expected that any archaeological sites remaining on the current project area will be related to traditional pre-Contact era agriculture, temporary habitation, burial practices, and to early post-Contact era and Historic era ranching and agricultural activities.

It is likely that many of the pre-Contact to early post-Contact era sites have been removed or disturbed by Historic era and modern ranching and commercial agriculture. This is especially true because the area around the current project era was used as cattle pasture and coffee farming from the Historic era to the present. Additionally, the project area is in a location that was bulldozed sometime between the 1940s and the 1970s in preparation for a commercial agricultural project, most likely coffee growing. Aerial photos clearly show that bulldozer transects were cut north/south across the entire five-acre project area.

Archaeological sites and features that are likely to remain on the project area will likely include pre-Contact era to early post-Contact era rock clearing mounds, terraces, small enclosures, platforms, and burials. It is also likely that Historic era and modern features related to ranching and agriculture will also be identified on the project area. These include primarily rock walls constructed to confine cattle.

RESULTS OF FIELDWORK

Seventeen of the twenty one previously identified archaeological sites were located during the course of the archaeological inventory survey study (Figure 12 and Table 6). All site numbers in this report are preceded by the numerical prefix #50-10-37, and are abbreviated to the last five digits. Two of the previously documented sites (Site 10020 and Site 10034) relocated by SCS are natural bedrock outcrops and one site former burial site (Site 10012). The burials at Site 10012 were reinterred off-project in 1993.

The four remaining previously documented sites (Sites 10017, 10033, 10049, and 10071) were bulldozed prior to the SCS fieldwork and the remains of the sites are no longer present on the ground surface. Three previously undocumented sites were also recorded, including a portion of the railroad berm (Site 30592), a small coffee shed enclosure (Site 31181), and several ranch walls (Site 31182). A single petroglyph on a loose cobble was recorded as Isolated Find 1 (IF-1).

A total of 21 sites, 17 previously documented and four newly documented, were identified on the project area and are documented in this report. Two of the sites (Site 10020 and Site 10034) were determined to be natural geological features. Six of the sites were determined to be pre-Contact era, three associated with habitation, one with agriculture, a single petroglyph site, and one single feature site (Site 10012) formerly contained two burials. Twelve of the sites were determined to be Historic era sites, the majority associated with coffee agriculture and cattle ranching. Two Historic era habitation sites were also documented in the AIS study. One site (Site 10015) was determined to be a short segment of modern bulldozer road.

The burials at Site 10012 were removed and reinterred off-project prior to 1993 with the approval of the Hawaiian Island Burial Council (HIBC) and SHPD. The site was further excavated to ensure that all *iwi* had been removed. The site was then back-filled and leveled by bulldozer.

The following site summaries include information from the CSH archaeological studies (Hammatt et al. 1992; Hammatt and Shideler 2007) and new information documented during the current AIS resurvey used to updated site documentation.

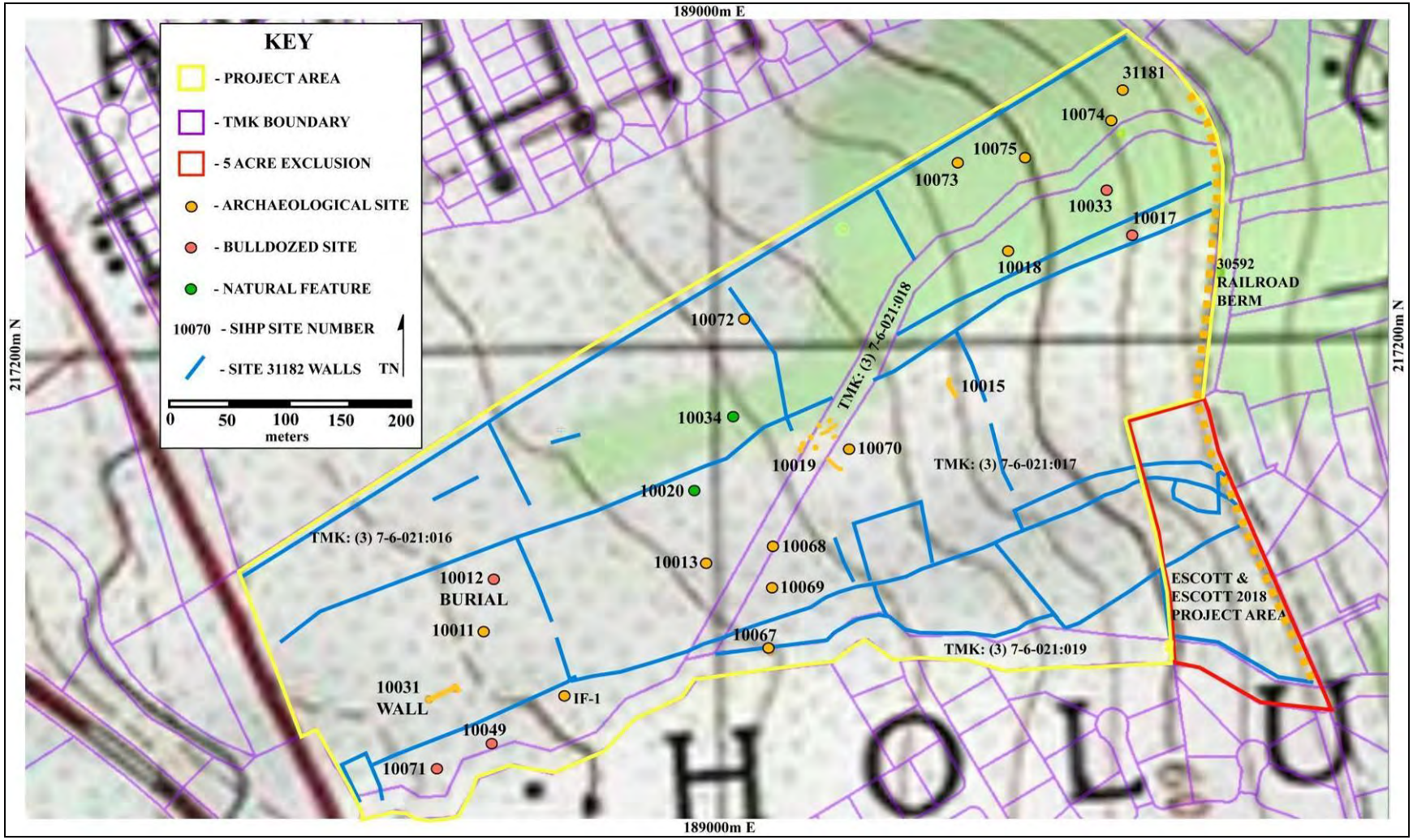

Figure 12: 7.5-Minute Series USGS Topographic Map Showing Location of Archaeological Sites and Project Area (ESRI, 2011. Sources: National Geographic Society, USGS. Kealakekua Quadrangle).

Table 6: Inventory of Hammatt et al. (1992) Archaeological Sites and Current AIS Results.

SIHP#	TYPE	FUNCTION	AGE	DOCUMENTATION	EXCAVATIONS	DISPOSITION
10011	Platform	Ag./Temp Habitation	Pre-Contact	Description, Plan & Photos	1.5 m long trench, TU-1	Recorded
10012	Platform & Wall	Burial	Pre-Contact	Description, Plan, Profiles & Photos	Entire Feature	Removed – No Longer Present
10013	Enclosure & Lava Tube	Habitation	Pre-Contact	Description, Plan & Photos	4.5 m square total	Recorded
10015	Bulldozed Road	Transportation	Modern	Description	N/A	Modern Road Bed
10017	Platform	Cattle Ramp	Historic	Tabular	N/A	Bulldozed – No Longer Present
10018	Enclosure	Agricultural	Historic	Description	N/A	Partially Bulldozed
10019	6 Rock Mounds	Ag. Clearing	Historic	Description	3 1.0 m x 1.0 m trenches	Recorded
10020	Bedrock Outcrop	Geological Feature	Natural	Description	N/A	Natural – Not an Archaeological Site
10031	Enclosure Wall	Agriculture	Historic	Description & Photos	N/A	Recorded
10033	Planting Complex	Coffee Ag	Historic	Description	N/A	Bulldozed – No Longer Present
10034	Bedrock Outcrop	Geological Feature	Natural	Description	N/A	Natural – Not an Archaeological Site
10049	Terraces	Agriculture	Historic	Description	N/A	Bulldozed – No Longer Present
10067	Terraces	Habitation	Pre-Contact	Description, Plan, & Photos	1.0 X 1.0 m	Recorded
10068	Enclosure	Habitation	Pre-Contact	Description, Plan, & Photos	0.5 X 0.25 m	Mostly Bulldozed
10069	Modified Bluff/Platform	Habitation	Historic	Description & Photos	0.5 X 0.5 m	Recorded
10070	U-Shape Enclosure	Agriculture	Historic	Description, Plan & Photos	1.0 X 0.5 m	Recorded
10071	Platform	Habitation	Pre-Contact	Description	N/A	Bulldozed – No Longer Present
10072	Complex	Ag. Clearing	Pre-Contact	Description, Plan & Photos	7.0 m square total	Recorded
10073	Complex	Ranching/Ag.	Historic	Description, Plan & Photos	TU-1 & TU-2	Recorded
10074	Enclosure	Coffee Work Shed	Historic	Description, Plan & Photos	1.25 m square total	Recorded
10075	Enclosure	Pig Pen	Historic	Description, Plan & Photos	-	Recorded
30592	Railroad Berm	Transportation	Historic	Description, Plan & Photos	N/A	Recorded
IF-1	Petroglyph	Marker	Pre-Contact	Description, Plan & Photos	N/A	Recorded
31181	Enclosure	Coffee Work Shed	Historic	Description, Plan & Pho	-	Recorded
31182	Rock Walls	Ranching & Ag.	Historic	Description, Plan & Pho	N/A	Recorded

* Site numbers are preceded by the prefix 50-10-37-.
Orange Shading - Site no longer present.
Green Shading – Natural geological feature. Not an archaeological site.

SIHP 10011	**Platform**
FUNCTION:	Agricultural Rock Clearing/Temporary Habitation
AGE:	Pre-Contact era
DIMENSIONS:	7.50 m in length by 5.0 m wide by 0.86 m in height (max)
CONDITION:	Fair
INTEGRITY:	Altered: retains integrity of location, setting, materials, and workmanship
SURFACE ARTIFACTS:	None
EXCAVATION:	CSH 1.5 m trench, SCS TU-1 2.4 m by 1.2 m

DESCRIPTION: SIHP 10011 is a pre Contact era rectangular stone platform located at 405 ft amsl in the southern portion of the project area (see Figure 12). The platform is approximately 7.50 m by 5.0 m wide, with a maximum height of 0.86 m (Figure 13). The platform is constructed of angular and subangular cobbles and small boulders piled and stacked two to three courses high along the perimeter and filled with large pebbles, cobbles and small boulders (Figure 14 and Figure 15). Portions of the perimeter are very roughly faced (Figure 16 and Figure 17). The top surface of the platform is slightly uneven and is paved with large pebbles, cobbles, and small boulders (see Figure 13 and Figure 15). Portions of the north and west sides have collapsed.

The CSH AIS interpreted that the platform to be a prehistoric agricultural rock clearing mound, based on formal construction and size, though they noted that the feature has formal construction elements suggesting possible use other than an agricultural rock clearing.

CSH EXCAVATION RESULTS: CSH excavated a 1.5 m wide trench through the platform (see Figure 13) and recovered three *cowrie* shell fragments. The form, construction method and location of the feature suggest that the feature could be a temporary habitation platform used periodically during agricultural activities. However, the near absence of cultural material recovered from the CSH excavation suggests the platform is a pre-Contact era rock clearing mound.

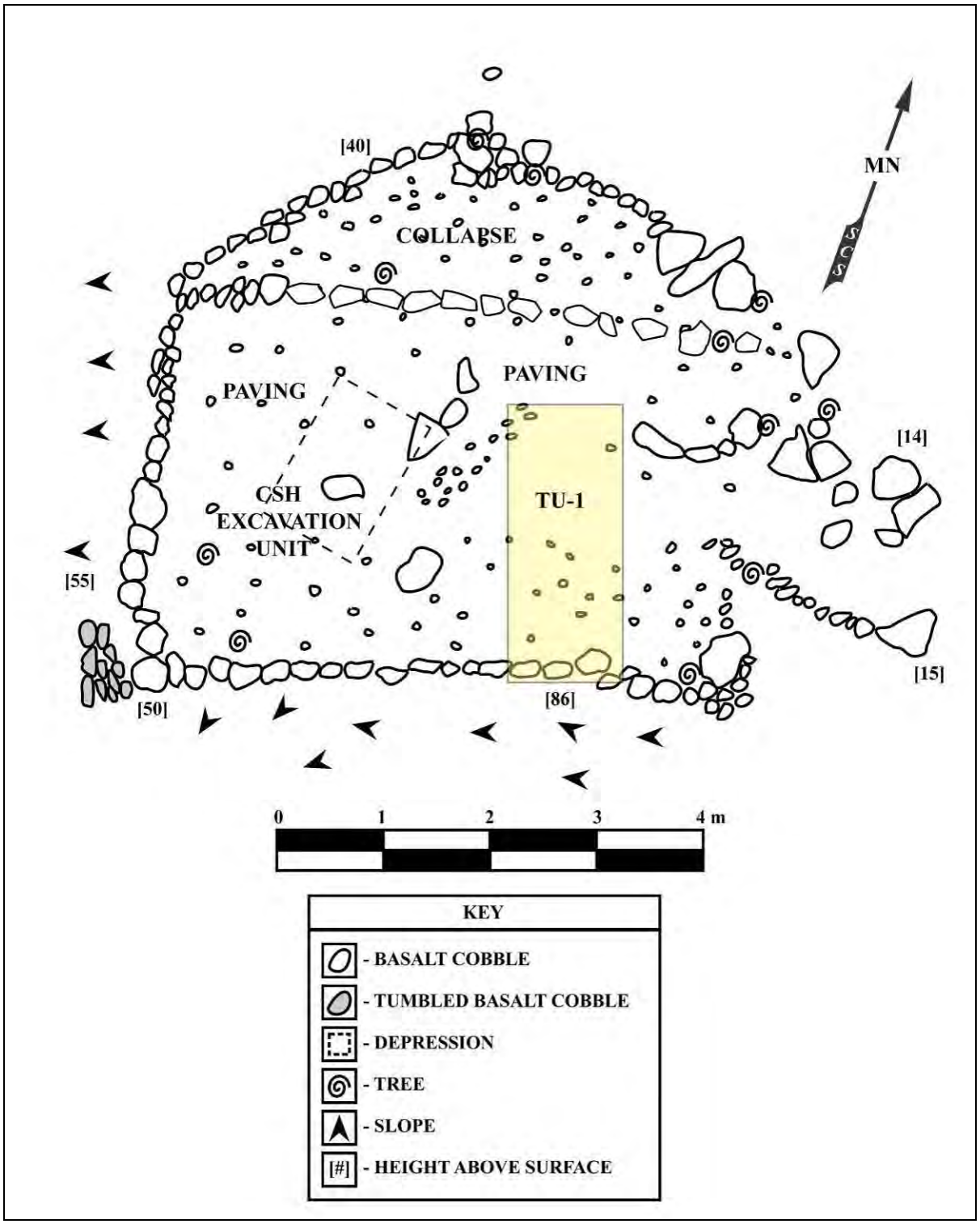

Figure 13: Site 10011 Plan View Map.

Figure 14: Photograph of Site 10011, Looking East.

Figure 15: Photograph of Site 10011 Top Surface, Looking Southwest.

Figure 16: Photograph of Site 10011 South Edge Construction, Looking North.

Figure 17: Photograph of Site 10011 West Edge Construction and Collapse, Looking Northeast.

SCS EXCAVATION RESULTS: SCS excavated a 2.4 m long (N/S) by 1.2 m wide test unit (TU-1) in the southeast quadrant of the platform (see Figure 13). TU-1 was excavated as an architectural layer and three natural stratigraphic layers, and terminated on bedrock (Figure 18 through Figure 20). The natural stratigraphic layers were excavated in arbitrary 10 cm levels.

The Architectural Layer (45 cm maximum thickness) consisted of angular and subangular pebbles, cobbles and small boulders with a small amount of decomposing organic detritus. There were no artifacts, cultural deposits or subsurface features in the architectural layer. The top surface of the architectural layer was a fairly level cobble paving. The architectural layer continued into Layer I and terminated on bedrock approximately 40 cm to 45 cm below the top surface of the feature.

Layer I (0-10 cmbs) was dark brown (10YR3/3) loose sandy silt loam with blocky peds and 40% cobbles, pebbles and small boulders. The rock excavated in Layer I was architectural rock. The architectural layer continued into Layer II below. Layer I terminated on bedrock on the northern half and the southern end of the unit. In the south half of the unit, the base of Layer I terminated on Layer II sediment and was fairly level and clear. There were no artifacts in Layer I.

Layer II (10-26 cmbs) was very dark grayish brown (10YR3/2) soft sandy silt with 30% cobbles and small boulders excavated from the south half of TU-1. The rock excavated in Layer II was architectural rock and fragments of exfoliated bedrock. Layer II was excavated as a 10.0 cm Level 1 and a 6.0 cm Level 2. The bottom portion of Layer II, Level 1 (15-20 cmbs) contained a small amount of charcoal flecking, five small pieces of burnt wood (0.48 grams), a small coral fragment (4.9 g) and two very small fragments of *vana* shell (0.17 g). Layer II, Level 2 did not contain artifacts. Small, thin deposits of very fine Pāhala ash were identified in portions of the base of Layer II. Layer II terminated on bedrock along the southern end of TU-1 and terminated on Layer III sediment near the middle of TU-1. The boundary between Layer II and Layer III was fairly level and clear.

Layer III (26-90 cmbs) was yellowish brown (10YR5/4) loose fine silt with 50% bedrock cobbles excavated near the middle of TU-1. Layer III did not contain artifacts.

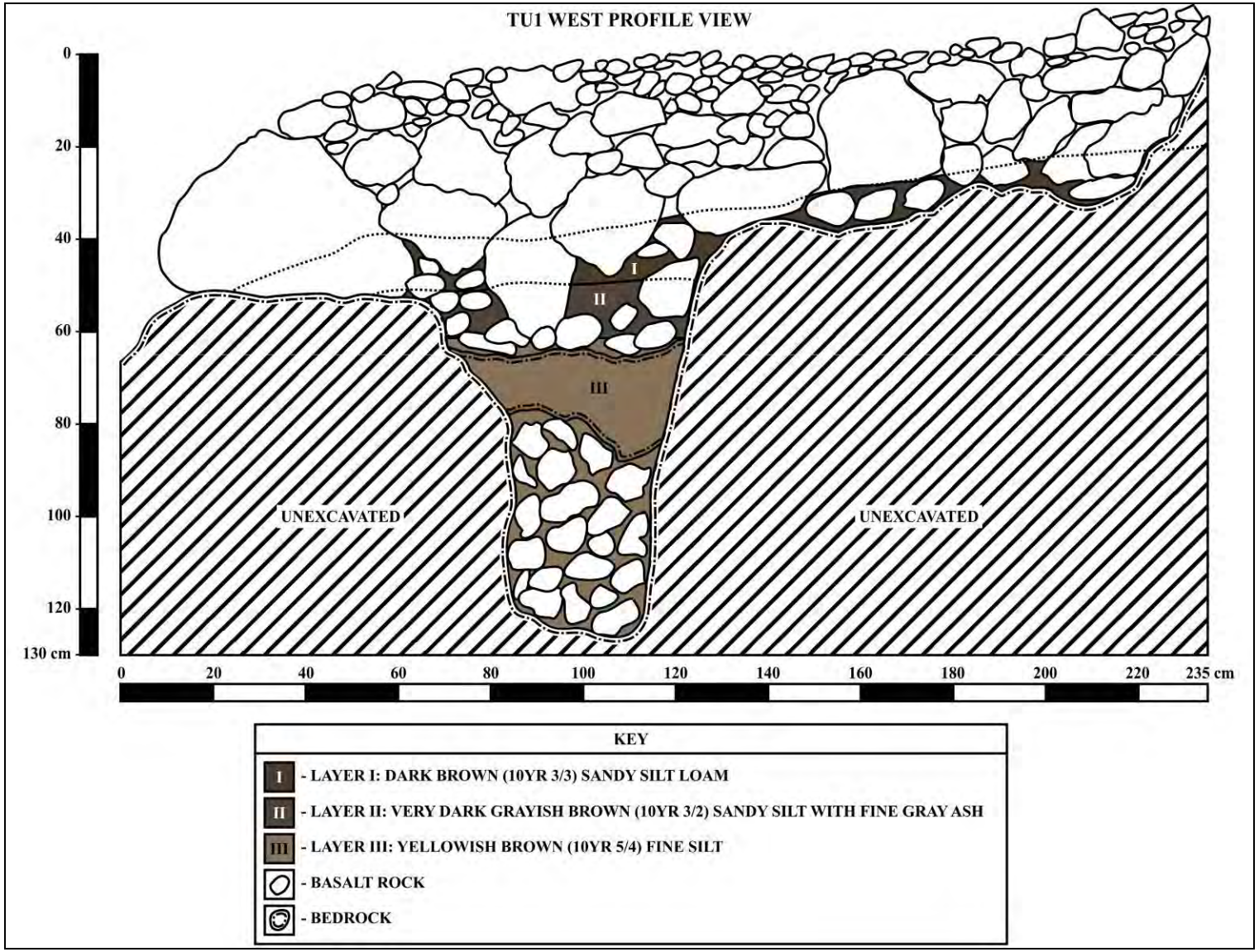

Figure 18: Site 10011 Test Unit 1 West Profile.

Figure 19: Photograph of Site 10011 Test Unit 1 West Profile Looking West.

Figure 20: Photograph of Site 10011 Test Unit 1 Overview Looking Northeast.

Site 10011 was interpreted by CSH as a pre-Contact era agricultural rock clearing mound (ACM) based on the limited amount of cultural material recovered from excavation. TU-1 artifacts recovered during the current AIS study were similar in type and numbers. However, the size and construction of the platform suggest a temporary habitation component. It is possible that the feature was originally constructed by clearing rocks from surrounding agricultural fields and piling them on an exposed bedrock outcrop. However, the completed platform is well constructed with a stacked rock perimeter and level cobble paved surface. The platform is similar to other temporary habitation platforms identified in North Kona.

The small number of artifacts recovered from test excavations suggests the platform had limited use, likely as a location for resting and while conducting seasonal gardening. It is also likely that the platform is a late pre-Contact era, or even early post-Contact era feature that was abandoned soon after completion and use.

The area surrounding Site 10011 has been impacted by grazing cattle and heavy equipment. The platform has been altered by pasture clearing, is partially collapsed and is in fair condition. No further work is recommended at Site 10011.

SIHP 10012	**Former Burial Platform**
FUNCTION:	Burial (Reinterred Elsewhere)
AGE:	Pre Contact era
DIMENSIONS:	26 ft. in long by 12 ft. wide, with a maximum height of 4 ft.
CONDITION:	No longer present
INTEGRITY:	Altered, does not retain integrity
SURFACE ARTIFACTS:	None
EXCAVATION:	Entire feature excavated

DESCRIPTION: SIHP 10012 was an oval shaped platform located at 410 ft amsl approximately 50.0 m north of Site 10011 (see Figure 12). The following description is from Hammatt et al. (1992). The platform was 26 feet long by 12 feet wide with a maximum height of 4 feet (Figure 21). There was no clearly defined level upper surface, paved terrace or rock alignments. The surrounding area was been bulldozed adjacent to the site on all sides except the south side. The site appeared to have been disturbed by this grading and there were rocks bulldozed onto the feature from the north side.

CSH EXCAVATION RESULTS: The upper 2 to 3 feet of rock fill was removed from the mound and a rectangular alignment measuring 12 by 15 feet was exposed. At the base of the rock fill and partially burying the stone alignment was stratum I light brown silt loam containing organic debris containing volcanic glass, bone and coral artifacts, and adze flakes. On the *makai* or west side of the site were two stone cupboards with a corbelled construction. These cupboards measured 2 feet in diameter and the interior spaces were one foot high. They appeared to be contemporaneous with the construction of the rectangular alignment.

After exposing the rectangular alignment and the cupboard, the interior of the rectangular alignment was excavated. Directly underlying Stratum I in the alignment interior and under the cupboards was a second stratum, designated Stratum II. This was a light grey unconsolidated silt loam which contained wood ash and cultural material including stone, shell and bone artifacts and midden. As this stratum was excavated, a 3 foot wide by 5 foot long stone crypt was exposed. The crypt consisted of a rectangular arrangement of squared boulders.

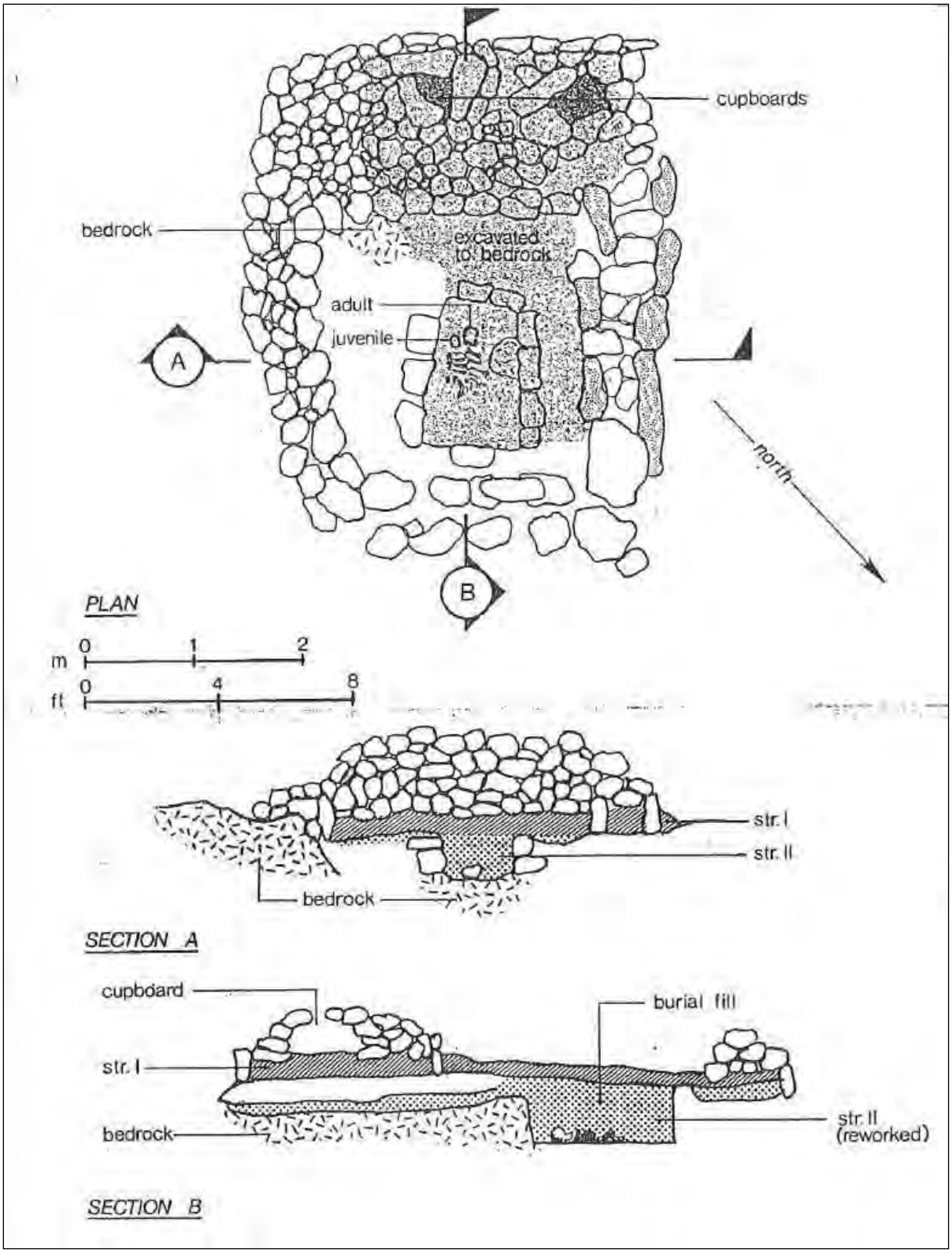

Figure 21: Site 10012 (CSH Site 10) Plan View Map and Excavation Profiles (Hammatt et al. 1992:65).

The crypt fill was removed (Stratum II) and the skeletal remains of two individuals was uncovered at a depth of 2 feet below the top of the crypt and resting directly on bedrock. Two skulls were lying 1 inch apart at the northeast end of the crypt and in both cases were articulated to the vertebrae. The skull on the north side was of an adult female. [Hammatt et al. 1992:64]

The unfused cranial sutures particularly the coronal suture also show a mature but young age. The skull was articulated to the vertebrae and the scapulae, the clavicles and the pelvis were all in articulated position. An examination of the sacrum and hip bone show characteristics of a female. All long bones were absent including tibia, fibulae ulna, radius and humerus. However, the articulated hands and feet had been placed on the pelvis with fingers and toes pointing upwards.

The skeleton of the child immediately to the south was completely articulated and semi flexed. All skeletal parts were present but were in a partially decomposed state. It is clear from the stratigraphic context that both skeletons were buried at the same time. It was not possible to determine the sex of the child. The first molar had partially emerged indicating a child between the age of 4 and 6. There were no anomalies observed in the skeletal parts.

A summary of the stratigraphic events which occurred at the site are as follows:

1. An enclosure was constructed with roughly stacked boulders on 3 sides and a double alignment of vertical slabs on the other.

2. The enclosure was occupied and used for every day work activities and food consumption. This resulted in the deposition of Stratum 11 which includes stone adze fragments and shell and bone artifacts.

3. A stone lined crypt was constructed at the base of the Site and intrusive into the occupation deposits of Stratum ll.

4. Two human skeletons were interred in the crypt, one child (6i~6 years) and one adult female (18-25 years). Before the adult female was interred and while she was still with musculature her long bones were removed and her separated hands and feet were placed on her pelvis.

5. Following the internment of the burial, the crypt was filled and covered with reworked deposits of Stratum ll. The two cupboards were constructed on the *makai* side of the crypt possibly for the purpose of marking the burial site.

6. Stones were piled on the crypt and on the cupboards to create a level living surface and the site was once again occupied resulting in the deposition of Stratum I which filtered through the rock fill.

7. During modern bulldozing of the area around the site rocks were piled on the top and sides giving what was a level platform a mound like appearance.

A radiocarbon sample collected 30-40 cmbs and associated with the burial returned a date of A.D. 1830±50 (Hammatt et al. 1992:107).

The burial platform at Site 10012 was completely excavated and the remains were reinterred off-project (see Appendix A Reinterment Documentation). The excavated site was backfilled and leveled with a bulldozer. The site location was relocated by SCS during the current AIS study. The present ground surface is level bulldozed rock (Figure 22). Site 10012 is no longer present and no further work is recommended.

Figure 22: Photograph of Ground Surface at Former Site 10012, Looking Northwest.

SIHP 10013	**Enclosure & Platforms**
FUNCTION:	Habitation
AGE:	Pre Contact era
DIMENSIONS:	18.3 m long (NW/SE) by 18.3 m wide, 0.9 m max. height
CONDITION:	Poor
INTEGRITY:	Altered: retains integrity of location, setting, materials, and some workmanship
SURFACE ARTIFACTS:	None
EXCAVATION:	CSH excavated seven test-units totaling 4.5 square meters

DESCRIPTION: SIHP 10013 is a roughly square pre-Contact era enclosure and a small modified lava tube located approximately 200 meters northeast of Site 10011 (see Figure 12). As indicated in the CSH AIS report and confirmed by SCS during the current AIS study, the enclosure is nearly square (60 feet long NW/SE by 60 feet wide, exterior dimensions) and is constructed roughly level ground (Figure 23).

The enclosure walls range from five (5) feet wide on the *mauka* side to nearly ten (l0) feet wide on the *makai* side where the outside facing is three (3) feet high relative to the exterior ground surface on the *makai* side of the structure. The enclosure walls were probably higher originally but at present they appear to have been knocked down by previous bulldozing operations. The walls are primarily 30 to 50 cm in height above the modern ground surface (Figure 24 and Figure 25).

The walls are constructed of angular and subangular basalt large cobbles and small boulders stacked and piled two to three courses high on the ground surface. They are roughly faced in places. The northwest corner of the enclosure has been bulldozed.

The enclosure interior (measuring 35 feet *mauka-makai* by 45 feet north-south) was predominantly dirt with a rock platform about 20 feet square situated near the center of the interior. Immediately *mauka* (5 feet) of the northeast corner of the enclosure was a low, boulder platform about 15 feet by 20 feet (see Figure 23). The platform appears to have been run over by a bulldozer and is no longer present. There is a one (1) foot square and one (1) feet deep opening in the east corner of the site (see Figure 23 and Trench 7 excavation description below). [Hammatt et al. 1992:68].

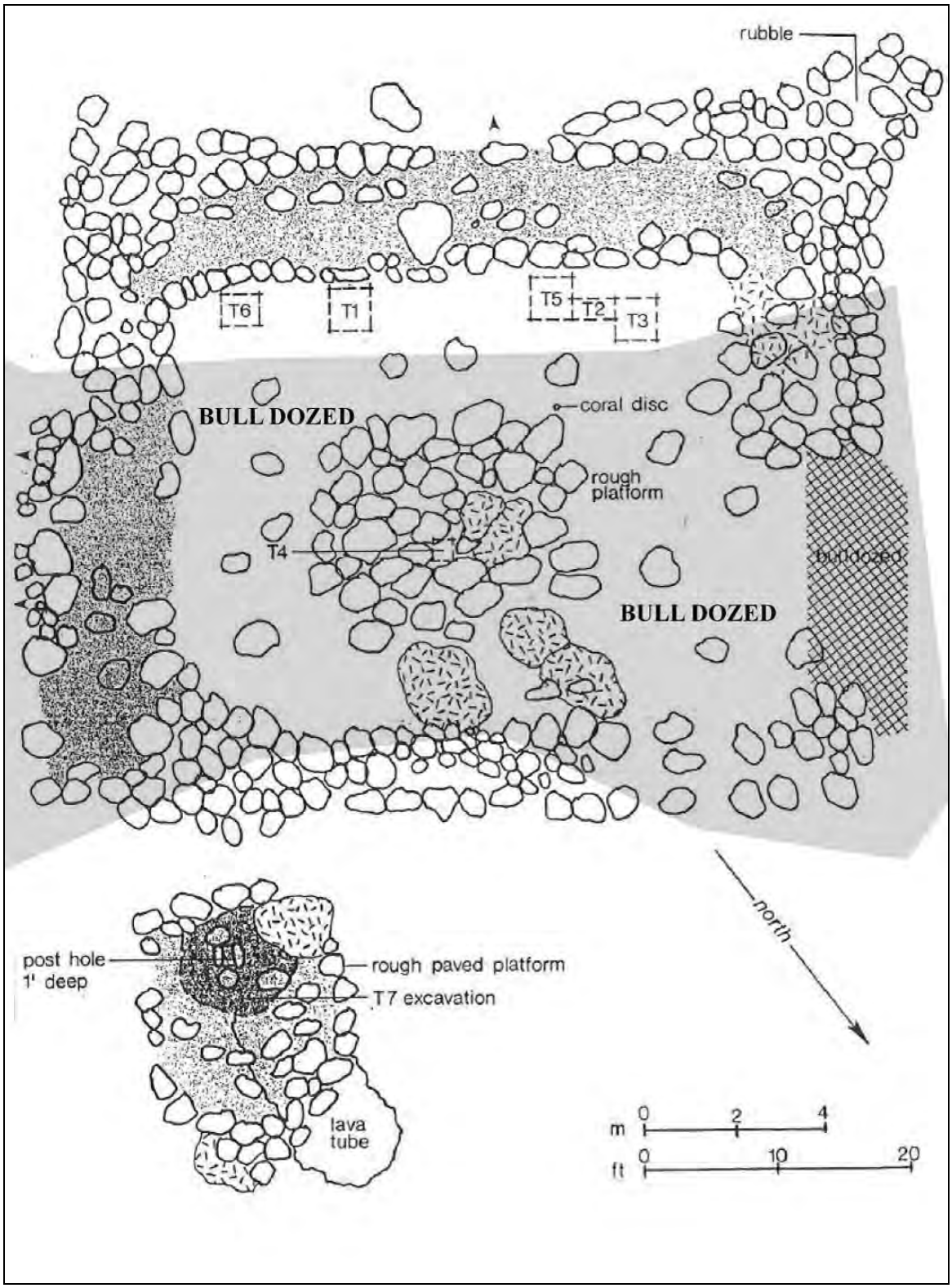

Figure 23: Site 10013 Plan View Map Showing Test Units (Hammatt et al. 1992:69).

Figure 24: Photograph of Site 10013 Enclosure South Corner and West Wall, Looking Northwest.

Figure 25: Photograph of Site 10013 Enclosure South Corner and West Wall, Looking North.

Figure 26: Photograph of Site 10013 Northeast Platform (Left Top Corner) and Tube Opening (Foreground), Looking Northeast.

CSH EXCAVATION RESULTS: Close inspection of the dirt surface in the interior of Site 10013 showed that the *makai* area contained a dark grey to black dirt while in the *mauka* portion the dirt layer was a reddish brown and generally shallow with exposed bedrock. The *makai* portion of the site was chosen for the first excavation on the basis of sediment color (grey to black sediments in sites usually being a good indicator of human activity and potential depth. A total of 4.5 square meters (Trenches l, 2, 3, 5 and 6) were excavated adjacent to the *makai* wall. Trenches l and 6 established the presence of a single cultural layer up to 30 cm. thick overlain by 10 cm. to 20 cm. of modern Al horizon. These two (2) trenches produced six (6) basaltic glass flakes, a polished adze flake and two (2) coral file fragments.

Trenches 2, 3 and 5 adjoin one another and are situated in the northwest corner of the site interior. They defined the limits of a large rock lined hearth area with multiple ash lens contained in it. A substantial amount of midden material was present in the hearth (Refer to Table 8). A total of 33 items listed as artifacts included a one piece bone fish hook fragment, a piece of worked mammal bone, coral file, saw and abrader fragments, *wana* file fragments, polished adze flakes and basaltic glass flakes. Trench 4 was excavated into the platform in the center of the structure. Bedrock was present at a depth of only 20 cm. below the platform surface, that being at the level of the dirt surface of the site in the other trenches. Some midden was present in the gaps in the bedrock and one polished adze flake and one basaltic glass flake were also recovered from trench 4. [Hammatt et al. 1992:68]

A final excavation (Trench 7) was excavated in the platform just *mauka* of the enclosure. This involved removal of rocks to a depth of two (2) meters where a capped off entrance to a lava tube was found. The lava tube five (5) feet wide was accessible for fifteen (15) feet in a mauka direction. It was fully explored and was found to exhibit no signs of human use. A slight flow of cool air through the tube and the absence of cultural material within the tube suggest that its primary function may have been a source of ventilation for the platform built over it. On the basis of size, thickness of the cultural layer, complexity of the structural remains and the variety of cultural items present Site 10013 is a good example of a semi-permanent or permanent occupation site. The two (2) platforms (one inside and one outside of the enclosure) suggest the former presence of pole and thatch structures. The excavations clearly show the primary work area in the site was along the *makai* edge of the enclosure. [Hammatt et al. 1992:71]

Site 10013 has been impacted by heavy equipment prior to and following the CSH AIS study and is in poor condition. The majority of the walls of the enclosure have been impacted by bulldozing although portions of the base of the enclosure walls are visible on the ground surface. No further work is recommended at Site 10013.

SIHP 10015 **Bulldozer Road Segment**
FUNCTION: Transportation
AGE: Modern
DIMENSIONS: 12.0 m long (N/S) by 2.4 m wide
CONDITION: Fair
INTEGRITY: None, not an archaeological site
SURFACE ARTIFACTS: None
EXCAVATION: No
DESCRIPTION: SIHP 10015 is a bulldozer road edge located 560 ft amsl in the center of Parcel 017 (see Figure 12). The site was recorded by CSH as a terrace. SCS relocated the feature and after clearing determined that it is the edge of a bulldozer road cut along a fairly steep slope. The earthen *maka*i edge of the bulldozer road is similar in appearance to an earthen terrace. The feature is not an archaeological site and no further work is recommended.

SIHP 10018 **Enclosure Remnant**
FUNCTION: Agriculture
AGE: Historic Era
DIMENSIONS: 5.0 m long (N/S) by 1.0 m wide by 1.0 m height
CONDITION: Poor
INTEGRITY: Altered: retains integrity of location, setting, materials, and workmanship
SURFACE ARTIFACTS: None
EXCAVATION: No
DESCRIPTION: SIHP 10018 is a the remains of an enclosure located at 580 ft amsl 120 m northeast of Site 10015 (see Figure 12). The site was recorded by CSH as a rectangular enclosure with core-filled walls 0.6 m (2 to 3 feet) high and 3.0 m by 6.0 m (10 by 20 feet) across the interior dimensions. The walls were 1.8 to 2.4 m. (6 to 8 feet) thick and with much collapsed rubble. Based on the enclosure size and construction, and the presence of numerous coffee trees surrounding the enclosure, CSH interpreted the site to be associated with coffee agriculture.

SCS relocated a remnant of the west wall of the enclosure where it is constructed to abut onto the west side of the Site 31182 Feature 3 wall (Figure 27 and Figure 28). The wall segment is roughly 6.0 m long (N/S) by 1.3 m wide and is 1.4 m in maximum height. The wall is constructed of angular and subangular cobbles and small boulders stacked on the ground surface. The wall is roughly bi-faced and is not core-filled. The north end of the wall has been bulldozed and the north and east enclosure walls have been bulldozed and are no longer present.

Site 10018 was likely an Historic era enclosure likely associated with agriculture or ranching. All but a small portion of the enclosure west wall at Site 10018 has been bulldozed. The remaining wall has been altered by ranching and bulldozing and is badly collapsed. The site is in poor condition, contains very little integrity and no further work is recommended.

SIHP 10019	**Rock Clearing Mounds**
FUNCTION:	Agriculture
AGE:	Historic Era
DIMENSIONS:	5.0 m long (N/S) by 1.0 m wide by 1.0 m height
CONDITION:	Poor
INTEGRITY:	Altered: retains integrity of location and setting
SURFACE ARTIFACTS:	None
EXCAVATION:	No

DESCRIPTION: SIHP 10019 is a complex of six rectangular and oval rock mounds (Features A through F) located between 490 and 500 ft amsl 120 m northeast of Site 10013 (see Figure 12). The rock mounds are located around a seasonal gulch and the site is roughly 20.0 m in diameter. The rock mounds are 2.0 to 3.0 meters in diameter and range in height from 0.6 to 0.9 m. The rock mounds are constructed of angular and subangular basalt cobbles and small boulders piled on the ground surface. Several of the rock mounds were constructed by constructing an outside perimeter of slightly larger rocks and then infilling them with slightly smaller rocks. This type of rock clearing mound construction was commonly used in Historic to modern era coffee and sugarcane fields across Hawai‘i Island.

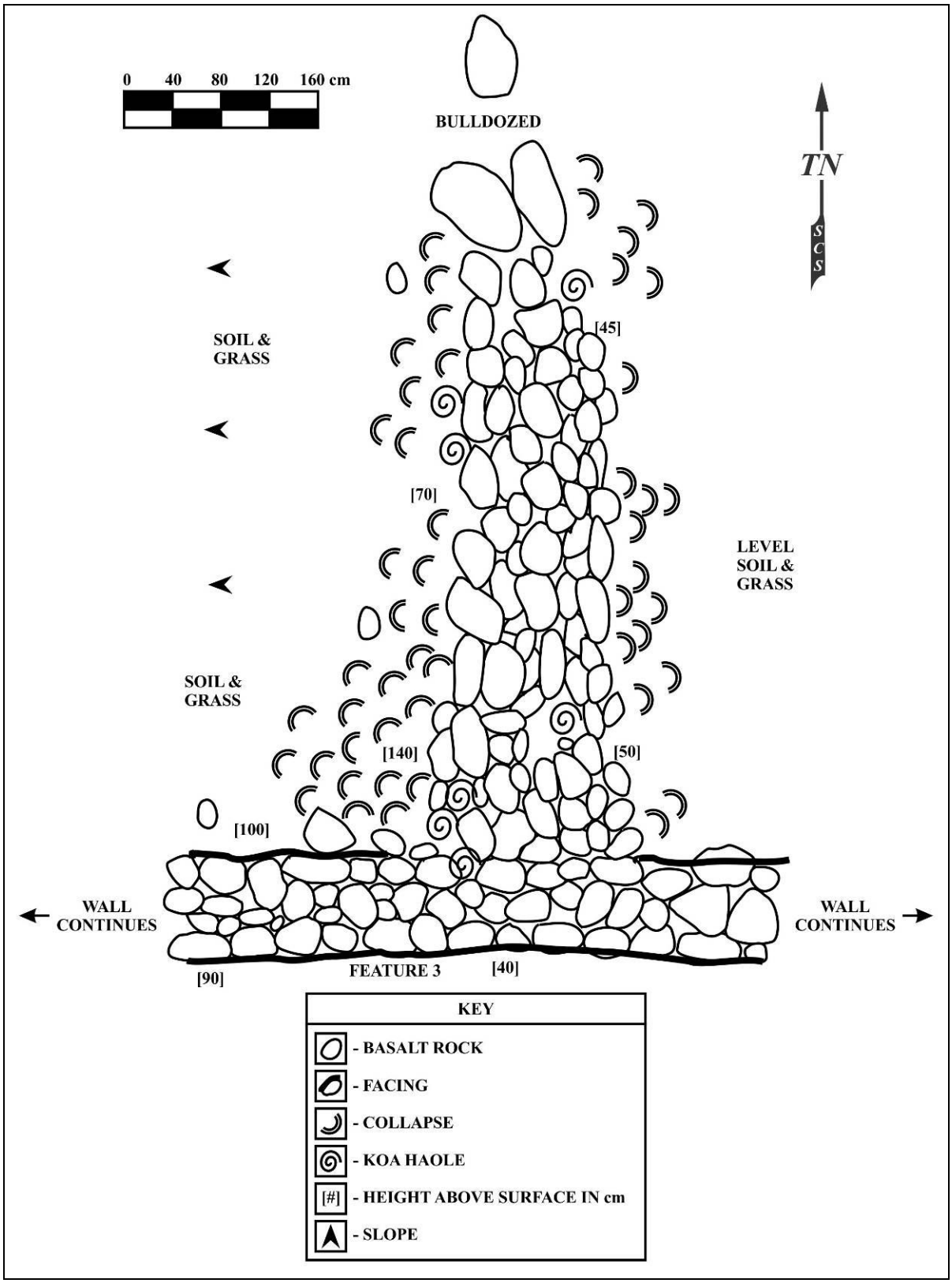

Figure 27: Site 10018 Remnant Enclosure Wall Plan View Map.

Figure 28: Photograph of Site 10018 Enclosure Wall and Site 31181 Feature 3 Ranch Wall Corner Looking Southeast.

CSH EXCAVATION RESULTS: Three of the mounds were cross sectioned by CSH with one meter wide trenches oriented *mauka-makai*. All of the trenches were excavated to bedrock with no midden material or artifacts occurring. However, in the excavation of feature B a rusted metal file was discovered under a large slab at the base of the mound. This find leaves little doubt that this feature is historic in age and this conclusion is applied to all other features in this complex.

Site 10019 was relocated during the current study. The rock mounds are no longer intact and all that remains are scattered concentrations of rocks where the mounds were once located. The rock mounds were either altered by flooding or were knocked over by bulldozing.

The location of the rock mounds adjacent to the stream channel indicates that they are stone agricultural clearing mounds likely constructed by coffee planters (Hammatt et al. 1992:27). Site 10019 has been altered by flooding and bulldozing and is in poor condition. The type, function and age of the rock clearing mounds was determined through feature construction and text excavations, and no further work is recommended for Site 10019.

SIHP 10020	**Bedrock Outcrop**
FUNCTION:	Natural geological feature, not an archaeological site
AGE:	N/A
DIMENSIONS:	2.4 m long by 3.0 m wide
CONDITION:	N/A
INTEGRITY:	N/A
SURFACE ARTIFACTS:	None
EXCAVATION:	No

DESCRIPTION: SIHP 10020 is located at 450 ft amsl approximately 70 m north of Site 10013 (see Figure 12). The site is described in the CSH AIS table as a platform. The area where Site 10020 was plotted on the project map is an area of bulldozed pasture with natural bedrock outcrops and loose rocks. A roughly rectangular pile of natural bedrock boulders was identified at the location of Site 10020. The boulders are naturally occurring bedrock small boulders and cobbles. There is a portion along the west side of the pile that appears to contain bulldozer push from a nearby wall breach. The top of the rock pile is uneven but somewhat level. There is no stacking or facing apparent on the rock pile.

The rock pile is natural, but its roughly rectangular shape and somewhat level top surface make it appear to be a possible archaeological feature. It is likely that CSH added the feature to their pedestrian survey summary table for these reasons. CSH did not include a site description or map of the feature in the AIS report, likely because it was determined to be natural. No further work is recommended at Site 10020.

SIHP 10031	**Enclosure Remnant**
FUNCTION:	Agriculture
AGE:	Historic Era
DIMENSIONS:	12.2 m long (NE/SW) by 2.0 m wide by 0.8 m max. height
CONDITION:	Poor
INTEGRITY:	Altered: retains integrity of location, setting, materials, and workmanship
SURFACE ARTIFACTS:	None
EXCAVATION:	No

DESCRIPTION: SIHP 10031 is a the remains of an enclosure located between 380 ft and 390 ft amsl near the southeast boundary of the project area (see Figure 12). The site was recorded by CSH as a remnant enclosure wall 12.2 m long (NE/SW). The wall is L-shaped and is likely the northwest side and north corner of an enclosure. Based on the enclosure size and construction, and its location, CSH interpreted the site to be associated with keeping cattle out of an agricultural field (Hammatt and Shideler 2007:10).

SCS relocated the wall and confirmed that the CSH documentation is correct. The L-shape wall segment is roughly 12.2 m long (NE/SW) by 0.6 to 1.0 m wide and is 0.8 m in maximum height. The wall is constructed of angular and subangular cobbles and small boulders piled and stacked on the ground surface (Figure 29). It is cobble and small boulder core filled and roughly bi-faced. The wall has been bulldozed on both ends and the other three sides of the enclosure have all been removed by bulldozing.

All but a small portion of the northwest enclosure wall at Site 10031 has been bulldozed. The site is in poor condition, contains very little integrity and no further work is recommended.

Figure 29: Photograph of Site 10031 Remnant Enclosure Wall, Looking Southeast.

SIHP 10034 **Bedrock Outcrop**

FUNCTION: Natural geological feature, not an archaeological site

AGE: N/A

DIMENSIONS: 2.5 m long by 1.8 m wide

CONDITION: N/A

INTEGRITY: N/A

SURFACE ARTIFACTS: None

EXCAVATION: No

DESCRIPTION: SIHP 10034 is located at 475 ft amsl approximately 55 m northeast of Site 10020 (see Figure 12). The site is described in the CSH AIS table as a platform. The feature was relocated along the north edge of a seasonal gulch during the current AIS fieldwork. The feature is a natural bedrock outcrop roughly 2.5 m long (E/W) by 1.8 m wide by 0.35 m high.

The outcrop is a pile of exfoliated bedrock and is natural, but its shape and somewhat level top surface make it appear to be a possible archaeological feature. It is likely that CSH added the feature to their pedestrian survey summary table for these reasons. CSH did not include a site description or map of the feature in the AIS report, likely because it was determined to be natural. No further work is recommended at Site 10034.

SIHP 10067 **Terraces**

FUNCTION: Habitation

AGE: Pre Contact era

DIMENSIONS: 6.7 m long (E/W) by 5.8 m wide by 0.9 m max. height

CONDITION: Good

INTEGRITY: Altered: retains integrity of location, setting, materials, and workmanship

SURFACE ARTIFACTS: Basalt Flakes

EXCAVATION: CSH 1 X 1 m test unit

DESCRIPTION: SIHP 10067 is three soil retaining terraces located at 440 ft amsl approximately 90 m southeast of Site 10013 (see Figure 12). The terraces are constructed on the south sloping bank of a seasonal gulch. As indicated in the CSH AIS and confirmed by SCS during the current study, the three small terraces are constructed of angular and subangular cobbles and small boulders piled and stacked on the ground surface (Figure 30 and Figure 31).

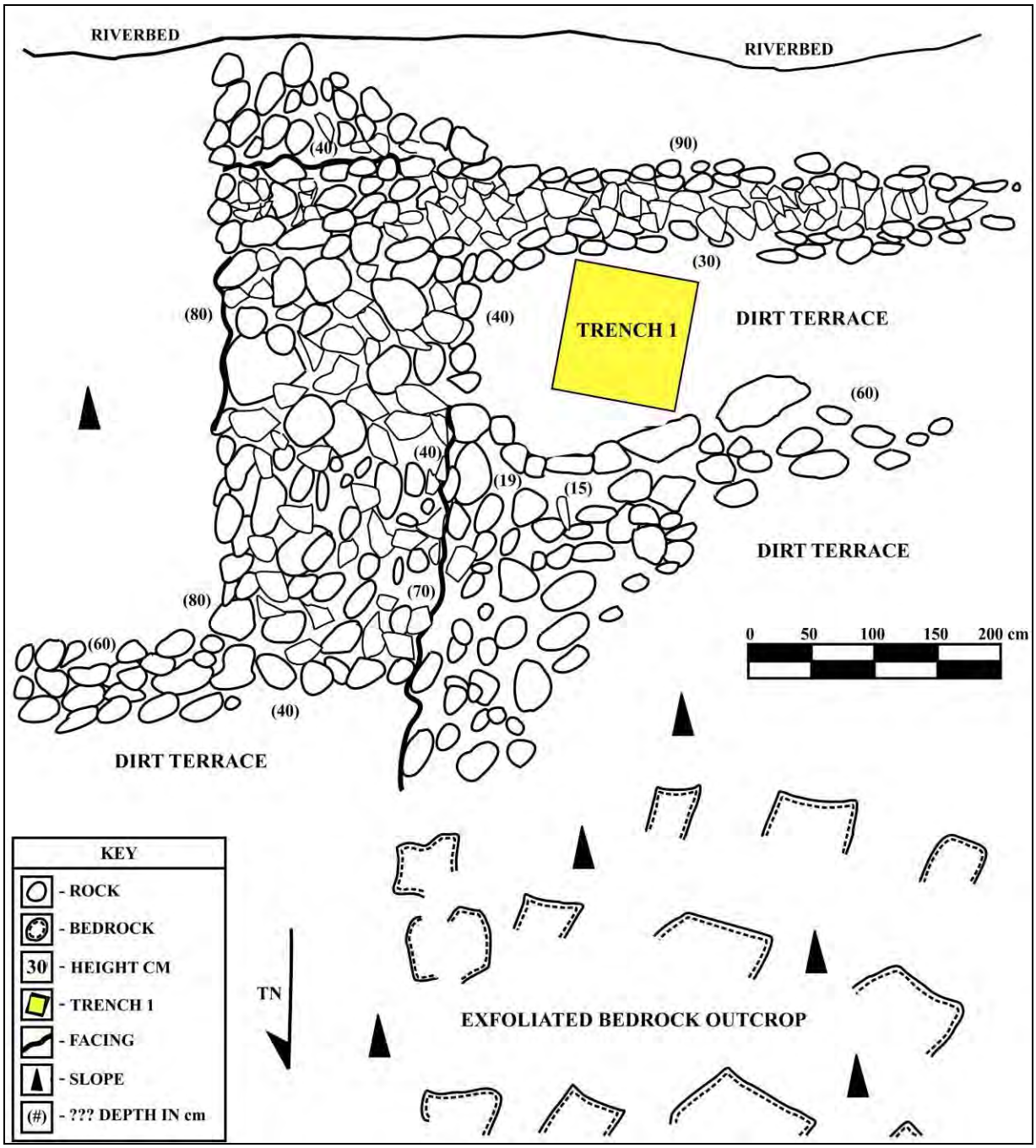

Figure 30: Site 10067 (CSH Site 232) Plan View Map (Hammatt et al. 1992:49**).**

Figure 31: Photograph of Site 10067, North View.

The terraces form three roughly level soil areas (0.9 m to 3.7 m across) along the south slope of a brick-a-brack *pu'u* (hill). Hōlualoa School stream runs along the south flank of the *pu'u*. The southernmost rock ranch wall (Feature 2) at Site 31182 at least sixty (60) feet in length, runs along the north bank of the stream and connects to the terraces. The *mauka* (upslope) corner of the wall serves as the facing for a small black dirt covered terrace where basaltic glass flakes can be observed on the dirt surface.

CSH EXCAVATION RESULTS: A one (1) meter square trench (Trench 1) was excavated in the black dirt covered terrace where basaltic glass flakes were observed. The test unit contained large quantities of basaltic glass flakes (avg. 64 flakes/10 cm. level) to bedrock at a maximum depth of 30 cm. Midden material on the other hand was sparse consisting of some shell fragments and very few pieces of fish and mammal bone. A small hearth lens (30 cm. diameter by 20-30 cm. depth) was excavated in the northwest corner of the test unit. This terrace was clearly used for volcanic glass tool production. Other terraces in the proximity were interpreted as agricultural. [Hammatt et al. 1992:48]

SIHP 10067 is a pre-Contact era site based on cultural material recovered from the excavation, and is likely associated with lithic tool production, possible limited use temporary habitation and agriculture. The site appears to be slightly altered by grazing cattle and is in good condition. No further work is recommended at Site 10067.

SIHP 10068	**Enclosure**
FUNCTION:	Habitation
AGE:	Pre-Contact era
DIMENSIONS:	4.3 m long (NE/SW) by 3.7 m wide by 0.3 m max. height
CONDITION:	Poor
INTEGRITY	Altered: retains integrity of location and setting
SURFACE ARTIFACTS:	None
EXCAVATION:	CSH, 0.5 m X 0.25 m test unit

DESCRIPTION: SIHP 10068 was a rectangular enclosure located at 470 ft amsl approximately 80 meters north of Site 10067 (see Figure 12). Site 10068 was documented in the CSH AIS study as a small rectangular enclosure 4.3 m long by 3.7 m wide with a maximum height of 0.3 m (Figure 32). The internal dimensions were 2.4 m by 1.5 m. The enclosure was constructed of angular and subangular basalt cobbles and small boulders piled and stacked on the ground surface. The walls were core filled and portions of the enclosure walls were faced.

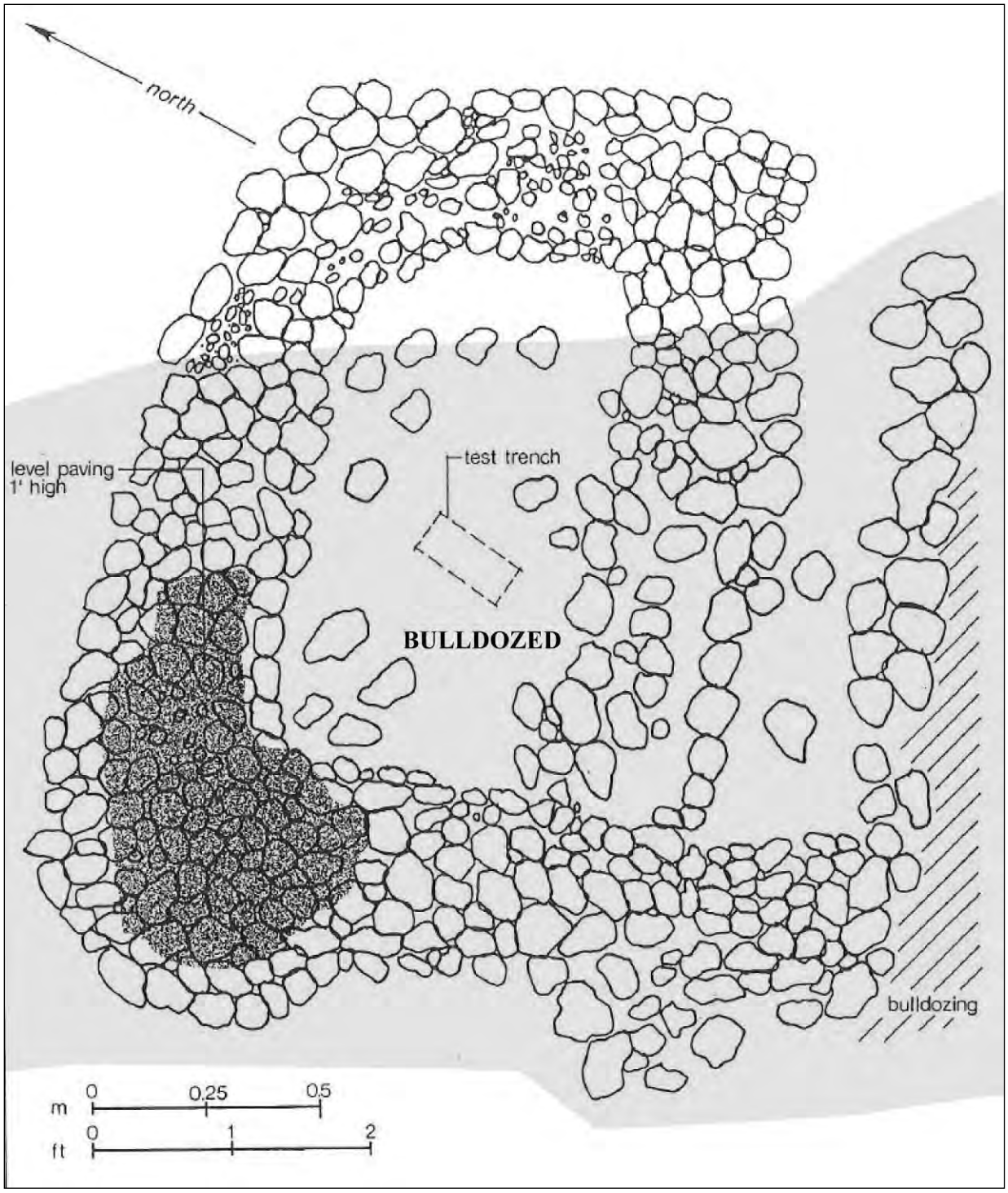

Figure 32: Site 10068 (CSH Site 233) Plan View Map Showing Test Trench (Hammatt et al. 1992:50).

The walls of the enclosure were removed by bulldozing after the CSH fieldwork and prior to the SCS resurvey fieldwork. A roughly 2.0 m long portion of collapsed enclosure wall still remained on the ground surface during the current study (Figure 33).

CSH EXCAVATION RESULTS: A one meter by 50 cm test trench was excavated in the center of the enclosure. The unit was excavated to bedrock at a depth of 35 cm. Although there was no distinct cultural deposit, a small amount of midden material was found including cowrie, *pipipi*, sea urchin and fragments of fishbone. Because of the scarcity of material and the disturbed nature of the deposits, the excavation was discontinued. However, the site probably functioned as a habitation enclosure. [Hammatt et al. 1992:48]

Site 10068 has been altered by bulldozing, is mostly no longer present and is in poor condition. No further work is recommended at Site 10068.

SIHP 10069	**Modified Bluff**
FUNCTION:	Temporary Habitation Associated with Agriculture
AGE:	Pre-Contact era
DIMENSIONS:	15.0 m long (N/S) by 6.0 m wide by 0.6 m max. height
CONDITION:	Poor
INTEGRITY:	Altered: retains integrity of location and setting
SURFACE ARTIFACTS:	None
EXCAVATION:	CSH 0.5 m x 0. 5 m test unit

DESCRIPTION: SIHP 10069 is located at 460 ft amsl approximately 30 m northeast of Site 10067 (see Figure 12). The site is described in the CSH AIS report as a rock platform constructed against the south edge of a bedrock bluff north of Hōlualoa School stream (Figure 34). The bluff top is roughly level with low linear bedrock outcrops. The site appears to have been scraped over during previous bulldozing leaving the rock platform and possible walls along the edge of the bluff collapsed, scattered and in a poor state of preservation. There is also a soil deposit approximately 3.0 m long by 2.1 m wide on the top of the bluff immediately north of the platform that was tested by excavating a 50 cm. square test unit.

Figure 33: Photograph of Site 10068 Bulldozed Remnant Enclosure Wall, Looking Northwest.

Figure 34: Photograph of Site 10069 Remains Looking Northwest.

CSH TEST RESULTS: The 50 cm by 25 cm test unit was excavated as a single stratigraphic soil layer extending to a maximum depth of 22 cm below surface. Midden recovered from the excavation consisted of few shell fragments and very small number of small animal bone fragments. Volcanic glass was relatively abundant (avg. 10 flakes/each in four 5 cm thick levels). A single basalt flake was the only other artifact recovered. The CSH report interpreted the site to be a temporary habitation feature used for tool production associated with nearby agriculture. [Hammatt et al. 1992:51]

Site 10069 was relocated y SCS during the current AIS study. The site has been badly disturbed by bulldozing. The terrace retaining walls consist of dislocated and scattered cobbles and small boulders (Figure 35). Site 10069 was significantly altered by bulldozing and is in poor condition. No further work is recommended at Site 10069.

SIHP 10070	**Enclosure Remnant**
FUNCTION:	Agriculture
AGE:	Historic era
DIMENSIONS:	2.6 m long (N/S) by 2.5 m wide by 1.2 m max. height
CONDITION:	Fair
INTEGRITY	Altered: retains integrity of location, setting and materials and workmanship
SURFACE ARTIFACTS:	None
EXCAVATION:	CSH 1.0 m x 0.5 unit

DESCRIPTION: SIHP 10070 is a U- shaped enclosure located at 500 ft amsl approximately 15 meters east of Site 10019 (see Figure 12). As indicated in the CSH AIS study and confirmed by SCS during the current study, the enclosure is 2.6 long (N/S) by 2.5 m wide with maximum height of 1.2 m (Figure 36). The eastern side of the enclosure has been impacted by heavy equipment, although the remaining portions of the walls of the structure are well constructed and in good condition (Figure 37).

CSH EXCAVATION RESULTS: A 1.0 m by 0.5 m test unit (Trench 1) was excavated along the interior wall of the enclosure. The unit was excavated to bedrock at a depth of 15 cm. No cultural material was recovered from the excavation. The comparatively new condition of the stonework at the site and its proximity to other historic features (Site 10019) indicate that the enclosure is most likely of recent age and probably associated with historic agricultural activities such as coffee growing or grazing. [Hammatt et al. 1992:51]

Figure 35: Photograph of Site 10069 Remains Showing Bulldozer Disturbance, Looking Northwest.

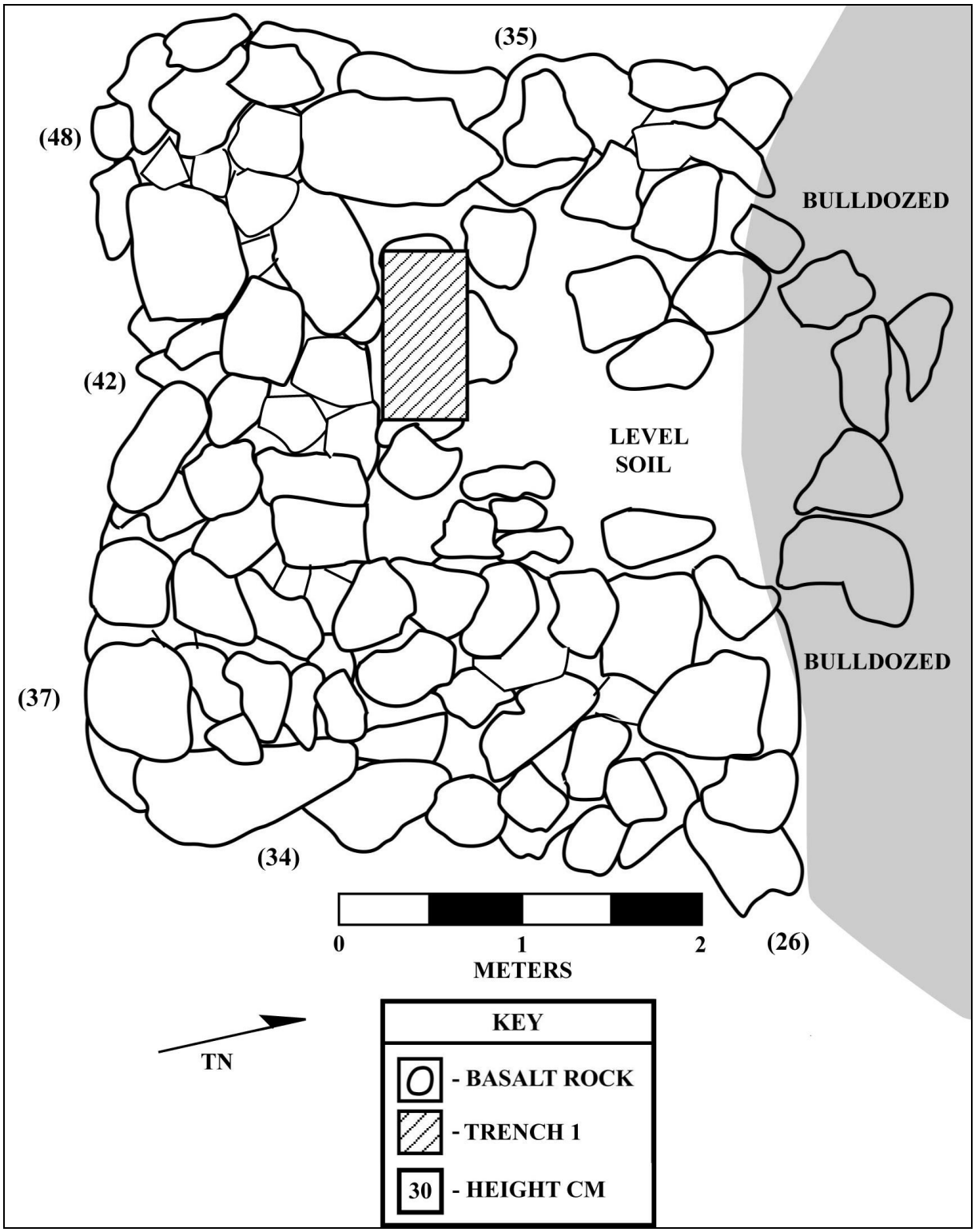

Figure 36: Site 10070 (CSH 235) Plan View Map,

Figure 37: Photograph of Site 10070 Enclosure, Looking West.

Site 10070 was relocated by SCS during the current AIS study. Based on feature type, dimensions, construction, lack of artifacts recovered during excavation, and the features association with rock mounds at Site 10019, it is likely that the Site 10070 enclosure associated with Historic era ranching and coffee agriculture. Site 10070 has been altered by bulldozing and is in fair condition. No further work is recommended at Site 10070.

SIHP 10072	**Complex**
FUNCTION:	Agricultural
AGE:	Late pre-Contact to Historic era
DIMENSIONS:	38.8 m long (N/S) by 36.3 m wide by 1.3 max. height
CONDITION:	Poor
INTEGRITY:	Altered: retains integrity of location, setting, materials, and workmanship
SURFACE ARTIFACTS:	None
EXCAVATION:	CSH TU-1 and TU-2, 7.0 m square total

DESCRIPTION: SIHP 10072 was a modified bedrock outcrop bluff (Feature 1), a rock mound (Feature 2) and a series of level dirt terraces (Feature 3) located between 480 ft and 490 ft amsl along the central northwest boundary of the project area (see Figure 12 and Figure 38). The site is bounded to the northeast by Site 31182 Feature 9 ranch rock wall (Figure 38). The features were constructed on a fairly steep southerly slope. The Feature 3 terraces were bounded by linear rock mounds and Feature 1 was called a large bluff. Site 10072 was 38.8 m long (NE/SW) by 36.3 m wide with a maximum feature height of 1.3 m.

Feature 1 was a modified exfoliated large bedrock outcrop located at the center of Site 10072 (see Figure 38). The top of the outcrop was relatively level. The modified portion of Feature 3 was roughly 13.0 m long (NE/SW) by 8.7 m wide by 1.6 m in maximum height. The modified portions of Feature 3 were constructed by removing angular and subangular basalt cobbles and small boulders from relatively level areas on the slope of the feature and piling them above and below the level cleared ground surface (Figure 39 through Figure 41). Feature 1 was relocated by SCS during the current study. The CSH feature description and plan view map were correct. TU-1 was excavated by CSH on the level top surface of Feature 3 (see excavation summary below).

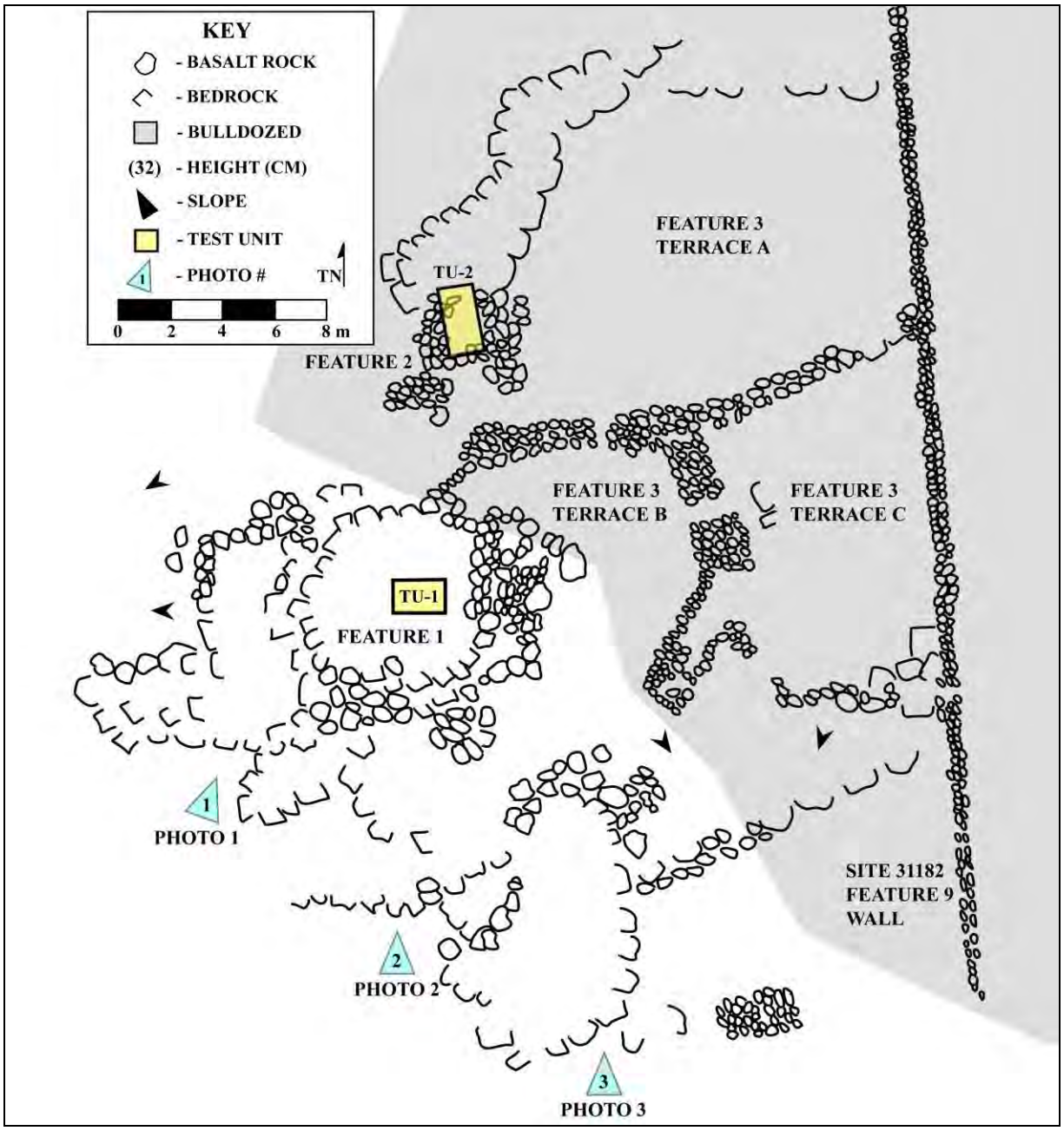

Figure 38: Site 10072 (CSH Site 238) Plan View Map (Hammatt et al. 1992:53).

Feature 2 was a rock clearing mound located 3.3 m north of Feature 1. The rock mound measured 3.7 m long (NE/SW) by 3.3 m wide. The rock mound was constructed of angular and subangular cobbles and small boulders piled and loosely stacked on exposed bedrock. There was no facing evident in the feature construction. TU-2 was excavated by CSH through the north half of the rock mound (see excavation summary below). Feature 2 was bulldozed and was no longer present during the current AIS survey.

Figure 39: Photograph 1 of Site 10072 Feature 3 South Corner of Bluff, Looking Northeast.

Figure 40: Photograph 2 of Site 10072 Feature 3 Southeast Edge Corner of Bluff, Looking North.

Figure 41: Photograph 3 of Site 10072 Feature 3 East Corner of Bluff, Looking North.

Feature 3 was three level soil-filled terraces (Terrace A, B and C) located along the east side of the site (see Figure 38). Feature was 20.0 m long (NE/SW) by 13.8 m wide. Terrace A was bounded on the north by a linear (NW/SE) bedrock outcrop and was bounded on the southeast by a linear (NE/SW) rock mound. There was a roughly oval clearing rock mound (Feature 2) on the south end of the linear bedrock outcrop.

Feature 3, Terrace B and Terrace C were two soil terraces south of Terrace A and along the east side of Site 10072 (see Figure 38). The two terraces were bounded on the west by Feature 1 and by exposed bedrock outcrop to the south. The two terraces were approximately 17.5 m long (NE/SW) by 14.7 m wide. There was a low linear rock mound that divided the two terraces. The upper (east) tier was approximately 1.0 m above the lower tier. The terraces and low liner rock mounds that formed the three terraces were constructed of angular and subangular cobbles and small boulders piled and loosely stacked on exposed bedrock. There was no facing evident in Feature 3 construction.

CSH EXCAVATION RESULTS: Test Unit 1 (1.5 meters by 2 meters) was excavated on the middle of the top of Feature 1 to a depth of 0.5 meters. The unit was excavated as a single stratigraphic layer of basalt cobbles and small boulders, and less than 1 cm of soil. The unit did not contain artifacts or cultural deposits and terminated on bedrock. Based on the structure of the bluff, limited modifications and lack of artifacts, CSH determined that Feature 1 was an exposed bedrock outcrop with small areas of agricultural rock clearing mounds. [Hammatt et al. 1992:51]

Test Unit 2 (2.0 meters by 2.0 meters) was excavated through the middle of Feature 2. The unit was excavated to the base of the feature and contained an architectural layer of angular and subangular cobbles and small boulders and 40 cm of loose sediment. A few small fragments of *cowrie* and *wana* shell were recovered from the excavation. There were no other artifacts or cultural deposits in TU-2. The Feature was most likely an agricultural rock clearing mound.

SCS relocated Site 10072 during the current AIS survey. The north and east portions of the site, including Feature 2 and Feature 3 and the Site 31182 Feature 9 ranch rock wall have been bulldozed and are no longer present. Feature 1 was the only feature remaining. Feature 1 is only slightly altered, is partially collapsed in places and is in fair condition.

Based on the types of features, their construction method and very limited amount of marine shell recovered from subsurface testing at Feature 1 and Feature 2, Site 10072 is most likely a late pre-Contact to Historic era agricultural site. The site has been altered by bulldozing, is in poor condition and no further work is recommended at Site 10072.

SIHP 10073	**Complex**
FUNCTION:	Agricultural
AGE:	Historic Era
DIMENSIONS:	15.0 m long (NW/SE) by 14.0 m wide
CONDITION:	Good
INTEGRITY:	Altered: retains some integrity of location, setting, materials, and workmanship
SURFACE ARTIFACTS:	None
EXCAVATION:	TU-1 and TU-2

DESCRIPTION: SIHP 10073 is two rock clearing mounds (Feature1 and Feature 2) and an enclosure (Feature 3) located at 575 ft amsl in the northeast quadrant of the project area (see Figure 12). CSH recorded two platforms, one (Feature 1) measuring eight feet high on the downhill (*makai*) side. CSH interpreted the features as historic cattle loading ramps (Hammatt et al. 1992:23). SCS relocated Site 10073 and recorded two rock clearing mounds, Feature 1 and Feature 2, and an enclosure, Feature 3 (Figure 42). The site is approximately 15.0 m long (NW/SE) by 14.0 m wide.

Feature 1 is a platform shaped rock clearing mound constructed on a south slope along the southwest corner of the site (see Figure 42). The rock mound is 5.5 m long (NE/SW) by 5.0 m wide, with a maximum height of 1.40 m. It is constructed of angular and subangular large basalt cobbles and small boulders stacked and piled three to six courses on the ground surface (Figure 43). The top surface is partially paved with small cobbles. The walls are faced. Feature 1 appears to be unaltered and is in good condition.

Feature 2 is a linear rock mound located upslope to the northeast of Feature 1 (see Figure 42). The platform is approximately 6.5 m long (SE/NW) by 3.0 m wide, with a maximum height 0.81 m. Feature 2 is constructed of large basalt cobbles and small boulders piled and stacked two courses high on the ground surface (Figure 44). The southwest side of the platform is roughly faced. Feature 2 appears to be unaltered and is in good condition.

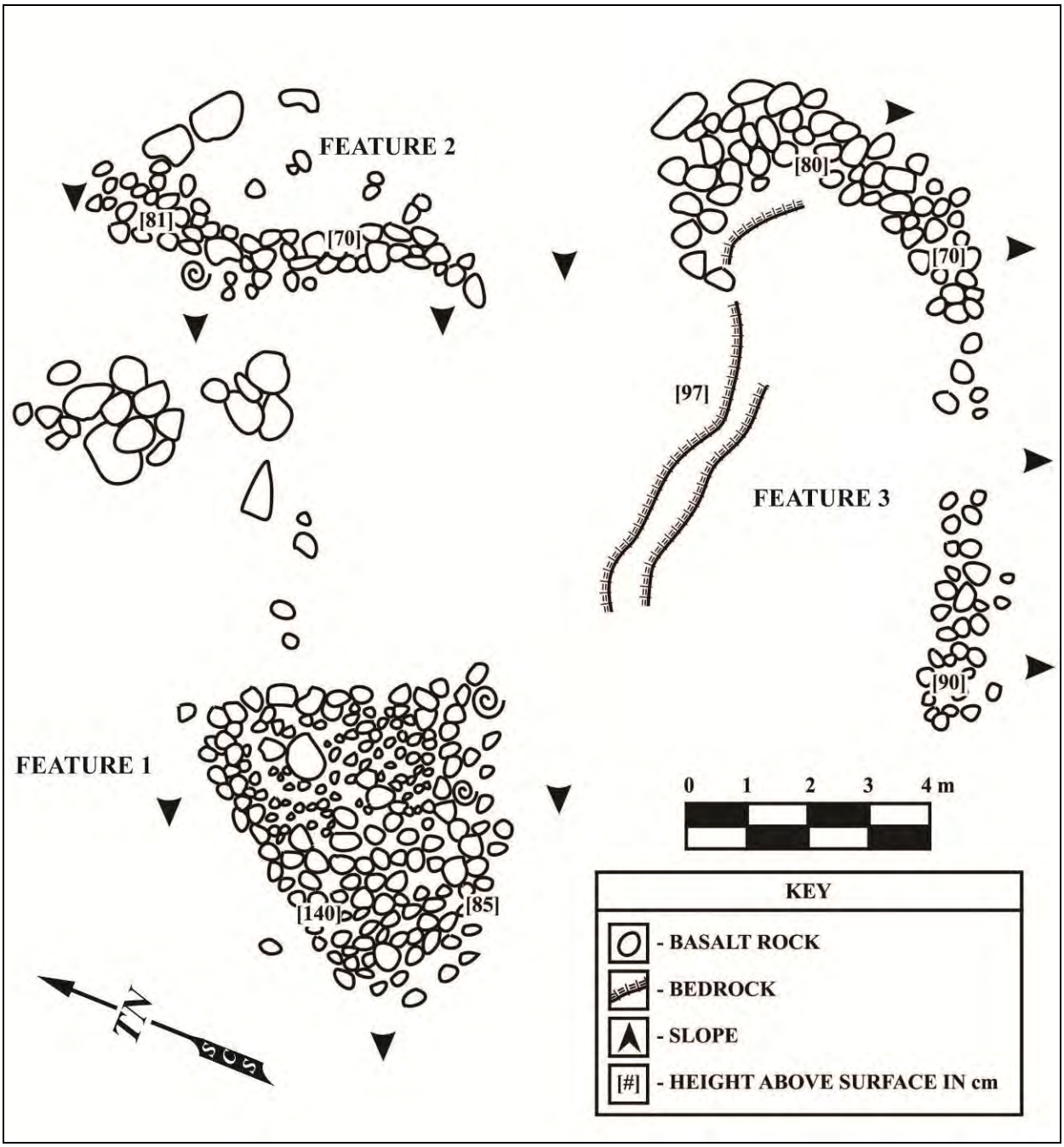

Figure 42: Site 10073 Plan View Map.

Figure 43: Photograph of Site 10073 Feature 1 Platform Looking South.

Figure 44: Photograph of Site 10073 Feature 2 Platform Looking East.

Feature 3 is an enclosure located southeast of Feature 1 and Feature 2 (see Figure 42). The enclosure is approximately 11.0 m Long (NE/SW) by 5.0 m wide, with a maximum height of 97.0 m. The enclosure walls are constructed of angular and subangular basalt cobbles and small boulders piled and stacked one to three courses (0.9 m maximum height) on the ground surface (Figure 45). The interior of the enclosure is primarily pāhoehoe bedrock outcrop with sediment built up along the interior of the enclosure walls. Feature 3 appears to be unaltered and is in good condition.

SCS EXCAVATION RESULTS: SCS excavated a test excavation unit (TU-1) in Feature 1 and a test unit (TU-2) within Feature 3. The test units were excavated to document feature construction and to determine feature function and age through diagnostic artifacts.

TU-1 was a 2.3 m long (NW/SE) by 1.2 m wide test unit (TU-1) excavated in the southeast quadrant of the Feature 1 rock clearing mound (see Figure 42). TU-1 was excavated as an architectural layer and one natural stratigraphic layer, and terminated on bedrock at 97 cm below the top surface of the feature (Figure 46 through Figure 48). The natural stratigraphic layer (Layer I) was not screened in arbitrary 10 cm levels.

The Architectural Layer (38 cm maximum thickness) consisted of angular and subangular cobbles and small boulders with a small amount of decomposing organic detritus. There were no artifacts, cultural deposits or subsurface features in the architectural layer. The top surface of the architectural layer was fairly level cobbles and small boulders. The architectural layer continued into Layer I and terminated on bedrock approximately 75 cm to 100 cm below the top surface of the feature.

Layer I (0-65 cmbs) was very dark grayish brown (10YR3/2) loose sandy silt loam 95% cobbles and small boulders. The rock excavated in Layer I was architectural rock. The architectural layer terminated on bedrock throughout the entire unit. There were no artifacts in Layer I.

Based on feature shape, dimensions, construction, and the absence of artifacts recovered from TU-1, it is likely that Feature 1 is a rock clearing mound. The shape and construction method is similar to Historic era sugarcane rock clearing mounds documented in other parts of Hawai‘i Island.

Figure 45: Photograph of Site 10073 Feature 3 Enclosure Showing Interior Level Bedrock Outcrop, Looking Southeast.

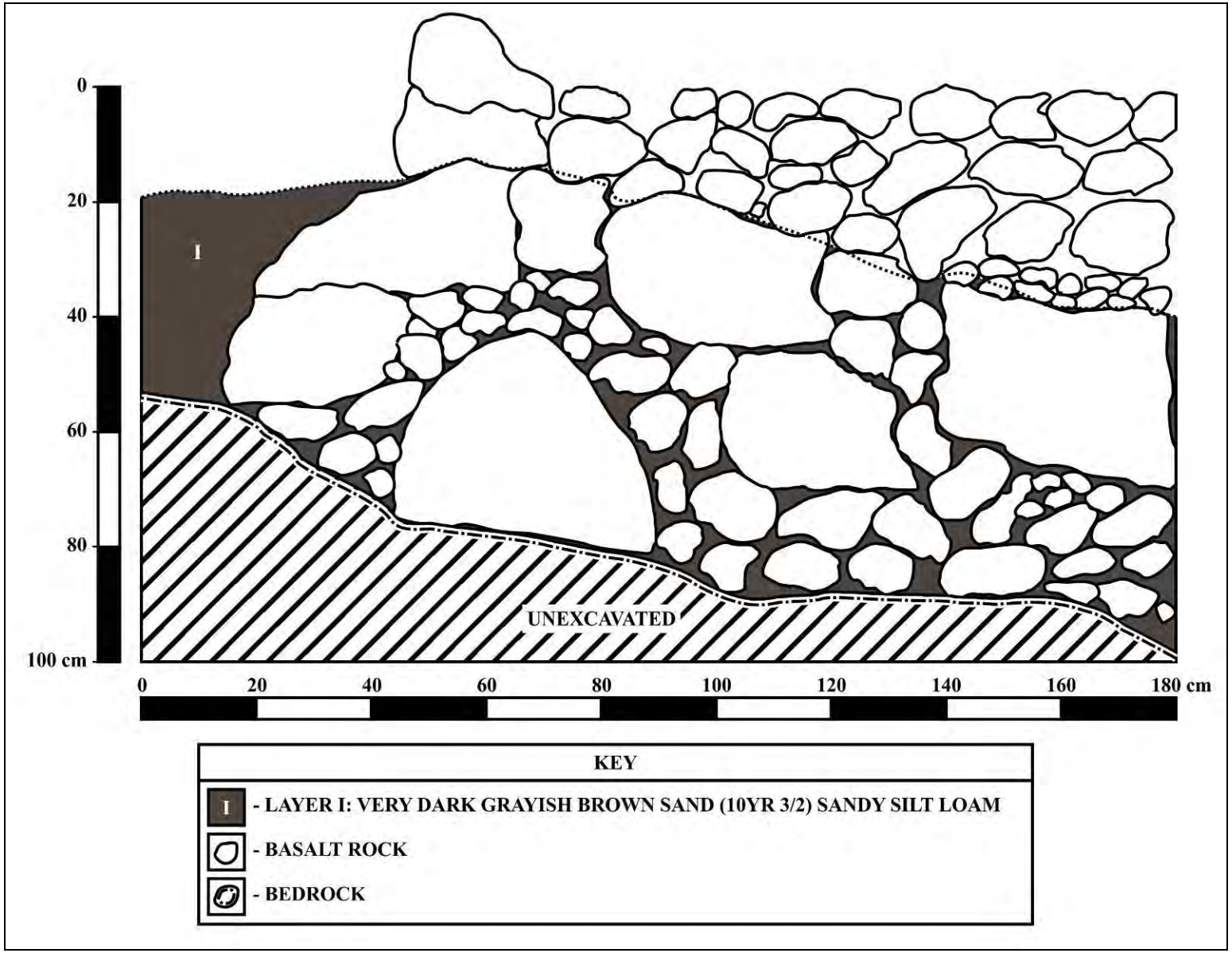

Figure 46: Site 10073, Feature 1, TU-1 Southwest Profile.

Figure 47: Photograph of Site 10073, Feature 1, TU-1 Southwest Profile.

Figure 48: Photograph of Site 10073, Feature 1, TU-1 Northeast and Northwest Profiles.

TU-2 was a 1.0 by 1.0 m test unit excavated within the southern portion of the Feature 3 enclosure (see Figure 42). TU-2 was excavated as four natural stratigraphic layers, and terminated on bedrock at 58 cmbs (Figure 49 through Figure 52). The natural stratigraphic layers were excavated in arbitrary 10 cm levels.

Layer I (0-10 cmbs) was very dark brown (7.5YR2.5/2) loose sandy loam with 1% pebbles and cobbles. Layer I terminated on Layer II sediment below. The boundary between Layer I and Layer II was fairly level and diffuse. There were no artifacts in Layer I.

Layer II (10-28 cmbs) was very dark brown (7.5YR2.5/2) soft sandy loam with 5.0 cm of black (7.5YR2.5/1) sandy silt loam mottling at its base. Layer II contained 5% gravels. Layer II was excavated as a 10.0 cm Level 1 and an 8.0 cm Level 2. Layer II, Level 2 contained a small amount of charcoal flecking and a *cowrie* shell fragment. The base of the enclosure wall architecture was 20-28 cmbs in Layer II, Level 2. Layer II terminated on Layer III sediment below. The boundary between Layer II and Layer III was fairly level and clear.

Layer III (28-40 cmbs) was black (7.5YR2.5/1) soft sandy silt loam with 15% pebbles and cobbles. Layer III did not contain artifacts.

Layer IV (40-58 cmbs) was dark yellowish brown (10YR3/4) soft sandy silt with 5% bedrock cobbles. Layer IV was excavated as two levels, was terminated on bedrock and did not contain artifacts.

The CSH AIS report interpreted Site 10073 to be a Historic era agricultural site. The dimensions, shape, and construction of Feature 1 and Feature 2 are similar to Historic era sugarcane rock clearing mounds documented in other locations on Hawai‘i Island. The absence of artifacts in test excavation units also suggests Feature 1 and Feature 3 are associated with agricultural use. Site 10073 appears to be unaltered and is in good condition. No further work is recommended at Site 10073.

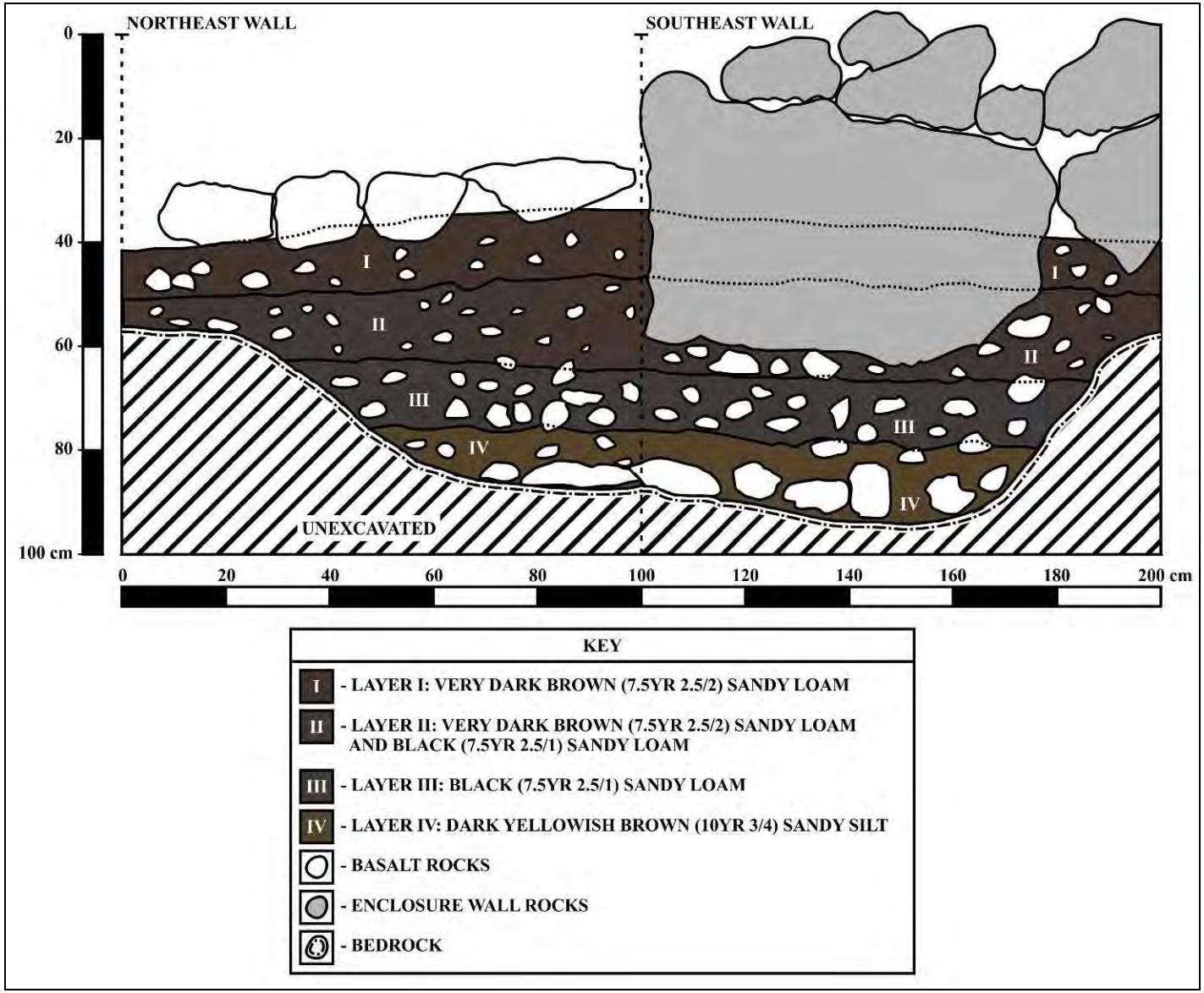

Figure 49: Site 10073, Feature 3, TU-2 Northeast and Southeast Profiles.

Figure 50: Photograph of Site 10073, Feature 3, TU-2 Southeast Profile Showing Base of Architecture.

Figure 51: Photograph of Site 10073, Feature 3, TU-2 Northeast Profile.

Figure 52: Photograph of Site 10073, Feature 3, TU-Bas of Excavation Looking Southeast.

SIHP 10074	**Enclosure Remnant**
FUNCTION:	Coffee Work Shed
AGE:	Historic Era
DIMENSIONS:	16.5 m long (NE/SW) by 15.0 m wide
CONDITION:	Poor
INTEGRITY	Altered: retains minimal integrity of location, setting, materials, and workmanship
SURFACE ARTIFACTS:	Coral abrader and corrugated metal roofing
EXCAVATION:	CSH TU-1 and TU-2, 1.25 m square total

DESCRIPTION: SIHP 10074 was a rectangular enclosure, a low rock wall and collapsed pig pen located at 640 ft amsl roughly 50 meters east of Site 10073 (see Figure 12). The site is on roughly level ground above a seasonal gulch to the southeast. There are several old growth ironwood trees at the site.

The CSH AIS report site plan and description showed an 8.5 m long (NE/SW) by 8.2 m wide by 1.2 m high enclosure along the northeast side of Site 10074 (Figure 53). The enclosure was constructed of angular and subangular basalt cobbles and small boulders stacked on the ground surface. The walls were bi-faced and pebble and cobble core-filled. The exteriors of the walls were neatly faced. The interior of the enclosure was level rocky soil with a remnant low rock wall 3.7 m long (NW/SE) that divided the center of the enclosure. There was a cobble paving between the west enclosure wall and the central dividing wall. The enclosure was likely used as a house foundation and the paved area might have functioned as a lanai outside of the house structure. A coral abrader was located on the surface of the cobble paving.

There is a low rock wall along the southeast and southwest sides of the house enclosure. There was also a C-shape enclosure at the northwest end of the terrace. The rock wall was 19.7 m long total by 0.6 m wide and was constructed of a one to two courses (wide) of large cobbles and small boulders piled and stacked two to three courses high on the ground surface. There was a small rock mound on the southeast end of the wall. The collapsed C-shape enclosure (pig pen) was 4.0 m long (NE/SW) by 3.5 meters wide and opened to the north. The C-shape was constructed of angular and subangular cobbles piled and stacked on the ground surface. No heights were given for the terrace or C-shape.

SCS relocated the site during the current AIS fieldwork. All but a portion of the rock wall (SE and SW segments) has been bulldozed (see Figure 53 and Figure 54). The rock wall matched the CSH AIS description and was also partially collapsed.

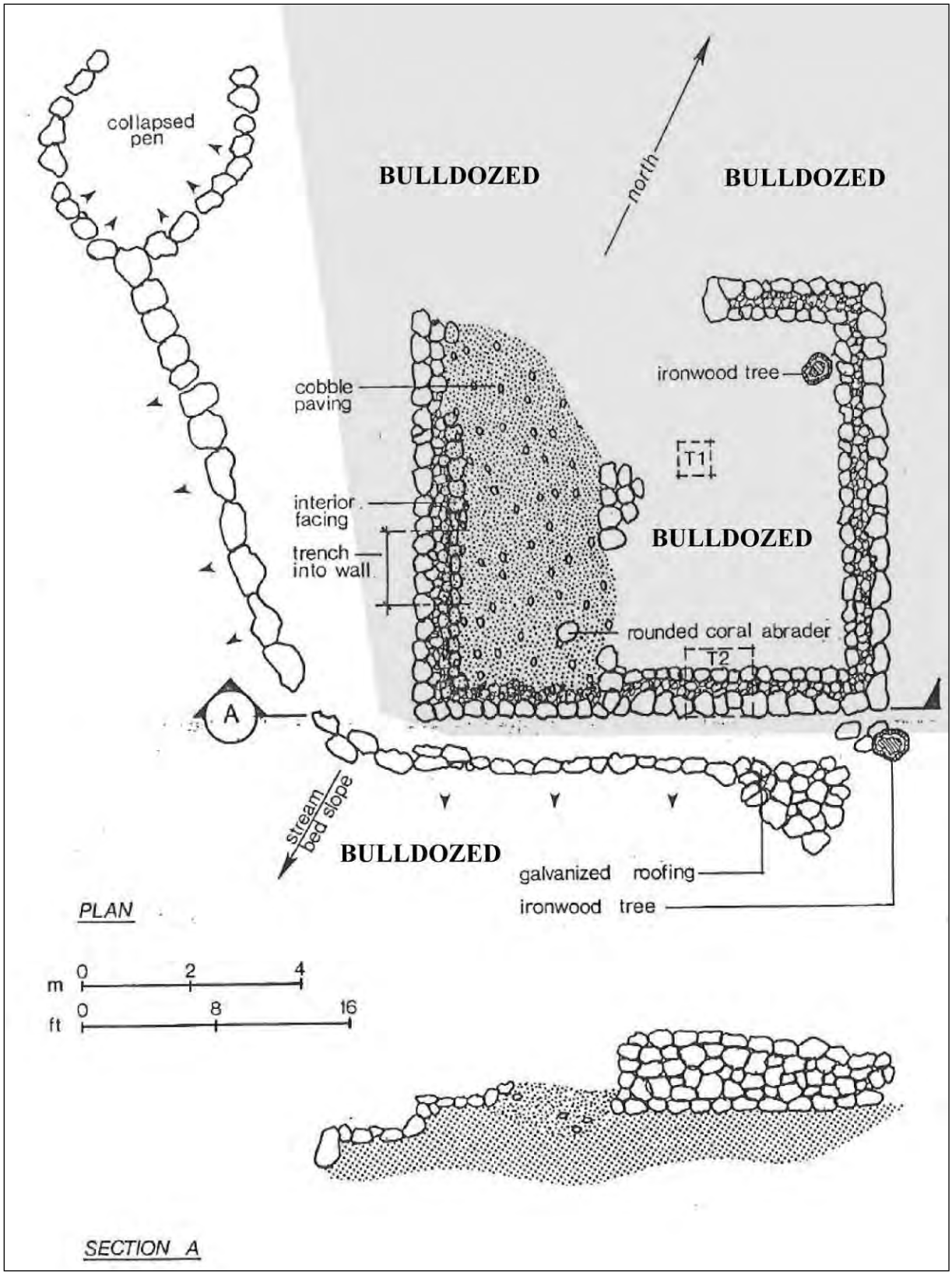

Figure 53: Site 10074 Plan View Map (Adapted from Hammatt et al. 1992:9).

Figure 54: Photograph of Site 10074 Rock Wall, Looking South.

CSH EXCAVATION RESULTS: A 50 cm square test unit (TU-1) was excavated in the soil deposit in the center of the rectangular enclosure. The unit was excavated to sterile Pāhala ash at a depth of 35 cm below the modern ground surface. The trench yielded a few fragments of *cowrie* shell and one volcanic glass flake. CSH suggested that the recovered artifacts were not consistent with what appeared to be the historic age of the foundation. CSH suggested that the artifacts might represent the scattered remains of a prehistoric occupation.

A second test unit (TU-2) was excavated by CSH through the southwest wall of the rectangular enclosure. Artifacts recovered from the wall's architectural layer were fragments of bottle glass, glazed ceramic sherds, wire nails and fragments of redwood. Site 10074 was interpreted as most likely a small dwelling or work shed associated with coffee farming. Coffee trees were identified along the seasonal gulch to the south. [Hammatt et al. 1992:54]

The site was bulldozed at some point after the CSH AIS study. When SCS relocated the site, it was almost completely bulldozed and is in poor condition. All that remains is the partially collapsed portion of what appears to be the southeast corner of the enclosure wall. Site 10074 has been altered by bulldozing, is in poor condition and no further work is recommended at the site.

SIHP 10075	**Enclosure Remnant**
FUNCTION:	Pig Pen
AGE:	Historic Era
DIMENSIONS:	9.0 m long (NW/SE) by 4.6 m wide by 1.8 m max. height
CONDITION:	Poor
INTEGRITY	Altered: retains minimal integrity of location, setting, materials, and workmanship
SURFACE ARTIFACTS:	None
EXCAVATION:	None

DESCRIPTION: SIHP 10075 is a large rectangular enclosure remnant located at 630 ft amsl in the north corner of the project area (see Figure 12). The CSH AIS report describes the enclosure as measuring roughly 9.0 m long (NW/SE) by 4.6 m wide with wall height ranging from , long axis oriented north-south, with walls 1.5 m to 1.8 m in height. The northwest wall had a low (one foot high) stone slab "lintel" opening a few feet from the northeast corner of the structure (Hammatt et al. 1992:23).

When SCS relocated Site 10075 during the current AIS study, the northeast and northwest walls had been bulldozed and were no longer present. Only portions of the southeast and southwest walls remained intact. The remaining walls have been impacted by bulldozing and were partially collapsed.

The Site 10075 enclosure remnant is currently 4.75 m long (NW/SE) by 4.6 m wide and has maximum wall heights of 0.58 m (Figure 55). The enclosure walls range from 0.5 to 0.65 m in width. The walls are constructed of angular, subangular and slabby basalt large cobbles and large boulders stacked three to four courses high on the ground surface (Figure 56 and Figure 57). The walls were likely faced in places but are now collapsed. The interior of the enclosure is roughly level rocky soil.

CSH interpreted the enclosure as a Historic era pig pen based on its size, feature construction, wall heights, and their similarities to other Historic era pig pens documented across Hawai‘i Island. Site 10075 has been altered by bulldozing, in poor condition and no further work is recommended at the site

SIHP 30592	**Railroad Berm**
FUNCTION:	Transportation
AGE:	Historic Era
DIMENSIONS:	300.0 m long (N/S) by 4.0 m wide max. by 5.0 m max. height
CONDITION:	Good
INTEGRITY:	Unaltered: retains integrity of location, setting, materials, and workmanship
SURFACE ARTIFACTS:	Railroad Spike
EXCAVATION:	None

DESCRIPTION: Site 30592 is a segment of the railroad berm located between 680 m and 690 m amsl along the project area east boundary (see Figure 12). The railroad berm continues south off the current project area. The railroad berm is approximately 300.0 m in length (N/S) and between 2.5 m and 4.0 m wide by 5.0 m in maximum height. The railroad bed is a level dirt and rock surface (Figure 58), and the berm is located along the west side of the railroad bed. The berm is a west sloping retaining wall constructed of small boulders and large cobbles stacked up to nine courses high (Figure 59 and Figure 60). The berm is well faced with fairly tightly fitted natural rock. The rock has not been worked prior to stacking. The berm face slopes slightly toward the east as it approaches the top to prevent collapse.

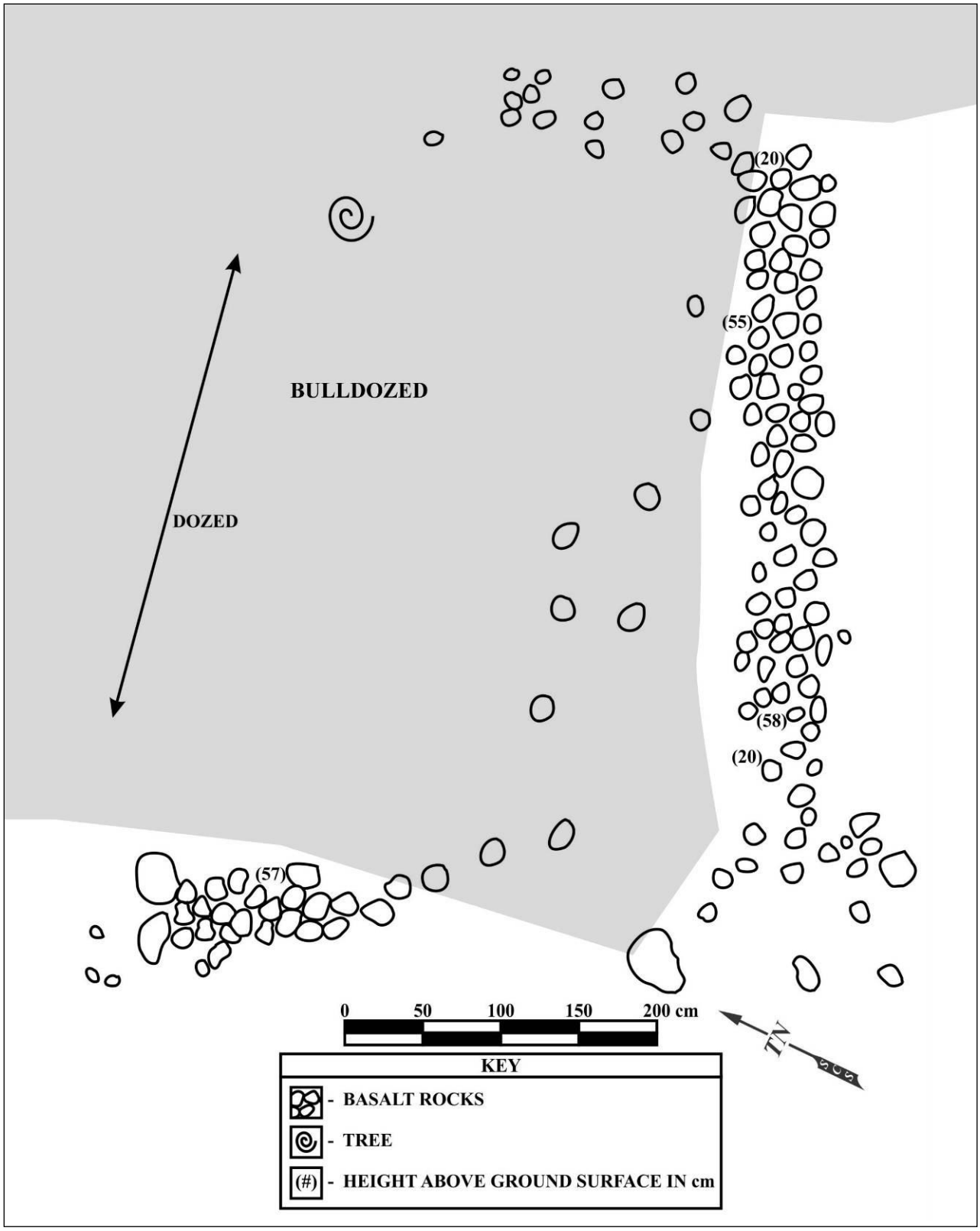

Figure 55: Site 10075 Plan View Map.

Figure 56: Photograph of Site 10075 Enclosure, Looking West.

Figure 57: Photograph of Site 10075 Enclosure Southwest Wall, Looking Southwest.

Figure 58: Photograph of Site 30592 Railroad Berm Rail Bed, Looking South.

Figure 59: Photograph of Site 30592 Railroad Berm Retaining Wall, Looking Southeast.

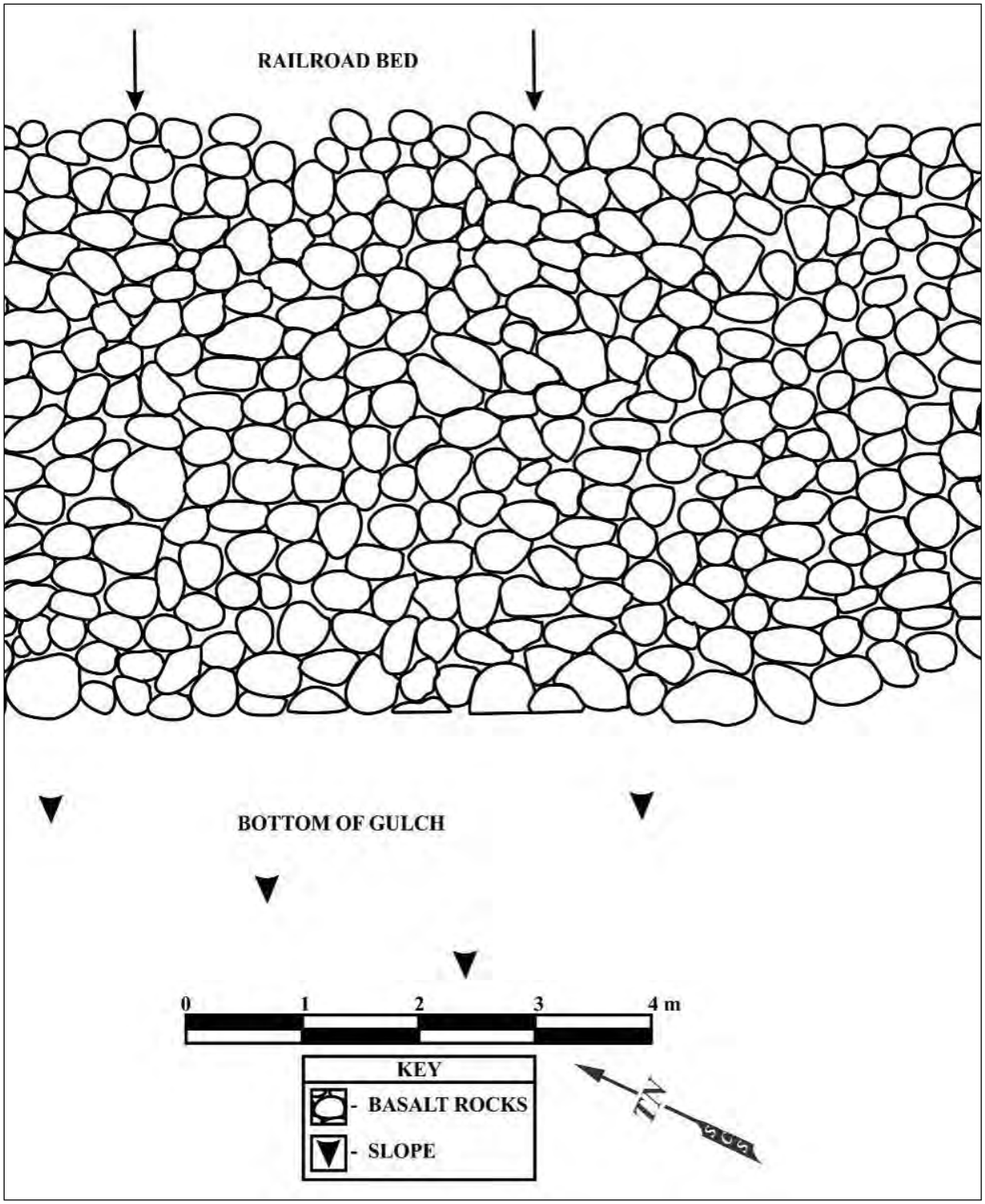

Figure 60: Site 30592 Railroad Berm Retaining Wall Profile.

The retaining wall is approximately 5.0 m high and is constructed of fifteen courses of large basalt cobbles and small boulders. The north end of the berm has been bulldozed roughly 60.0 m south of the northeast corner of the project area. Site 30592 appears to be unaltered and is in good condition. Only the north end of the railroad berm has been altered by bulldozing. Site 30592 is in good condition and is recommended for preservation.

SIHP 31181	**Enclosure Remnant**
FUNCTION:	Habitation
AGE:	Pre Contact Era
DIMENSIONS:	3.40 m long (NW/SE) by 1.24 m wide by 1.10 m max. height
CONDITION:	Poor
INTEGRITY:	Altered: retains minimal integrity of location, setting, materials, and workmanship
SURFACE ARTIFACTS:	Coral Abrader
EXCAVATION:	None

DESCRIPTION: Site 31181 is an enclosure remnant located at 645 ft amsl in the northeast corner of the project area (see Figure 12). The feature is constructed on a fairly level pāhoehoe bedrock outcrop. The feature has been altered by bulldozing and only a portion of the southwestern wall remains intact. The remnant wall as well as the bedrock outcrop on which it rests, are situated in an area that has been heavily dozed (Figure 61). The enclosure remnant is approximately 3.40 m long (NW/SE) by 1.24 m wide by 1.10 m in maximum height. The enclosure is constructed of angular basalt small boulders stacked three to four courses high on the bedrock outcrop (Figure 62). The walls are very roughly faced. The bedrock outcrop which functions as the interior floor of the structure appears to extend beyond the limits of what was once the original structure. A coral abrader fragment was located in the south corner of the enclosure (Figure 63).

Based on the size and construction of the enclosure, it is possible that it was used for pre-Contact era temporary habitation. It will not be possible to test excavate the feature as it is constructed on bedrock. Site 31181 has been altered by bulldozing, is in poor condition and no further work is recommended at the site.

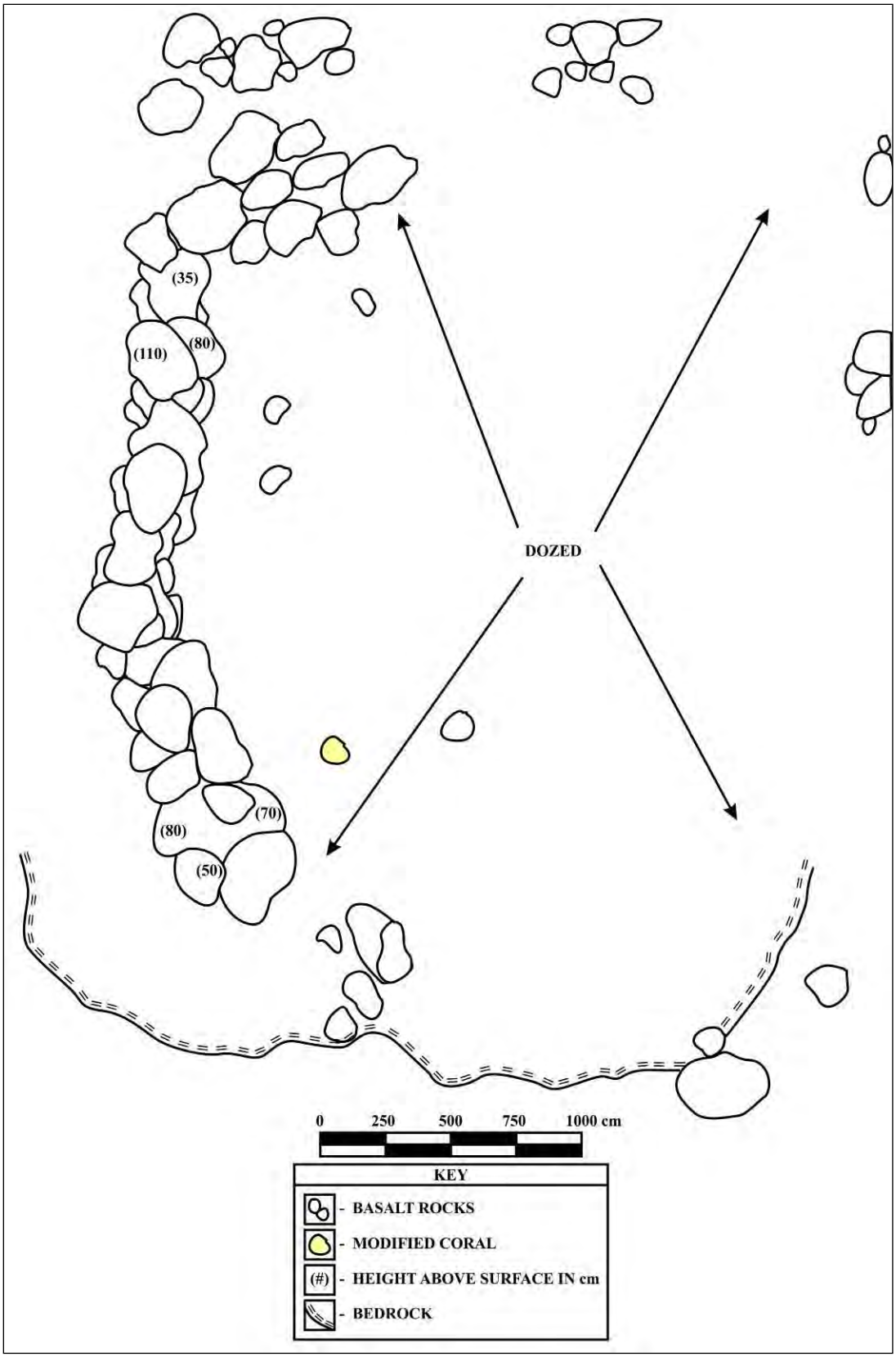

Figure 61: Site 31181 Plan View Map.

Figure 62: Photograph of Site 31181 Enclosure Remnant, Looking Northwest.

Figure 63: Photograph of Coral Abrader Fragment at Site 31181.

SIHP 31182	**Ranch Walls**
FUNCTION:	Ranching and Agriculture
AGE:	Historic Era
DIMENSIONS:	900.0 m long (NE/SW) by 550.0 m wide by 1.20 m max. height
CONDITION:	Fair
INTEGRITY:	Altered: retains minimal integrity of location, setting, materials, and workmanship
SURFACE ARTIFACTS:	Historic to Modern era bottles and cans
EXCAVATION:	None

DESCRIPTION: Site 31182 is the ranch rock walls (Features 1 through 14) that divide the entire project area into paddocks and agricultural fields (Figure 64). They are located between 360 and 700 ft amsl. The majority of rock walls (n=10) are oriented *mauka-makai* (NE/SW) while a smaller number (n=6) of shorter north/south walls create divided spaces within the longer *mauka-makai* walls. There is a small pen in the southwest corner of the project area at the southwest end of wall Feature 4 (Figure 65). The small pen at the southwest end of Feature 4 is either for calves or is a pig pen. The small pen has metal pipe gates to allow access and appears more modern than most of the walls.

There are also three lager corrals, or paddocks (Feature 12, 14, and between those features and wall Feature 5) in the southwest corner of the project area (see Figure 64). Wall Features 1 and 5 are property boundary walls and do not follow LCA or LG boundaries. The northern end of Feature 2 wall and Feature 3 wall appear to be constructed along the boundaries of LCA #3630 to John G. Munn (see Figure 7).

The rock walls are of a very similar construction. They are constructed of angular, subangular and slabby basalt large cobbles and small boulders stacked four to six courses high on the ground surface (Figures 66 through 72). The walls range from four to six courses wide. The outer rocks are placed so that their flattest edges are facing the outside of the wall. The walls are not cobble core filled but are bi-faced. The outsides of the walls slope slightly inward from the base to the top of the walls for stability. There are openings in some of the walls, and some with and metal pipe or wood gates to allow access through the walls. Barbed wire fence has been installed along one side of some of the walls.

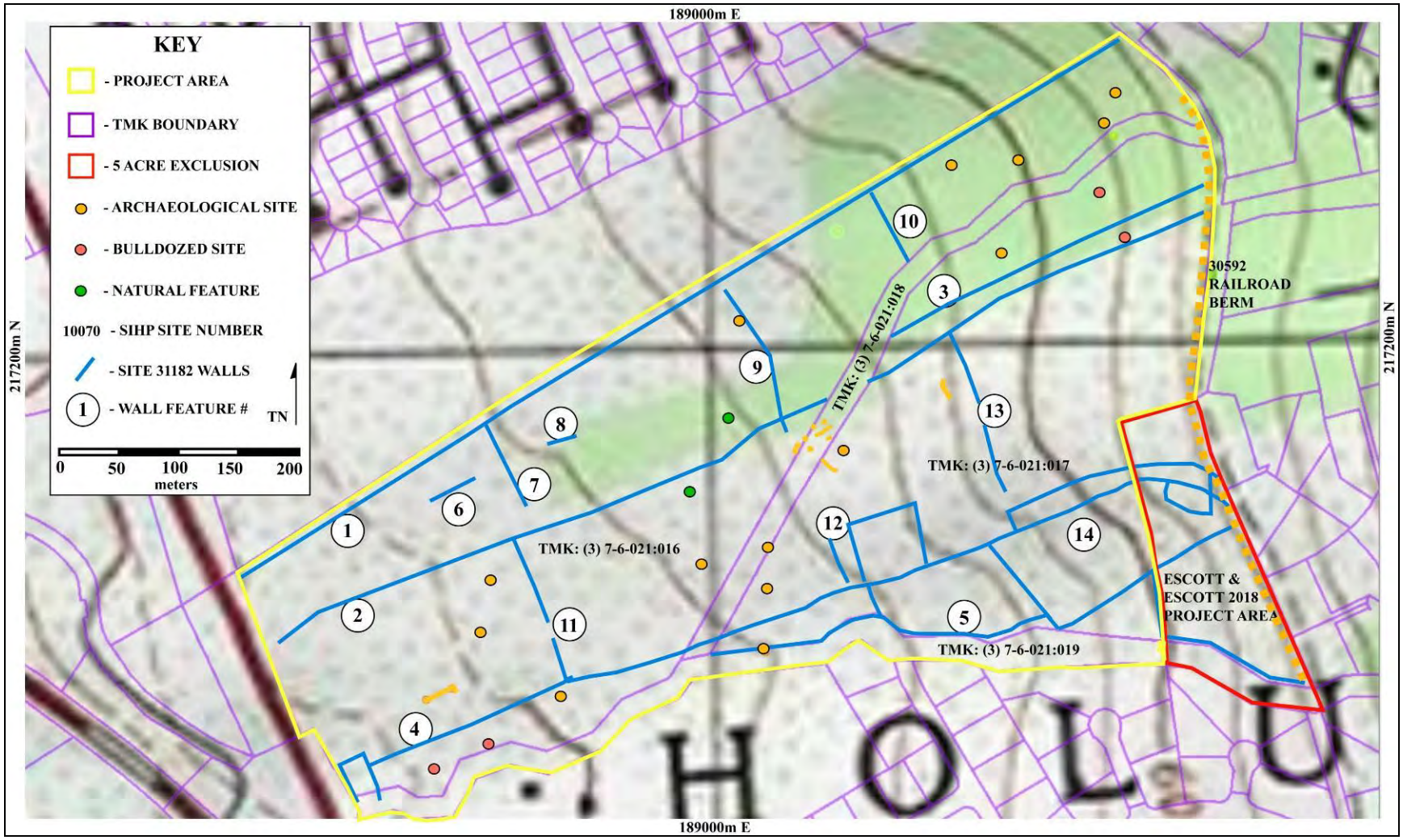

Figure 64: 7.5-Minute Series USGS Topographic Map Showing Location of Site 31182 Ranch Wall Features and Project Area (ESRI, 2011. Sources: National Geographic Society, USGS. Kealakekua Quadrangle).

Figure 65: Photograph of Site 31182 Feature 4 Pin Pen Looking Southeast.

Figure 66: Photograph of Site 31182 Feature 4 South End Showing Wall Construction, Looking North.

Figure 67: Photograph of Site 31182 Feature 4 South End Showing Wall Construction, Looking North.

Figure 68: Photograph of Site 31182 Feature 4 Showing Top of Wall Construction, Looking Northeast.

Figure 69: Photograph of Site 31182 Feature 2 South End Showing Top of Wall Construction, Looking Northeast.

Figure 70: Photograph of Site 31182 Feature 2 South End Showing Wall Construction, Looking Southeast.

Figure 71: Photograph of Site 31182 Feature 11 Showing Wall Construction, Looking East.

Figure 72: Photograph of Site 31182 Feature 11 North End Showing Top of Wall Construction, Looking North.

Many of the walls have been altered and are either collapsed in places or have had their ends bulldozed or have bulldozer breaches through them, providing new access. The remaining Site 31182 walls have not been altered, are in good condition and no further work is recommended for them.

IF-1	**Isolated Petroglyph**
FUNCTION:	Marker
AGE:	Pre Contact Era
DIMENSIONS:	0.90 m by 0.70 m
CONDITION:	Fair
INTEGRITY:	Altered
SURFACE ARTIFACTS:	None
EXCAVATION:	None

DESCRIPTION: Isolated Find-1 (IF-1) is a petropglyph located at 410 ft amsl along the southwest boundary of the project area (see Figure 12). The single petroglyph is an image of a person etched onto a small basalt boulder (Figure 73) in a bulldozed disturbed area north of a seasonal gulch. The boulder is 0.90 m in length, 0.70 m wide and is not associated with any features (Figure 74). The petroglyph likely depicts a human form, although an interpretation of its significance is difficult as the image has deteriorated.

SCS contacted Shane Nelson, the Office of Hawaiian Affairs West Hawai‘i Representative to consult on the on the final disposition and preservation treatments for the petroglyph. IF-1 appears to be unaltered, is in fair condition and preservation at a nearby protected location on the property is recommended.

Figure 73: Photograph of Site 31181 Petroglyph.

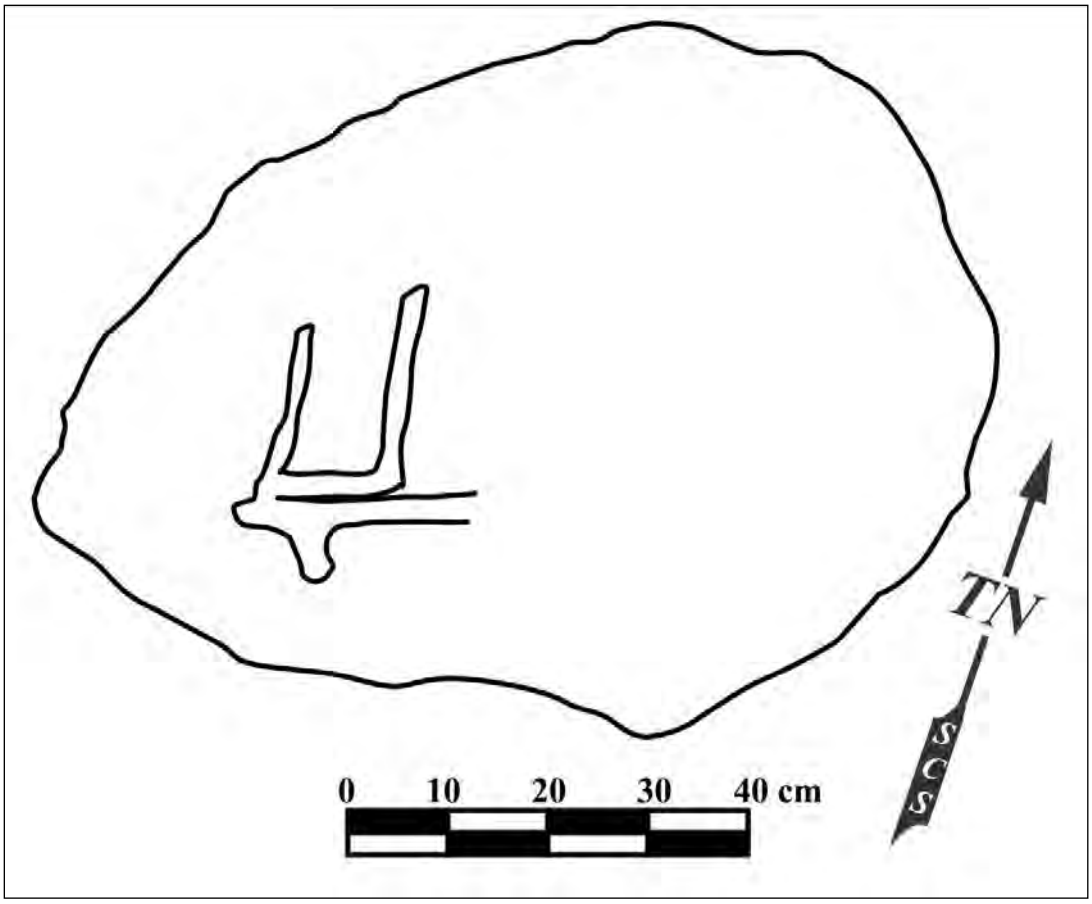

Figure 74: Site 31181 Petroglyph Plan View Drawing.

CONCLUSION

Seventeen archaeological sites were identified and recorded in the project area (Table 7 and Figure 75). Fifteen of the sites were previously documented and two sites were previously undocumented (Site 31181, a small coffee shed enclosure and Site 31182, ranch walls). The location of one of the 17 sites (Site 10012), was relocated, though the burials were reinterred off project and the archaeological features at Site 10012 are no longer present on the ground surface. An isolated petroglyph (IF-1) was also recorded during the current AIS study.

Six of the sites and IF-1 were determined to be pre-Contact era sites, three associated with habitation, one with agriculture, one single feature site (Site 10012) formerly associated with burials, and a single petroglyph. The burials at Site 10012 were removed and reinterred off-project prior to 1983. Eleven of the sites were determined to be Historic era sites, the majority associated with coffee agriculture and cattle ranching. Four of the Historic era sites likely had a habitation component.

Table 7: Inventory of Archaeological Sites in the Current AIS Project Area.

SIHP# *	TYPE	FUNCTION	AGE
10011	Platform	Ag. Clearing/Temp. Habitation	Pre-Contact
10012 •	Platform & Wall	Burial	Pre-Contact
10013	Enclosure & Lava Tube	Habitation	Pre-Contact
10018	Enclosure	Agricultural	Historic
10019	6 Rock Mounds	Ag. Clearing	Historic
10031	Enclosure Wall	Agriculture	Historic
10067	Terraces	Habitation	Pre-Contact
10068	Enclosure	Habitation	Pre-Contact
10069	Modified Bluff/Platform	Habitation	Historic
10070	U-Shape Enclosure	Agriculture	Historic
10072	Complex	Ag. Clearing	Pre-Contact
10073	Complex	Ranching & Ag.	Historic
10074	Enclosure	Coffee Work Shed	Historic
10075	Enclosure	Pig Pen	Historic
30592	Railroad Berm	Transportation	Historic
31181	Enclosure	Coffee Work Shed	Historic
31182	Rock Walls	Ranching & Ag.	Historic
IF-1	Petroglyph	Marker	Pre-Contact

* Site numbers are preceded by the prefix 50-10-37-.
Orange Shading - Site no longer present.
• Burial Site 10012 reinterred off project prior to 1983.

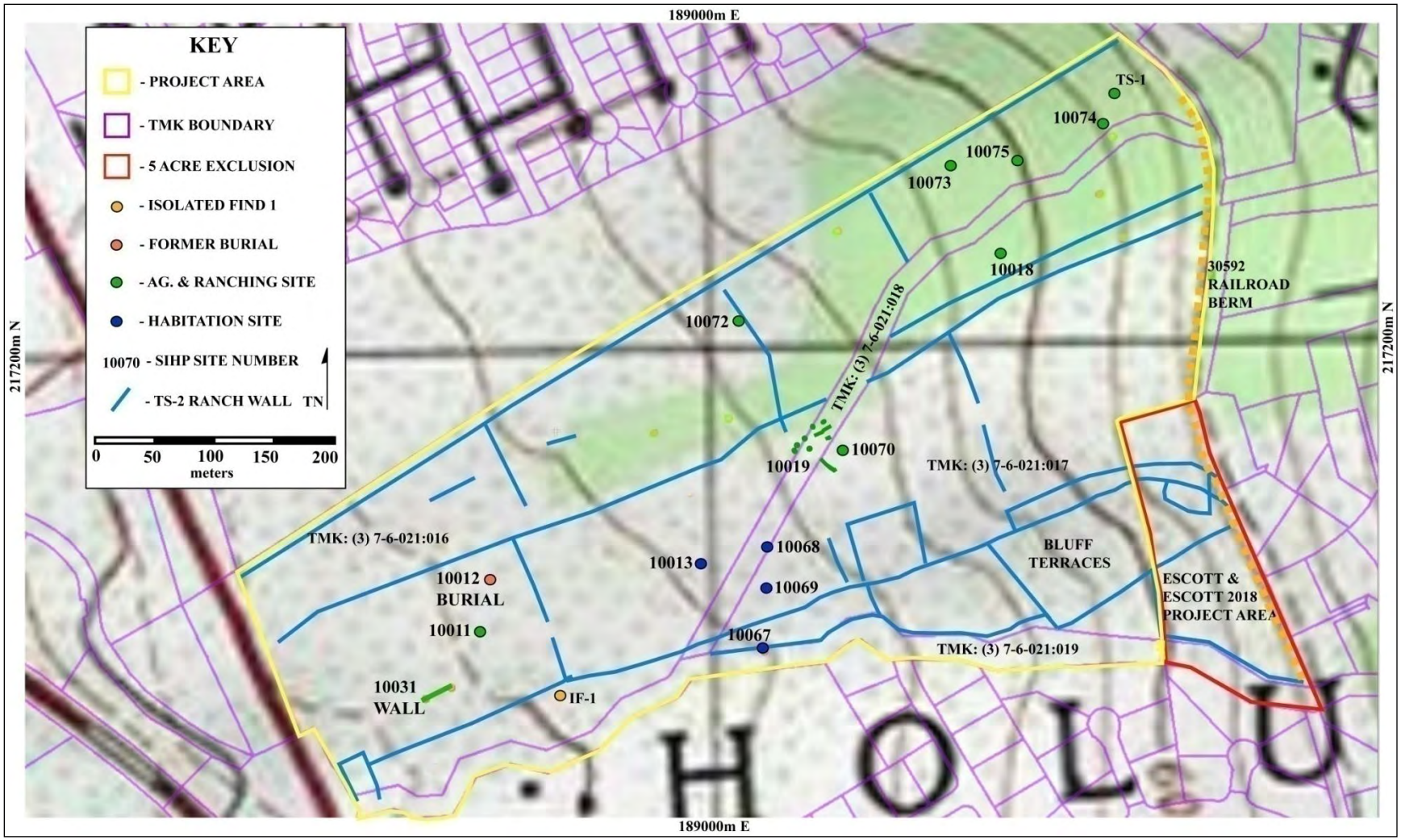

Figure 75: 7.5-Minute Series USGS Topographic Map Showing Location of Archaeological Sites and Project Area (ESRI, 2011. Sources: National Geographic Society, USGS. Kealakekua Quadrangle).

There is a concentration of Historic era agricultural and livestock sites (Site 10019 10018, 10070, 10073, 10074, 10075, and 31181) located in the northeast quadrant of the project area. The features include rock clearing mounds and enclosures. The sites are clustered along a seasonal gulch. Sites include rock clearing mounds and small enclosures associated with coffee and sugarcane growing.

There are a smaller number of pre-Contact era agricultural sites (Site 10011 and 10072) and temporary habitation sites associated with agriculture (Site 10013, 10067, 10068, and 10069) near the south central portion of the project area. Three of the habitation sites are north of the Hōlualoa School stream located along the south boundary of the project area. Artifacts recovered from test excavations at these sites included a number of volcanic-glass flakes, indicating tool manufacture.

The many Historic era rock walls (Site 31182) are associated with cattle ranching. There are *mauka-makai* walls divide the entire length of the project area into separate paddocks. There are north-south walls that further divide the paddocks into smaller pastures. There are also a series of large corrals in the southwest corner of the project and a small pen in the southeast corner of the project area. Ranchers often move cattle from paddock to paddock to prevent overgrazing. They also pasture yearlings separate from older cattle. Corrals and smaller pens are use for branding, inoculation and to gather cattle for transport to market. There is a dirt ranch road leading to corral Feature 12 that crosses the Hōlualoa School stream.

Given the extensive land Historic era and modern land alteration in the project area, it is difficult to synthesize a clear picture of pre-Contact era site distribution and land use for the project area lands. It is clear that there were pre-Contact agricultural sites and associated temporary habitation sites in the lower and mid-elevation portions of the project area, especially along the stream (seasonal gulch) to the south. The few remaining sites do not provide a good sample to compare with site distribution patterns recorded at less disturbed projects of similar location in Kona.

The project area does provide a fairly complete picture of Historic era cattle ranching and agricultural land use, including information on cattle pasturing, management, care, and transport.

SIGNIFICANCE ASSESSMENTS

Sites identified during this project were assessed for their significance as outlined in Hawai‘i Administrative Rules §13-284-6. To be assessed as significant a site shall possess integrity of location, design, setting, materials, workmanship, feeling, and association and shall meet one or more of the following five criteria:

(a) It must be associated with events that have made a significant contribution to the broad patterns of our history, or be considered a traditional cultural property.

(b) It must be associated with the lives of persons significant in the past.

(c) It must embody distinctive characteristics of a type, period, or method of construction, or represent a significant and distinguishable entity whose components may lack individual distinction.

(d) It must have yielded or may be likely to yield, information important in prehistory or history.

(e) Have important value to native Hawaiian people or other ethnicities in the state, due to associations with cultural practices and traditional beliefs that were, or still are, carried out.

All of the archaeological sites documented in this report were evaluated for their significance (Table 8). All of the sites identified during the current AIS study possess integrity of location and materials and were assessed significant under criterion “d” as they have yielded or are likely to yield information important to prehistory and/or history. All of the sites, with the exception of the railroad berm Site 30592 and the burial Site 30593 provide information important to pre-Contact era and Historic era agricultural pursuits and cattle ranching. They provide data on pre-Contact era through post-Contact era and the Historic era features constructed for growing subsistence and commercial crops and raising beef for commercial markets. They also provide data important to changing land-use as some farmers began to use land for cattle pasture in response to developing local and external markets on Hawai‘i Island and O‘ahu. The ranch walls, paddocks and corral sites provide information on the ways land was altered and divided to accommodate both farming and ranching.

Table 8: Inventory of Archaeological Sites in the Current AIS Project Area.

SIHP# *	TYPE	FUNCTION	AGE	SIGNIFICANCE CRITERIA	RECOMMENDATION
10011	Platform	Ag. Clearing	Pre-Contact	d	No Further Work
10012 •	Platform & Wall	Burial	Prehistoric	No longer Significant	No Further Work
10013	Enclosure & Lava Tube	Habitation	Pre-Contact	d	No Further Work
10018	Enclosure	Agricultural	Historic	d	No Further Work
10019	6 Rock Mounds	Ag. Clearing	Historic	d	No Further Work
10031	Enclosure Wall	Agriculture	Historic	d	No Further Work
10067	Terraces	Habitation	Prehistoric	d	No Further Work
10068	Enclosure	Habitation	Prehistoric	d	No Further Work
10069	Modified Bluff/Platform	Habitation	Historic	d	No Further Work
10070	U-Shape Enclosure	Agriculture	Historic	d	No Further Work
10072	Modified Bluff	Ag. Clearing	Pre-Contact	d	No Further Work
10073	Complex	Ranching & Ag.	Historic	d	No Further Work
10074	Enclosure	Coffee Work Shed	Historic	d	No Further Work
10075	Enclosure	Pig Pen	Historic	d	No Further Work
30592	Railroad Berm	Transportation	Historic	a, c, d	Preservation In-Place
31181	Enclosure	Coffee Work Shed	Historic	d	No Further Work
31182	Rock Walls	Ranching & Ag.	Historic	d	No Further Work
IF-1	Petroglyph	Marker	Prehistoric	d, e	Preservation

* Site numbers are preceded by the prefix 50-10-37-.
Orange Shading - Site no longer present.
• Burial Site 10012 reinterred off project prior to 1983.

The pre-Contact era agricultural and habitation sites (10011, 10013, 10067, 10068, and 10072) and the petroglyph (IF-1) were assessed significant under criterion "d" as they have yielded or are likely to yield information important to pre-Contact era agriculture and temporary habitation and tool production associated with agricultural pursuits in the region.

The railroad berm Site 30592 is also significant under criteria "a" and "c" as it is associated with events that have made a significant contribution to the broad patterns of our history and it embodies distinctive characteristics of the type, period, and method of railroad bed construction. SCS consulted with the Office of Hawaiian Affairs (OHA) Kona representative Shane Nelson to ask for any input regarding Site 30592.

RECOMMENDATIONS

The railroad berm Site 30592 is recommended for preservation with preservation measures to be outlined in an archaeological preservation plan. The petroglyph (IF-1) is recommended for preservation in a safe location on the project area, preferably within the Site 30592 railroad berm preservation area.

No further work is recommended for the remaining 16 archaeological sites. Information recorded for all 16 archaeological sites during the current study has adequately ascertained their function and age.

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APPENDIX A: REINTERMENT DOCUMENTATION

Project Planners Hawaii
75-127 Lunapule Road, Suite 14
Kailua-Kona, Hawaii 96740
Telephone: (808) 326-7204
FAX: (808) 329-1202

March 19, 1993

Mr. Edward H. Ayau
State Historic Preservation Division
Department of Land & Natural Resources
State of Hawaii
33 South King Street
6th Floor
Honolulu, Hawaii 96813

Re: Burials
Gamrex, Inc.
Kona Vistas Subdivision
Holualoa, North Kona, Hawaii

Dear Ed:

Pursuant to our phone conversations today regarding the decision of the Burial Council, may I confirm the following. The council has decided that the site located in the South-east corner of the subdivision near Kilohana Street is acceptable for all three (3) burials. A six foot deep hole will be excavated of sufficient size to accomodate a 4'X4'X4' box (of the type used for electrical connections) with no bottom and a cover. The remains will be buried on or about April 1, 1993. The hole will be backfilled over the cover of the box to ground level after reburial. I have asked our contractor to leave a ladder in the hole for you so that you can get down to the box safely.

Gamrex authorizes you to enter on site to the burial area for the services on April 1, 1993, or thereabouts. Please contact me with the exact time and date prior to the ceremony. Please note that you and your council members will be allowed on site at your sole risk and that Gamrex, and or its contractors will not be held liable for any damages and/or injuries should they occur.

Thank you for your assistance in the settlement of this matter. Please contact me when you have set the date for the reburials.

Respectfully,

Gregg Kashiwa

Gregg Kashiwa

cc: Gamrex, Inc.
Isemoto Contracting

JOHN WAIHEE
GOVERNOR OF HAWAII

KEITH AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCE

DEPUTIES

JOHN P. KEPPELER II
DONA L. HANAIKE

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION DIVISION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

April 5, 1993

Gamrex, Inc.
Attention: Mr. Gregg Kashiwa
75-127 Lunapule Road, Suite 14
Kailua, Kona, Hawai`i 96740

Re: Reinterment of Hawaiian Skeletal Remains, Tax Map Key 7-6-21:4,9-13,15-17, Hōlualoa, North Kona, Hawai`i

Dear Mr. Kashiwa:

This is to notify you that on the evening of April 1, 1993, the three sets of Hawaiian remains recovered from the above mentioned property were respectfully reinterred. Thank you for your cooperation and assistance throughout this important matter.

If there are any questions, please contact Edward Halealoha Ayau, Esq. at 587-0010.

Sincerely,

DON HIBBARD, Administrator
State Historic Preservation Division

c: Edward L.H. Kanahele, Chair, Hawai`i Burial Council

APPENDIX 6: Archaeological Preservation Plan

SCS PROJECT 2252-1

AN ARCHAEOLOGICAL PRESERVATION PLAN FOR SITE #50-10-57-30592 LOCATED IN HŌLUALOA 1st AHUPUA‘A, NORTH KONA DISTRICT, HAWAI‘I ISLAND, HAWAI‘I [TMK: (3) 7-6-021:016-019]

Prepared by:
Glenn Escott, M.A.
and
Nicole A. Mello, M.A.

MAY 2020

DRAFT

Prepared for:
Kona Three, LLC
111 Hualalai St.
Hilo, HI 96720

SCIENTIFIC CONSULTANT SERVICES Inc.
1347 Kapi‘olani Boulevard, Suite 408 Honolulu, HI 96814
Hawai‘i Island Office: PO Box 155 Kea‘au, HI 96749

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INTRODUCTION

As requested by the Hawai‘i State Historic Preservation Division (SHPD) in a letter dated May 31, 2018 (Log No. 2018.01123, Doc No. 1805SN05) (Appendix A), Scientific Consultant Services, Inc. (SCS) produced this Archaeological Preservation Plan (PP) for Site #50-10-37-30592 (hereafter referred to as Site 30592) located on a portion of TMK: (3) 7-6-021: 016-019 in Hōlualoa 1st Ahupua‘a, North Kona District, Island of Hawai‘i, Hawai‘i (Figure 1 through Figure 4, and Figure 14 to Figure 15).

The owner is proposing to develop the property and contracted SCS produce this PP as required for a County of Hawai‘i Planning Department grubbing and grading permit application. Prior to writing the preservation plan, a search of geological maps, aerial photos, historical maps, historical documents, land titles, land-use documents, and previous archaeological reports was conducted. A summary of the research is included in this preservation plan. The preservation plan was prepared in accordance with Hawai‘i Administrative Rules (HAR) §13-277 rules for site archaeological preservation. The property is owned by Kona Three, LLC. The contact person for Kona Three, LLC is Mr. Richard Wheelock. Mr. Wheelock can be reached by phone at (808) 753-3167, and by email at richard@eastwestrealty.org. His mailing address is 700 Bishop Street Honolulu, HI 96813-4112.

ENVIRONMENTAL SETTING

Site 30592 is a portion of the Historic era Kona Sugar Company railroad bed and berm located along the eastern boundary of the project area of an undeveloped portion of TMK: (3) 7-6-021:016-019. The project area is located between 360 and 660 feet (110 to 201 meters) above mean sea level (amsl) on fairly steep sloping land with level areas in between elevation breaks. The land is a small portion of a larger former cattle ranch and agricultural area that was started in the early 1900s. The lower portion of the project area is still used to pasture cattle. The project area and surrounding lands were bulldozed sometime between the 1940s and 1970s. Evidence of bulldozing is visible in aerial photographs as alternating bands of cleared bulldozer tracks and bands of push pile. Pedestrian survey confirmed the linear bands in the aerial photographs are bulldozer-cleared paths and linear piles of bulldozed rock along the cleared bulldozer paths.

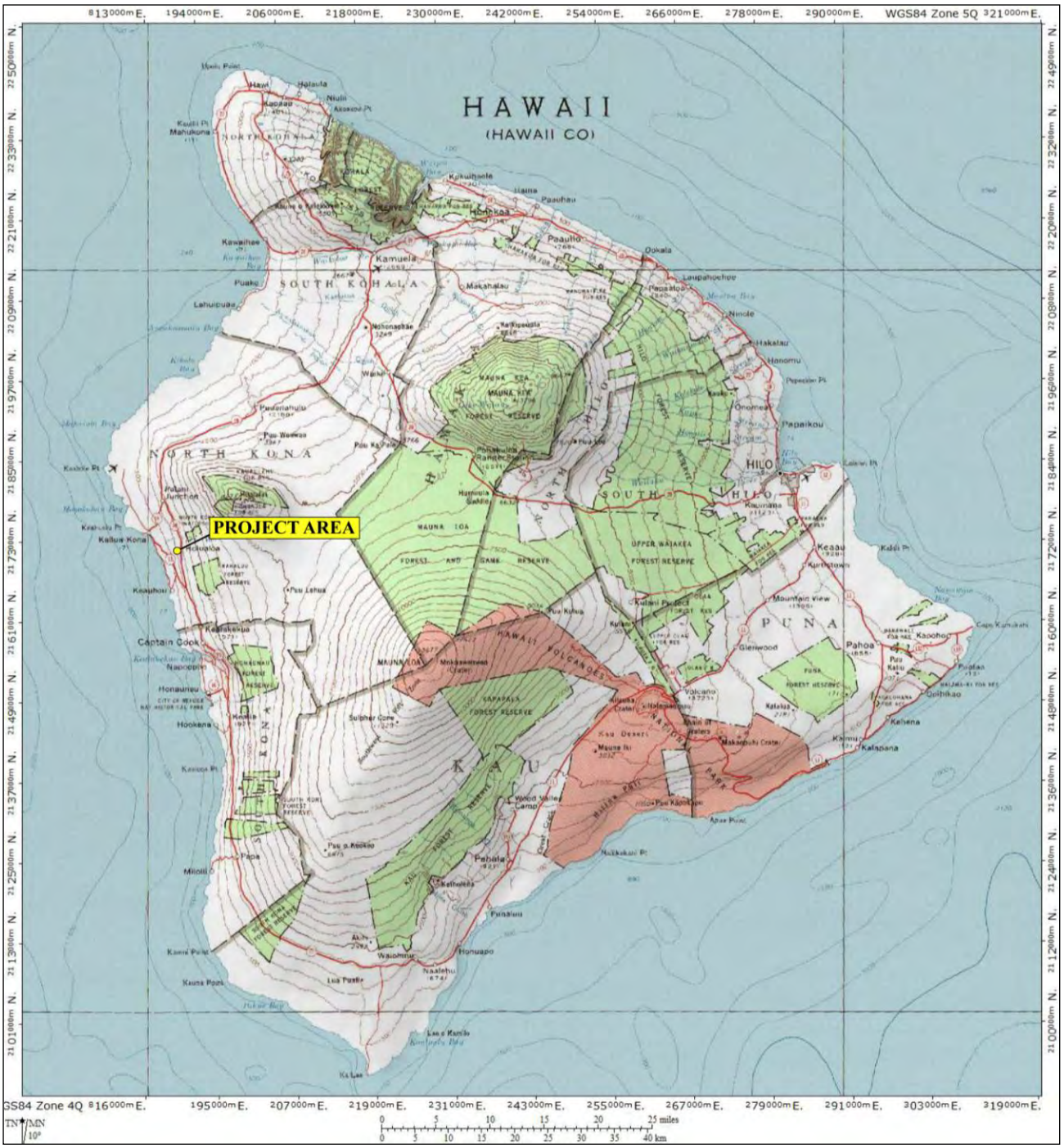

Figure 1: 5,500 K-Series Map of Hawai‘i Island Showing Location of Site Project Area (National Geographic Topo!, 2003. Sources: National Geographic Society, USGS).

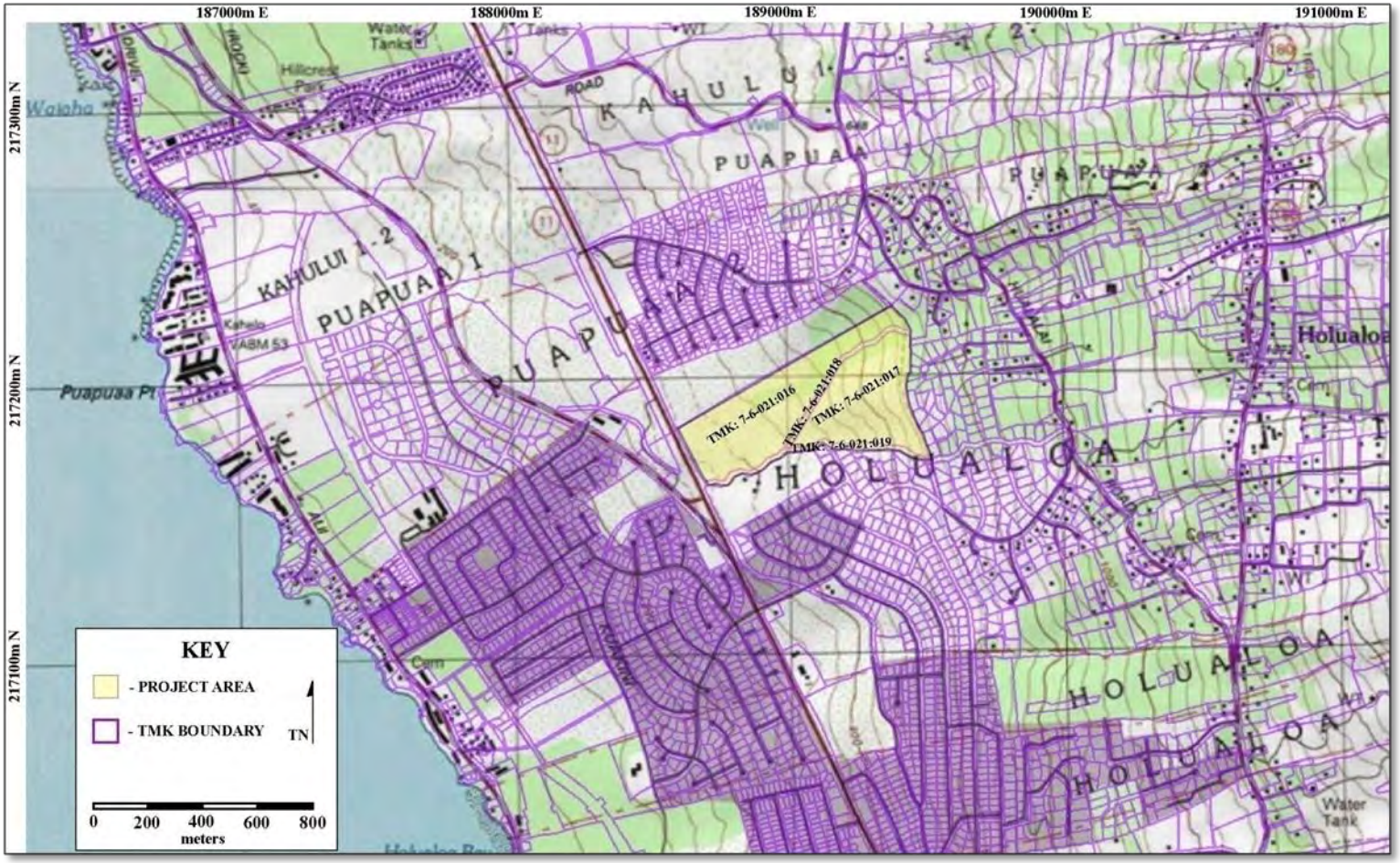

Figure 2: 7.5-Minute Series USGS Topographic Map Showing the Location of Project Areas and TMK Parcels (Kealakekua Quadrangle. ESRI, 2013. Data Sources: National Geographic and County of Hawai‘i Planning Department, 2019).

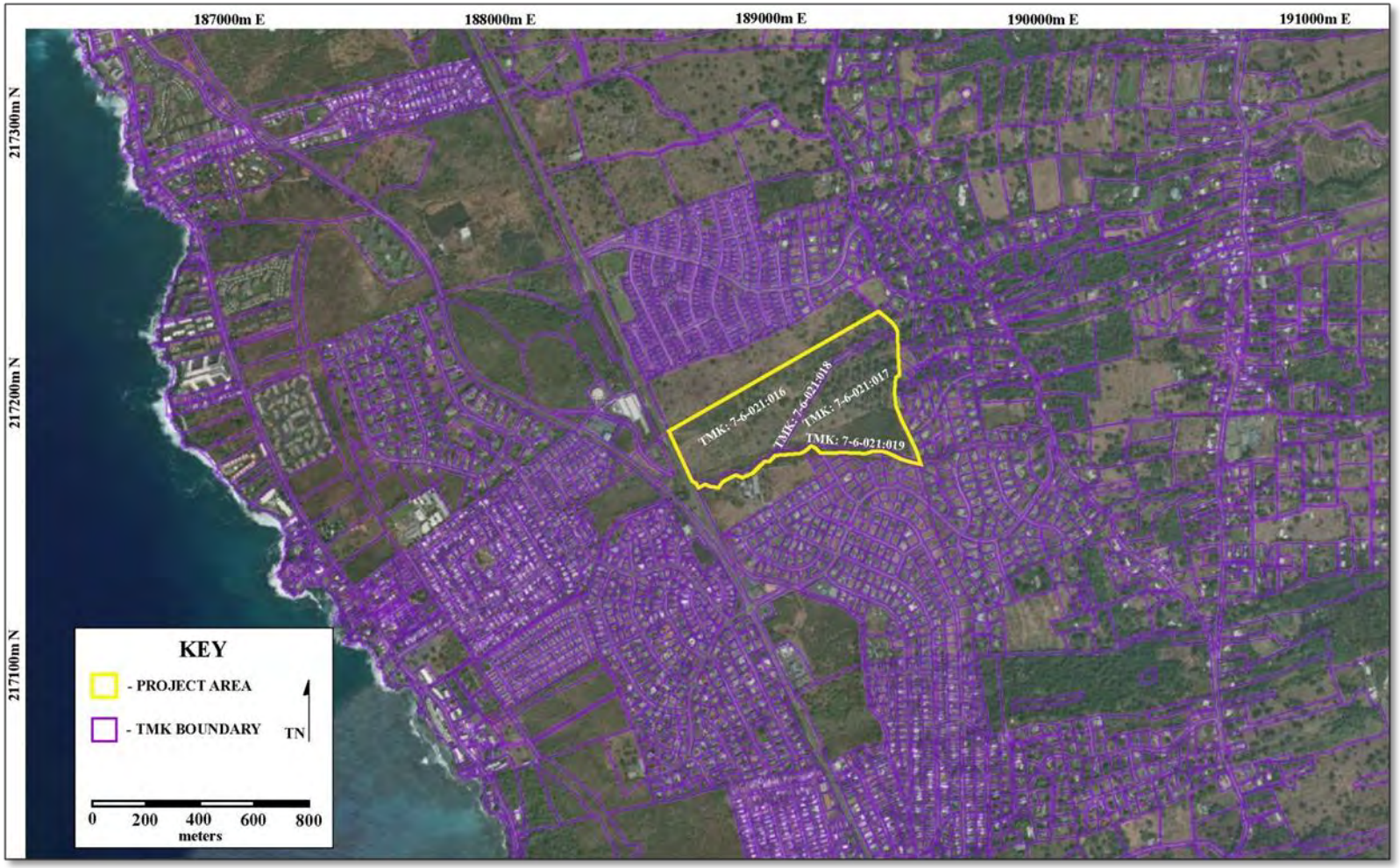

Figure 3: Aerial Photograph Showing Project Area, Hōlualoa, HI, Zone 5 North, 189445 m E, 2171790 m N. (ESRI, 2013 Image. Data Sources: Digital Globe, GeoEye, Earthstar, USDA, and USGS).

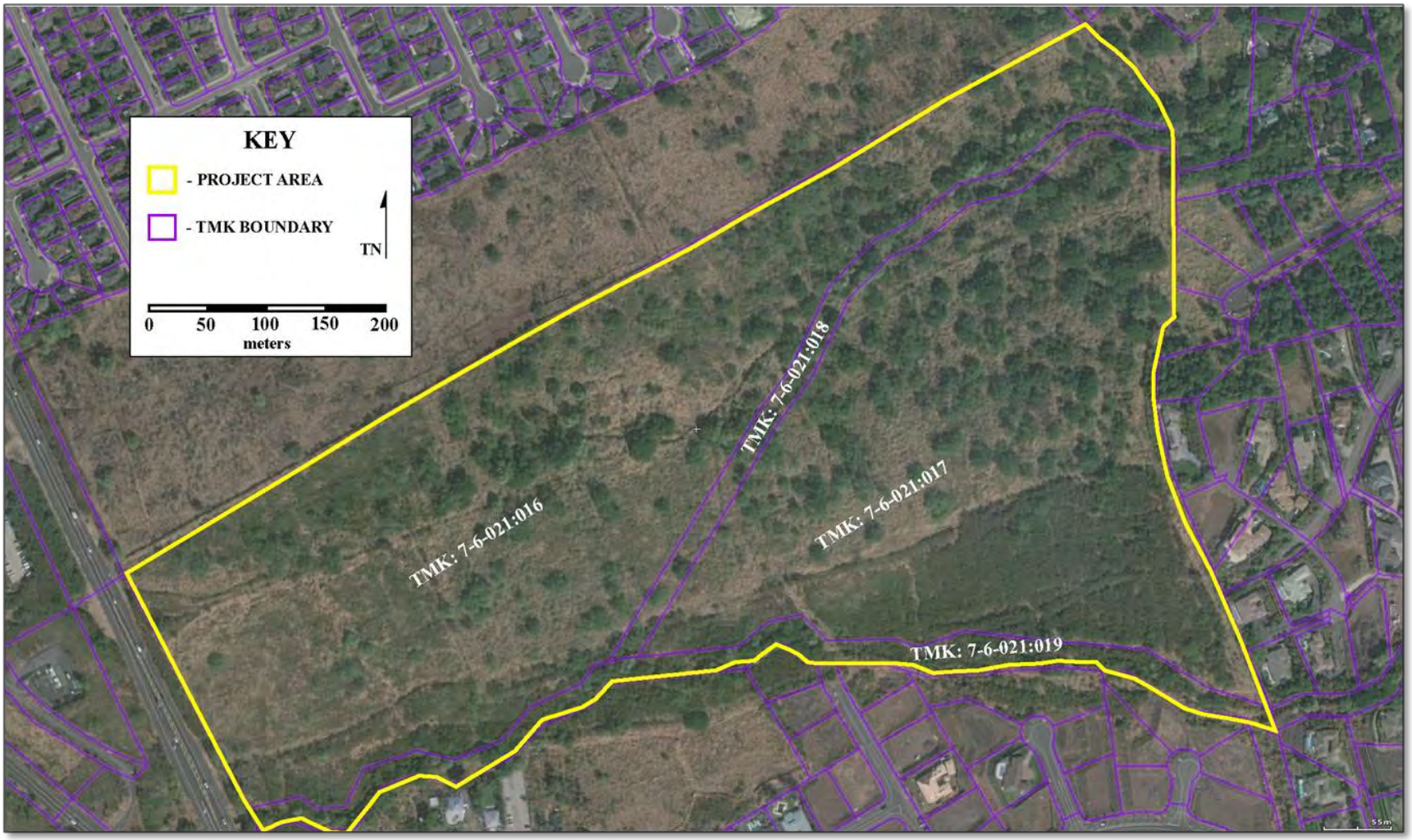

Figure 4: Aerial Photograph Close-Up Showing Project Area, Hōlualoa, HI, Zone 5 North, 189445 m E, 2171790 m N. (ESRI, 2013 Image. Data Sources: Digital Globe, GeoEye, Earthstar, USDA, and USGS).

The project area ground surface is a Hualālai lava flow dating between 5,000 and 10,000 years before present (ybp) (Wolfe and Morris 1996). Soil in the project area is Punalu‘u Series (rPYD series) extremely rocky peat with six to twenty percent slopes (Sato 1973:48). The majority of the project area has been bulldozed in the past and the present ground surface is rocky soil.

Rainfall in the project area is very low, less than thirty inches per year. There is a seasonal gulch along the southern edge of the project area. This region is extremely dry, hot, and somewhat barren except for thick California grass (*Urochloa mutica*), Guinea grass (*Megathyrsus maximus*), and some *koa haole* (*Leucaena leucocephala*), *kiawe* (*Prosopis pallida*), and *kukui* nut (*Aleurites moluccana*) trees (Starr Environmental 2016).

HISTORICAL AND CULTURAL CONTEXTS

Kona is divided into two sections: North Kona or *Kona ‘akau*, and; South Kona, or *Kona hema* (Maly 1996). *Kona ‘akau* was further subdivided into north (called *Kekaha*) and south (called *Konakai‘ōpua*) areas, with the division between the two at the *ahupua‘a* of Keahuolu. The project area is in Hōlualoa 1st Ahupua‘a (Figure 5) within the area of *Konakai‘ōpua* in *Kona ‘akau*. Hōlualoa means (literally) “long sled course” (Pukui *et al*. 1974:48). Hōlualoa 1st is a traditional *ahupua‘a* stretching from the ocean to the foot of Hualālai in the uplands. The coastline of Hōlualoa 1st Ahupua‘a is primarily low rock cliffs.

Very little is recorded of Hōlualoa Ahupua‘a in traditional oral accounts. *The Heart Stirring Legend of Ka-Miki*, published in the Hawaiian language newspaper *Ka Hoku o Hawaii* and translated by Maly (1993) contains the only description of Hōlualoa. The legend is set in the 13th century but also reflects more recent influences (Maly and Maly 2002: 17).

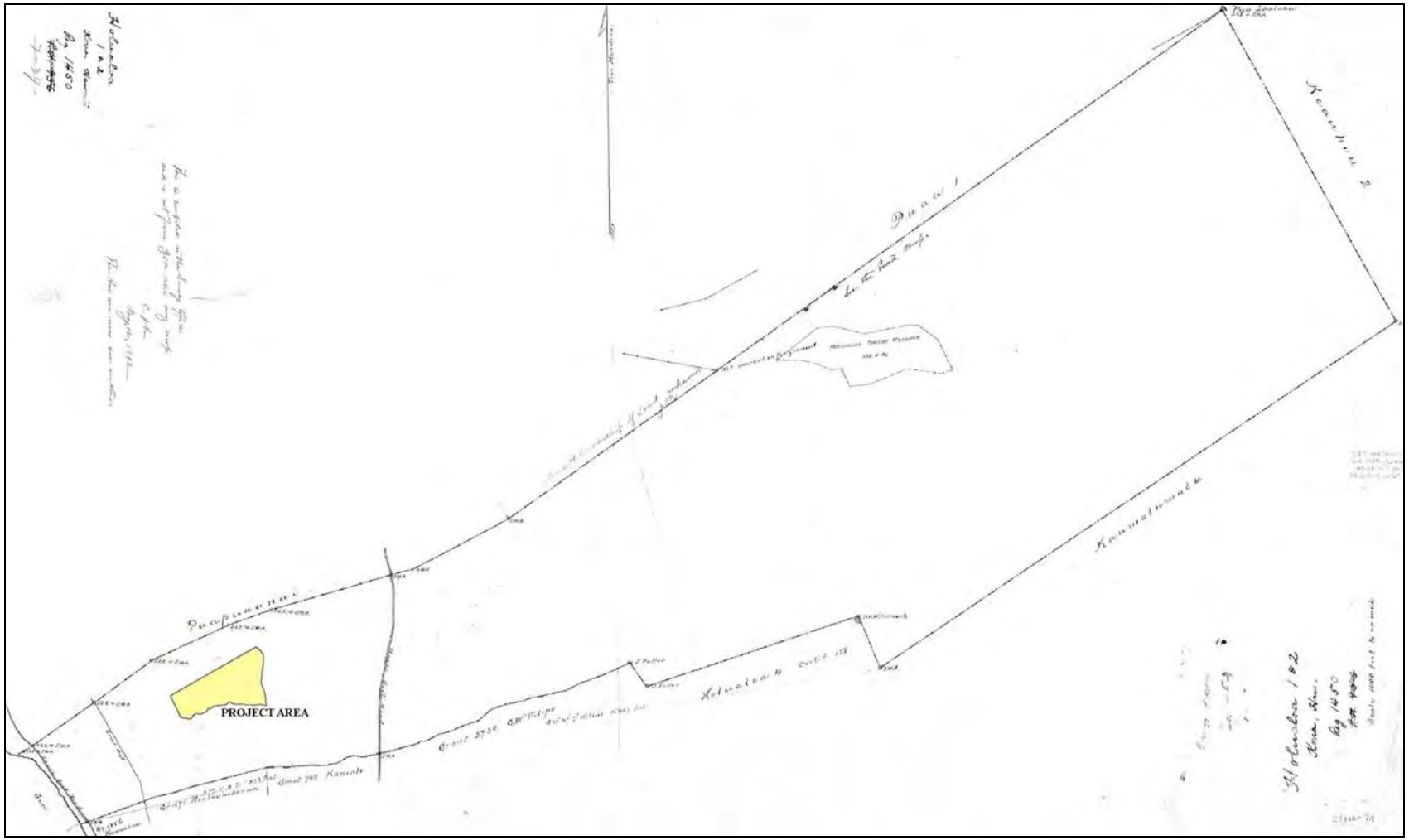

Figure 5: Map of Hōlualoa 1st and 2nd Ahupua‘a Showing Location of Project Area (Alexander 1855).

According to the narrative,

> The lands of Hōlualoa were named for the chief of that name; both Hōlualoa and Puapuaʻa were high chiefs, who controlled the lands from mountain to sea, which bear their names… Kaluaokalani served as a priest of Hōlualoa at the temple of Pākiha. This *heiau* was near the contest field of Hōlualoa… The lands of this region are named for various *aliʻi*, all of whom were related. When the chief Hōlualoa took up the challenge against Kepakaʻiliʻula on behalf of the Kona chiefs, Hōlualoa called upon his god *Kālaipāhoa* to assist him in his battle… Hōlualoa was the first chief to call upon the god *Kālaipāhoa*, and this was the beginning of this gods' use by the chiefs of Hawaiʻi [Maly 1993:208-209].

PRE-CONTACT ERA

Hōlualoa, Kona, and much of the leeward side of Hawaiʻi Island, while well populated at the time of European Contact, were settled later than the windward side. This in part may be due to the fertile land, numerous streams, and abundant rainfall on the windward side (Maly 1996:3). Many archaeologists believe that Hawaiʻi Island was first settled around A.D. 1,000 by people sailing from the Marquesas (Athens et al. 2014; Dye 2011; Kahn et al. 2014; Kirch 2011; Kirch and McCoy 2007; McCoy 2005 and 2007; Mulrooney et al. 2011; Reith et al. 2011; Wilmhurst et al. 2011a and 2011b).

During early settlement of the leeward side permanent habitations were established in Kona concentrated along the shoreline and lowland slopes (Cordy 1981, 1995; Schilt 1984). Informal fields were cleared at higher elevations where rainfall was higher. Between AD 1200 and 1400, habitation and agriculture expanded across the slopes and coastal area of Hualālai (Burtchard 1995; Cordy 1995). The initial construction of the Kona Field System (KFS) began approximately between AD 1400 and 1600 (Schilt 1984). The development of these extensive formal walled fields coincides with a dramatic population increase and with the development of the stratified chiefdom structure which is reflected through large residential complexes and *heiau* (Burtchard 1995; Cordy 1981; Haun *et al*. 1998; Hommon 1986; Schilt 1984). Thus, there was a need to expand the previously limited agricultural base. The royal centers and larger heiau were in place by AD 1600 to 1800 reflecting the growth in power of the rulers and chiefs in the region (Barrera 1971; Hammatt and Folk 1980). Royal centers were located at Kailua, Hōlualoa, Kahaluʻu, Kealakekua, and Honaunau (Cordy 1995).

The region of Hōlualoa developed into a royal center in the late 1600s to early 1700s under the reigns of Keakamahana (reigned 1680-1700) and Keakealaniwahine (reigned 1700-1720) (Cordy 2000:244). Many *ʻaliʻi* and *konohiki* residences and numerous religious sites are known to have existed here. The majority of the heiau and royal residences were constructed along or near the coast, most notably at Kamoa Point south of the project area. The royal center at Hōlualoa was eclipsed in the second half of the 1700s by the royal center in the Kahaluʻu and Keauhou region.

The Kona Field System

The Kona Field System extends north at least to Kaʻu Ahupuaʻa and south to Honaunau, west from the coastline and east to the forested slopes of Hualālai (Cordy 1995). During his travels in 1823, William Ellis noted the extensive field system divided with "low stone walls, made of fragments of lava", producing "bananas, sweet potatoes, mountain taro, tapa trees, melons and sugar cane" and "flourishing luxuriantly in every direction" (Handy and Handy 1940:114 and 162). Many of the archaeological projects conducted within Kona deal with components of the Kona Field System (Cordy 1995; Newman 1970; Schilt 1984).

The *kula* zone of the Kona Field System is from sea level to 150 m amsl. This zone is associated with habitations along the shoreline and cultivation of sweet potatoes (*uala*), paper mulberry (*wauke*), and gourds (*ipu*). Clearing mounds, planting depressions, planting mounds, planting terraces, and modified outcrops are common agricultural features in the *kula* zone (Hammatt and Clark 1980; Hammatt and Folk 1980; Haun *et al*. 1998; Schilt 1984). Permanent habitation including royal and high chiefly centers as well as non-agricultural activities such as fishing, ceremonies and burial practices were usually concentrated along the shoreline zone portion of the *kula* zone.

The higher elevation zones are the *kaluʻulu zone, ʻapaʻa* zone and the *ʻamaʻu* zone. The current project area is in the *kaluʻulu* zone. This wetter region is above 150 m amsl where bread fruit, sweet potatoes (*Ipomoea batatas*), *ti*, (*Cordyline fruticosa*) *wauke* (*Broussonetia papyrifera*), *taro* (*Colocasia esculenta*), sugar cane (*Saccharum* sp.), and other arboreal crops were grown (Kelly 1983, Menzies 1920). The *ʻapaʻa* zone is above the *kaluʻulu* zone. Hawaiians cultivated melons, sweet potatoes, *ti,* bananas, *taro*, *wauke* and sugar cane in fields with low stone walls. The highest zone, the *ʻamaʻu* zone, was used to grow bananas and plantains in walled fields. The *ʻapaʻa* zone and the *ʻamaʻu*

zone were also used to collect timber and catch birds therefore temporary habitations were constructed.

POST-CONTACT ERA

During the post-contact era, the Kona Field System was exploited and the planting of coffee, sugar, sisal, citrus, and cotton took over original Hawaiian crops until eventually the land was used for cattle pasture. The first cattle and sheep were brought to the island by Vancouver in 1793 and 1794 (Vancouver 1967). Horses, mules, oxen, goats, and donkeys were brought shortly after. Feral cattle, sheep, and goats overran agricultural fields by 1813 to 1815 (Ellis 1963: 291; Wilkes 1970: 204). By 1848, in the Kona District, a Great Wall (the Kuakini Wall) was constructed from Lanihau to ʻŌnouli to keep them away from homes and agricultural areas (Maly and Maly 2001:286). Formal cattle ranching began in the Kona region in the mid-1800s.

The Kona landscape evolved rapidly with the turn of the century. The rapid growth of the sugar industry produced the Kona Sugar Company in 1899. A railroad was built in 1901 to help sustain this influx in produce. It was later used to haul lumber and freight along with the sugarcane. The rail line was seven miles long and extended from Hōlualoa to Keōpuka (Figure 6). Cotton, tobacco, and sisal were grown in the dryer lands below the railroad (Kelly 1983).

The changing subsistence and trade regimes developed by incoming European and American settlers, as well as other historical factors, caused a depopulation of the coastal areas of Kona. Ranches were established at middle and upper elevations, and farms were established in the uplands where rainfall was higher and the temperatures were cooler. Cattle ranching and clearing for sugar cane and coffee removed many of the endemic species of plants. The suite of vegetation that existed prior to the pre-Contact era were replaced by *koa haole* (*Leucaena leucocephala*), *kiawe* (*Prosopis pallida*), and other newly introduced invasive plant species.

Figure 6: Portion of 15-Minute Series USGS Topographic Map Showing Location of Railroad and Project Area (USGS 1928).

Schools, churches, stores, and other businesses were also established in the uplands. During the late 1800s and early 1900s, coastal Kona was no longer the densely populated sociopolitical center it once was. It became a small cluster of houses along the trail from Kailua Bay to Keauhou (Tomonari-Tuggle 1993:15). Homesteads, ranches, and plantations developed in the uplands during this period as reflected in the pattern of Land Commission Awards (LCA) and Land Grants (LG) recorded during the Māhele (Escott and Escott 2018).

The project area is just *makai* (west) of most of the land commission awards and is at the same elevation as portions of the land grants in the region. Based on historic documents, the project area and surrounding lands were likely being used for subsistence and commercial agriculture, as well as for cattle pasture from the mid to late 1800s. The project area might have been used later than surrounding lands because of its steep slopes and very rocky soil, but based on aerial photographs, the project area was bulldozed sometime around the 1950s in preparation for commercial agriculture.

THE MĀHELE

The Land Commission awarded the majority of Hōlualoa 1st and 2nd Ahupuaʻa to Victoria Kamāmalu Kaʻahumanu IV, *Kuhina Nui* of Hawaiʻi Island and Crown Princess of Hawaiʻi as Land Commission Award (LCA) Number 7713, ʻApana 43 (Figure 7). Several smaller LCA and LG properties were also recorded in the upland region of Hōlualoa 1st and 2nd Ahupuaʻa (Figure 8). Twenty four Land Commission awards were recorded in Hōlualoa 1st Ahupuaʻa, the ahupuaʻa where the project area is located (Table 1).

A portion of LCA #3660 to John G. Munn makes up a thin strip of land located through the center of the current project area. With the notable exception of LCA #3660 and a few other large LCAs, the average award was 2.8 acres, most (n=16) were for less than 3.0 acres. Three Land Grants (LG #1592, 1602, and 3630) were also recorded in Hōlualoa 1st and 2nd Ahupuaʻa. LG #1592 was a 25.0-acre parcel sold to Kealalio and LG #3630 was a 38.2-acre parcel sold to W.H. Cromwell. Almost all of the awards and grants were used as subsistence and commercial farm land, and some were used to pasture cattle (Escott and Escott 2018).

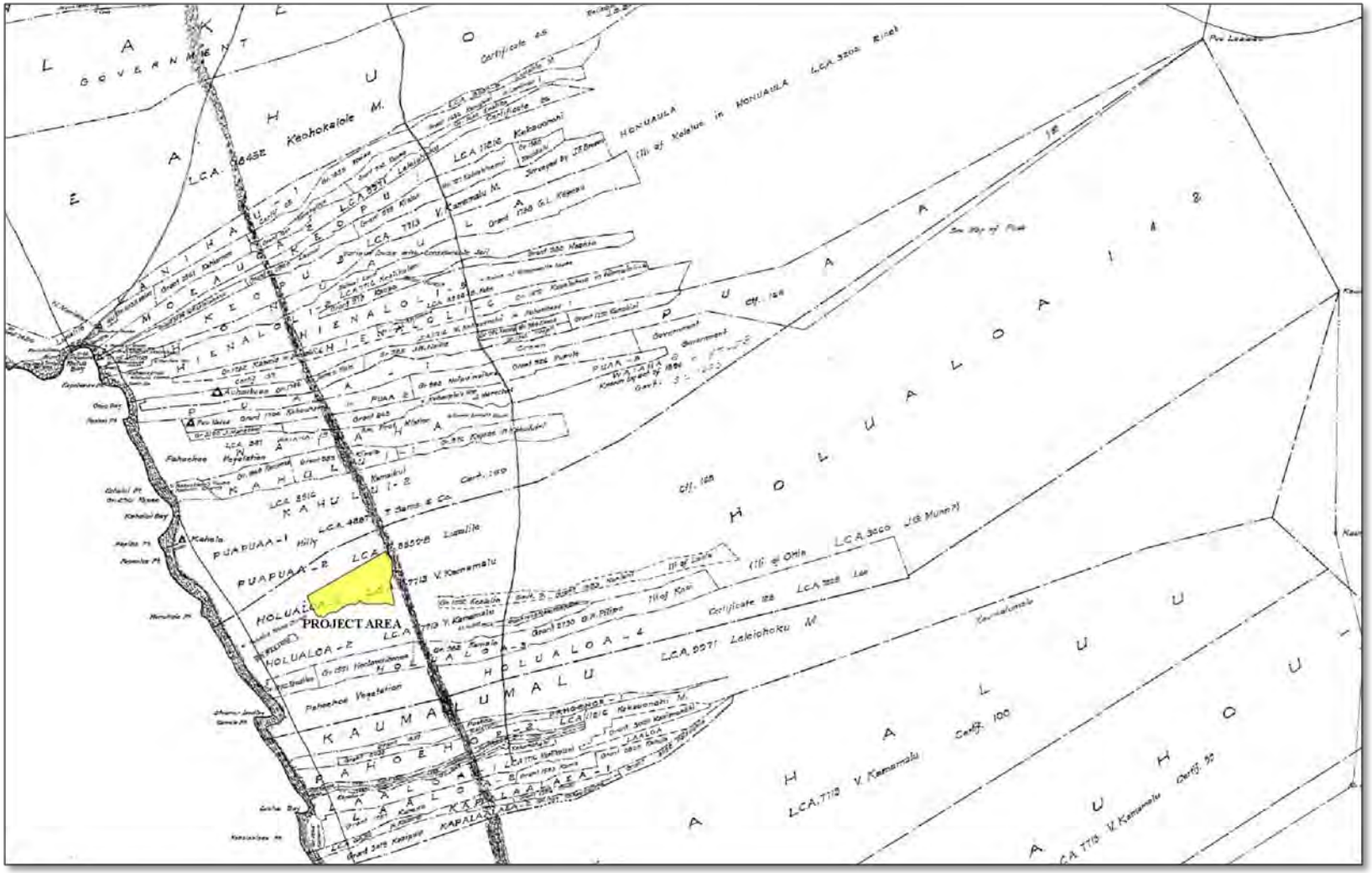

Figure 7: Portion of Kailua Section, North Kona Map Showing Location of LCA 7713 and Project Area (Aki 1952).

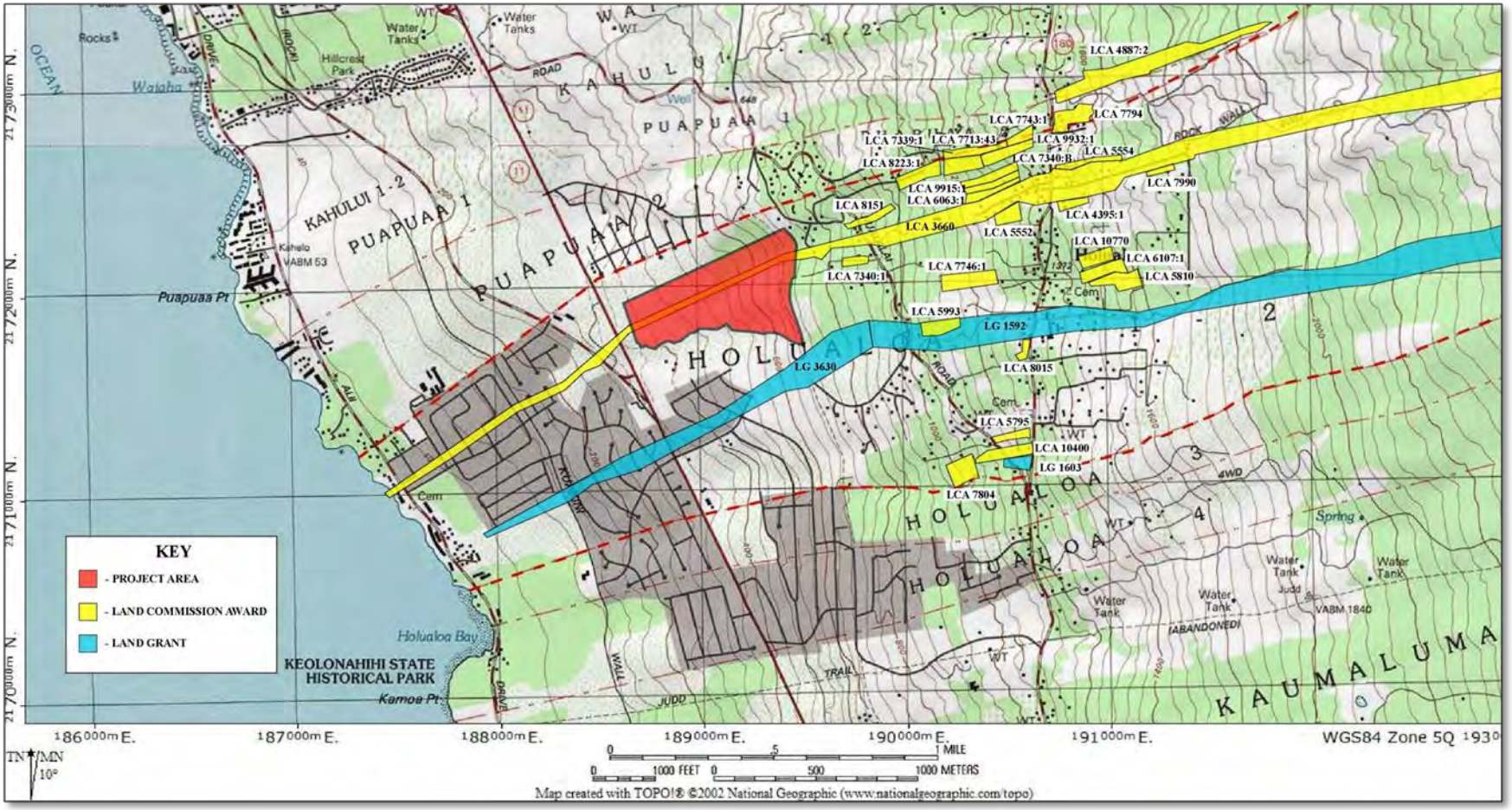

Figure 8: 7.5-Minute Series USGS Topographic Map Showing Location of Land Commission Awards, Land Grants, and the Project Area (National Geographic Topo!, 2003, Kailua Quad. Data Sources: National Geographic Society, USGS).

Table 1: Land Commission Awards Recorded in Hōlualoa 1st and 2nd Ahupuaʻa.

LCA#	AWARDED TO	AHUPUAʻA	ACRES
3660	John G. Munn	Hōlualoa 1st	111.5
4395	Kekoi	Hōlualoa 1st	1.7
5552	Kauila	Hōlualoa 1st	1.9
5554	Keawekolohe	Hōlualoa 1st	11.27
5795	Keliikanakaole	Hōlualoa 2nd	2.2
5810	Kaopukauila	Hōlualoa 1st	1.74
5993	Leipalapala	Hōlualoa 2nd	2.0
6063	Hāna	Hōlualoa 1st	2.9
6107	Naai	Hōlualoa 1st	3.94
7339	Kuaana	Hōlualoa 1st	4.15
7340	Kama 2	Hōlualoa 1st	2.5
7340:B	Kama 1	Hōlualoa 1st	1.3
7443	Kalimapaa	Hōlualoa 1st	1.94
7713	Kamamalu	Hōlualoa 1st & Hōlualoa 2nd	Large
7746	Kamahalo	Hōlualoa 1st	5.0
7794	Kauakini	Hōlualoa 1st	1.8
7990	Pupuka	Hōlualoa 1st	1.1
8015	Aipo	Hōlualoa 2nd	1.4
8151	Hehena	Hōlualoa 1st	2.3
8223	Ikaiaka	Hōlualoa 1st	3.5
9915	Limahana	Hōlualoa 1st	2.42
9932	Lumaawe	Hōlualoa 1st	2.98
10770	Puuone	Hōlualoa 1st	3.06
10400	Naaimakaohi	Hōlualoa 1st & Hōlualoa 2nd	3.5

PREVIOUS ARCHAEOLOGICAL STUDIES

There are at least 26 previous archaeological reports for lands near the current project area, including studies in Puapuaʻa 2nd and Hōlualoa 1st, 2nd, and 3rd Ahupuaʻa (Table 2 and Figure 9). The studies were conducted from the coast to roughly 1,460 ft amsl and encompass the *kula* region (0-500 ft), the *kaluʻulu* region (500-1,000 ft), and the lower portions of the *ʻāpaʻa* region (1,000-2,500 ft). Results of the previous archaeological studies are summarized below by elevation: studies numbered 1 through 15 in Table 2 and Figure 9 are situated from the coast to Queen Kaʻahumanu Highway (0-360 ft amsl), studies 16 through 21 are located from above the Queen Kaʻahumanu Highway to just below Hualālai Road (306-760 ft amsl), and studies 22 through 24 are above Hualālai Road to just above Māmalahoa Highway (1,100-1,460 ft amsl).

Table 2: Inventory of Previous Archaeological Investigations.

Project Number (Figure 8)	Reference	Type of Study	Area in Acres	Results
1	Landrum et al. 1990	Archaeological Inventory Survey	N/A	46 Sites
1	Calis et al. 2004	Archaeological Data Recovery	N/A	10 Sites
2	Carlson & Rosendahl 1990	Archaeological Inventory Survey	65	64 Sites
3	Haun et al. 1998	Archaeological Inventory Survey	15	31 Sites
4	Hammatt & Folk 1981	Archaeological Survey	20	20 Sites
4	Hammatt et al. 1986	Archaeological Survey & Excavations	20	21 Sites
5	Haun & Henry 2001	Archaeological Data Recovery	1.59	1 Site
6	Escott 2013	Archaeological Inventory Survey	1.962	2 Sites
7	Sinoto 1979	Archaeological Reconnaissance Survey	6	Rock Walls
8	Hammatt 1979b	Archaeological Survey	22	3 Sites
9	Hammatt 1979c	Archaeological Survey	23	39 Sites
10	Conolly & Gunness 1979	Archaeological Reconnaissance Survey	46.8	80 Sites
10	Hammatt 1979a	Archaeological Inventory Survey	46.8	11 Sites
10	Hammatt 1980	Archaeological Survey & Excavation	103	88 Sites
11	Nelson et al. 205	Archaeological Inventory Survey	28	22 Sites
12	Rosendhal 1978	Archaeological Reconnaissance Survey	2.5	1 Site

Project Number (Figure 8)	Reference	Type of Study	Area in Acres	Results
12	Soehren 1980a	Archaeological Reconnaissance Survey	n/a	7 Sites
12	Wolforth et al. 2000	Archaeological Inventory Survey	8	7 Sites
13	Barrera 1995	Archaeological Reconnaissance Survey	17	3 + several ag. mounds
13	Haun & Henry 2000	Archaeological Inventory Survey	17	12 (104 Features, 82 of Which Were Agricultural)
14	Rosendahl 1989	Archaeological Field Inspection	6	Modified Outcrops
15	Schilt 1984	Archaeological Study	17	134 Sites
16	Walker & Rosendahl 1988	Archaeological Reconnaissance Survey	104	67 Sites
16	Graves & Goodfellow 1993	Archaeological Data Recovery	104	58 Sites
16	Maly & Rosendahl 2006	Archaeological Preservation Plan	104	67 Sites
17	Hammatt et al. 1992	Archaeological Survey	174	71 Sites
18	Soehren 1980b	Archaeological Reconnaissance Survey	16	1 Site
19	Rechtman 2006	Archaeological Inventory Survey	1.008	2 Sites
20	Rosendahl 1988	Archaeological Reconnaissance Survey	17	17 Sites
20	Fager & Graves 1993	Archaeological Inventory Survey	17	17 Sites
21	Dircks et al. 2013	Archaeological Inventory Survey	10.266	1 Site (149 Historic to Modern Farming Features)
22	Desilets et al. 2004	Archaeological Inventory Survey	11.7	1 Homestead Features
23	Rechtman 2013		29	24 Sites
24	Clark & Rechtman 2006	Archaeological Inventory Survey	2.7	6 Historic Era Sites
25	Escott & Escott 2018	Archaeological Inventory Survey	5.0	22 Pre-Contact and Historic Era Sites
26	Escott & Escott 2020	Archaeological Inventory Survey	73.122	18 Pre-Contact and Historic Era Sites 1 Isolated Find (Petroglyph)

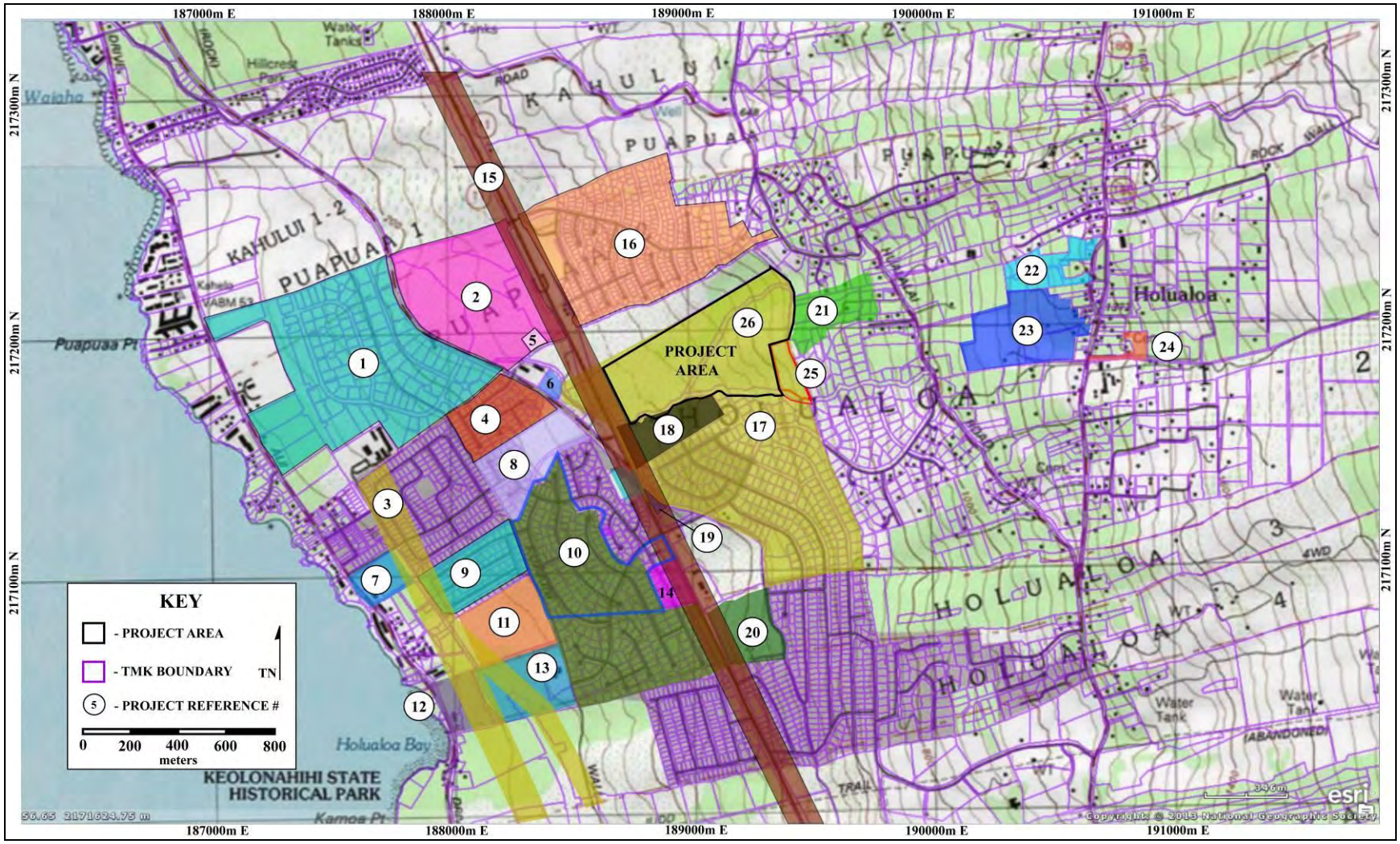

Figure 9: 7.5-Minute Series USGS Topographic Map Showing Location of Previous Archaeological Studies and Project Area (Kealakekua Quad, ESRI, 2013. Data Sources: National Geographic Society, USGS).

REGIONAL PREVIOUS ARCHAEOLOGICAL STUDIES

1. Landrum et al. 1990, and Calis et al. 2004. PHRI, Inc. conducted an archaeological inventory survey (Landrum et al. 1990) and SCS, Inc. conducted data recovery investigations (Calis et al. 2004) at the Kahakai development project. The project area is located within the lower elevations of Puapuaʻa 2nd Ahupuaʻa. Pre-Contact era to early post-Contact era cave shelters, agricultural rock clearing mounds, burials, shrines, and a possible heiau were identified during the AIS study. A heiau complex, several burials, and five permanent habitation sites were recommended for preservation. All of the preservation sites are near the coast.

2. Carleson and Rosendahl 1990. PHRI, Inc. conducted an archaeological inventory survey of 65 acres between Kuakini and Queen Kaʻahumanu highways in Puapuaʻa 2nd Ahupuaʻa. Their study recorded 64 archaeological sites including pre-Contact era habitation, agricultural, and burial sites. Seven sites were assessed as significant and recommended for preservation (Carleson and Rosendahl 1990: 34).

3. Haun et al. 1998. PHRI, Inc. conducted an archaeological inventory survey of the proposed Aliʻi Drive corridor through several ahupuaʻa. Numerous pre-Contact era site complexes were recorded in Puapuaʻa 2nd and Hōlualoa 1st through 4th Ahupuaʻa. The site complexes included a large number of agricultural features, as well as habitation, burial, and ceremonial features.

4. Hammatt and Folk 1981, and Hammatt et al. 1986. Two archaeological surveys were conducted on a 20-acre parcel of below Kuakini Highway. The first study recorded 20 sites, and the second recorded 21 sites. None of the sites were recommended for preservation (Hammatt and Folk 1981: ii, and Hammatt et al. 1986: 87). The report also recommended that the single documented burial be relocated.

5. Haun & Henry 2001. Haun and Associates conducted an archaeological data recovery study at a c-shaped enclosure located on 1.59 acres of land below Queen Kaʻahumanu Highway

6. Escott 2013. SCS conducted an archaeological study on1.962 acres of land near the intersection of Kuakini and Queen Kaʻahumanu highways. Two historic era ranch walls were recorded during the study.

7. Sinoto 1979. Aki Sinoto recorded several Historic era ranch rock walls on a six acre parcel of land just mauka of Ali‘i Drive.

8. Hammatt 1979b. The Archaeological Research Center, Inc. conducted an archaeological survey of 22 acres just south of Kuakini Highway. Three archaeological sites were recorded during the study. None of the sites were recommended for preservation (Hammatt 1979b: ii, and 10).

9. Hammatt 1979c. The Archaeological Research Center, Inc. conducted an archaeological survey of 23 acres located in the near coastal portion of Hōlualoa 1st and 2nd Ahupua‘a. Thirty nine archaeological sites were recorded during the study. The report recommended that all burials, including a known cemetery site be relocated (Hammatt 1979a: 5). None of the remaining sites (pre-Contact era habitation and agriculture sites) were recommended for preservation in place.

10. Conolly and Gunness 1979, and Hammatt 1979a and 1980. The Archaeological Research Center, Inc. conducted an archaeological survey of 103 acres within the near coastal portions of Hōlualoa 1st through 4th Ahupua‘a (Hammatt 1980). One hundred and thirty six archaeological sites were recorded on the project area. They included pre-Contact era habitation, agriculture, burial, and a ceremonial sites. The Hammatt report recommended that a heiau (Site 6661) was significant and should be preserved in place (Hammatt 1980: 4). The report also recommended that the single documented burial be relocated to the perimeter of heiau (Site 6661) and preserved. No other sites were recommended for preservation.

11. Nelson et al. 2005. An archaeological inventory survey was conducted by Rechtman Consulting on 28.0 acres located in the near coastal portion of Hōlualoa 2nd Ahupua‘a. A total of 22 sites containing 150 features were recorded. The sites were primarily pre-Contact era agricultural and habitation sites, though five burial sites, a possible heiau, and a trail were also documented within the project area.

12. Rosendahl 1978, Soehren 1980a, Wolforth et al. 2000. PHRI conducted an archaeological inventory survey of eight acres of coastal Hōlualoa 3rd Ahupua‘a and recorded seven archaeological sites including three Historic era rock walls, three residential sites, and Hikapaia Heiau.

13. Barrera 1995, Haun & Henry 2000. Barrera (1995) recorded a possible burial platform, two habitation site, agricultural rock clearing mounds and modified outcrops during a reconnaissance survey of 17 acres in near coastal Hōlualoa 2nd Ahupuaʻa. Haun and Associates conducted an archaeological inventory survey of the property and recorded 12 sites with 104 features (Haun and Henry 2000:14). The majority of features (n=82) were pre-Contact era agricultural rock clearing mounds. Eleven permanent habitation and one temporary habitation feature were also recorded during the study.

14. Rosendahl 1989. PHRI conducted an archaeological field inspection of 6.0 acres of land just below Queen Kaʻahumanu Highway in Hōlualoa 2nd Ahupuaʻa. Several modified outcrops were recorded in the letter report. There were no other archaeological features identified on the project area.

15. Schilt 1984. The Bishop Museum conducted an archaeological study of the Kuakini Highway Realignment Project located roughly along present day Queen Kaʻahumanu Highway and recorded 39 sites Puapuaʻa 2nd and Hōlualoa 1st and 2nd Ahupuaʻa. Twenty two of the sites were pre-Contact to early post-Contact era agricultural gardens and modified outcrops (rock clearing). There were also traditional habitation platforms and trails, as well as Historic era roads and walls recorded during the study.

16. Walker and Rosendahl 1988, Graves and Goodfellow 1993, and Maly and Rosendahl 2006. An archaeological reconnaissance survey (Walker and Rosendahl 1988), an archaeological data recovery study (Graves and Goodfellow 1993), and an archaeological preservation plan (Maly and Rosendahl 2006) were conducted by PHRI, Inc. for 104 acres in the upland region of Puapuaʻa 2nd Ahupuaʻa. A total of 67 sites were documented within the project area, including traditional (KFS) sites, temporary habitation sites, three burials, and a *heiau*. The archaeological preservation plan recommended that the three burials be relocated to the *heiau* site, and that the *heiau* be preserved as a formal historic preservation area (Maly and Rosendahl 2006).

17. Hammatt et al. 1992. An archaeological survey was conducted by Cultural Surveys Hawaiʻi on 174 acres of land in the upland region of Hōlualoa 1st, 2nd, and 3rd Ahupuaʻa. The project area lands had been heavily bulldozed during the modern era for ranching and agricultural purposes. Despite the bulldozing, seventy one sites were recorded during the study, including temporary habitation features, rock walls, agricultural features, and

three burial sites. Many of the sites were determined to be associated with Historic era ranching and agriculture.

18. Soehren 1980b. Soehren conducted an archaeological reconnaissance survey of 16.0 acres above Queen Ka‘ahumanu Highway in the inland region of Hōlualoa 1st Ahupua‘a (Soehren 1980b). A single enclosure was identified during the survey.

19. Rechtman 2006. An archaeological inventory survey was conducted by Rechtman Consulting, LLC on a roughly one-acre parcel located *makai* of Queen Ka‘ahumanu Highway in Hōlualoa 2nd Ahupua‘a. Two rock walls were recorded on the project area. The report recommended no further work at the wall sites.

20. M. Rosendahl 1988, Fager & Graves 1993. Fager and Graves (1993) conducted an archaeological inventory survey of 17.0 acres just mauka of Queen Ka‘ahumanu Highway in Hōlualoa 3rd Ahupua‘a. Seventeen sites containing 27 pre-Contact to early post-Contact era agricultural features, including rock mounds, modified outcrops, C-shaped enclosures, terraces, walls, and rock enclosures, were recorded.

21. Dircks et al. 2013. Rechtman Consulting conducted an archaeological inventory survey of 10.266 acres of land located between 840 and 920 ft amsl in Hōlualoa 1st and 2nd Ahupua‘a. One Historic era to modern era homestead/agriculture site (Miyose Farm) containing 149 features was recorded during the survey.

22. Desilets et al. 2004. Desilets et al. (2004) conducted an archaeological inventory survey of 11.7 acres of land in the *‘āpa‘a* region of Hōlualoa 1st Ahupua‘a. A single site associated with Historic era and modern era homesteads, commercial agriculture (coffee), and ranching was recorded. Features included rock walls, roads, coffee terraces, and buildings.

23. Rechtman 2013. Rechtman Consulting conducted and archaeological inventory survey of 29 acres of land located in the *‘āpa‘a* region of Hōlualoa 1st Ahupua‘a. Twenty four sites were recorded. The majority of the sites were associated with Historic era and modern era homesteads, commercial agriculture. Features included rock walls, roads, and remnants of structures. A single pre-Contact era to early post-Contact era residential and agricultural site was also recorded.

24. Clark & Rechtman 2006. Rechtman Consulting conducted an archaeological inventory survey of 2.7 acres of land located in the *ʻāpaʻa* region of Hōlualoa 1st Ahupuaʻa. Six sites were recorded, including five ranch walls and an area of coffee terraces.

A number of conclusions can be made from the previous archaeological studies. A primary conclusion is that the majority of habitation features, especially permanent habitation features, are located from the coast to about 360 ft amsl, below the present day Queen Kaʻahumanu Highway. The same is true of ceremonial features, burials, and, to a lesser extent, agricultural features. The density of agricultural features and habitation features, mostly temporary habitation features, in the upland regions between 360 ft amsl and 700 ft amsl is much lower than the site density in the coastal *kula* and lower *kaluʻulu* regions of the KFS. The pre-Contact traditional Hawaiian settlement and agricultural patterns are strongly oriented to the *kula* and lower *kaluʻulu* regions.

Even though cattle ranching and commercial agriculture may have removed some archaeological sites from the ground surface in the *kaluʻulu* region, there appear to be fewer sites than at lower elevations. The majority of sites in the *kaluʻulu* region are KFS agricultural sites including rock clearing mounds, modified outcrops, garden enclosures, and low garden walls. Within the lands of the current project, it is clear that ranching and commercial agricultural practices have removed and damaged many of the pre-Contact era sites from the ground surface (see the Hammatt et al. 1992 summary below). Moreover, many of the sites identified near the current project area are associated with Historic era ranching and commercial agriculture.

A second conclusion is that the establishment of Historic era homesteads, ranches, and commercial agriculture seems to have removed, or obscured, the majority of pre-Contact era sites in the upper *kaluʻulu* and lower *ʻāpaʻa* regions. It might be that pre-Contact uses in these regions did not involve the construction of large or permanent features, as in the lower regions of Kona. It is also likely that Historic era ranching and commercial agriculture in the lower *ʻāpaʻa* region have caused large scale land alterations through the use of bulldozers for pasture and garden. It is possible that traditional features were disassembled to build rock walls and coffee terraces.

CURRENT PROJECT AREA SPECIFIC PREVIOUS ARCHAEOLOGY

26. Hammatt et al. 1992. Lands of the current AIS study were subject to an AIS study conducted by Hammatt et al. (1992). That study encompassed 66.039 acres of land within the current project area located between 320 to 690 feet (98 to 210 meters) amsl [TMK: (3) 7-6-021:016 and 017] (see Figure 9, Project #17). The current project area is located within the northern portion of the Hammatt et al. (1992) project area.

Twenty one archaeological sites and two areas of bulldozed modern planting "terraces" were recorded in the AIS report (Figure 10 and Table 3). Eight of the 21 archaeological sites (SIHP #50-10-37-10015, #50-10-37-10017, #50-10-37-10018, #50-10-37-10020, #50-10-37-10031, #50-10-37-10033, #50-10-37-10034, and #50-10-37-10049, hereafter abbreviated to the last five digits) were recorded by CSH in tabular format only. Written descriptions of the remaining 13 sites are in the CSH AIS report. Excavations were conducted at ten of the 13 sites. The AIS report included plan view figures for four of the 13 sites. At the request of SHPD, additional site documentation for Sites 10011, 10012, 10031, 10049, and 10071 was submitted to SHPD in a letter report (Hammatt and Shideler 2007).

Six of the sites were determined to be pre-Contact era, four associated with habitation, one with agriculture, and one single feature site (Site 10012) contained two burials. Fifteen of the sites were determined to be Historic era sites, the majority associated with coffee agriculture and cattle ranching. Two Historic era habitation sites were also documented in the AIS study.

The burials at Site 10012 were removed and reinterred off-project prior to 1983. The site was further excavated to ensure that all *iwi* had been removed. The site was then back-filled and leveled by bulldozer.

The AIS recommended no further work at all 21 sites documented in the current project area. The Hammatt and Shideler (2007) letter report repeated the AIS recommendation that "all surface sites in the area were documented" in the AIS report and that "significant material from the study area has been recovered and that further investigation would be of minimum productivity" (Hammatt and Shideler 2007:11). However, the authors recommended that the sites should be located to document their current conditions and to document the sites to prevailing SHPD AIS standards.

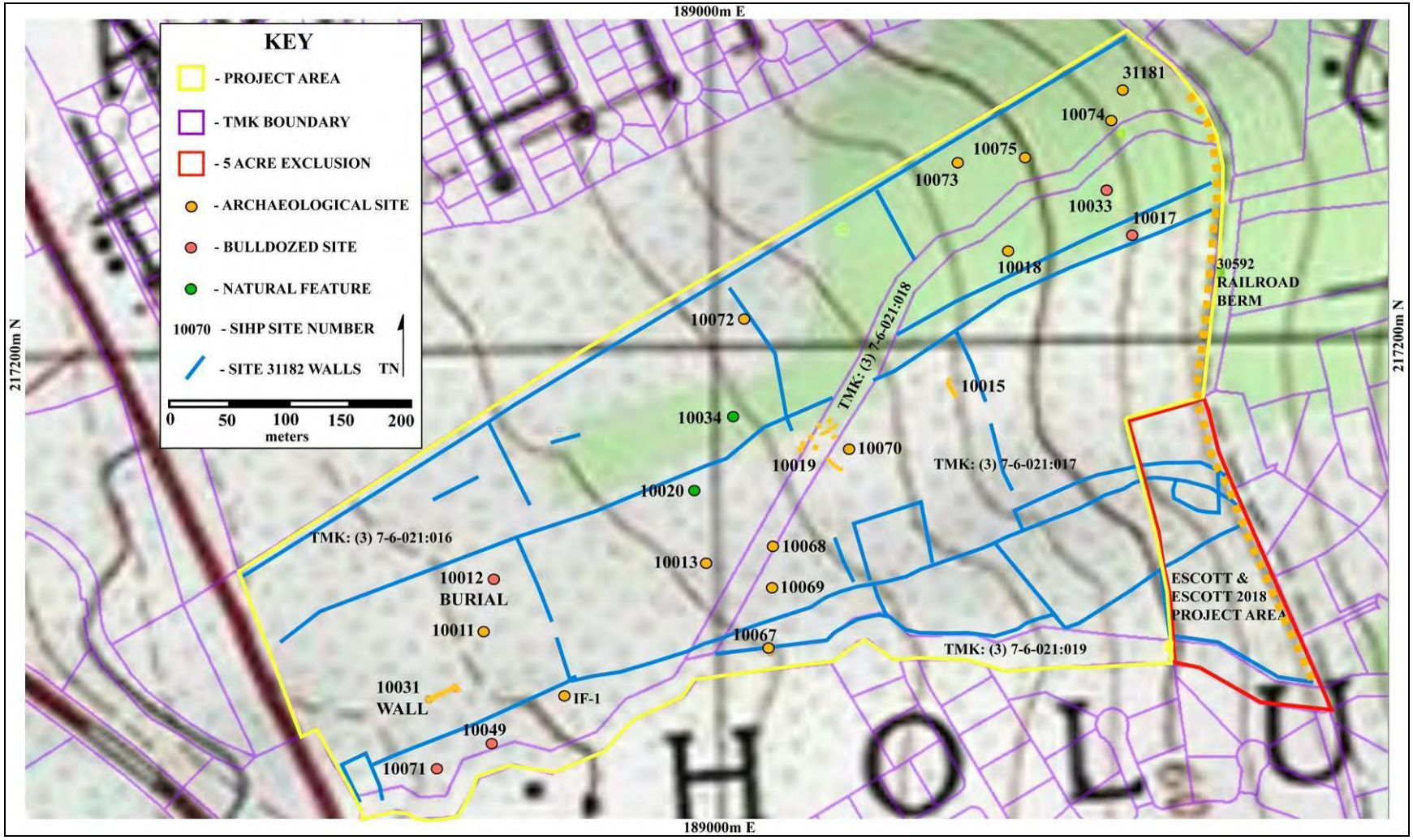

Figure 10: 7.5-Minute Series USGS Topographic Map Showing Location of Northern Portion of Hammatt et al. (1992) Sites and Current Project Area (ESRI, 2011. Sources: National Geographic Society, USGS. Kealakekua Quadrangle).

Table 3: Inventory of Previously Recorded Archaeological Sites (Hammatt et al. 1992; Hammatt and Shideler 2007).

SIHP #	CSH SITE#	TYPE	FUNCTION	AGE	EXCAVATION	CULTURAL MATERIAL
10011	9	Platform	Ag. Clearing	Prehistoric	1.5 m long trench	3 cowrie shells
10012	10	Platform & Wall	Burial	Prehistoric	Entire Feature	Burial reinterred off-project
10013	11	Enclosure & Lava Tube	Habitation	Prehistoric	4.5 m square total	Fire features & Prehistoric artifacts
10015	13	Terrace	Road Bed	Historic		
10017	15	Platform	Cattle Ramp	Historic		
10018	16	Enclosure	Habitation	Historic		
10019	17	6 Rock Mounds	Ag. Clearing	Historic	3 1.0 m wide trenches	Metal File
10020	18	Platform	Ag. Clearing	Historic		
10031	110	Enclosure Wall	Agriculture	Historic		
10033	112	Planting Complex	Coffee Ag	Historic		
10034	113	Platform	Ag. Clearing	Historic		
10049	216	Terraces	Agriculture	Historic		
10067	232	Terraces	Habitation	Prehistoric	1.0 X 1.0 m	VG & a small amount of midden & fire feature
10068	233	Enclosure	Habitation	Prehistoric	0.5 X 0.25 m	small amount of midden
10069	234	Modified Bluff/Platform	Habitation	Historic	0.5 X 0.5 m	VG & a small amount of midden
10070	235	U-Shape Enclosure	Agriculture	Historic	1.0 X 0.5 m	No artifacts
10071	237	Platform	Habitation	Prehistoric		
10072	238	Modified Bluff	Ag. Clearing	Historic	7.0 m square total	No arts Small amount of MS in TU-2
10073	239	Platforms	Ranching/Ag.	Historic		
10074	240	Enclosure	Coffee Work Shed	Historic	1.25 m square total	1 VG, little MS, historic artifacts
10075	241	Enclosure	Pig Pen	Historic		

In a letter to the County of Hawai‘i Department of Planning dated July 30, 2018, (Log. No. 2018.00878 Doc. No. 1807SN01), SHPD requested a new pedestrian survey to identify all archaeological historic properties present on the project area, and to update previous archaeological documentation to include site plans for each site with site boundaries and areas impacted by bulldozing, photographs of all sites and features, an assessment of their integrity, and site significance.

25. Escott & Escott 2018. SCS conducted an archaeological inventory survey on a 5.0-acre portion of Parcel 017 in the southeast portion of the current project area (Escott and Escott 2018) and recorded twenty-two new archaeological sites within the project area (Table 4 and Figure 11). Fifteen of the sites are single-feature sites. The remaining seven agricultural sites contained two to seven features. A majority of the sites are agricultural terraces and complexes dating to the pre-Contact era to the Historic era. The agricultural complexes are located in the lower *kalu‘ulu* zone, between 600 and 700 feet (182 to 213 meters) amsl.

Three of the ranch walls (Site 30595, 30601, and 3065) are the primary dividers of the five-acre project area. These Historic era walls have typical characteristics of ranch walls including cobble core fill and bi-faced inward sloping walls toward the top. They are approximately 1.0 meter tall. Site 30602 and Site 30603 are Historic era ranching and agricultural enclosures constructed along wall Site 30595 and wall Site 30601. These two wall sites are constructed onto the west edge of the Site 30592 railroad berm and post-date the railroad berm.

The northern third of the project area only has two sites (Site 30591 and 30956). Site 30591 is an agricultural complex with six terraces. Portions of the sites were bulldozed in the early Modern era. Both sites date to pre-Contact to early Historic era. The terraces reflect Kona Field System features but are roughly constructed that more closely resemble Historic era commercial agriculture. Site 30956 is a rectangular Historic style hearth.

The middle one third of the project area between wall sites 30595 and 30605 is within the bulldozed “terraces” portion of the project area. Site 30593 is a pre-Contact era to early post-Contact era lava tube burial. The burial will be preserved in place in accordance with a Burial Site Component of a Preservation Plan. Site 30594 is an

agricultural terrace complex that resembles the Kona Field System but is more roughly constructed. Artifacts recovered from subsurface testing at Site 30604 suggest it is a Historic era agricultural terrace.

The southern third of the project area, south of wall Site 30605, contained six primarily agricultural sites (Site 30598, 30600, 30606, 30607, 30610, and 30611) and four Historic era sites (Site 30599, 30608, 30609, and 30612) with functions other than agriculture. The agricultural features included rock walls (Site 30598 and30606), terraces (Site 30600 and 30610), and agricultural complexes with terraces (Site 30607 and 30610). The non-agricultural features included three enclosures (Site 30599, 30608, and 30609), and a refuse disposal area lava blister (Site 30612). The cluster of these sites indicates their use for Historic era commercial agriculture.

Twenty-nine shovel probes and two excavation units tested the sites. Marine shell fragments, a basalt flake and volcanic-glass flakes recovered during testing indicate that Hawaiians likely used the area for limited agricultural purposes. However, the agricultural terraces more closely resemble the remains of Historic era commercial agriculture.

All 22 sites identified during the current AIS study were assessed significant under criterion "d" as they are likely to yield information important to history. The railroad berm is also significant under criteria "a" and "c" as it is associated with events that have made a significant contribution to the broad patterns of our history and it embodies distinctive characteristics of the type, period, and method of railroad bed construction. The railroad berm was recommended for preservation with preservation measures outlined in an archaeological preservation plan (Escott and Mello 2019b). The rest of the sites require no further work.

The burial is also significant under criterion "e" as it has important value to Hawaiian people and people of other ethnic backgrounds in the state. The burial was recommended for preservation in place with preservation treatments outlined in a Burial Site Component of a Preservation Plan (Escott and Mello 2019a).

Table 4: Inventory of Archaeological Sites Identified on the AIS Project Area (Escott and Escott 2018).

Site #	Site Type	Features	Site Function	Age	Testing
30591	Agricultural Complex	6	Agriculture	Pre-Contact to Historic Era	SP-1, 2, 3
30592	Railroad Bed and Berm	1	Transportation	Historic Era	
30593	Lava Tube Burial	1	Burial	Pre-Contact to Early Post-Contact Era	
30594	Agricultural Complex	6	Agriculture	Pre-Contact to Historic Era	SP-1 & 2
30595	Rock Wall	1	Ranching	Historic Era	
30596	Hearth	1	Food Preparation	Historic Era	TU-1
30597	Rock Wall	1	Ranching	Historic Era	
30598	Rock Wall	1	Agriculture/Ranching	Pre-Contact to Historic Era	
30599	Platform & Enclosure	2	Ranching/Agriculture	Historic Era	SP-1 & 2, TU-1
30600	Terrace	1	Agriculture	Historic Era	SP-1
30601	Rock Wall	1	Ranching	Historic Era	
30602	Enclosure	1	Ranching/Agriculture	Historic Era	SP-1, 2, 3 & 4
30603	Enclosure	4	Ranching/Agriculture	Historic Era	SP-1 & 2
30604	Agricultural Complex	4	Agriculture	Pre-Contact to Historic Era	SP-1
30605	Rock Wall	1	Ranching/Agriculture	Historic Era	
30606	Rock Wall	1	Ranching/Agriculture	Pre-Contact to Historic Era	
30607	Agricultural Complex	7	Agriculture	Pre-Contact to Historic Era	SP-1 to SP-10
30608	Enclosure	1	Structure	Historic Era	
30609	Enclosure	1	Structure	Historic Era	
30610	Terrace	1	Agriculture	Pre-Contact to Historic Era	SP-1
30611	Agricultural Complex	3	Agriculture	Pre-Contact to Historic Era	SP-1, 2, 3
30612	Lava Blister	1	Refuse Dump	Historic Era	

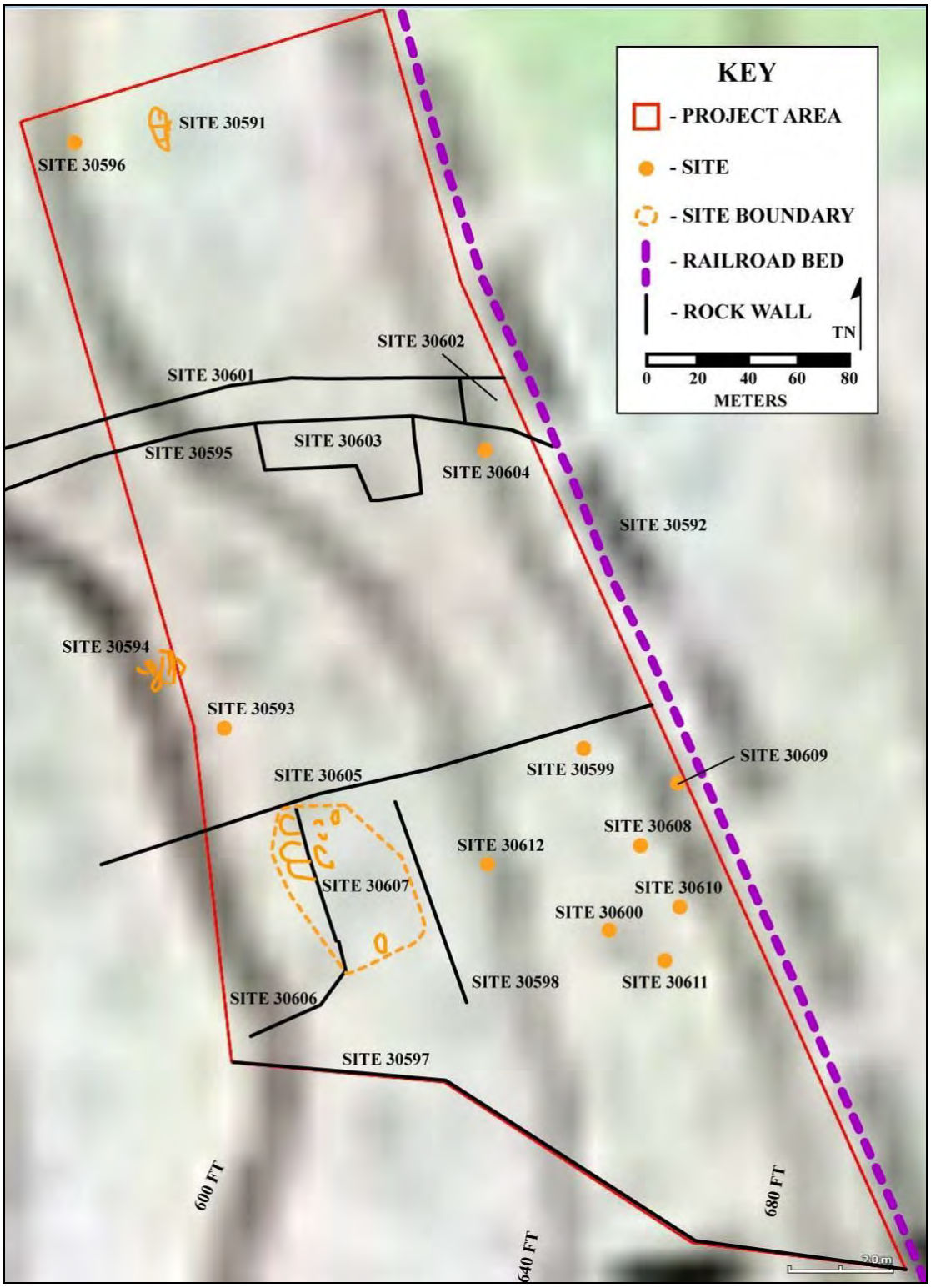

Figure 11: 7.5-Minute Series USGS Topographic Map Showing Locations of Escott and Escott (2018) AIS Project Area Archaeological Sites (ESRI, 2011. Sources: National Geographic Society, USGS. Kealakekua Quadrangle).

26. Escott & Escott 2020. SCS conducted an archaeological inventory survey on a 73.122-acre portion of the current project area in Parcel 016, 017 (por.), 018, and 019 to identify all archaeological historic properties present on the project area, and to update previous archaeological documentation (see Figure 10).

Seventeen of the twenty-one sites previously identified in Hammatt et al. (1992) were located during the course of the archaeological inventory survey study (Figure 10 and Table 5). Two of the previously documented sites (Site 10020 and Site 10034) relocated by SCS are natural bedrock outcrops and one site former burial site (Site 10012). The burials at Site 10012 were reinterred off-project in 1983.

The four remaining previously documented sites (Sites 10017, 10033, 10049, and 10071) were bulldozed prior to the SCS fieldwork and the remains of the sites are no longer present on the ground surface. Three previously undocumented sites were also recorded, including a portion of the railroad berm (Site 30592), a small coffee shed enclosure (Site 31181), and several ranch walls (Site 31182). A single petroglyph on a loose cobble was recorded as Isolated Find 1 (IF-1).

A total of 21 sites, 17 previously documented and four newly documented, were identified on the project area and are documented in this report. Two of the sites (Site 10020 and Site 10034) were determined to be natural geological features. Six of the sites were determined to be pre-Contact era, three associated with habitation, one with agriculture, a single petroglyph site, and one single feature site (Site 10012) formerly contained two burials. Twelve of the sites were determined to be Historic era sites, the majority associated with coffee agriculture and cattle ranching. Two Historic era habitation sites were also documented in the AIS study. One site (Site 10015) was determined to be a short segment of modern bulldozer road.

The burials at Site 10012 were removed and reinterred off-project prior to 1983. The site was further excavated to ensure that all *iwi* had been removed. The site was then back-filled and leveled by bulldozer.

Table 5: Inventory of Escott & Escott (2020) Archaeological Sites.

SIHP#	TYPE	FUNCTION	AGE
10011	Platform	Ag. Clearing	Pre-Contact
10012	Platform & Wall	Burial	Pre-Contact
10013	Enclosure & Lava Tube	Habitation	Pre-Contact
10015	Bulldozer Road	Transportation	Modern
10017	Platform	Cattle Ramp	Historic
10018	Enclosure	Agricultural	Historic
10019	6 Rock Mounds	Ag. Clearing	Historic
10020	Bedrock Outcrop	Geological Feature	Natural
10031	Enclosure Wall	Agriculture	Historic
10033	Planting Complex	Coffee Ag	Historic
10034	Bedrock Outcrop	Geological Feature	Natural
10049	Terraces	Agriculture	Historic
10067	Terraces	Habitation	Pre-Contact
10068	Enclosure	Habitation	Pre-Contact
10069	Modified Bluff/Platform	Habitation	Historic
10070	U-Shape Enclosure	Agriculture	Historic
10071	Platform	Habitation	Pre-Contact
10072	Complex	Ag. Clearing	Pre-Contact
10073	Platforms	Ranching/Ag.	Historic
10074	Enclosure	Coffee Work Shed	Historic
10075	Enclosure	Pig Pen	Historic
30592	Railroad Berm	Transportation	Historic
31181	Enclosure	Coffee Work Shed	Historic
31182	Rock Walls	Ranching & Agri	Historic
IF-1	Petroglyph	Marker	Pre-Contact

AIS SIGNIFICANCE ASSESSMENTS

All sites identified during the Escott and Escott (2018) and Escott and Escott (2020) AIS studies were assessed as significant under criterion "d" as they are likely to yield information important to history. The railroad berm is also significant under criteria "a" and "c" as it is associated with events that have made a significant contribution to the broad patterns of our history and it embodies distinctive characteristics of the type, period, and method of railroad bed construction. The railroad berm was recommended for preservation. The petroglyph (IF-1) is recommended for preservation in a safe location on the project area, preferably within the Site 30592 railroad berm preservation area.

Burial Site 30593 is also significant under criterion "e" as it has important value to Hawaiian people and people of other ethnic backgrounds in the state. The burial is recommended for preservation in place with preservation treatments outlined in the SHPD-approved burial site component of a burial treatment plan (Escott and Mello 2019). The remaining sites are recommended for no further work. Site 30592 is summarized below from Escott and Escott (2018:53-54).

SITE 30592	**RAILROAD BERM**
FUNCTION:	Transportation
AGE:	Historic Era
DIMENSIONS:	300.0 m long (N/S) by 4.0 m wide max. by 5.0 m max. height
CONDITION:	Good
INTEGRITY:	Unaltered: retains integrity of location, setting, materials, and workmanship
SURFACE ARTIFACTS:	Modern Trash Debris
EXCAVATION:	None

DESCRIPTION: Site 30592 is an Historic era railroad berm located between 680 m and 690 m amsl along the eastern boundary of the project area (see Figure 8). The railroad berm is approximately 300.0 m in length (SE/NW) and 4.0 m wide by a maximum of 5.0 m in height. The railroad bed is a level dirt and rock surface, and the berm is located along the west side of the railroad bed.

The southern portion of the berm retaining wall is constructed of small boulders and large cobbles stacked up to nine courses high (Figure 9 and Figure 10). The berm is well faced with fairly tightly fitted natural rock. The rock has not been worked prior to stacking. The berm face slopes slightly toward the east as it approaches the top to prevent collapse.

The southern portion of the railroad bed top surface has been bulldozed in the fairly recent past, likely during construction of the homes along the east edge of the project area property. Portions of the berm are partially collapsed. There is a fair amount of modern construction debris and refuse along the southern course of the railroad bed.

The northern portion of the railroad berm retaining wall is constructed of small boulders and large cobbles stacked up to nine courses high (Figure 12 and Figure 13). The berm is well faced with fairly tightly fitted natural rock. The rock has not been worked prior to stacking. The berm face slopes slightly toward the east as it approaches the top to prevent collapse.

Figure 12: Photograph of Site 30592 Railroad Berm Rail Bed, Looking South (25 cm scale).

Figure 13: Photograph of Site 30592 Railroad Berm Retaining Wall, Looking Southeast.

The retaining wall is approximately 5.0 m high and is constructed of fifteen courses of large basalt cobbles and small boulders. The north end of the berm has been bulldozed roughly 60.0 m south of the northeast corner of the project area. Site 30592 appears to be unaltered and is in good condition. Only the north end of the railroad berm has been altered by bulldozing. Site 30592 will be preserved under significance Criteria a, c, and d.

SITES #50-10-37-30592 PRESERVATION TREATMENTS

The former Kona Sugar Company railroad bed and berm (Site 30592) is a long linear feature extending across the eastern boundary of Parcel 016 and Parcel 017. Preservation at Site 30592 consists of avoidance and protection (conservation) per HAR §13-277-3(1). The majority of the feature will be preserved with the proviso that it may be breached for purposes of access.

Short-Term Preservation Measures

In the event of land disturbance or construction in the area of Site 30592 using heavy earthmoving equipment, a buffer will be established at twenty feet from the western perimeter of the railroad berm (Figure 14 and Figure 15). The twenty-foot buffer will be clearly marked with orange fencing. Any construction work using earthmoving equipment in close proximity to the twenty-foot buffer will require the presence of an archaeological monitor. No construction will take place between the railroad berm and the eastern property boundary. Any construction within 30 feet of the railroad bed and berm shall be monitored by a qualified archaeologist familiar with Site 30592 and previous archaeological studies conducted on the property.

Long-Term Preservation Measures

A permanent preservation buffer will be established twenty feet from the western perimeter of Site 30592 (see Figure 14 and Figure 15). Native ornamental plants may be used to mark the twenty-foot preservation buffer. No use of heavy earthmoving equipment will be allowed within the twenty foot buffer. Hand-tools only shall be permitted within the twenty-foot permanent preservation buffer.

Bureau of Conveyances

Subsequent to final approval by SHPD of this Preservation Plan, a metes and bounds description of the burial and archaeological preservation sites, and permanent preservation easements shall be surveyed and recorded with the State of Hawai‘i Bureau of Conveyances in conformance with HAR §13-300-38(g). The TMK plat map will include a map of the preservation area.

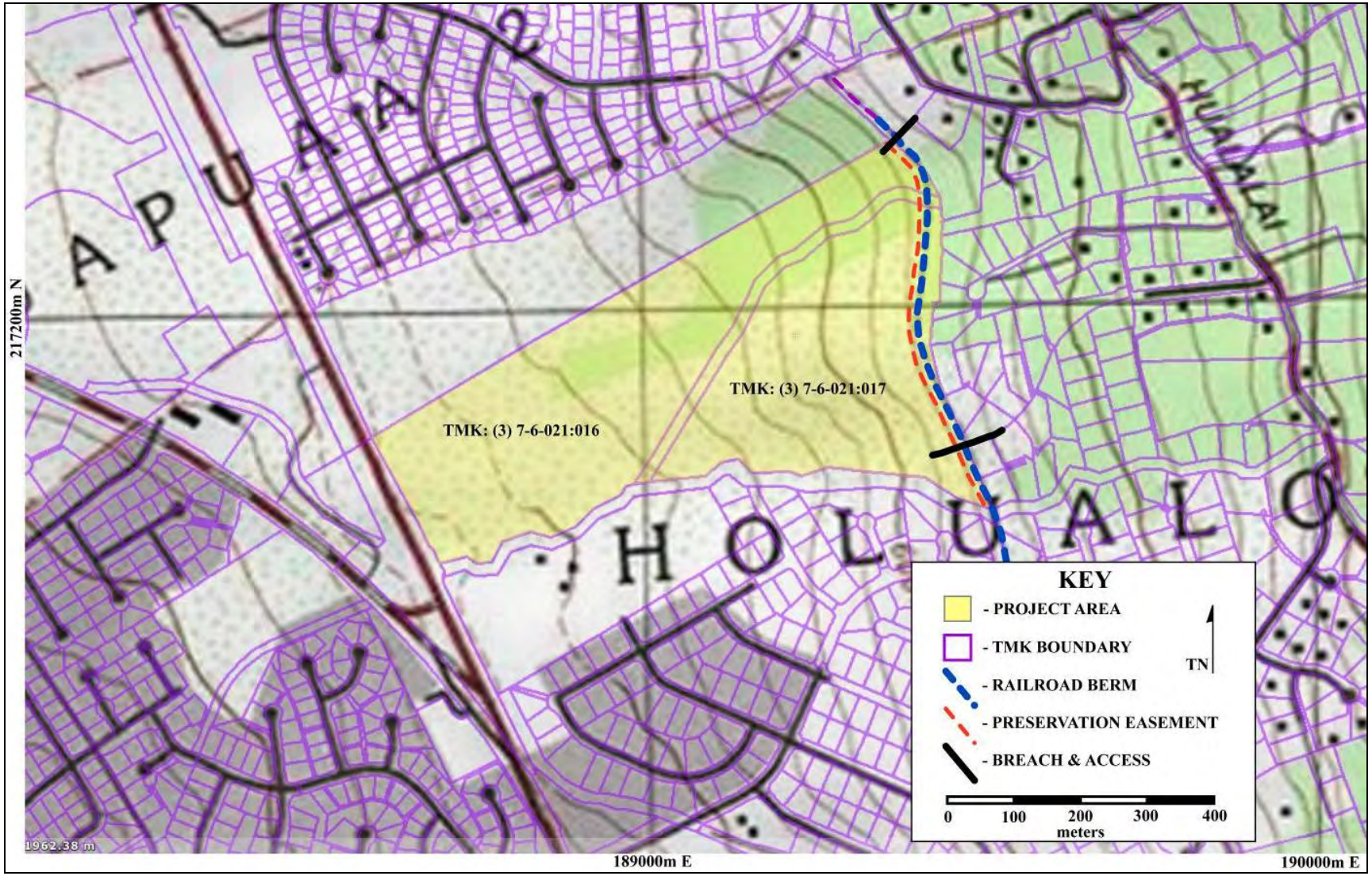

Figure 14: 7.5-Minute Series USGS Topographic Map (Kauluoa and Puu Pohakuloa Quads) Showing Location of Project Area, Archaeological Sites and Preservation Easements (ESRI 2013. Data Sources: NASA, NGS and USGS).

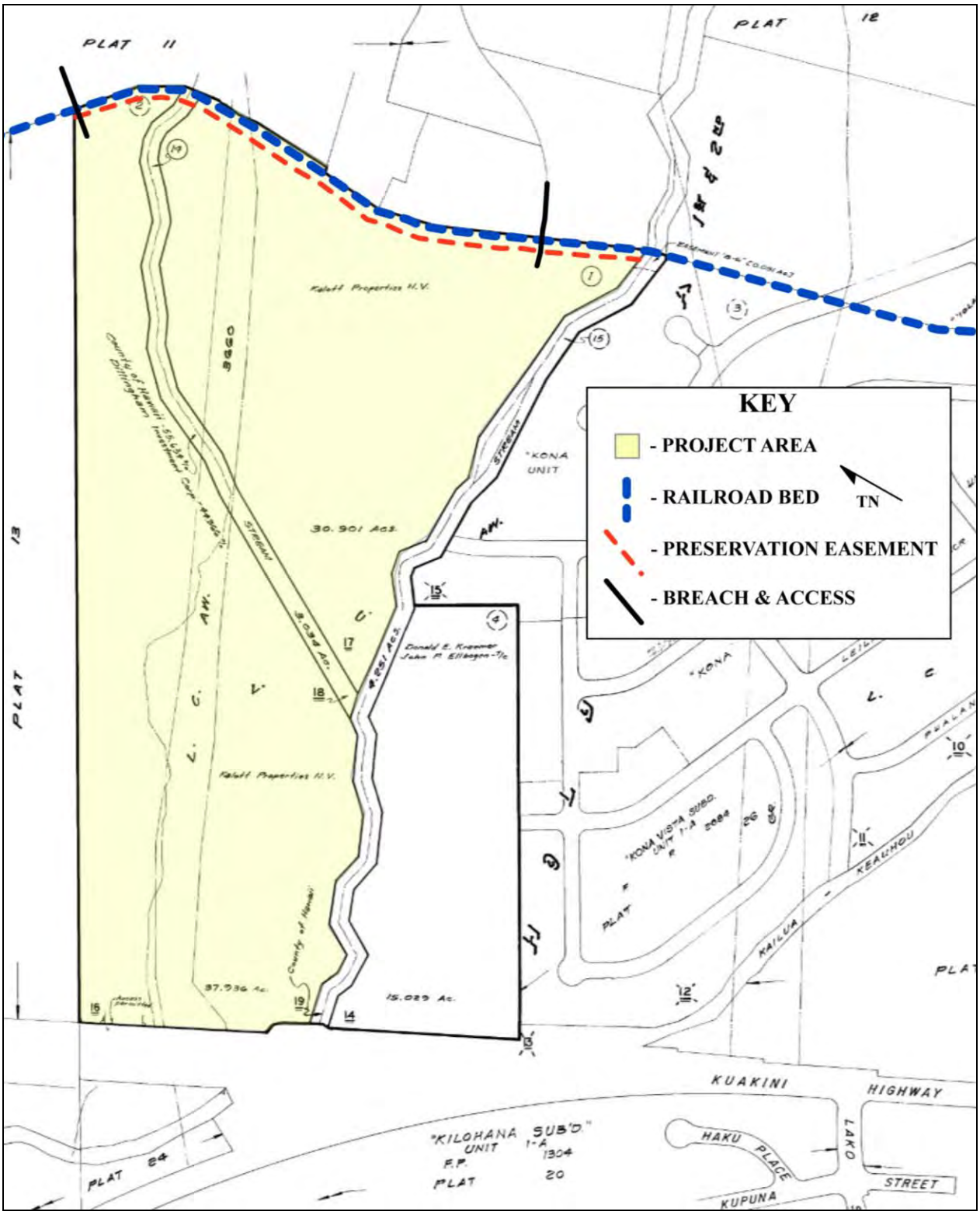

Figure 15: Portion of TMK: (3) 7-6-021 Map Showing the Locations of Site 30592, Preservation and Access Easements, and Access Breach.

Property Title

The details of this preservation plan and its preservation measures shall become a matter of record with the parcel title. The descriptions of the preservation easements will be added to the title, including the specific requirements and restrictions related to physical improvements, signage, maintenance and access.

Access

Pedestrian access to Site 30592 shall be from Io Place located east of the site (see Figure 12 to Figure 15). Parking is available on Io Place. The property owner is responsible for ensuring the access easement is usable for pedestrian travel, and is responsible for keeping the access easement clear and open. Access will be permitted seven days a week, one-half hour before sunrise to one-half hour after sunset. Access can be arranged by calling the property owner.

Signage

Weather-resistant signs, approximately 18 by 24 inches in size, shall be placed at the railroad bed at the end of Io Place. The signs shall read:

Kona Sugar Company Railroad Preserve
This site is historically significant.
Historic sites are protected under state law.
Violation could result in a $20,000 fine.
(Chapter 6E-11, Hawai‘i Revised Statutes)
DLNR-SHPD (808) 692-8015

Maintenance

The landowner is responsible for maintenance of the preservation easement, access path, signage, vegetation clearing, and general appearance of the preservation area.

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APPENDIX A: SHPD AIS APPROVAL LETTER

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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
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May 31, 2018

IN REPLY REFER TO:
Log No. 2018.01123
Doc. No. 1805SN05
Archaeology

Rick Wheelock
181 Kalaniana‘ole Street
Hilo, Hawai‘i 96720
Email: richardeastwestrealty.org

Dear Mr. Wheelock:

SUBJECT: **Chapter 6E-42 Historic Preservation Review –**
Archeological Inventory Survey of 5.0 Acres in Hōlualoa
Hōlualoa 1st Ahupua‘a, North Kona District, Island of Hawai‘i
TMK: (3) 7-6-021:017 por.

This letter provides the State Historic Preservation Division's (SHPD's) review of the revised report titled *Archaeological Inventory Survey Report for 5.0 Acres Located in Hōlualoa 1st Ahupua‘a, North Kona, Hawai‘i Island, Hawai‘i [TMK: (3) 7-6-021:017 por.]* (Escott and Escott, revised May 2018). Revisions to the report were requested via email on May 13, 2018 (Susan Lebo [SHPD] to Glenn Escott [Scientific Consultant Services, Inc. (SCS)]) and SHPD received the revised report on May 18, 2017.

SCS conducted the archaeological inventory survey (AIS) at the request of the landowner, Kona Three, LLC. The AIS was conducted in support of a County of Hawaii permit application for proposed development of the property. The AIS covered a 5.0-acre portion of the 30.901-acre parcel. The fieldwork included a 100% pedestrian survey of the entire project area. Ground visibility was fair to poor. Subsurface testing was conducted at several features.

The AIS documented twenty-two newly identified historic properties (Table 1). The sites include a pre- and/or early post-Contact lava tube burial, pre- and/or early post-Contact agricultural terraces, and post-Contact walls and enclosures associated with agriculture and/or ranching, and a post-Contact railroad berm.

Table 1. Summary of Sites Documented in AIS

Site #50-10-37-	Type	Function	Age
30591	Agricultural Complex	Agriculture	Pre- to Post-Contact
30592	Railroad and Berm	Transportation	Historic
30593	Lava Tube	Burial	Pre- to Early Post-Contact
30594	Agricultural Complex	Agriculture	Pre- to Post-Contact
30595	Rock Wall	Ranching	Historic
30596	Possible Hearth	Food Preparation	Historic
30597	Rock Wall	Ranching	Historic
30598	Rock Wall	Agriculture/Ranching	Pre- to Post-Contact
30599	Platform & Enclosure	Ranching/Agriculture	Historic
30600	Terrace	Agriculture	Historic
30601	Rock Wall	Ranching	Historic
30602	Enclosure	Ranching/Agriculture	Historic
30603	Enclosure	Ranching/Agriculture	Historic

Site #50-10-37-	Type	Function	Age
30604	Agricultural Complex	Agriculture	Pre- to Post-Contact a
30605	Rock Wall	Ranching/Agriculture	Pre- to Post-Contact
30606	Rock Wall	Ranching/Agriculture	Pre- to Post-Contact
30607	Agricultural Complex	Agriculture	Pre- to Post-Contact
30608	Enclosure	Dwelling and Storage	Historic
30609	Enclosure	Dwelling and Storage	Historic
30610	Terrace	Agriculture	Pre- to Post-Contact
30611	Agricultural Complex	Agriculture	Pre- to Post-Contact
30612	Lava Blister	Refuse Dump	Historic

The 22 sites were assessed as significant under HAR §13-284-6 Criterion d. Site 30592 (railroad berm) was also assessed as significant under Criteria a and c and was recommended for preservation. Site 30593 (lava tube burial) was assessed as significant under Criterion e and was recommended for preservation. Preservation measures will be outlined in Burial Treatment Plan. The AIS report recommends no further archaeological work for the Site 30591 and for Sites 30594 through 30612. Sufficient information has been collected for these sites to adequately provide information on their age and function.

Based on the above information, SHPD's determination is "effect, with agreed-upon mitigation". SHPD concurs with the significance and treatment recommendations.

The report meets the requirements specified in HAR §13-276-5. **The report is accepted**. Please send two hard copies of the document, clearly marked FINAL, along with a copy of this review letter and a text-searchable PDF version to the Kapolei SHPD office, attention SHPD Library (Helen.W.Smith@hawaii.gov).

As stipulated in HAR §13-284-7, when SHPD comments that a project will result in "effect with agreed-upon mitigation commitments", then detailed mitigation plans shall be developed for SHPD review and acceptance prior to project initiation. The agreed upon mitigation commitments are preservation and archaeological monitoring.

Pursuant to HAR §13-284-8, **SHPD looks forward to receiving** a burial treatment plan for Site 30593, an archaeological preservation plan meeting the requirements of HAR 13-279-4 for Site 30592, and an archaeological monitoring plan meeting the requirements of HAR §13-279-4, prior to any County permit issuance.

SHPD shall notify the County when our office has reviewed and accepted the archaeological preservation plan and the archaeological monitoring plan, and the interim preservation and the burial treatment measures have been implemented, and the permit application has been reviewed, and permit issuance may occur.

Please contact Sean Nāleimaile at (808) 933-7651 or at Sean.P.Naleimaile@hawaii.gov if you have any questions or concerns regarding this letter.

Aloha,

Susan A. Lebo

Susan A. Lebo, PhD
Archaeology Branch Chief

cc. Glenn Escott, SCS, ggescott@yahoo.com